GLOBAL REVIEW OF WETLAND RESOURCES AND PRIORITIES FOR WETLAND INVENTORY

(eds CM Finlayson & AG Spiers)

CONTENTS

Preface

This review was undertaken by four small teams on four continents. Through the adoption of common procedures and reporting formats we have been able to assemble an international overview of the extent of wetland inventory information in each of the seven Ramsar administrative regions plus a further continental-scale review. A workshop was used to draw out the truly global lessons and recommendations and these are presented separately from the regional reports.

An inventory database and bibliography accompanied each of the regional reviews and the continental review. These are presented on the CD-ROM version of this report along with the various reviews, an introductory and a summary paper. The hardcopy version of the report does not contain the databases or bibliography.

In conducting this review, the four teams worked towards a common goal, but with different approaches and resource levels relative to the real costs. Thus, whilst similar sums of money were assigned to each team it was acknowledged from the outset that the financial terms did not necessarily reflect the costs that would be incurred by each. This was reflected in terms of labour and communication costs which, in turn, were influenced by the extent of existing support services. Further, the overall budget for the project was considered to be a minimum required for addressing the ambitious terms of reference.

Staff from Wetlands International–Africa, Europe, Middle East in the Netherlands and those from the Environmental Research Institute of the Supervising Scientist in Australia were fortuitously able to link their reviews with other related projects, thereby extending the effort and output from each. The reports received from the various teams contracted to undertake these reviews reflect this difference.

Nevertheless, we believe the outputs and recommendations from this review provide an exciting opportunity for the global community to address the problems and inadequacies of the current global inventory resource, and take up the challenge of improving wetland inventory and management into the 21st Century.

Max Finlayson & Abbie Spiers

ERRATA

Summary Report
[http://www.wetlands.agro.nl/wetland_inventory/GRoWi_2nd_edn/summary.doc]; Page 3:

- The total wetland area estimate figure cited for Eastern Europe should have been 225 849 930 ha (instead of 229 217 000 ha).

Review of wetland inventory information in Eastern Europe
[http://www.wetlands.agro.nl/wetland_inventory/GRoWi_2nd_edn/report_easterneurope.doc] Pages 12, 16:

- The total wetland area estimate figure cited for Eastern Europe should have been 225 849 930 ha (instead of 229 217 000 ha
or alternatively, instead of 229 216 972 ha).

Page 15:

- The total wetland area estimate figure cited for Estonia should have been 1,198,830 ha (instead of 4,543,700 ha).

Page 45 (Estonia wetland coverage estimate spreadsheet replica):

- Reference code 103: the area estimate derived for this reference should have been 218,681 ha (instead of 646,851 ha).
- Reference code 504: the area estimate derived for this reference should have been 1,181,730 ha (instead of 4,521,500 ha).
- Reference code 117: the area estimate derived for this reference should have been 17,100 ha (instead of 22,200 ha).
- The total wetland area estimate figure cited for Estonia should have been 1,198,830 ha (instead of 4,543,700 ha).

Eastern Europe database (dbase_eeur.mdb) accessible from
http://www.wetlands.agro.nl/wetland_inventory/GRoWi_2nd_edn/dbase_list.html:

- ORDER=103: the field WETLAND_HA should contain the value 218,681 [ha] (instead of 646,851 [ha]).
- ORDER=504: the field AREA_CATEG should use the area figure 994,730 ha for mires (instead of 4,521,500 ha).

Review of wetland inventory information in Africa
[http://www.wetlands.agro.nl/wetland_inventory/GRoWi_2nd_edn/report_africa.doc] Pages 1, 5:

- Somalia appeared twice in tables 1.1 and 2.1, respectively. [The duplicate has been removed in this on-line edition].

Page 15:

- Table 3.1 -- # of national datasets which can be regarded as comprehensive in cover should have been 33 (NOT 35)
[This has been corrected in this on-line edition].
- Table 3.2 -- # of countries should have been 54 (NOT 55)
[This has been corrected in this on-line edition].

Page 19:

- Table 3.4 -- The entry for area of Marine&Coastal wetland types for Namibia contained an extraneous "0".
  [This cosmetic error has been corrected in this on-line edition]

Page 28:

- The sentence: "In the Africa region, only 27 out of the 55 countries ..." was incorrect.
  It should have read:
  "In the Africa region, only 27 out of the 54 countries ..."
  [This has been corrected in this on-line edition].
- The sentence: "There are only 74 Ramsar sites distributed through 55 countries ..." was incorrect.
  It should have read: "There are only 74 Ramsar sites distributed through 54 countries ..."
  [This has been corrected in this on-line edition].

Global review of wetland resources and priorities for wetland inventory

Summary Report

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Contents

Acknowledgments

This review was undertaken by Wetlands International and the Environmental Research Institute of the Supervising Scientist (***eriss***), Australia, under contract to the Bureau of the Ramsar Wetlands Convention and with financial support from the United Kingdom Government. It was undertaken by a team that included personnel based in Australia, Canada, Malaysia and the Netherlands with support from colleagues spread around the globe and an international steering committee. The European team was also supported by project funding from the Institute for Inland Water Management and Waste Water Treatment (RIZA) from the Netherlands and the Norwegian Agency for Development Cooperation (NORAD) from Norway. This summary was taken from the material supplied by this collective group. Individual reports and databases prepared for each of the Ramsar global regions will be published separately in hardcopy and CD-ROM formats.

Executive summary

This summary is based on reviews of the extent of wetland inventory in each Ramsar region. These were supplemented by a review of regional and international wetland inventories. Standardised data collation and recording formats were used in each of the reviews.

It is important to note that these reviews were limited by available funds and time, and that further effort will unearth more information.

It was not possible to make reliable overall estimates of the size of the wetland resource globally or regionally. Some good examples of wetland inventory processes exist (eg the MedWet program), but many inventories allowed only a cursory assessment of the extent of wetland area or condition. Whilst not undermining the value of individual inventories, this highlights wetland inventory as being incomplete and difficult to undertake.

Recommendations are made to improve the accuracy of quantifying and describing the wetland resource through wetland inventory, and to provide the basic information required for managing the wetland resource.

Recommendations focus on the need to conduct national inventory programs, and the inclusion of basic information on the location and extent of each wetland and its major ecological features as a forerunner to collecting further management-oriented information.

Development of standardised methods for data collection, collation and storage are called for. These methods should address the use of relatively new techniques for collecting and interpreting remotely-sensed data; storage in electronic formats, including Geographic Information Systems (GIS); and recording key information in a meta-database.

The key conclusion of this review is that little is still known about the extent and condition of the global wetland resource. On a regional basis, only parts of North America and Western Europe have adequate past and current inventory. Without good inventory it is difficult to promote the wise use of the wetland habitats covered by the Ramsar Convention.

Priority habitats for future inventory are identified. These are seagrasses, coral reefs, salt marshes and coastal flats, mangroves, arid-zone wetlands, peatlands, rivers and streams and artificial wetlands.

The Ramsar Convention should play a pivotal role in implementing these recommendations.

Recommendations

This review makes many critical comments on the state of global wetland inventory. In summary, global wetland inventory is incomplete and inadequate for most management purposes. From our many comments, eight are recommended for priority action. These reflect the effort required to implement an effective inventory program as the basis for wise use of the global wetland resource. Not all recommendations are, however, relevant to all geographic situations or inventory programs.

1. All countries lacking a national wetland inventory should undertake one, using an approach that is comparable with other wetland inventories and for which the Ramsar Convention should provide guidance (see below). These inventories are needed to underpin national planning, policy development and all efforts directed at wetland conservation and wise use promoted by the Ramsar Convention, and other related conventions. The inventories will assist in identifying wetlands of national and international importance, and through this to contribute to the Ramsar Convention achieving its vision for the List of Wetlands of International Importance (Ramsar COP7 Doc. 15.11 – Proposal No.11).

2. Quantitative studies of wetland loss and degradation are urgently required for much of Asia, Africa, South America, the Pacific Islands and Australia.

3. Further inventory should focus on a basic data set describing the location and size of each wetland, and its major biophysical features, including variations in area and the water regime. This information should be made available in both hardcopy and electronic formats.

4. After acquisition of the basic data, further information oriented to management on wetland threats and uses, land tenure and management regimes, benefits and values, should be collected. Source(s) of information should be clearly recorded along with comments on its accuracy and availability.

5. Each inventory should include a clear statement of its purpose and the range of information that has been collated or collected. This extends to defining the habitats covered and the date the information was obtained or updated.

6. The Ramsar Convention should support the development and dissemination of models for improved globally-applicable wetland inventory. These should be derived from existing models (for example the MedWet program) that are capable of using both remote sensing and ground techniques, as appropriate. Models should cover appropriate habitat classifications (eg those based on landform categories), information collation and storage, in particular Geographic Information Systems for spatial and temporal data that can be used for monitoring purposes.

7. The Ramsar Convention should support development of a central repository for both hardcopy and electronic inventories. The meta-data that describe the inventories should be published on the World Wide Web for greater accessibility.

8. Further support is required for completion of the global review of wetland resources and priorities for wetland inventory; and to develop procedures for regular updating and publishing of inventory information on the World Wide Web. Regular updating (eg in conjunction with the triennial national reporting to the Ramsar Convention) may require restructuring the format and style of the current databases and bibliographic materials supplied by this project.

1 Background and objectives

1. Knowing the location, distribution and character of wetlands, their values and uses, and the threats to them is an essential basis for developing and implementing management for their wise use. This is required at geographical scales ranging from local site management, through development of national policies to global priority setting.

2. Differences in the purpose and use of wetland inventories mean that the information that is collated is often not readily accessible for broader uses or users. Much of this information is scattered so it has not been clear where adequate inventory information exists, nor where the major gaps are.

3. Action 6.1.3 of the Ramsar Convention Strategic Plan 1997–2002 is to:

   > utilise information from regional wetland directories, national scientific inventories of wetlands and other sources, to begin development of a quantification of global wetlands resources, as baseline information for considering trends in wetland conservation or loss.

   A pledge of funding for this action was made by the United Kingdom Government at the 6th Conference of the Contracting Parties of the Convention (Brisbane 1996) and resulted in this review.

4. There were three aims of the review:

   - To provide an overview of international, regional and national wetland inventories (including regional and national Directories of important wetlands) as well as other general information on global wetland resources from publications, Ramsar Convention literature, and information collected by other institutions doing work on the same or related subject(s).
   - To provide recommendations for how to proceed to meet the objective as set out in Action 6.1.3 of the Ramsar Convention Strategic Plan for the current data holdings identified through 1 above.
   - To identify the priorities for either establishing, updating or extending wetland inventories so as to improve the accuracy with which the global wetland resource can be quantified and described in future.

5. Wetlands International undertook the review during 1998 under a contract from the Ramsar Bureau. Collation and assessment work was undertaken through sub-contracts with Wetlands International's regional and sub-regional licensees and the Environmental Research Institute of the Supervising Scientist, Australia, supporting Wetlands International's Wetland Inventory and Monitoring Specialist Group. A steering committee comprised of representatives of the Ramsar Bureau, the Wetlands International licensees, the UK Government and invited experts was established to review progress and outputs.

6. Members of the steering committee and project teams met in a workshop held in association with the 2nd International Conference on Wetlands and Development in Dakar, Senegal, during November 1998, to review progress with the project reports.

7. As funding obtained was considered to be an absolute minimum for satisfactorily undertaking the project, it was linked to other Wetlands International work under the Biodiversity Conservation Information System (BCIS) initiative. The BCIS project is developing guidance for wetland assessment and inventory and proposals for developing

improved wetland inventory and assessment tools. Work in Wetlands International–Africa, Europe, Middle East was conducted jointly with another wetland inventory project in Europe. This contributed information to support the European component of the project and permitted completion of a more detailed compilation and analysis for the African and European Ramsar regions.

2 Methodology

8. Initial work focused on the development of definitions for inventory categories, the scope and procedures for identifying inventory sources, and for the compilation and handling of inventory information. This was essential to ensure that compilation and handling of information were consistent between regional teams. Three information handling tools were developed:

   - *Wetland inventory assessment sheet* – to permit rapid compilation and assessment of information on each wetland inventory.
   - *Wetland inventory assessment database* – to store the information compiled from the wetland inventory assessment sheet.
   - *Bibliographic database* – to compile details of inventory information that was in a report format, and to allow later searching.

9. These tools were used in reviews of the extent of inventory information available for each of the seven Ramsar regions – Africa, Asia, Eastern Europe, Neotropics, North America, Oceania and Western Europe. Regional reviews were based primarily on national inventories, although sub-national reviews were used where these covered a large area or a major administrative zone. The regional reviews were supplemented by a review of continental and global scale inventory sources. All reviews and their supporting databases are available as hardcopy and on CD-ROM. A summary only is presented here.

3 Results and conclusions

3.1 General information

10. Based on the reports for the seven Ramsar regions it is clear that the extent of global wetland inventory effort is patchy – it does not provide a comprehensive information base for the wise use and monitoring of wetlands. Of 206 countries or territories for which the state of inventory was assessed, only 7% have adequate or good national inventory coverage. Of the remainder, 69% have only partial coverage, and 24% have little or no national wetland inventory. Much information is outdated or incomplete and there is very little information on wetland assessment or values derived from wetlands. Thus we do not yet know globally what wetlands we have and how important they are, even as they are being degraded and lost.

11. Much of the inventory effort has not progressed beyond the collation of existing information. Further, such compilations often used differing sources of information without providing an indication of the age or reliability of the information, or even an adequate reference to the source material.

12. Except for a few imagery-based programs many inventories do not provide a basis for monitoring the status of wetlands. Even basic questions about wetland extent and

distribution are still not answered. This basic information is not readily available for much of Oceania, Asia, Africa, Eastern Europe and the Neotropics. Notable exceptions are provided by national inventory efforts in the USA and some Western European countries.

3.2 Extent and distribution of wetlands

13. Data on the extent and distribution of wetlands at various scales, from global estimates to the areal extent of particular wetland types at specific sites, were obtained. *However, there is considerable inconsistency in the information, with data unavailable for some sites or countries*.

14. Based on current information it is not possible to provide an acceptable figure of the areal extent of wetlands at a global scale. Firstly, there is little agreement on what constitutes a wetland. Secondly, there are many gaps and inaccuracies in the information. *Thus, the 'best' minimum global estimates provided below are indicative only:*

    - natural freshwater wetlands 570 000 000 ha
    - rice paddy 130 000 000 ha
    - mangroves 18 100 000 ha
    - coral reefs 30–60 000 000 ha

    On these figures the area of wetlands worldwide ranges from 748 100 000–778 100 000 ha, but this does not include many wetland types, such as saltmarshes and coastal flats, seagrass meadows, karsts and caves, and reservoirs. Previously published global estimates range from 560 000 000–970 000 000 ha.

15. Anything but a cursory consideration of the above values is immediately thrown into doubt when the regional minimum estimates for wetland area are considered:

    - Africa 121 322 000–124 686 000 ha
    - Asia 204 245 000 ha
    - Eastern Europe 229 217 000 ha
    - Neotropics 414 917 000 ha
    - North America 241 574 000 ha
    - Oceania 35 750 000 ha
    - Western Europe 28 822 000 ha

    These figures total 1 275 847 000–1 279 211 000 ha – well in excess of the best global estimates given above.

16. These major discrepancies in the areal estimates make their usefulness very dubious. The discrepancies can be attributed to many factors, such as differences in the definition of wetlands, the techniques used to collect and interpret the basic data, and the scale of the analyses. It is not possible to make an objective assessment of the various figures given as many inventories merely repeat previously gathered information and/or do not clearly describe the methods being used and the accuracy and reliability of the data, especially in relation to determining the boundaries of seasonal and intermittently flooding wetlands.

3.3 Wetland types and definitions

17. The broad Ramsar definition of a wetland was adopted in 1971 and is now commonly used in many countries. It has provided, generally with modification, the basis for many national wetland inventories. However, this is not always the case and many inventories are restricted to more specific habitats (eg lakes, mangroves or reefs), or do not include both marine and inland wetlands (eg the continental scale inventories of Asia and Africa).

18. In many inventories there was no clear definition made of the range of habitats being considered. This is confusing given that the range of wetland habitats covered in inventories varies from coral reefs to coastal mangroves inland to high altitude lakes and bogs.

19. Artificial wetlands are an important part of the wetland resource in many regions (eg rice paddy in Asia), but these habitats are often not included in wetland inventories and were not equally considered in the regional reviews that supported this summary analysis.

20. Regardless of which wetland definitions were used the boundaries of wetlands were often not given, making comparisons between different sources difficult, as did the variable treatment of individual wetlands in wetland complexes.

3.4 Rate and extent of wetland loss and degradation

21. Outside Western Europe and North America there is very little information available or attempt made to calculate wetland loss on a systematic basis. The loss of wetlands worldwide has been estimated at 50% of those that existed in 1900 – a figure that includes inland wetlands and possibly mangroves, but not large estuaries and marine wetlands such as reefs and seagrasses. Much of this loss occurred in the northern temperate zone during the first half of this century. However, since the 1950s tropical and sub-tropical wetlands, particularly swamp forests and mangroves, have increasingly been lost.

22. Agriculture is considered the principal cause for wetland loss worldwide. By 1985 it was estimated that 56–65% of available wetland had been drained for intensive agriculture in Europe and North America, 27% in Asia, 6% in South America and 2% in Africa.

23. Linked with the rate and extent of wetland loss and degradation worldwide is the issue of water allocation and distribution. Many rivers around the world have been heavily regulated by the construction of dams to satisfy the increasing demand for irrigation and hydropower. Impacts on the rivers and associated natural waterbodies, swamps and marshes include increased salinisation, diminishing underground water reserves, declining biodiversity and impoverishment of fish stocks due to impeded migration and degraded habitat.

24. Impacts are not limited to inland or coastal wetlands. A recent study of coral reefs indicated that 58% of the world's reefs are at moderate to high risk of damage from human disturbance. Globally, 36% of all reefs were classified as threatened by overexploitation, 30% by coastal development, 22% by land-based pollution and erosion, and 12% by marine pollution.

25. The Ramsar site database provides a regularly updated but still uneven analysis of threats to wetlands. Data provided by Ramsar Contracting Parties indicated that 84% of Ramsar-listed wetlands had undergone or were threatened by ecological change. The most

widespread threats were from pollution, drainage for agriculture, settlements and urbanisation, and hunting.

3.5 Land tenure and management

26. Many of the continental, and some national, wetland inventories contain generic information on land management and land tenure. Generally this is in the form of basic statements about jurisdiction, conservation status and proposed conservation measures. This information is usually brief and often does not outline the effectiveness or otherwise of land tenure measures in protecting wetland resources.

27. From these inventories and other sources, it is apparent that many wetland sites in Africa, Oceania, Asia and the Neotropics are unprotected or protection measures are ineffective.

28. In parts of Oceania and Asia despite some progress in implementing conservation legislation many countries still require means to enforce safeguards against increasing pressures due to population increases. This is particularly urgent for mangrove conservation.

3.6 Wetland benefits and values

29. Many of the inventory sources provided some information on the values and benefits of wetlands. However, this was usually in the form of a summary of the biodiversity values and human use, with little quantitative or economic data being given. Exceptions are the productivity of artificial wetlands, such as rice paddy, fish ponds and salinas.

30. At a global scale the values and benefits of all wetlands for biodiversity and human uses have been outlined. Information is most detailed for mangroves, where values and benefits include coastal protection, flood reduction, sediment accumulation, fish and crustacean nurseries. Similar descriptions are available for peatlands.

31. In Europe there has been an emphasis on the values of protected areas, in particular on the basis of their value as breeding or feeding habitat for birds. This emphasis has also been repeated elsewhere, but not usually as thoroughly. Protected areas are valued by people for various reasons, including conservation, tourism and fishing.

3.7 Extent and adequacy of updating programs

32. Few inventories have been regularly updated. At a national level the status and trends analyses done in the USA make a comprehensive attempt to provide updated information. As few other studies were identified the overall extent of wetlands and wetland loss cannot be determined.

33. The Ramsar Convention Bureau provides a directory, updated every six years, of sites listed as internationally important. This is now available on the World Wide Web and CD-ROM as well as in hardcopy. However, the directory does not contain a comprehensive updated overview of all sites.

34. The apparent absence of regular updating of wetland inventories is not unexpected given the overall cost and logistical effort of conducting and publishing (in hard copy) such work. Recent development of ‘user-friendly’ database packages and increased availability of electronic information systems, such as geographic information systems (GIS) and the World Wide Web, is increasing the options available for data storage,

analysis and access. It is increasingly possible to store wetland inventory information in an electronic database and make it widely accessible.

3.8 Standardising of inventory approaches

35. There is inadequate standardisation of inventory techniques, including the means of recording and reporting the basic information that is necessary for determining, with confidence, the status of wetlands worldwide. Inventories often lack basic information, notably the objective or purpose of the inventory, the wetland definition and classification systems used, the method/s of data collection, source data for statistics of wetland area and wetland loss, name and affiliation of the compiler for individual site data, a program for updating the inventory, etc.

36. The development of a standardised and flexible framework for wetland inventory will help individual countries to prepare national wetland inventories not only in a format compatible with their objectives but also compatible with the inventory of neighbouring countries. This would greatly improve the capacity for comprehensive wetland inventory on a regional, and ultimately global, scale.

37. Using electronic data storage systems such as databases and Geographic Information Systems linked to the World Wide Web will enhance the availability of data and related information (eg bibliographies) for particular countries and wetland sites. It will also permit regular, cost-effective updating of inventory information.

38. Countries with limited resources or expertise in wetland inventory may particularly benefit from access to standardised or generic wetland inventory methods, including generic databases for recording and storing basic inventory program information. This information could then be added to a globally accessible meta-database, such as that developed by the Biodiversity Conservation Information System (BCIS), to ensure details and contacts are available to others for future access to the inventory.

39. Such standardisation could be derived from existing models, notably the Mediterranean wetland inventory (MedWet), and the United States Fish and Wildlife Service national wetland inventory. The remote sensing techniques and the classification systems used in these approaches have been successfully adapted for use in other countries and could provide a basis for a standardised framework and/or generic wetland inventory database.

40. There are regular calls for the increased use of remote sensing technology for wetland inventory. These techniques are available and many are being tested for different wetland habitats. The emphasis should not be on wholescale adoption of such techniques, but rather on the development of models that suit particular purposes and which are linked to on-the-ground management activities, including effective ground truthing and monitoring.

41. Overall, given the difficulties in obtaining even the most basic information for many wetlands, there is a need to identify a basic data set to describe the wetland. This would include the location and area and the basic features of the ecological character that provides values and benefits to humans. The latter would include general indicators or descriptors of the water regime, water quality and biota. An agreed landform classification system would make it possible to compare between sites and regions and hence provide a basis for management decisions that may lead to the collection of more specific information on threats, values and benefits, land tenure and management, and monitoring.

3.9 Information sources

42. A broad range of inventories and published reports on wetlands were reviewed. These included global, regional and supra-national inventories available in published reports, books and journals and augmented by unpublished reports, atlases (eg for mangroves) and web pages (eg for coral reefs). Much of the information assessed was not from published inventory sources.

43. We acknowledge that many other sources of information were not accessed during this review. This is particularly so for the Americas where an immense quantity of information exists. Much less information exists for Africa and Asia. In such instances at least some further information may be available in reports dealing with land and water resources, especially for fisheries. However, much of this is believed to be in small library collections that are not easily accessed through library exchange procedures. More extensive networks and familiarity with more languages may enable more information sources to be located.

44. Collections of remotely-sensed imagery and national and global scale maps and charts were not assessed. It seems that topographical and navigational maps have not been greatly used for inventory purposes, partly as they are not easy to obtain and collate. This situation may change as more maps are produced in electronic formats. The increased availability of global and national scale image databases (on CD and the web) may also provide improved opportunities for use of remotely sensed data.

45. Whilst we cannot claim that this current review is comprehensive our development of the bibliographic and inventory databases provides an initial tool for adding more sources once they are located. If this were to be done on a regular basis (eg in conjunction with the triennial inventory of Ramsar sites), restructuring of the format and style of the current databases may be appropriate.

46. The regional reviews identified a large number of sources for wetland inventories, but coverage at national level is patchy. Many inventories covered only part of a country's wetland resource (eg estuaries or peatlands or lakes). Supra-national inventories cover more countries but these are not usually comprehensive (eg covering only important wetlands).

47. Many inventories were based on biodiversity criteria, particularly those important for waterbirds. Others were based on specific habitats, such as lakes or reefs. Many of these were non-specific reviews or summaries of wetland information.

48. Many national inventories had been undertaken by national or provincial governmental agencies. In contrast, supra-national inventories were undertaken by international non-governmental organisations. Although the latter have provided valuable collations of existing material, many have not been well distributed and only occasionally have been updated.

49. The major inventory effort seems to have occurred during the 1980s and early 1990s. Much of the earlier material is now considered of only historical use given continued loss and degradation that is believed to have occurred in many regions. Where possible our analyses focused on inventory sources from the 1990s.

3.10 Priorities for future wetland inventory

50. Knowledge of the global wetland inventory resource is, on the whole, far from complete and is inadequate to support management needs. All regions of the world – Africa, Asia, Oceania, Neotropics, North America, Western and Eastern Europe – have information gaps and priority areas for wetland inventory. Some of these information gaps are urgent, and will become increasingly so as wetland loss continues.

51. Priority should be given to regions in which the wetlands are least known and considered the most threatened: areas where rapid population growth and development are combining with ineffective or non-existent wetland protection and sustainable use legislation, to destroy and degrade wetlands at an alarming rate. The priority regions for further wetland inventory and wetland loss studies so as to determine the current extent of wetlands, and the rate and extent of loss, are the Neotropics, Asia, Oceania, Africa and Eastern Europe.

52. To make the task more manageable, priority should be given to encouraging countries which do not yet have a national wetland inventory to commit resources to complete one. The great importance and urgency of national wetland inventories cannot be over emphasised. They provide the base information for effective monitoring, management, sustainable use and conservation of wetlands at all levels – local, national, and international.

53. Attention must also be given to the inventory of priority wetland habitats, targeting those for which there is little or no information, and those at greatest risk of degradation and destruction. Priority wetland habitats are:

- *seagrasses* – in southern Asia, south Pacific, South America and some parts of Africa, are under increasing threat from pollution, coastal development, destructive fishing practices, recreational use, etc.
- *coral reefs* – an important biodiversity resource that is under continuing threat due to the development, deforestation and pollution of coastal and inland wetlands.
- *salt marshes and coastal flats* – have generally not been included in wetland inventories, with few areal estimates and no true global 'picture' available. However, they are under increasing threat worldwide, particularly in Africa, Asia and Oceania due to increasing coastal development.
- *mangroves* – better mapped than other coastal and marine wetlands, but serious inconsistencies exist and more comprehensive inventory is required. This should be used to better determine the mangrove loss that is proceeding at an alarming rate in many parts of Africa, south-east Asia and Oceania through deforestation, land reclamation, and development for aquaculture.
- *arid-zone wetlands* – poorly mapped but increasingly important in the light of escalating population pressures and water demand. For example, in Africa and the Middle East pressures for increased water supply have led to the construction of many large dams and to disputes over trans-boundary sharing of limited water resources.
- *peatlands* – well mapped in comparison with other wetland habitats. However, they are threatened by drainage for agriculture and afforestation in Europe, Asia and North America in particular, despite their importance as a global carbon sink and economic resource, and are poorly known in tropical regions such as south-east Asia.

- *rivers and streams* – seriously threatened by industrial and domestic pollution, water diversion and regulation in many regions of the world. Although generally considered to be well mapped, it is difficult to obtain areal estimates of rivers and streams and the extent of associated swamps, marshes, ox-bow lakes and lagoons.
- *artificial wetlands* – increasingly important with reservoirs, dams, salinas, paddy, and aquaculture ponds important in many regions, notably Asia, Africa and the Neotropics, where they can provide habitat for wildlife, particularly migratory birds. Under some circumstances they provide many values and benefits to humans and can partially compensate for the loss and degradation of natural wetlands.

54. The work required to establish, update or extend wetland inventory seems monumental when viewed at a global scale, but is achievable by national action if a genuine will exists and key processes are targeted for improvement. These include improved communication to ensure that wetland inventory information is useful to people at all levels, from local to global.

55. Co-operation between countries and agencies, with the common aim of improving wetland inventory for all wetland habitats, particularly those most threatened, should be enhanced. Resources and effort are often 'wasted' on pilot studies or overly-ambitious projects that have little reward in terms of inventory and improved management of wetlands. This indicates a need for even more careful prioritisation when allocating resources for wetland inventory.

56. When undertaking further wetland inventory every effort should be made to link this with other national and international initiatives, such as the identification and delineation of further sites of international importance. Further, the inventory effort could assist with moves to achieve the vision for the List of Wetlands of International Importance.

Global review of wetland resources and priorities for wetland inventory

Project description and methodology

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Contents

Acknowledgments

This review was undertaken by Wetlands International and the Environmental Research Institute of the Supervising Scientist, Australia, under contract to the Bureau of the Ramsar Convention on Wetlands and with financial support from the United Kingdom Government. It was undertaken by a team that included personnel based in Australia, Canada, Malaysia and the Netherlands with support from colleagues spread around the globe and an international steering committee. The European team was also supported by project funding from the Institute for Inland Water Management and Waste Water Treatment (RIZA) from the Netherlands and the Norwegian Agency for Development Cooperation (NORAD) from Norway.

Summary

A review of the global wetland resource, as available in national wetland inventories, was undertaken by Wetlands International, with support from the Environmental Research Institute of the Supervising Scientist (***eriss***, Jabiru, Australia), on behalf of the Bureau of the Ramsar Convention on Wetlands. Funding support came from the United Kingdom with complementary support provided through concurrent projects.

The project was organised through the Wetlands International Inventory and Monitoring Specialist Group and coordinated by the International Coordination Unit. Reviews of the extent of wetland inventory effort in each of the seven Ramsar regions were assigned to an individual Wetlands International regional licensee or sub-licensee. A further review of supra-national and continental scale inventories was also undertaken. The project was overseen by an international steering group and draft reports and progress discussed in a workshop (Dakar, Senegal, November 1998) before the final reports were produced.

The limited time and resources available for the project have meant that a fully comprehensive global analysis has not been possible. However, the use of standardised data collating and recording procedures have provided a sound basis for a thorough analysis of the coverage and quality of wetland inventory worldwide.

The findings of the regional and supra-national analyses of inventories form the basis for a summary report that accompanies the seven regional and one global reports (note that the Ramsar Asia Region was reviewed in two separate components). All reports and their accompanying inventory database and bibliography are presented in hardcopy and CD-ROM formats.

This section of the report provides details of project management and methodology developed to ensure consistent review procedures in each element of the work. The overall recommendations of the review are presented in the summary report and the regional analyses and their recommendations in the respective regional reports.

1 Introduction

Conservation and management of wetlands and their biodiversity have been identified as a priority area for action in international conventions and regional policies. The importance of sustainable management of wetlands and their biodiversity is also being increasingly recognised in the wide-ranging debate on managing the world's water resources. However, despite these priorities and frameworks for action, many natural wetlands, and the species which depend upon them, continue to be threatened or degraded through a variety of human actions, both direct and indirect (Dugan 1994, Finlayson & Moser 1992). In part this arises because at national and international levels decision-takers are unaware of the features and values of the wetland resource in their charge (Finlayson & van der Valk 1995a).

Although there is much information about wetland resources and their management, it is held scattered in a variety of sources in incompatible formats, making it difficult to access or use, both to assess the state of the global wetland resource, and source the information and expert guidance needed to establish priorities for wetland management. There is thus an urgent need to develop tools and mechanisms to provide a more integrated management system for the world's wetlands, to use this system to monitor the changing status of the global wetland resource and to make it available for those undertaking national and regional wetland conservation planning.

Knowledge of the location, distribution and character of wetlands, their values and uses, and the threats to them is an essential basis for developing and implementing management for their wise use (Dugan 1990, Hollis et al 1992, Finlayson & van der Valk 1995a, Finlayson 1996). This is required at a variety of geographical scales, ranging from local site management, through development of regional and national policies to global priority setting. There have been many wetland inventories and assessments undertaken for different purposes, at differing geographical scales, and at differing levels of detail and topic coverage (see papers in Finlayson & van der Valk 1995b). Others are known to be underway or planned. However, many basic features of wetlands around the globe have not apparently been recorded or documented (Mitsch et al 1994, Finlayson & van der Valk 1995a).

Because of such differences in the purpose and use of wetland inventories, the information that is collated is often not readily accessible for broader uses or users. Furthermore, because of the scattered nature of wetland inventories it is not entirely clear where adequate inventory information exists, or where there are major gaps. This has precluded accurate assessment of the size and distribution of the global wetland resource and its pattern of change (Mitsch et al 1994, Finlayson & van der Valk 1995a).

2 Global review of wetland resources

Shortcomings in the wetland information base have been debated at length within fora held by the Ramsar Convention on Wetlands and Wetlands International. This has resulted in a call for countries to undertake national wetland inventories (Davis 1993). Further, it has resulted in agreement on a specific action under the Convention's Strategic for 1997–2000 (http://www.ramsar.org/key_strat_plan_e.htm). Action 6.1.3 of the strategic plan is to:

> utilise information from regional wetland directories, national scientific inventories of wetlands and other sources, to begin development of a quantification of global wetlands resources, as baseline information for considering trends in wetland conservation or loss.

A pledge of funding support to develop quantification of global wetland resources was made by the United Kingdom at the 6th Conference of the Contracting Parties of the Convention (Brisbane 1996). Terms of reference for this review were developed by the Scientific Technical and Review Panel (STRP) of the Convention, and accepted at the 6th meeting of the STRP in Gland, Switzerland, 15–17 April 1997. These are given below while the agreed project description is attached in Annex 1.

The aims of the review are threefold:

1. To provide an overview of international, regional and national wetland inventories (including regional and national directories of important wetlands) as well as other general information on global wetland resources from publications, Ramsar Convention literature, and information collected by other institutions doing work on the same or related subject(s).
2. To provide recommendations for how to proceed to meet the objective as set out in Action 6.1.3 of the Ramsar Convention Strategic Plan for the current data holdings identified through 1 above.
3. To identify the priorities for either establishing, updating or extending wetland inventories so as to improve the accuracy with which the the global wetland resource can be quantified and described in future.

3 Methodology

3.1 Project management

The review was undertaken by Wetlands International, and in particular its Wetland Inventory and Monitoring Specialist Group (WIMSG), acting as technical advisors to the Ramsar Convention. Work on the review began in late 1997 and a schedule was soon agreed to ensure a technical report on the outcomes of the review was presented to the 7th Conference of the Contracting Parties of the Convention (Costa Rica, May 1999).

The review was managed through a contract from the Ramsar Bureau with the International Co-ordination Unit of Wetlands International. The information collation and reporting was undertaken through four sub-contracts, as follows:

1. To the Environmental Research Institute of the Supervising Scientist (***eriss***), Jabiru, Australia, supporting Wetlands International's Wetland Inventory and Assessment Specialist Group. This contract was to undertake project co-ordination, compilation of information on supra-national wetland inventories, and preparation and production of the final global report.
2. Three sub-contracts to Wetlands International regional licensees/sub-licensees to undertake compilation of national inventory information and compilation of regional reports for each of the Ramsar regions, and the supply of these to ***eriss*** for compilation of the global analysis. Sub-contracts were as follows:
   - Wetlands International–Africa, Europe, Middle East (Wageningen, The Netherlands) covering Western Europe, Eastern Europe, Africa and the 'Middle East' part of the Asia Ramsar region
   - Wetlands International–Americas (Ottawa, Canada) covering North America and Neotropics regions

- Wetlands International–Oceania (Canberra, Australia), covering Oceania and the bulk of the Asia regions.

Terms of Reference for each of the sub-contracts are appended in Annex 2 and contact points listed in table 1.

Table 1 Contact points and project personnel from each of the sub-contractors

Institution	Contact Point	Project Officer
Wetlands International–International Coordination Unit	Nick Davidson	n/a
Environmental Research Institute of the Supervising Scientist	Max Finlayson	Abbie Spiers
Wetlands International–Africa, Europe, Middle East	Scott Frazier	Nathalie Stevenson
Wetlands International–Oceania	Roger Jaensch	Doug Watkins
Wetlands International–Americas	Ian Davidson	Rob Vanderkam

To ensure consistency of regional inventory review procedures by sub-contractors, a Technical Specification was developed by the International Co-ordination Unit and agreed by all partners. The Technical Specification (Annex 3) was designed to clarify and expand on the regional analysis requirements as set out in the original project outline (Annex 1). It formed part of each sub-contract.

The contract called for the establishment of a project Steering Committee, to be comprised of representatives of each of the Ramsar Bureau, the Wetlands International partners, the United Kingdom Government (as the source of the project funds) and invited experts (table 2). The Steering Committee's role was to review progress and outputs, and facilitate access to information held in databases, libraries and other information sources. The Steering Committee communicated largely by electronic mail with one meeting in a workshop in Dakar, Senegal, during November 1998 to review the draft final outputs.

Table 2 Members of the project steering committee

Name	**Institution**
Bill Phillips	Bureau of the Ramsar Convention on Wetlands, Gland, Switzerland
Brij Gopal	Jawaharlal Nehru University, New Delhi, India
David Stroud	Joint Nature Conservation Council, Peterborough, United Kingdom
Douglas Taylor	Somerset County Council, Taunton, United Kingdom
Geoff Cowan	Department of Environment, Pretoria, South Africa
Ian Davidson	Wetlands International–the Americas; Ottawa, Canada
Luis Naranjo	Universidad del Valle, Cali, Colombia
Martine Michou	International Geosphere Biosphere Program – Data and Information System; Toulouse, France
Max Finlayson	Environmental Research Institute of the Supervising Scientist, Jabiru, Australia
Nick Davidson	Wetlands International–International Coordination Unit; Wageningen, The Netherlands
Roger Jaensch	Wetlands International–Oceania; Canberra, Australia
Scott Frazier	Wetlands International–Africa, Europe, Middle East; Wageningen, The Netherlands
Stuart Phinn	University of Queensland, Brisbane, Australia

3.2 Finances

The initial contract was for SFR 71 675. This was considered by all parties involved to be an absolute minimum for undertaking this project satisfactorily. Therefore the project was linked to existing work already planned by Wetlands International under the Biodiversity Conservation Information Systems initiative (funded by NORAD). This enabled a far more comprehensive review to be made for the Eastern European, Western European and African regions than was possible for the other regions.

The BCIS project is developing good practice guidance and proposals for wetland inventory and assessment tools which will follow-up the work under this project, and it is therefore highly appropriate to link these two projects. The 'BCIS Wetlands Pilot Project' also held a workshop in Dakar, Senegal, in November 1998 and effectively provided an additional SFR 20 000 towards the costs of attendance at the workshop being run for the global review project. Wetlands International–Africa, Europe, Middle East also launched a project in Europe (funded by RIZA of the Netherlands) that contributed information to support the European component of the project.

Participation in the Dakar workshop was also boosted by a further SFR 4000 from the Ramsar Bureau. The project also received support from Environment Australia and ***eriss*** through work to review and develop further approaches for wetland inventory at different scales across the continent of Australia.

Payments from the Ramsar Bureau to Wetlands International–ICU were SFR 50 000 on signing the contract, with the remaining SFR 21 675 payable on completion of the contract. Sub-contract payments were as follows:

- ***eriss*** **–** SFR 39 950, with half payable on signing of contract and half on contract completion. This included SFR 4700 for the costs of the project workshop and SFR 2350 for report production.
- **Wetlands International–Africa, Europe, Middle East (AEME) –** SFR 7050, with SFR 5000 payable on signing of contract and the remainder on contract completion.
- **Wetlands International–Oceania –** SFR 11 750, with SFR 5875 payable on signing of contract, SFR 4875 on satisfactory supply of regional inventory analyses, and the remainder on contract completion.
- **Wetlands International–Americas –** SFR 11 750, with SFR 5875 payable on signing of contract, SFR 4875 on satisfactory supply of regional inventory analyses, and the remainder on contract completion.

SFR 1175 was retained by Wetlands International–ICU as a contribution towards the costs of project administration and communications.

3.3 Schedule

After the contracts were signed work began on each of the regional reviews. Each of the sub-contractors had three months to produce a draft review for all regions being considered. Given the overall schedule and the period of contracted time work on the regional reviews began at different times in 1998: Wetlands International–Oceania and ***eriss*** project work began in February 1998, Wetlands International–Africa, Europe, Middle East began in March, and Wetlands International–Americas in May. The sub-contracts required delivery of regional inventory listings and regional analyses to ***eriss*** by end of April 1998 (Oceania and Americas) and end of July 1998 (Africa, Europe, Middle East). The later supply date for

Africa, Europe, Middle East analyses was agreed owing to the large amount of inventory material known to exist for these regions, coupled with the need for linkage with the RIZA-funded European inventory project to ensure completion of this part of the project.

These draft reports were discussed at the workshop held in Dakar, Senegal, on 7 November 1998. Following this workshop a revised schedule and priority tasks were agreed in order to deliver the final report for distribution at the May 1999 Ramsar CoP7.

The project description called for hard copies (ring-bound) of the full report to be available for consultation by Contracting Parties at the May 1999 Ramsar CoP7. Copies of the full report were also made available for supply to CoP7 conference delegates in electronic (CD-ROM) form. A summary of the report was translated into French and Spanish for distribution with the documentation prior to the 1999 CoP7. These documents were supported by a progress report in June 1998.

Data recording

Initial tasks focused on the development and agreement between project partners of definitions of inventory categories (eg regional, national and international) and which team handled each category, on the detail of the scope and procedures for identifying inventory sources, and for the compilation and handling of inventory information. This was essential to ensure that a) duplication of effort was avoided (for example where a regional (supra-national) inventory contains national inventory summaries), and b) compilation and handling of information was as consistent as possible between regional partners. This required substantial dialogue between the project teams, and a considerable amount of testing of planned procedures against the wide variety of types of wetland inventory being identified.

To compile standard national (and equivalent) inventory information in a form suitable for undertaking regional analyses of inventory scope and quality and coverage, and to produce estimates of the size and character of the wetland resource, four component data and information handling elements were developed in line with the project specification. These are as follows:

1. A *Wetland Inventory Assessment Sheet*, designed to permit rapid assessment and compilation of information on each identified inventory, and to compile summary information about the wetland resource contained in each inventory. An example is given in Annex 4. To ensure consistency of coding of each information field a set of guidelines for the completion of entries was developed (Annex 5).

2. A *Wetland Inventory Assessment Database*, based on the fields developed in the assessment sheet, for electronic compilation of information about each wetland inventory. Database structure, fields and coding are given in Annex 6. To permit its use by the different partners it was necessary to develop the database in both FoxPro and Microsoft Access software formats, in such a way that the material for the final report could be subsequently compiled into one format (Access). Information compiled in this database formed the basis for the regional and international analyses required of the project. The populated database formed a substantial part of the final report in electronic format.

3. A *Bibliographic database* for each inventory reference (fields are listed in Annex 7). (In future a link may be established between references in this database and the bibliographic reference included in the wetland inventory database.)

4. A *Meta-database*, to permit compilation of details of inventory information sources that are not in a report format (eg map sheets, atlas studies, posters, collations of photos/images). This was expected to provide a catalogue of sources (analogous to the

bibliographic database) unlike the inventory database which contains actual data and information extracted from the inventories. The meta-database structure is given in Annex 8.

To facilitate common entry of bibliographic and meta-data information an attempt was made to make these two databases available to the regional project teams on the World Wide Web. Due to problems with multiple access to servers this was not successful and the regional and global review teams reverted to individual databases with standardised fields, as originally envisaged.

4 Outputs

The outcomes of the regional and global reviews are presented in two forms on the CD-ROM. First, the summary report that was translated into French and Spanish and circulated to all official national delegations at CoP7 is presented. This is a collation of the principle issues that were presented in the regional and global reviews and elaborated during the workshop in Dakar. Members of the Steering Committee provided comment on a draft version. An acknowledged copy of the summary has also been included in a report by the IGBP-DIS. A short report on the project is available in the Wetlands International newsletter *Wetlands* (7 May 1999).

The individual regional and global reviews are presented along with the separate inventory and bibliographic databases that were compiled for each. These should be referred to when checking information for each of the regions considered. The Asian regional review is presented as two individual reports (and databases) with 14 countries being treated in the report labelled ‘Middle East’ and the remaining countries of Asia being treated in the report labelled ‘Asia’, with the exception of Russia which is contained within the Eastern European report.

The global-scale review is an analysis of inventory material available at the supra-national and continental scales. In this respect there is some overlap with some of the regional reviews. However, given that the latter focus primarily on national and sub-national inventory scales we are not concerned about such overlap. Our objective was to undertake as complete an analysis as possible given the budget and time frame.

The major recommendations from the combined reviews are presented in the summary report (available on the CD-ROM and hardcopy versions and also will be available from the World Wide Web page of the Ramsar Wetland Convention – http://www.ramsar.org/). We also refer readers to the individual reports for details and bibliographic sources.

Finally, we recognise that we have not been able to identify and collate all inventory sources during the time-frame and resourcing of this study. However, as wetland inventory is an ongoing component of wetland management and wise use, we anticipate further additions to the databases developed during this study so as to enhance the coverage of information on worldwide wetland inventory. We also draw the reader’s attention to the recommendation that the Ramsar Convention supports the development of a central repository for wetland inventory information.

Readers are encouraged to send details (as per the information fields outlined in the accompanying databases – see Annexes 4–8) and copies of sources missing from our analyses and all further wetland inventory work at the national, supra-national and international scales to the following addresses:

Co-coordinator, Wetlands Inventory & Monitoring Specialist Group
C/- Environmental Research Institute of the Supervising Scientist
Locked Bag 2
Jabiru, NT 0886, Australia
e-mail enquiries@eriss.erin.gov.au

Science Coordinator, Wetlands International
International Co-ordination Unit
Wetlands International, Wageningen
PO Box 471
6700 AL Wageningen
The Netherlands
e-mail icu@wetlands.agro.nl

Inventory information at the national and sub-national scale could also be sent to the above addresses and to the relevant regional Wetland International licensee:

Wetlands International–Africa Europe Middle East
PO Box 7002
6700 CA Wageningen
The Netherlands
e-mail post@wetlands.agro.nl

Wetlands International–Americas
7 Hinton Avenue North, Suite 200
Ottawa
Ontario K1Y 4P1
Canada
e-mail wia@wetlands.org

Wetlands International–Asia Pacific
3A37 Kelana Centre Point
Kelana Jaya, No 3 Jalan SS7/19
47300 Petaling Jaya, Selangor
Malaysia
e-mail wiap@wiap.nasionet.net

In conclusion we reiterate that this project presents an initial assessment only of the global wetland resource. We have acknowledged the uneven nature of the assessments that have been undertaken of each of the seven Ramsar regions and encourage others to help fill these gaps and complete the analyses with materials that we may have not unearthed and with new and improved wetland inventory.

Further wetland inventory is required before we have an adequate record of the extent and status of the world’s wetland resource. This study provides a basis for further work through recommended procedures and the provision of databases and bibliographic sources.

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Annex 1 Project description

Global review of wetland resources

Project proponent: Wetlands International, Wetland Inventory and Monitoring Specialist Group

Project supervisor/coordinator: Dr CM Finlayson, ***eriss***

Budget: SFR 71 675

Duration: October 1997 – May 1999

Background

1. The Scientific Technical and Review Panel (STRP) of the Ramsar Wetlands Convention was requested to develop terms of reference for a Global Review of Wetland Resources. This was in response to a pledge of funding support made at the 6th Conference of the Contracting Parties of the Convention by the United Kingdom Government. The terms of reference for the global review were accepted at the 6th meeting of the STRP in Gland, Switzerland, 15–17 April 1997.
2. The review will contribute to meeting the objective of Action 6.1.3 of the Ramsar Convention Strategic Plan 1997–2002, to: 'utilise information from regional wetland directories, national scientific inventories of wetlands and other sources, to begin development of a quantification of global wetlands resources, as baseline information for considering trends in wetland conservation or loss'.
3. The Wetland Inventory and Monitoring Specialist Group (WIMSG) of Wetlands International proposes to undertake this review and will bring together the combined experience, expertise and information holdings of the regionally based Wetlands International staff and associated technical specialists.

Aims

4. Based on the terms of reference the project will:

4.1. Provide an overview of international, regional and national wetland inventories (including regional and national Directories of important wetlands) as well as other general information on global wetland resources from publications, Ramsar Convention literature, and information collected by other institutions doing work on the same or related subject(s);

4.2. Provide recommendations for how to proceed to meet the objective as set out in Action 6.1.3 of the Ramsar Convention Strategic Plan for the current data holdings identified through aim 4.1 above; and

4.3. Identify the priorities for either establishing, updating or extending wetland inventories so as to improve the accuracy with which the the global wetland resource can be quantified and described in future.

Project management

Organisation of technical work

5. The WIMSG is a voluntary network, established by Wetlands International, to provide expert advice and support to program development in the field of wetland inventory and monitoring. It is co-ordinated by Dr Max Finlayson (Australia) and Dr Luis Naranjo (Colombia). WIMSG has the support of the three regional offices of Wetland International: Asia Pacific (Kuala Lumpur, Malaysia); Americas (Ottawa, Canada); and Africa, Europe, Middle East (Wageningen, Netherlands).

6. The WIMSG will provide the focal point for the project under the supervision of Dr Finlayson. A project Steering Committee will be established and will comprise a representative from each of the regional offices of Wetlands International, the Ramsar Convention Bureau, a UK representative, and selected experts. This Committee will review progress and outputs and will facilitate access to information held in databases, libraries and other information sources. The Group will communicate largely by electronic mail, but will meet once in a workshop in late 1998 to review the final outputs.

7. Apart from this workshop (provisionally planned for November 1998, in Senegal) no international travel is foreseen, due to budgetary limitations. However, advantage will be taken of meetings of the Ramsar STRP and Wetlands International to advance the development of the project.

8. Direct coordination and supervision of the project will be provided by Dr Finlayson who will, through his host agency – the Environmental Research Institute of the Supervising Scientist (***eriss***) – in Jabiru, Australia, take responsibility for the completion of the project and submission of the report to the Ramsar Convention Bureau. Through the aegis of ***eriss***, Dr Finlayson will contract one person to undertake the primary tasks of the review, including liaison and contact with Wetlands International offices and other information sources. The nature of the contract will be discussed with the person engaged and will be in line with accepted public procedures adopted by ***eriss***.

9. That part of aim 4.1 of the review concerning regional analysis of wetland inventories will be undertaken through subcontracts to the three regional headquarters of Wetlands International, who are best placed to obtain the regional information.

10. The report will be prepared by the contracted person in consultation with the Steering Committee and submitted to the Ramsar Convention Bureau by 31 January 1999 by Dr Finlayson on behalf of the WIMSG. The summary of the final report will be distributed with the documentation for the Costa Rica Conference.

Administration and funding

11. The project will be funded primarily by the money pledged by the United Kingdom Government to the Ramsar Convention. A contract will be signed between Wetlands International (on behalf of the WIMSG) and the Ramsar Convention Bureau. Subcontracts will then be arranged by Wetlands International to ***eriss*** and the three regional offices of Wetlands International.

12. The budget of SFR 71 675 is considered an absolute minimum for undertaking this project satisfactorily. Therefore the project will be linked to existing work already planned by Wetlands International under the BCIS initiative (funded by NORAD), which

will provide additional SFR 20 000 towards the costs of the workshop. The BCIS project aims to develop a proposal which will follow-up the work proposed under this project, and it is therefore highly appropriate to link these two projects. Wetlands International — Africa, Europe, Middle East is also launching a project in Europe (funded by RIZA of the Netherlands) which will contribute information to support the European component of the project. ***eriss*** will make available normal communications and office facilities and the supervisory time of Dr Finlayson, and will take responsibility for completion of the report and a detailed financial acquittal. These links and in-kind support will be recognised in the project acknowledgments.

Project tasks

13. Each of the terms of reference will be addressed separately and combined into a summary report. Sources of information other than reference materials will be collated and listed in a meta-database which will indicate the nature of the material, its location and means by which it can be accessed.

14. Each of the aims is addressed below.

14.1 Provide an overview of international, regional and national wetland inventories (including regional and national Directories of important wetlands) as well as other general information on global wetland resources from publications, Ramsar Convention literature, and information collected by other institutions doing work on the same or related subject(s).

14.1.1 A comprehensive literature search will be conducted to determine the extent and distribution of wetland area and, where figures exist, the rate and extent of wetland loss presented. Reports prepared for the Ramsar Convention and Wetlands International, plus maps and databases held by national and international agencies will be consulted.

14.1.2 Analysis of the data will include an examination of the means of calculating wetland area (including definitions and classifications) and, where possible, the reliability and age of the data. Access to key libraries and information services will be critical for this analysis and will provide the basis for further addressing the terms of reference given below. A bibliography and meta-database will be prepared.

14.1.3. A (Ramsar) regional analysis will be conducted from the three regional headquarters of Wetlands International, to summarise the countries and regions covered by wetland inventories in tabular and/or data matrices. These will display:

- wetland types (and definition) covered in each inventory;
- data/information fields contained within each inventory;
- means of collecting, collating and storing the data;
- methods, means and frequency of updating the inventory;
- possible use of satellite and remote sensing data in the updating process.

Staff at the regional headquarters of Wetlands International are already involved in numerous wetland inventory projects in their respective regions, and are thus well placed to collate this disparate information. Regional summaries will be provided and key points presented.

14.1.4 Modern communication media and library services will provide an initial data source with support from the regional offices of Wetlands International.

14.2 Provide recommendations for how to proceed to meet the objective as set out in Action 6.1.3 of the Ramsar Convention Strategic Plan for the current data holdings identified through aim 14.1 Above.

14.2.1 The above analyses and collation will be used to ascertain the availability and types of information on — the location and areal extent of wetland types; the benefits and values provided by wetlands; the extent of wetland loss and degradation; land tenure and management structures in place or proposed; and the extent and adequacy of updating programs in place or proposed. Regional summaries will be provided with key points presented.

14.2.2 The regional analyses will be collated and used to provide information on preferred options for obtaining standardised approaches for wetland inventory, covering data/information fields; means of collecting, collating and storing the data; methods and means of updating the inventory; and, where possible, regional or national priority areas.

14.3 Identify the priorities for either establishing, updating or extending wetland inventories so as to improve the accuracy with which the the global wetland resource can be quantified and described in future.

14.3.1 The analysis of wetland inventory and data handling procedures will be assessed to determine options for future data management. These options will be based on predicted needs, the existence and adequacy of national and regional inventories, and the mechanics and costs of obtaining, storing and updating such a data resource.

Timescale and outputs

15. The project will commence in October 1997, once the contract is signed and a schedule for payments and progress reviews is agreed.

16. A comprehensive (ring-bound) report will be produced by WIMSG with the joint logos of Wetlands International and the Ramsar Convention, with acknowledgment to the United Kingdom Government and other supporting agencies and initiatives (eg NORAD, RIZA, ***eriss***).

17. The report will contain global and regional analyses with specific summaries and recommendations. This will be supported by a bibliography and a meta-database in internationally acceptable electronic formats. Where possible the analyses will be presented with the assistance of maps and diagrams that could form the basis of a CD-ROM or WWW presentation to supplement the report and enhance access to the data resource.

18. A summary of the report should be ready by 31 December 1998 for translation into French and Spanish and distribution with the documentation for the 1999 Conference of the Contracting Parties. Hard copies of the full report will be made available for

consultation during the Conference; copies of the full report will be available also on diskettes for supply to conference delegates.

19. Follow-up to the project may be sought through the BCIS initiative on wetlands assessment, which is being led by Wetlands International, but other possible avenues will also be considered.

BUDGET (SFR)		
Salary – project officer	(6 months over project period)	32 900
Regional Subcontracts	(11 750 Americas; 11 750 AP; 7050 AEME)	30 550
Workshop		4 700
Admin/communications		1 175
Report		2 350
Total		71 675

Annex 2 Sub-contract terms of reference

Global Review of Wetland Resources

Terms of Reference

The overall contract is between Wetlands International and the Ramsar Convention Bureau. Work is being undertaken through four sub-contracts from Wetlands International:

- one to ***eriss***, Australia, to co-ordinate the work and compile and deliver the report;
- one to each Wetlands International regional HQ to compile and supply to ***eriss*** the regional inventory analysis part of the work.

Direct co-ordination and supervision of the work will be undertaken by Dr Max Finlayson (as co-ordinator of Wetland International's Wetland Inventory and Monitoring Specialist Group) through ***eriss***.

Wetlands International's International Co-ordination Unit (contact point Dr Nick Davidson) is responsible for the overall financial management of the sub-contracts, and ensuring progress reporting, including financial reporting, as required to the Ramsar Convention Bureau.

Terms of Reference

Dr CM Finlayson (acting as co-ordinator of the Wetlands International Wetland Inventory and Monitoring Specialist Group [WIMSG]), *eriss*

To undertake the co-ordination and supervision of the Global Review of Wetlands Resources, as set down in the attached project specification, and specifically to:

1. Be responsible for the timely completion of the project and submission of the report (including detailed statement of accounts) to the Ramsar Convention Bureau, as set out in the project specification, clause 14;
2. Establish a project Steering Committee and co-ordinate its input;
3. Co-ordinate and lead a project workshop, provisionally planned for Senegal in November 1998;
4. Appoint and supervise a person to undertake the primary tasks of the review, including *inter alia* liaison and contact with Wetlands International offices and other information sources; analysis of international wetland inventories (as defined in the Technical Specification); and compilation of the final report;
5. Prepare a specification (including technical details of the formats for the supply of information) and timetable for the (Ramsar) regional analyses to be undertaken by each Wetlands International regional licensee, and agree this with the contract officer in each regional licensee;
6. Provide guidance to each Wetlands International regional licensee for the handling and supply of information where Wetlands International and Ramsar regional boundaries are not coincident;
7. Co-ordinate and liaise with Wetlands International staff undertaking and supervising each of the regional analyses;

8. Prepare a progress report (in format agreed between Wetlands International and Ramsar Convention Bureau) for April 1998; and a summary of the final report by 31 December 1998;
9. Manage the funding allocated to the project workshop (SFR 4700) so as to ensure attendance, so far as is practicable, by project officers and members of the project Steering Committee;
10. Obtain copyright clearance for the use of any material (eg maps and charts), other than those supplied in the regional analyses, for which copyright is held by another person or organisation.
11. Prepare and produce the final project report, as specified in the project specification, for delivery to the Ramsar Convention Bureau by 31 January 1999.

Terms of Reference

Wetlands International–Africa, Europe, Middle East

1. To undertake a (Ramsar) regional analysis of wetland inventories in the Wetlands International–Africa, Europe, Middle East region as set out in clauses 14.1.3 and 14.1.4 of the project specification, and in the attached technical specification. Analyses to cover all of the Africa, Western Europe and Eastern Europe Ramsar regions, and parts of the Asia Ramsar Region.
2. To compile and supply this information to the ***eriss*** project officer undertaking the primary tasks of the review, in a format or formats established by and agreed with the project co-ordinator and following the outline Technical Specification set out below.
3. Where Wetlands International regional coverage and Ramsar regions differ, to supply the information to the ***eriss*** project officer in a form of coverage permitting later compilation by Ramsar region.
4. To advise the ***eriss*** project officer of supra-regional and international wetlands inventories.
5. To supply the regional analyses information to a timetable established by and agreed with the project co-ordinator. Unless otherwise agreed with the project co-ordinator, regional analyses should be completed and supplied by 31 July 1998.
6. For any material (eg maps and charts) included in the regional analysis supplied to the ***eriss*** project officer for which copyright is held by another person or organisation, to obtain copyright clearance for its use.
7. To supply the ***eriss*** project officer with a list of acknowledgements for the regional analysis, for inclusion in the final report.
8. To provide information on progress to the project co-ordinator for inclusion in a summary progress report to Ramsar Bureau in April 1998.
9. To ensure presentation of the regional assessment at the project workshop, provisionally scheduled for Senegal, November 1998.
10. To comment on the interim and final draft project reports.

Terms of Reference

Wetlands International–Asia-Pacific (Oceania office)

1. To undertake a (Ramsar) regional analysis of wetland inventories in the Wetlands International–Asia-Pacific region as set out in clauses 14.1.3 and 14.1.4 of the project specification. Analyses to cover all of the Oceania Ramsar region, and the major parts of the Asia Ramsar Region.
2. To compile and supply this information to the ***eriss*** project officer undertaking the primary tasks of the review, in a format or formats established by and agreed with the project co-ordinator and following the outline Technical Specification set out below.
3. Where Wetlands International regional coverage and Ramsar regions differ, to supply the information to the eriss project officer in a form of coverage permitting later compilation by Ramsar region.
4. To advise the ***eriss*** project officer of supra-regional and international wetlands inventories.
5. To supply the regional analyses information to a timetable established by and agreed with the project co-ordinator. Unless otherwise agreed with the project co-ordinator, regional analyses should be completed and supplied by 31 May 1998.
6. For any material (eg maps and charts) included in the regional analysis supplied to the ***eriss*** project officer for which copyright is held by another person or organisation, to obtain copyright clearance for its use.
7. To supply the ***eriss*** project officer with a list of acknowledgements for the regional analysis, for inclusion in the final report.
8. To provide information on progress to the project co-ordinator for inclusion in a summary progress report to Ramsar Bureau in April 1998.
9. To ensure presentation of the regional assessment at the project workshop, provisionally scheduled for Senegal, November 1998.
10. To comment on the interim and final draft project reports.

Terms of Reference

Wetlands International–Americas

1. To undertake a (Ramsar) regional analysis of wetland inventories in the Wetlands International–Americas region as set out in clauses 14.1.3 and 14.1.4 of the project specification. Analyses to cover all of the Neotropics and North America Ramsar regions.
2. To compile and supply this information to the ***eriss*** project officer undertaking the primary tasks of the review, in a format or formats established by and agreed with the project co-ordinator and following the outline Technical Specification set out below.
3. Where Wetlands International regional coverage and Ramsar regions differ, to supply the information to the ***eriss*** project officer in a form of coverage permitting later compilation by Ramsar region.
4. To advise the ***eriss*** project officer of supra-regional and international wetlands inventories.

5. To supply the regional analyses information to a timetable established by and agreed with the project co-ordinator. Unless otherwise agreed with the project co-ordinator, regional analyses should be completed and supplied by 31 May 1998.
6. For any material (eg maps and charts) included in the regional analysis supplied to the ***eriss*** project officer for which copyright is held by another person or organisation, to obtain copyright clearance for its use.
7. To supply the ***eriss*** project officer with a list of acknowledgements for the regional analysis, for inclusion in the final report.
8. To provide information on progress to the project co-ordinator for inclusion in a summary progress report to Ramsar Bureau in April 1998.
9. To ensure presentation of the regional assessment at the project workshop, provisionally scheduled for Senegal, November 1998.
10. To comment on the interim and final draft project reports.

Annex 3 Technical specification — regional analyses

Global Review of Wetland Resources

Technical specification – regional analyses of wetland inventories

Note. Parts of this specification may be changed by agreement between the project partners as the project develops.

Geographical coverage

1. Throughout this specification *Region* refers to the area covered by a Wetlands International regional licensee. Where the reference is to a region as covered by the Ramsar Convention this is referred to as *Ramsar Region*.

2. Each Wetlands International region will compile inventory information (national and sub-regional inventories) for their region. For the Americas this is straightforward, as the Wetlands International region covers two whole Ramsar Regions (Neotropics and North America). The boundary between the Wetlands International–Africa, Europe, Middle East (AEME) and Wetlands International–Asia-Pacific is more complex. Here parts of the AEME coverage in the Middle East lies within the Asia Ramsar Region (note that all of Russia is covered by AEME and is treated as part of the Eastern Europe Ramsar Region). Inventory information for these parts of the Asia Ramsar Region will be compiled by AEME, with Asia Ramsar Region information to be supplied separately (see 3 below). This will then be combined (by the ***eriss*** project officer) with the information for the bulk of the Ramsar Asia Region that will be compiled by Wetlands International Asia-Pacific.

3. The final report will be structured by the seven Ramsar Regions, and this should be kept in mind by each Wetlands International regional office in compiling the national and regional inventory material. Where an inventory covers more than one Ramsar region (even if both Ramsar regions lie wholly within one Wetlands International region), the tabulations and summaries should, therefore, provide information separately for each Ramsar region (wherever it is possible to separate such information), as well as a summary for the whole inventory.

4. Summaries of international inventories (ie inventories covering major supra-national areas) will be covered by ***eriss***, and so will not appear in the national/regional reviews. The final report will, however, need to consider both scales of inventory in its overall analysis. Wetlands International project staff should, therefore, notify the ***eriss*** project officer of any such inventories about which they are aware, as soon as possible after the start of the project.

Software

5. The key software requirements are for compatibility. Preferred format for text and tabulations is MS Word6 (or an earlier Word version, but **not** Word7).

6. For any material to be supplied in database format, the field name format and content should be that listed in paragraph 8, unless otherwise agreed in advance with the ***eriss***

project officer. Preferred database format is Access, with Paradox or Dbase if Access is not available.

7. All electronic material supplied to the ***eriss*** project officer should be virus-checked before supply. A note confirming the results of the check and the virus-checking software used should accompany the material supplied.

Structure and content of inventory summaries

8. **Wetland inventories.** For each national or regional inventory, a summary of information about the inventory should be compiled (and supplied preferably as an MS Word table or Access database, format to be agreed with the ***eriss*** project officer) under the following basic headings:

Topic heading	database field-name
• Ramsar region(s) covered by the inventory	Ramsar_region
• the country (or countries) covered by the inventory	Country
• the date(s) done	Date
• lead agency responsible and contact addresses etc	Agency
• other agencies involved	Agency_other
• geographic region covered (eg province, biogeographical zone, national)	Geog_region
• methods used (eg collation of existing information, ground-based analysis, remotely sensed imagery which includes air-photos and videography)	Method
• details of maps (scale, availability, date source such as topographical series or digital or ...)	Maps
• types of wetlands covered (coded according to Ramsar types where possible) and definitions used	Wetland_type Wetland_definition
• categories of information (eg wetland extent, status, values, benefits) included	Info_category
• method of data/info storage – is the inventory available in hard copy, word processing files or databases, and is it accessible (and by whom) on internet?	Data_storage
• monitoring and means of updating the inventory	Monitor_update

9. **Wetland extent and status**. For each inventory, compile a standard summary of wetland extent and status, to include:

- extent of wetlands (best estimates of areas based on existing Ramsar classes where possible);
- overall status of wetlands (extent of loss and degradation and major threats identified);
- information on wetland values and benefits.

10. **Bibliography**. All information sources identified should be recorded, with each report being listed in a bibliography based on a standard reference citation style, to be supplied by ***eriss*** project officer. This may be presented as an MS Word file or, preferably, as an MS Access database.

11. **Maps and other less regular sources of information** should be recorded in a meta-database format (ref. project clause 14.1.2). A list of fields for recording the information will be supplied by the ***eriss*** project officer. Any maps supplied should be either in

hardcopy or ARCVIEW or ARCINFO formats, by agreement with the ***eriss*** project officer.

12. **Regional summary of inventory status**. A Ramsar Regional Summary of wetland inventory status should also be compiled and provided in text and tabular form, following the headings listed in 8 above. Where a Wetlands International region is compiling information for only part of a Ramsar Region the summary supplied to ***eriss*** should be for that part of the Ramsar Region.

13. **Regional status of wetlands**. A Ramsar Regional Summary of wetland status should be compiled, following the headings listed in 9 above. Where a Wetlands International region is compiling information for only part of a Ramsar Region the summary supplied to ***eriss*** should be for that part of the Ramsar Region.

14. A **Conclusion and Recommendations** section should be added for each Ramsar Region (see project clauses 14.2 and 14.3). This should summarise the extent and competence of inventories in the region and provide recommendations for extension and/or updating as well as recording/reporting formats. Where a Wetlands International region is compiling information for only part of a Ramsar Region the conclusions and recommendations to eriss should be for that part of the Ramsar Region.

Annex 4 Wetland Inventory Assessment Sheet

1. Reference Details	
Ramsar region(s):	**Reference Number:** / / / /
	WI location:
List 3-letter UN codes for countries included in the study:	
Title of Inventory:	
Full Name of Author(s)/Correspondent:	
Publication reference details:	**or "in development/ in process"**
Wetland Inventory Directory? Y / N	**Date of Publication:**
Publication Type: (tick/circle as appropriate)	
Academic	NGO
Peer review Journal	Report
Peer review Book	Formal Publication
Chapter in a book	Consultancy Report
Conference	Practitioner material
Presentation/Keynote address	Newsletter
Article in proceedings	Periodical
Governmental or Agency	Database Manual /Software
Internal Report	
Publication	Other (specify)
Other	
State language used:	English summary available? Y / N / ?
If not a publication, how has the info been obtained? eg pers. comm	

2. Data availability (circle and enter details as appropriate)	
Data custodian:	**Contact details:**
Full name of data custodian/organisation	
not known	
not applicable	
Format of inventory material	
Paper	WWW pub. (provide URL)
Word Processed File (specify)	GIS (specify)
Database (specify)	
Personal communication	Map(s)
Circulation	
Published	Restricted
Interdepartmental	Unrestricted
Internal	Other
Data Storage	
paper text	database (specify)
paper maps	other electronic (specify)
part of GIS (specify)	digitised maps
3. Implementing Agency: (tick/circle as appropriate)	**4. Funding Sponsor** (tick/circle as appropriate)
NGO: Int'l / Nat'l / Sub-Nat'l / Local	NGO: Int'l / Nat'l / Sub- Nat'l / Local
GO: Int'l / Nat'l / Sub-Nat'l / Local	GO: Int'l / Nat'l / Sub-Nat'l / Local
Private	Private
Academic Institution	Academic Institution
Consultancy	Other (specify)
Other (specify)	Unknown
Unknown	
Name:	**Name:**

5. Objectives (NB not mutually exclusive)	
Are the objectives explicitly stated ? Y / N / ?	
Main issues being addressed:	
International designation	Wetland products (eg forestry, water reservoir)
Inventory/baseline	Wetland services
Biodiversity	Geographical/jurisdictional/scale
Academic / research	Public education
Landuse planning	Other (please specify)

6. Definitions – Wetlands and Classification	
Is a definition of wetlands:	**Wetland Classification:**
	Ramsar Wetland Type classification used ?
explicit	Y / N / variable / ?
inferred	Not applicable? Y / N / ?
nil	
Was the Ramsar definition used? Y / N / ?	Other classification (specify)
If not Ramsar please give details:	**Source of variability:**
	definition of wetland type
	between sites
	other

7. Basis of Study/Wetland Inclusion (circle as appropriate and provide details where possible)	
Does the wetland include all wetlands or just a sample?	all / sample
If sample, what was the basis of selection? (ie what 'filter' was used) *NB not mutually exclusive*	
Political boundary / Geographical (eg Africa)	
Land cover / Remotely sensed data	
"Situation" / Landform (coastal, inland, upland, lowland, etc)	

Suprahabitat / System (eg estuarine, lacustrine, marine, fresh) Habitat (eg saltmarsh, peat, mangrove) Floral/faunal groups (eg crocodile/bird/etc breeding ground) Climate (eg wetlands in arid areas) Function (eg wetlands as storm buffers) Hydrology (eg permanently flooded wetlands) Biodiversity Value Cultural value Artefact of data collation Other *Details:*

8. Temporal Scale of Study		
Not applicable (eg review/collation)		
Discrete survey Date (range) of data collection/collation Has the Inventory been updated? Y / N / ? Any plans to update inventory? Y / N / ?	**Material updated on ad-hoc basis** Purpose of update: add sites review status other unknown	
Ongoing survey/program Start date: Planned duration (in yrs/mths):	**Frequency/periodicity of survey regimen:** Current status	 open closed unknown

9. Methods (circle as appropriate)	
Data collection methods:	**Extent of ground survey**
collation /review	total
ground survey	partial (details?)
remote sensing	none
not stated	unknown
Details of remotely sensed data	
Satellite	map product
Aerial Photo	LIDAR
Video	Radar
Not provided	Satellite imagery used? (eg LTM, SPOT etc)
Spatial resolution :	**Data ground truthed?** Y / N / ?
10. Inventory Synthesis	
Summary given?	
Y / N / ?	
Total area covered by Inventory: (ha) / not available	
Extent of wetlands given?	
Y / N / ? / partial	
Total extent of wetlands covered (ha)	
Number of sites:	
Areas by class? Y / N / ?	
Give details: (list area covered for each class)	
Estimate or summary of wetland loss provided?	
(Give details)	

For site based inventories please assess the info fields shown below and circle those which are included in the inventory. For non-site based inventories assess only numbers 7-26	
1. Geographical coordinates	14. Noteworthy fauna
2. Map of site included?	15. Social and cultural values
3. Justification of criteria	16. Land tenure/ownership
4. General location	17. Current land use
5. Ramsar Criteria	18. Adverse Factors
6. Compiler	19. Conservation measures taken
7. Area	20. Conservation measures proposed
8. Overview	21. Current scientific research & facilities
9. Wetland Type	22. Current conservation education
10. Physical features*	23. Current recreation and tourism
11. Hydrological values	24. Jurisdiction
12. Ecological features	25. Management authority
13. Noteworthy flora	26. Bibliographical references
Attribute score 0 – 5 against field numbers 1-26 above according to approximate frequency of inclusion within the inventory or information source	
(5) always (100%)	(2) sometimes (26–50%)
(4) most of the time (76–99%)	(1) rarely (<25%)
(3) commonly included (51–75%)	(0) never

11. Overall status of wetlands	
Description of status of wetlands included? **Provide as much detail as possible** (append sheet where necessary)	
12. Values and benefits	
Description of values and benefits included?	
(5) always (100%)	(2) sometimes (26-50%)
(4) most of the time (76%-99%)	(1) rarely (<25%)
(3) commonly included (51-75%)	(0) never
Provide a summary (or append sheet where necessary)	
Date of form completion: **Completed by:**	

Space for additional information
or to continue where insufficient space in previous sections…

Annex 5 Guidelines for completion of Wetland Inventory Assessment Sheets

Reference Details

1. Ramsar Region

Simply enter which region(s) are covered by the inventory material. [Africa – **afri**; Asia – **asia**; Eastern Europe – **eeur**; Western Europe – **weeu**; Neotropics – **neot**; North America – **noam**; Oceania – **ocea**]

2. Reference number

The system we have devised is to reference material using 4 sets of codes as follows:

Set one: at the spatial level

Global – **glo**; supra-regional – **spr**; Regional – **reg**; sub regional – **sbr**; national – **nat**; subnational – **sbn**.

*Set two: Wetlands International / **eriss** office reference code:*

[aeme, amer, aspa, ocep, eriss]

Set three: filing number

3 digit number allocated as material is inventoried (ie 001, 002, 003). Each Office to determine its own system for filing.

Set four: library reference number

Office library reference number (if applicable).

3. Countries/nations covered in the Inventory

Use the UN 3 letter country codes to identify country covered in the inventory. (ftp://ftp.ripe.net/iso3166-countrycodes).

4. WI / ERISS location

Each Office to determine eg shelf, library, filing cabinet, personal copy with NJS etc (especially useful for large documents which are too big for filing, or are oversize, or in the library). See table below for examples.

eg the following references would be referenced as shown in the table below:

1. International Lake Environment Committee Foundation (ILEC) and United Nations Environment Programme (UNEP) 1988 (status ongoing). *Survey of the State of World Lakes, database*. ILEC Foundation, Kusatsu, Shiga, Japan.
   Located at http://www.ilec.or.jp/database/database.html
2. Scott DA (ed) 1995. *A Directory of Wetlands in the Middle East*. IUCN, Gland, Switzerland, and IWRB, Slimbridge, United Kingdom.
3. Hughes RH & Hughes JS 1992. *A Directory of African Wetlands*. IUCN/UNEP/WCMC, Gland, Switzerland, and Cambridge, United Kingdom.
4. Scott DA 1980. *A preliminary inventory of wetlands of international importance for waterfowl in west Europe and northwest Africa*. IWRB Special Publication No 2, IWRB, Slimbridge, United Kingdom.

5. Sheppard R 1993. *Ireland's wetland wealth*. Irish Wildbird Conservancy, Dublin.

6. Department of Lands 1974. *Report on wetlands of international and national importance in the Republic of Ireland*. Forest and Wildlife Service, Dublin.

(see ref	Set one	Set two	Set three	Set four	
Above)	**Spatial level**	**Office**	**Filing number**	**Library ref. #**	**WI – location**
1	glo	aeme	001	–	eg of entry in Global cabinet + WWW
2	spr	aeme	001	7549	NJS shelf + WI lib
3	reg	aeme	001	1839	NJS shelf + WI lib
4	spr	aeme	002	7563	WI-lib
5	n	aeme	001	7243	National cabinet + WI lib
6	n	aeme	002	7981	National cabinet + WI lib

5. Title of Material

Name used to refer to the Inventory (usually the formal name of the Inventory).

6. Full name of authors or correspondent

Use ***eriss*** Standards. Correspondent is for example a personal communication.

7. Publication details

Should be entered as would appear in a reference list (use ***eriss*** Standards). Reference should be entered as required for publications including author, date, title of article/report journal, Journal title and volume, page numbers etc. Also publisher, place of publication and ISBN if book. The reference details should also be entered separately into the bibliographic database as supplied by ***eriss***. If current plans to put biblio database on the WWW emerge then it is best to ensure that the reference details are complete in both the assessment form and the biblio database.

Enter either text (publication details) or code if in process/development **-in-devt**

8. Wetland Inventory Directory? Y / N

Is the information presented on a site by site basis (eg Wetlands of the Middle east), or is an overview presented without specific reference to sites referenced with co-ordinates?

9. Date of Publication

As appears in the reference details. For digital information use last update.

10. Publication Type

At the very least we should be able to describe the information to a primary level (ie Academic, NGO, GO, consultancy), but it would also be good to break this down further to a secondary level (eg peer review book, journal etc). Practitioner material is material primarily produced for people involved in 'managing', and doing, as opposed to researchers and for the government.

Peer review Journal – **journ**; Peer review Book – **book**; Chapter in a book – **chapt**; Conference presentation/Keynote address – **presn**; Conference article in proceedings – **proce**; Govt/Agency/Internal Report – **govrp**; Govt/Agency publication – **govot**; NGO report –

ngorp; NGO formal publication – **ngopb**; Consultancy report – **consl**; Practitioner newsletter – **newsl**; Practitioner periodical – **perio**; Database Manual – **dbman**; Database software – **dbsof**; Other – **other**.

11. Language used

We intend to incorporate items obtained in different languages where possible. Use first three letters of the language. If the publication is bi/tri lingual then use codes for each.

12. English Summary

Is an English summary available **Y**/**N**. Only complete this if publication is not in English.

13. Other Information

If not a publication, how has the information been obtained? eg pers. comm. There may be occasions where we have obtained information from a telephone call or a letter or similar detailing the existence of an inventory.

Data availability

14. Data Custodian

15. Contact Details

16. Inventory Format

Paper – **paper**; Word processed file – **wordp**; Database – **dbfil**; Personal communication – **persc**; WWW publication – **wwweb**; GIS – **gisys**; Map – **mapfo**.

17. Circulation

Published – **publi**; Interdepartmental – **idept**; Internal – **intrn**; Restricted – **rstri**; Unrestricted – **unres**; Other – **other**.

18. Data Storage

Format/Storage: eg overview of World Ramsar sites – the inventory material is a book, but the data storage is both on paper and electronically (database). Also when Scott receives requests for information on Ramsar sites, he gives them information usually on paper, but the information is held electronically using coded fields on the Ramsar database.

Paper text – **paper**; Paper maps – **map-p**; Part of GIS – **ingis**; Database – **datab**; Digitised maps – **map-d**; Other electronic – **elect**.

Implementing Agency

19. Implementing Agency

This is not really crucial, but we thought it could be included easily and may yield some useful information. Who is doing/did the work? Government departments? Academic institutions? NGOs?

NGO international – **ngo-I**; NGO national – **ngo-n**; NGO subnational – **ngo-s**; NGO local – **ngo-l**; International governmental organisation – **gov-i**; Government national – **gov-n**; Government subnational – **go-sn**; Government local – **gov-l**; Private – **privt**; Academic institution – **acadm**; Other – **other**; Unknown – **unkno**.

20. Name of Implementing Agency

Funding Sponsor

21. Funding Sponsor

ie who is paying/paid for it?

NGO international – **ngo-I**; NGO national – **ngo-n**; NGO subnational – **ngo-s**; NGO local – **ngo-l**; International governmental organisation – **gov-i**; Government national – **gov-n**; Government subnational – **go-sn**; Government local – **gov-l**; Private – **privt**; Academic institution – **acadm**; Other – **other**; Unknown – **unkno**.

22. Name of Sponsoring Agency

Objectives

23. Are the objectives explicitly stated? Y / N

24. Main Issues being addressed in the Inventory

In this section we are attempting to categorise the motivation for the inventory. This may not be easy to categorise. The inventories that come first to mind, such as potential 'Ramsar' wetlands, would be categorised as 'biodiversity' inventories.

Biodiversity-research – **bio-res**; Biodiversity-baseline – **bio-bas**; Biodiversity-monitoring – **bio-mon**; Biodiversity-repeat survey/surveillance – **bio-sur**; Biodiversity-management tool – **bio-man**; Wetland products – **wetprod**; Geographical – **geograf**; Other – **otheris**; Public-education – **pub-edu**; Research-other – **oth-res**.

Wetland Definitions and Classifications

This will provide information on which classification systems are commonly in use. Is the Ramsar system widely used, or is it Cowardin's system, or something else? If the answer is simply that 1001 different systems are in use, this is useful information in itself.

25. Is a definition of wetlands explicitly stated?

Yes, no, inferred.

26. Was the Ramsar definition used? Y/N

27. Wetland Classification

State the classification scheme used to determine wetlands types:

Ramsar – **ramsar**; Other – **other**; Not Applicable – **notapp**.

Ramsar wetland types can be found at: http://www.iucn.org/themes/ramsar/key_ris_types.htm

28. Other classification (specify)

text field

29. Source of variability:

Source of variability: We are trying to establish whether consistent classification systems are not being used needs some more thought.

If the answer is variable (the question is dependant on the question above) then we were trying to ascertain whether the variability was simply due to use of several classification schemes/different definitions of wetland types, or sites etc.

Basis of Study/Wetland Inclusion

Almost all inventories contain only a sample of the wetlands in the study area. This question seeks to identify the 'filters' that were used to identify wetlands to be included in the Inventory. Eg. was it coastal wetlands? Important wetlands for bird habitat? Freshwater wetlands? Wetland extent?

'Land cover/remotely sensed data' and 'political/geographical boundary' eg of latter eg where wetlands of Africa, or wetlands of Namibia etc, where the boundary of the study is set by geographic boundaries (this is what we meant by political boundary, eg for those cases which are sub national but say eg provincial boundaries).

30. All wetlands or just part? all / part

31. If sample, what was the basis of selection?

Land Cover/Remotely Sensed Data – **rs-landc**; Political/geographical boundary – **boundary**; Landform – **landform**; Suprahabitat / System – **system**; Habitat – **habitat**; Faunal or floral groups – **flo-faun**; Climate – **climate**; Function – **function**; Hydrology – **hydrolog**; Biodiversity value – **biovalue**; Cultural value – **culture**; Artefact of data collation – **artefact**; Other – **other**.

32. Text for details of 'other basis'

Temporal Scale of Study

This question assesses the temporal scale of the inventory program (ie was it a one off study of part of an ongoing program). It would also be interesting to examine planned durations vs real duration, do projects fold before completion, do they take much longer to complete than originally thought? This information is likely to be difficult to verify and/or obtain, but we can see how it goes. In most cases, the answer may well be 'unknown.' Most important is to identify which are discrete one-off surveys from those which are/were continuing over a period of time. May be difficult to identify a cut off point between one off (which takes ~3 years to complete) and an ongoing study which runs for 3 years and stops. The decision will ultimately lie with the aims of the study.

When the study is part of an ongoing program, are surveys carried out annually, 5 yearly and/or randomly, etc. Current status is whether the program is still running or whether it has now finished. If the start date was, for example, 1990 and the planned duration was 10 years but the program is now closed, then we learn that the program folded before completion. That was the logic behind it. And also to be able to assess how much inventory work is carried out by either on-off surveys or programs which only run a specified number of years and then stop or permanent programs.

33. Not applicable

eg review of data/collation of data or mix of several dates.

34. Discrete survey

35. Date (range) of data collection/collation

36. Has the inventory been updated?

Y / N / ?

37. Any plans to update the inventory

Y / N / ?

38. Material updated on ad-hoc basis

39. Purpose of update

addsites – **add**; review status – **rev**; other – **oth**; unknown – **unkno**.

40. Ongoing survey/program

41. Start date:

42. Planned duration (in yrs/mths):

43. Frequency/periodicity of survey regime:

44. Current status:

Is the Inventory ongoing – **Open**; or has the project been completed – **Closed**; or unknown – **unkno**.

Methods

45. Data collection methods

Collation/review – **collate**; Ground survey – **grounsur**; Remote sensing – **remote**; Unknown – **unknown**.

If ground survey, give further details (#46)

If remote sensing, give further details (#47)

46. Extent of ground survey

47. Details of remotely sensed data

Satellite – **satel**; Aerial photo – **aerial**; Video – **video**; LIDAR – **lidar**; Radar – **radar**; Satellite imagery – **s-imagry**; Not provided – **unknown**.

48. Spatial resolution

'Spatial Resolution' eg when satellite imagery is used, whether the pixel size is 10x10 m or 10x100 m or 100x100 m and so on. This depends on the sensor used, eg SPOT, LTM etc. Or if a video, what is the smallest object that can be discerned, ie a person-sized object, a car-sized object etc. If an aerial photo, it would refer to the smallest object discernible, NOT the scale ie 10:1000000 etc.

49. Was the Inventory ground truthed? Y / N

total; partial; none; unknown.

Inventory Synthesis

50. Summary given?

51. Extent of wetlands given?

52. Total extent of wetlands covered (ha)

53. Number of sites

54. Areas by class?

If wetlands are described in classes of some sort, are they inventoried in this way? If so provide details (eg freshwater wetlands – 2000 ha, marine wetlands – 7000 ha etc).

55. Details of area by class

text field

56. Estimate/summary of wetland loss?

We thought that there were just too many possibilities for information fields and decided that it would be best to have something to compare with. Therefore we suggest that we indicate *if* and *how often* these are included in the material which we examine. From there we will be able to see which ones are commonly used and we will be able to assess how comparable the Ramsar information fields are with those actually being used, ie are the information fields in use of any relation to the Ramsar information fields? Perhaps later it may be possible to assess what other information is commonly included.

57. Details of wetland loss

text field

Information fields included in inventory

Attribute score 0 – 5 against field numbers 1–26 above according to approximate frequency of inclusion within the inventory or information source

(5) always (100%)

(4) most of the time (76–99%)

(3) commonly included (51–75%)

(2) sometimes (26–50%)

(1) rarely (<25%)

(0) never

58. Geographical coordinates

59. Map of site included?

60. Justification of criteria

61. General location

62. Ramsar Criteria

63. Compiler

64. Area

65. Overview

66. Wetland type

67. Physical features

eg geology; geomorphology; origins – natural or artificial; hydrology; soil type; water quality; water depth; water permanence; fluctuations in water level; tidal variations; catchment area; downstream area; climate.

68. Hydrological values

69. Ecological features

70. Noteworthy flora

71. Noteworthy fauna

72. Social and cultural values

73. Land tenure/ownership

74. Current land use

75. Adverse factors

76. Conservation measures taken

77. Conservation measures proposed

78. Current scientific research and facilities

79. Current conservation education

80. Current recreation and tourism

81. Jurisdiction

82. Management authority

83. Bibliographical references

Overall status

In most cases it will not be possible to state what protection status the area covered in the source material has, unless the material is, for instance, a 'directory of wetlands of international importance' or listing of Ramsar sites in a country etc. However, please enclose a summary of information available which can be flagged (though not included in the meta-database) for re-examination at a later date.

84. Are summary comments made the overall status of wetlands?

85. Notes from comments in inventory

Values and benefits

State whether any information is provided (yes or no) and provide summary details. Information will be flagged (though not included in the meta-database) and can be re-examined at a later date. If assessing an inventory covering several sites with individual entries, we suggest that we indicate *if* and *how often* details of the values and benefits are included in the material which we examine.

86. Are summary comments made about the overall status of wetlands?

87. Notes from comments in inventory

Compilation Notes

88. Name of Compiler

89. Date of compilation

Annex 6 Wetland Inventory Assessment database fields

	Field Name	Type	Size	Question	Code words	3/6/98 Codes
				1. Reference Details		
1	RAMSAR_REG	Text	4	Ramsar region	Africa, Asia, Eastern Europe, Western Europe, Neotropics, North America, Oceania	afri, asia, eeur, weeu, noam, ocea, neot
2	REFER_NUMB	Text	20	Reference Number	(geo. scope)(Office)(number)(library reference code)	glo spr reg sbr nat sbn, aeme amer aspa ocep erris
3	STATESINCL	Text	180	Countries Covered	Use National code/s	
	sub_nation	Text	25	If sub-national, then describe geographic coverage	Text	
4	WI_LOCATIO	Text	20	WI / ERISS location	Text	
5	INV_TITLE	Text	180	Title of Inventory	Text	
6	AUTHORNAME	Text	100	Full Name of Author(s) / Correspondent:	Text	
7	PUB_DETAIL	Text	200	Publication details	Text (or "in development")	(text) or in-devt
8	DIRECTORY	Logical	1	Wetland Inventory Directory?	Y / N	y, n
9	PUBL_DATE	Date	8	Date of Publication:	Year	
10	PUBL_TYPE	Text	10	Publication Type:	A-Peer review Journal, A-Peer review Book, A-Chapter in a book, Conf-Presentation/Keynote address, Conf-Article in proceedings, Govt/Agency-Internal Report, Govt/Agency-Publication, Govt/Agency-Other, NGO-report, NGO-Formal publication, Consultancy report, Practitioner-newsletter, Practitioner-periodical, Database Manual /Software, Other	journ, book, chapt, presn, proce, govrp, govpb, govot, ngorp, ngopb, consl, newsl, perio, dbman, dbsof, other
11	LANGUAGE	Text	7	State language used:	Text	
12	ENG_SUMMRY	Logical	1	English summary available?	Y / N	y, n

	Field Name	Type	Size	Question	Code words	3/6/98 Codes
13	OTHER_INFO	Text	100	If not a publication, how has the info been obtained?	Personal communication, ??	
				2. Data availability		
14	CUSTODIAN	Text	100	Full name of data custodian/organisation	Text	
15	CONTACT_DT	Text	200	Contact details	Text	
16	INV_FORMAT	Text	30	Format of inventory material	Paper, Word Processed File, Database, Personal communication, WWW pub, GIS, Map	paper, wordp, dbfil, persc, wwweb, gisys, mapfo
17	CIRCULATIO	Text	10	Circulation	Published, Interdepartmental, Internal, Restricted, Unrestricted, Other	publi, idept, intrn, rstri, unres, other
18	DATA_STORE	Text	20	Data Storage	Paper text, paper maps, part of GIS, database, digitised maps, other electronic	paper, map-p, ingis, map-d, datab, elect
19	IMPLAGENCY	Text	25	**3. Implementing Agency**	NGO-I, NGO-N, NGO-SN, NGO-L, GO-I, GO-N, GO-SN, GO-L, Private, Academic Institution, Other, Unknown	ngo-i, ngo-n, ngo-s, ngo-l, gov-i, gov-n, go-sn, gov-l, privt, acadm, other, unkno
20	AGENT_NAME	Text	200	Name	Text	
21	FUND_SPONS	Text	25	**4. Funding Sponsor**	NGO-I, NGO-N, NGO-SN, NGO-L, GO-I, GO-N, GO-SN, GO-L, Private, Academic Institution, Other, Unknown	ngo-i, ngo-n, ngo-s, ngo-l, gov-i, gov-n, go-sn, gov-l, privt, acadm, other, unkno
22	SPONS_NAME	Text	200	Name	Text	
				5. Objectives		
23	EXPL_OBJEC	Logical	1	Are the objectives explicitly stated ?	Y / N /?	y, n, ?
24	MAINISSUES	Text	50	Main issues being addressed:	Biodiversity-research, Research-other, Biodiversity-baseline, Biodiversity-monitoring, Biodiversity-repeat survey/surveillance, Biodiversity-management tool, Wetland Products, Geographical, Landuse Planning, Other	bio-res, bio-bas, bio-mon, bio-sur, bio-man, wetprod, geograf, land-up, oth-res, pub-edu, otheris
				6. Definitions – Wetlands and Classification		

	Field Name	Type	Size	Question	Code words	3/6/98 Codes
25	WETLAN_DEF	Text	3	Is a definition of wetlands explicitly stated ?	explicit, inferred, nil	explicit, inferred, nil
26	RAMSAR_DEF	Text	1	Was the Ramsar definition used?	Y / N / variable	y, n, variable
27	WET_CLASSI	Text	10	Wetland Classification:	Ramsar, Other, Not Applicable	ramsar, other, not_app
28	CLASSNOTES	Text	200	Other classification (specify)	Text	
29	VARIABILIT	Text	20	Source of variability:	Definition of wetland type, between sites, other	
				7. Basis of Study/Wetland Inclusion		
30	ALL_OR_PRT	Text	10	All wetlands or just part?	All / Part	all, part
31	SAMPLE_BAS	Text	20	If sample, what was the basis of selection?	Land Cover/Remotely Sensed Data, Political/geographical Boundary, Landform, Suprahabitat / System, Habitat, Faunal or Floral Groups, Climate, Function, Hydrology, Biodiversity Value, Cultural value, Artefact of data collation, Other	rs-landc, boundary, landform, system, habitat, flo-faun, climate, function, hydrolog, biovalue, culture, artefact, other
32	OTHER_BASI	Text	50	*Text for Other*	Text	
				8. Temporal Scale of Study		
33	NOT-APPLC	Text	2	Not applicable (eg review/collation)		
34	DISCR_SURV	Text	1	Discrete survey	Y / N	y, n
35	DSURV_RANG	Date	16	Date (range) of data collection/collation ?	Dates	
36	DSURV_UPDT	Text	1	Has the Inventory been updated?	Y / N / U	y, n, u
37	DSURV_PLAN	Text	1	Any plans to update	Y / N / U	y, n, u
38	AH_UP_SURV	Text	1	Material updated on ad-hoc basis	Y / N / U	y, n, u
39	UPDAT_PURP	Text	10	Purpose of update	Add sites, review status, other, unknown	add, rev, oth, unkno
40	CURR_SURV	Text	1	Ongoing survey/program	Y / N / U	y, n, u
41	START_DATE	Date	8	Start date:	Year	

	Field Name	Type	Size	Question	Code words	3/6/98 Codes
42	PL_DURATIO	Text	10	Planned duration (in yrs/mths):	Years / U	(text) u
43	UPDAT_FREQ	Text	10	Frequency/periodicity of survey regimen:		
44	CURRSTATUS	Text	10	Current status:	Open / Closed / U	open, closed, unkno
				9. Methods		
45	DATA_METHO	Text	30	Data collection methods:	Collation /review, ground survey, remote sensing, not stated	collate, grounsur, remote, unkno
46	GRND-SURV	Text	10	Extent of ground survey?	Text	total, partial, none, unkno
47	RS_DETAILS	Text	50	Details of remotely sensed data	Satellite, Aerial Photo, Video, LIDAR, Radar, Satellite imagery, Map Product, Other, Not provided	satel, aerial, video, lidar, radar, s-imagry, unkno
48	SCALE_RESO	Text	20	Spatial resolution	Text (see Guidelines)	
49	GROUND_TRU	Text	1	Was the Inventory ground truthed?	Y / N	y, n,u
				10. Inventory Synthesis		
50	INV_SUMMAR	Text	1	Summary given?	Y / N / U	y, n, u
51	AMOUNT_WET	Text	1	Extent of wetlands given?	Y / N / U	y, n, u
52	WETLAND_HA	Numeric	10	Total extent of wetlands covered (ha)	Number of ha	
53	WET_SITES	Numeric	10	Number of sites	Number	
54	AREA_CLASS	Text	1	Areas by class?	Y / N / U	y, n, u
55	AREA_CATEG	Text	200		Text	
56	WET_LOSS	Text	1	Estimate/summary of wetland loss?	Y / N / U	y, n, u
57	LOSS_NOTES	Text	200	Additional notes on wetland loss	Text	y, n, u
58	GEO_COORDS	Numeric	1	Geographical coordinates		0, 1, 2, 3, 4, 5
59	MAP_PROVID	Numeric	1	Map of site included?		0, 1, 2, 3, 4, 5
60	GEN_LOCATI	Numeric	1	Justification of criteria		0, 1, 2, 3, 4, 5

	Field Name	Type	Size	Question	Code words	3/6/98 Codes
61	COMPILER	Numeric	1	General location		0, 1, 2, 3, 4, 5
62	RAM_CRITER	Numeric	1	Ramsar Criteria		0, 1, 2, 3, 4, 5
63	CRIT_JUSTI	Numeric	1	Compiler		0, 1, 2, 3, 4, 5
64	AREA	Numeric	1	Area		0, 1, 2, 3, 4, 5
65	OVERVIEW	Numeric	1	Overview		0, 1, 2, 3, 4, 5
66	WET_TYPE	Numeric	1	Wetland type		0, 1, 2, 3, 4, 5
67	PHYSFEATUR	Numeric	1	Physical features		0, 1, 2, 3, 4, 5
68	HYDROFEATU	Numeric	1	Hydrological values		0, 1, 2, 3, 4, 5
69	ECOLFEATUR	Numeric	1	Ecological features		0, 1, 2, 3, 4, 5
70	NOTEWFLORA	Numeric	1	Noteworthy flora		0, 1, 2, 3, 4, 5
71	NOTEWFAUNA	Numeric	1	Noteworthy fauna		0, 1, 2, 3, 4, 5
72	SOCULTVALU	Numeric	1	Social and cultural values		0, 1, 2, 3, 4, 5
73	LANDTENURE	Numeric	1	Land tenure/ownership		0, 1, 2, 3, 4, 5
74	LANDUSES	Numeric	1	Current land use		0, 1, 2, 3, 4, 5
75	THREATS	Numeric	1	Adverse factors		0, 1, 2, 3, 4, 5
76	CONSERVED	Numeric	1	Conservation measures taken		0, 1, 2, 3, 4, 5
77	CSV_PROPOS	Numeric	1	Conservation measures proposed		0, 1, 2, 3, 4, 5
78	RESEARCH	Numeric	1	Current scientific research and facilities		0, 1, 2, 3, 4, 5
79	CONSRV_EDU	Numeric	1	Current conservation education		0, 1, 2, 3, 4, 5
80	REC_TOURIS	Numeric	1	Current recreation and tourism		0, 1, 2, 3, 4, 5
81	JURISDICTI	Numeric	1	Jurisdiction		0, 1, 2, 3, 4, 5
82	MANAG_AUTH	Numeric	1	Management authority		0, 1, 2, 3, 4, 5

	Field Name	Type	Size	Question	Code words	3/6/98 Codes
83	REFERENCES	Numeric	1	Bibliographical references		0, 1, 2, 3, 4, 5
84	OVERSTATUS	Text	1	**11. Overall status of wetlands**		
85	STATUSNOTE	Text	200	Description of status of wetlands included?	Text	
				12. Values and benefits		
86	VALUE_BENE	Text	1	Description of values and benefits included?	Y / N / U	y, n, u
87	VALUE_NOTE	Text	200		Text	
88	ENTRY_BY	Text	20	**13. Completed by**	Text	
89	ENTRY_DATE	Date	8	Date of form completion	Year	

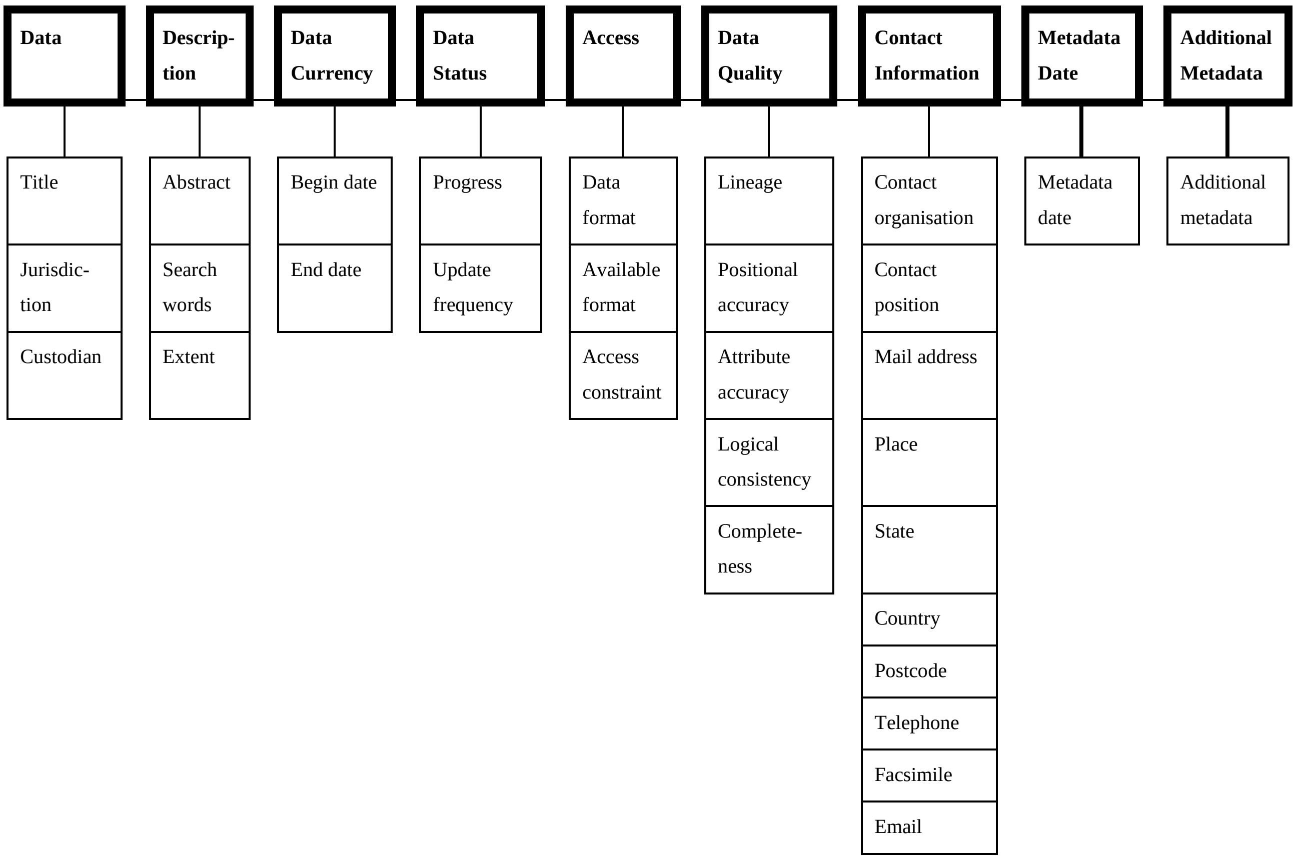
Annex 7 Wetland Inventory Bibliography fields

Note. A standard bibliography entry system was established by ***eriss*** *for bibliographic entry by all project teams, to assist compatibility in final report compilation.*

ITEM NUMBER	Automatic entry number
AUTHOR/S	
EDITOR/S	
TITLE	Title of paper or book
SOURCE	Title of source of paper(where relevant), eg book, journal
SERIES	Title of series (where relevant)
EDITION NUMBER	
VOLUME	
PART	
DATE	Date of publication
PUBLISHER	
LOCATION PUBLISHED	If several publishers at different locations, may just enter the first location listed
PAGE NUMBERS	Example: 223–267
CONFERENCE DETAILS	If ‘source’ is the proceedings of a conference
CITED IN	Where the ref has been used in other publications – can be a useful search tool. May refer to another Item Number in the database
ADDED AUTHORS	For other than the main author/s, eg illustrators and translators
AUTHOR AFFILIATION	Name of organisation, department, etc
SUBJECT DESCRIPTION	Key words and phrases in the reference
	NOTES – Less formal than ‘Subject Description’ field, for any extra comments about the reference, its authors, its subject matter, further work, etc

Annex 8 Wetland Inventory Metadatabase fields

An illustration of the meta-data fields that were designed for the WWW version of the meta-database, but note that little non-report format data was located through the regional analyses.



Review of international/continental wetland resources

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Contents

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1 Introduction

This component of the Global Review of Wetland Resources and Priorities for Wetland Inventory (GRoWI) reviews international and continental wetland inventories and other global wetland sources, in order to address the project aims. It covers all regions of the world, based on the seven regional categories used by the Ramsar Wetlands Convention – Africa, Eastern Europe, Western Europe, North America, Neotropics, Asia and Oceania.

This international/continental scale review contributes to quantification of the global wetland resource by compiling and reporting on existing wetland areal estimates and studies of wetland loss and degradation. It identifies knowledge gaps and makes recommendations as to priority areas for future wetland inventory effort, and preferred format for inventories in future.

2 Information sources

A broad range of inventories and other global wetland information sources were reviewed in this component of the GRoWI project, including global atlases for particular wetland types, regional inventories, journal and conference papers, books and web pages. Information sources were identified through literature searches, personal communication with relevant agencies and experts, and requests for assistance via wetland-related electronic mail forums.

Forty-five sources have been assessed and entered into a database (Microsoft Access 97). Others that were assessed and considered to contain too little relevant information were not included in the database, but all relevant information has been extracted and used in this written report, eg OECD (1996). References have been compiled in a bibliography. Some sources have proved difficult to locate or obtain, and new sources are being identified continually, so more could be assessed in future. Other sources such as continental or global scale maps or remotely sensed imagery have not been assessed; Sahagian and Melack (1996) have identified these as a source of inventory information that requires assessment.

2.1 Wetland coverage

As the sources reviewed have a broad-scale approach to wetlands, all were collations of information from a range of other regional, national and sub-national sources. They cover a wide range of wetland types, based on the definition of wetlands determined for the Ramsar Convention, namely ‘areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres’. Coral reefs and seagrasses have been included in this review.

Sources reviewed relate to the following wetland types: wetlands in general (26); coastal and marine wetlands (11) including 7 sources relating to mangroves and/or coral reefs; peatlands and mires (3); artificial wetlands and artificial beaches (3); and others (2) which relate to important bird areas and protected areas respectively.

2.2 Details of inventory sources

2.2.1 Perspective

Thirty of the sources reviewed gave a global or supra-regional perspective, providing information on wetland inventory and/or wetland loss. The remainder of sources gave a continental (in the case of Australia) or regional perspective, covering wetlands in general or specific wetland types in Africa (3), Neotropics (1), North America (1), Oceania (6) and Asia (4).

2.2.2 Age

The sources reviewed were published in 1980–85 (7), 1985–90 (12), 1990–95 (13) and 1995–98 (13). It can be expected that wetland area and/or wetland loss data from the earlier sources is now out of date, so the most recent data, eg post-1990, has been reported if available.

2.2.3 Format

Of the 45 sources reviewed, just two were electronic databases accessed via the World Wide Web (WWW), all others being paper publications. The majority of sources were reports or publications by non-government organisations (NGOs) (18) and books (12). The remainder were conference presentations or proceedings (7), journal articles (4) and government reports or publications (3).

The majority of sources reviewed (25) were non site-based inventories, reviews or overviews of wetland information. Sixteen sources were site-based inventories, and four were non site-based but included detailed descriptions of one or more wetland sites as case studies. Fourteen sources in total were true wetland directories or inventories.

2.2.4 Language

All sources reviewed had been published in English. It is possible that some supra-regional or continental sources have been published in languages other than English and have therefore been missed by this review, but it is believed that they are few. One such example is the South American Wetlands Assessment published recently in Spanish (I Davidson pers comm 1998), a copy of which has not been obtained in time for inclusion in this report. It appears the majority of large-scale reviews and inventories are published in one or more languages including English, ensuring a wide international distribution and readership.

2.2.5 Data storage

The method of data storage was mostly on paper only (13) or unspecified by the author/s (15). Nine sources stored data in electronic form, either on digital maps, database or WWW. Two sources stored data in a Geographic Information System.

2.2.6 Data method

The method of data collection was often poorly specified, if at all, but the vast majority of sources reviewed were collations (41), while just three were collations of information supplemented with remote sensing and/or ground survey (Gopal et al 1982, Frayer 1991, Spalding et al 1997), and one reference was entirely based on ground survey and remote sensing data (H Kirkman unpubl).

2.2.7 Implementing agency

Over half (24) of the inventories and reviews assessed were conducted by international NGOs. Others were carried out by academic agencies (8), national government agencies (4), and consulting agencies (1). The remaining eight sources were specified as ‘other’ or ‘unknown’, most being compilations of material from many contributors (and hence agencies) from around the world.

2.2.8 Funding sponsor

Funding sponsors varied, including international NGOs (12), national NGOs (2), national government agencies (9), and private companies (3). Six sources received joint sponsorship from combinations of international and national NGOs, international and national government agencies, and academic or private agencies. The funding sponsor was unspecified in 13 of the sources assessed.

3 Extent and distribution of wetlands

Sources reviewed provide data on extent and distribution of wetlands at various scales, from global estimates to the areal extent of particular wetland types at specific sites. There is considerable inconsistency in the information obtained for review, with data unavailable for some sites or countries due to a lack of adequate inventory or maps. Estimates obtained have been tabulated, including global wetland area (table 1), regional wetland areas (table 2) and national wetland areas (table 3).

Dugan (1993) provides a global estimate of 4 million km^2 (400 million ha) for peatlands (table 1), and presents some general wetland areas for Indonesia, Canada, Alaska, Mexico and the Caribbean (tables 2 & 3). Of particular note is the total of 1.4 million km^2 (140 million ha) of wetlands in western Canada and Alaska, which is said to equal one quarter of the world's total wetland area. Unfortunately, the method for this calculation is unclear and original data are not provided, but this statement implies that the world's wetland area is an estimated 5.6 million km^2 (560 million ha). Dugan (1993) uses the Ramsar definition of wetlands, and refers to non-marine wetlands only. Separate methane-emission studies have calculated the global extent of natural freshwater wetlands as 530 million ha (Matthews & Fung 1987), and 570 million ha (Aselmann & Crutzen 1989) respectively. The global distribution of wetlands has been mapped by NASA (1999), using data from Matthews and Fung (1987).

As part of an overview of wetland inventory, ecology and management, Whigham et al (1993) provide wetland area estimates for parts of Africa, the Mediterranean region, northern Australia, Papua New Guinea, South Asia, Canada, Greenland, United States of America, Mexico and tropical South America. This series was intended to supplement earlier regional inventories and directories, with global coverage and emphasis upon countries and wetlands of particular significance. Regional and national estimates from Whigham et al (1993) are included in tables 2 and 3 (listed as Britton & Crivelli 1993, Denny 1993, Glooschenko et al 1993, Olmsted 1993, Wilen & Tiner 1993).

Wetland directories for Asia (Scott 1989), Africa (Hughes & Hughes 1992), Middle East (Scott 1995), Neotropics (Scott & Carbonell 1986) and Oceania (Scott 1993a) provide areas and descriptions for individual wetland sites, with some data by wetland type at a national or continental scale.

Wetlands on the Ramsar Convention Bureau List of Wetlands of International Importance are generally well-inventoried, but note reservations on the completeness of this dataset identified by Pedretti (1997). The Ramsar Information Sheet is a standardised document for recording data on Ramsar wetland sites, and provides a general description of the wetland site, but was not designed to detect changes in ecological character and is at present unsuited to perform such a function. For the Ramsar Information Sheet (and hence the Ramsar Database) to be more useful for inventory and monitoring of Ramsar sites, it would need re-designing (Pedretti 1997). Ramsar site details are stored in the Ramsar Database and published regularly (Jones 1993a,b,c, WCMC 1990, Frazier 1996). As of 30 January 1999, Ramsar-listed wetlands total 965 sites covering 70 471 806 ha (D Peck pers comm 1999) (table 1). It is likely that future changes in format and publication method, eg WWW, will increase accessibility and improve the effectiveness of these directories as a source of wetland data and as a tool for wetland management.

Aside from wetland-specific directories, publications such as Grimmett and Jones (1989) and IUCN (1994) are useful sources of area data and inventory information for some wetland habitats, although their main emphasis is other than wetlands. Grimmett and Jones (1989) detail important bird areas in Europe, which includes wetland habitats such as rivers, lakes, islands and coastal wetlands. The recent South American Wetlands Assessment (published in Spanish only, a copy of which was not obtained in time for inclusion in this review) also assessed wetlands largely on the basis of their importance to birds. As a result not all wetlands of importance are included, and as such it is crucial to take the objectives of this and similar inventories into consideration when using the data (L Naranjo pers comm 1998).

IUCN (1994) provides site descriptions of protected areas throughout the world, including some area estimates for inland and marine wetlands, eg Sundarbans National Park in India, Egypt’s Ras Mohammed National Park, Victoria Falls National Monument in Zimbabwe and Haleji Lake Wildlife Sanctuary in Pakistan.

3.1 Freshwater wetlands

The global extent of natural freshwater wetlands is calculated by Matthews and Fung (1987) as 530 million ha, and by Aselmann and Crutzen (1989) as 570 million ha, forming the basis of their methane-emission studies (table 1). These figures are similar, especially when it is considered that they were each calculated using different methods, and are approximately double earlier global wetland area estimates (Lieth 1975, Whittaker & Likens 1975, Ajtay et al 1979). The huge discrepancy with earlier estimates is due to the fact that the two recent studies used a broader definition of methane-producing wetlands, including seasonal and permanent freshwater ecosystems, either peat-forming or not (Aselmann & Crutzen 1989), and small ponded wetlands (Matthews & Fung 1987). Saltwater wetlands are excluded as their methane production is usually insignificant (Aselmann & Crutzen 1989), and so other sources must be examined in order to determine the true global extent of wetlands under the broad Ramsar definition.

Estimates of total extent of freshwater wetlands also vary on a regional basis, partly due to the difficulty of defining the extent of permanent and seasonal wetlands, eg swamps and floodplains. Denny (1985) reports that Africa has a total of 345 000 km^2 (34.5 million ha) of freshwater wetlands, while Aselmann and Crutzen (1989) estimate that permanent and seasonal wetlands in Africa combined total 356 000 km^2 (35.6 million ha). Nevertheless, these figures indicate that approximately 1% of Africa’s surface area is freshwater wetland.

South America has an estimated total of 1.52 million km^2 (152 million ha) of freshwater wetlands (Aselmann & Crutzen 1989). The same authors also estimate that Europe has 6700 km^2 (670 000 ha) of various freshwater wetland types, noting that much of the original wetland area has been lost to development.

3.1.1 Extent and distribution of peatlands

There is an estimated 4 million km^2 (400 million ha) peatlands worldwide (Dugan 1993) (table 1). Taylor (1983) provides national peat areas and percentage of land surface area, although some of these estimates of peat area are considerably lower than more recent estimates (table 4). The current estimate for total area of undeveloped tropical peatland is 30–49 million ha, approximately 10% of the global peatland resource (Maltby et al 1996). Well over half is located in Southeast Asia, principally in Indonesia. Rieley et al (1996) provide summary statistics for the regional distribution of tropical peatlands (table 5). There is no agreement on the extent of the tropical peatland resource, due to differences in the definition of peat and peat soils, and the survey techniques employed. Rieley et al (1996) states that

Indonesia has the largest area of tropical peatlands, with the highest estimate of 27 million ha placing Indonesia fourth in the world league table of peatland by area, behind the former USSR, Canada and the United States of America.

Freshwater boreal wetlands cover an estimated 600 000 km^2 (60 million ha) of Alaska, and over 20% of central Canada. The wetlands are predominantly peatlands, but include a wide range of wetland types, including delta marshes, floodplain swamps and moist and wet tundra (Dugan 1993). Aselmann and Crutzen (1989) estimate the total area of mires in Alaska as 250–400 000 km^2 (25–40 million ha), mostly fens and bogs.

Zoltai and Pollett (1983) give the approximate area of wetlands in Canada as 1.7 million km^2 (170 million ha), defined as 'areas where wet soils are prevalent, having a water table near or above the mineral soil for most of the thawed season, supporting a hydrophilic vegetation, and pools of open water less than 2 metres deep'. Aselmann and Crutzen (1989) estimate that Canada's wetlands cover a total of 1.27 million km^2 (127 million ha), 95% of which are bogs and fens. Estimates provided by Cox (1993) concur, giving Canada's total wetland area as 127 199 000 ha, of which greater than 111 million ha is peatland.

Dugan (1993) provides areal extent of peatlands in many countries, notably Canada (70% of wetlands in eastern Canada are peatlands) and northern Europe (Sweden and Norway contain 60 000 km^2 (6 million ha) of bogs and fens). One-sixth of Sweden's land area is covered by peat, even if thin, including 20 000 km^2 (2 million ha) of wooded wetlands and over 50 000 km^2 (5 million ha) of open mire, mostly treeless (Sjörs 1983). Finland used to have over 100 000 km^2 (10 million ha) of mires, 30% of the country's land area, but 55 000 km^2 (5.5 million ha) has been lost to development (Ruuhijärvi 1983). Taylor (1983) provides peat areas for Great Britain and Ireland, specifically England (361 690 ha), Scotland (821 381 ha), Wales (158 770 ha) and Ireland (1 342 450 ha), totalling 26 842.91 km^2 (2 684 291 ha).

Peatlands in the former Soviet Union cover 830 000 km^2 (83 million ha), including 39 million ha (50% land area) in western Siberia. The total peat resources in this region are huge, estimated at 66% of the world's peat deposits (Botch & Masing 1983). Aselmann and Crutzen (1989) give a total wetland area of 1 500 000 km^2 (150 million ha) for the former Soviet Union, of which 1 450 000 km^2 (145 million ha) are bogs and fens.

China has an estimated 31 000–34 800 km^2 (3.1–3.48 million ha) of virgin peatlands, the majority located in the extreme north-east of the country (Aselmann & Crutzen 1989).

Legoe (1981) estimates Australia's peatland resource as 0.04% of the continent's land surface area, totalling 3072.92 km^2 (307 292 ha), although no areas are given for individual peatland sites in Australia. Yet Taylor (1983) estimates Australia's peat area at just 150 km^2 (15 000 ha), 0.002% of the land surface area. The difference may be due to the respective definitions of peatland, which were not detailed by either source.

Peat resources in South America and Africa are relatively poor. In Brazil, peatlands cover 1000 km^2 (100 000 ha), 0.01% of total land area (Junk 1983). African peatlands are very small areas and mostly low grade peat (Thompson & Hamilton 1983). Peat reserves in Central and East Africa are an estimated 430 ha (Denny 1985).

3.1.2 Extent and distribution of swamps

Swamps are often difficult to separate from other wetland types, and may include peatlands, bogs, flooded forest, etc. In this review all areas of wetland described as 'swamp' in their respective reference source have been reported, but with no attempt to choose a particular definition of the wetland type, or to separate the variety of definitions and information available.

Aselmann and Crutzen (1989) calculated the global area of bogs (1.9 million km^2), fens (1.5 million km^2), swamps (1.1 million km^2) and floodplains (800 000 km^2). They calculated the global area of truly permanent swamps, marshes and floodplains as 300 000 km^2 (30 million ha).

Africa has an estimated total of 345 000 km^2 (34.5 million ha) of wetlands (1% land surface area), including a number of very large swamp systems (Denny 1985). The Upper Nile Swamp covers 92 000 km^2 (9.2 million ha) including floodplain, of which 40 000 km^2 (4 million ha) is permanent swamp. Lake Bangweulu has 6000 km^2 (600 000 ha) of swamp and 6000 km^2 (600 000 ha) of floodplain. The swamps and islands of the Okavango Delta cover 16 000 km^2 (1.6 million ha). In Uganda there is a network of swamps over 11 800 km^2 (1.18 million ha), 6% of the total land surface area. Zambia has wetlands over 20% of its land surface to the total of 750 000 km^2 (75 million ha), including dambos (35 000 km^2), pans, swamp flats (Gopal et al 1982). Three percent of Zambia's land surface area is covered with swamps, totalling 24 000 km^2 (2.4 million ha) (Denny 1985).

Thompson and Hamilton (1983) provide areas for seven of Africa's largest swamps, which total over 60 000 km^2 (6 million ha) of permanent swamp and greater than 400 000 km^2 (40 million ha) of seasonally inundated swamps. They report a 1973 estimate of 340 000 km^2 (34 million ha) of tropical swamps in Africa, noting that this estimate is perhaps underestimated by up to 30%. They consider an estimate of the same date of 85 000 km^2 (8.5 million ha) for headwater swamps in Africa to be accurate. Further areal data for swamps, floodplains and shallow waterbodies of Africa are provided in Whigham et al (1993) and summarised in table 2.

South America is another region with vast areas of swamp, for example the Amazon River and its tributaries which Junk (1983) estimates has a catchment area of 7 million km^2 (700 million ha). It is estimated that there are 300 000 km^2 (30 million ha) of floodplains along the Amazon River and its tributaries, with an extra 1 million km^2 (100 million ha) of small river and stream floodplains in the Amazon Basin, much of it rainforest (Aselmann & Crutzen 1989). The small river floodplains in the Amazon basin contribute in a large part to the global area of 700 000 km^2 (70 million ha) of wetlands with no defined inundation period or unknown seasonality identified by Aselmann and Crutzen (1989).

It is estimated that the former Soviet Union has a total wetland area of 1.5 million km^2 (150 million ha), of which 65 000 km^2 (6.5 million ha) are swamps and marshes (Aselmann & Crutzen 1989).

Britton and Crivelli (1993) provide minimal estimated areas for Mediterranean wetlands including freshwater marsh, forested wetland and non-tidal salt marsh (table 3). However, they note that problems arise when inventorying wetlands in the Mediterranean region, eg difficulties in distinguishing non-tidal salt marsh from the larger wetland units in which it occurs (such as saline coastal lagoons and athalassic salt lakes), and the greatly reduced and fragmented distribution of freshwater marshes and forested wetlands.

Scott (1995) provides information on the extent and distribution of wetlands in the Middle East, including the Mesopotamian Marshes, a vast network of marshes covering 15 000 km^2 (1.5 million ha) in the middle and lower basin of the Tigris and Euphrates Rivers in Iraq. Until recently at least, these were considered the most extensive wetland ecosystems in the Middle East.

3.1.3 Extent and distribution of lakes and lagoons

Lakes contribute little to the global area of wetlands when compared with other wetland habitats such as peatlands. Aselmann and Crutzen (1989) calculate that the global area of lakes (12 million ha) and marshes (27 million ha) combined equal only 9% of the total wetland area.

Gopal and Wetzel (1995) contain information on the area of lakes, lagoons, reservoirs and other wetland types in developing countries. For example, Bangladesh has 36 663 km^2 (3 666 300 ha) of aquatic habitats, including rivers (217 135 ha), tributaries (262 600 ha), beels and haors (114 793 ha), oxbow lakes (5488 ha), seasonal floodplains (2 832 792 ha), and Kaptan Lake (68 800 ha).

Whigham et al (1993) contains some area estimates for African lakes and reservoirs. Taub (1984) presents information and areal data on lakes, reservoirs, rice fields, swamps and floodplains in many countries around the world.

Little information was available on salt lakes in continental and international inventories reviewed, although Gopal and Wetzel (1995) provide data on endorrheic depressions with a permanent salt layer which cover more than 6000 km^2 (600 000 ha) of Tunisia. Williams (1984) provides some information on saline lakes in Australia, but no figures for total area. Also in Taub (1984), are reports on the saline lakes of Canada (Hammer 1984) and Argentine, where the largest saline lagoon is Mar Chiquita at 1850 km^2 (185 000 ha) (Bonetto & Persia 1984). Whigham et al (1993) provide some information on the Kanem Lakes, including many small salt lakes 200 m^2 – 2 km^2 in area, in the northeast region of Lake Chad basin.

Williams (1998) describes the geographical distribution of salt lakes in Europe, North and South America, Africa, Asia, and the Australian continent, with brief mention of salt lakes in Antarctica and the Arctic region. Case studies are presented which provide areal estimates for the Caspian and Aral Seas (429 140 km^2 and 68 000 km^2 respectively) in Central Asia, Qinghai Hu (4437 km^2) in China, the Dead Sea (940 km^2) of Israel and Jordan, Australia's Lake Corangamite (251.6 km^2), Mono Lake (158–223 km^2) in the United States of America, and Mar Chiquita (1960–5770 km^2) in northern Argentina.

3.2 Coastal and marine wetlands

As the definition of wetlands adopted for this review includes coastal and marine wetlands such as coral reefs, seagrasses and mangroves, there has been considerable emphasis upon locating inventories that could provide areal estimates for these wetland habitats. As 'exclusively marine systems', coral reefs and seagrasses have been excluded from key regional wetland directories such as Scott (1989), Scott (1993a), Scott and Carbonell (1986) and Scott and Poole (1989). A literature search and requests for information through relevant channels was successful in obtaining information sources relating to coral reefs (Wells et al 1988, WCMC 1998, WRI 1998) and mangroves (Ellison 1994, 1996, Saenger et al 1983, Spalding et al 1997, WCMC 1998).

Bird and Schwartz (1985) have mapped the world's coastline, approximately 1 million km long, noting coastal features of mostly geomorphological interest. This source is potentially of use in monitoring coastal changes on a global scale. Couper (1983) and Elder and Pernetta (1996) provide an overview of the world's marine wetlands as part of an atlas of the oceans.

3.2.1 Extent and distribution of coral reefs

Of the marine wetlands, coral reefs in particular are receiving much-needed attention, and considerable effort is being directed towards enhanced inventory and monitoring for coral reefs at a global scale (A Alling pers comm 1998). Electronic inventories and bibliographic databases for reefs and mangroves such those developed by the World Conservation Monitoring Centre (WCMC 1998), World Resources Institute (WRI 1998), and the International Center for Living Aquatic Resources Management (ICLARM 1998) are highly accessible on the WWW. They provide maps, area estimates and key information, where available, for coral reefs and mangroves around the world. These sources, if regularly updated, are a good indicator of information gaps and priority areas for future research.

Sheppard and Wells (1988) note that the exact areal extent of coral reefs in the world is difficult to estimate, but quote an estimate from 1978 of 600 000 km² (60 million ha) of reefs to a depth of 30 metres. Some 60% of this area is in the Indian Ocean region – 30% in the Indian Ocean, Red Sea and Gulf, and 30% in the Asiatic Mediterranean. WCMC (1998) gives the global area of coral reefs as 300 000–600 000 km² (30–60 million ha), while noting that its reef area estimates are derived from a wide range of sources at various levels of scale and quality (table 1).

As part of an overview of coastal zone wetlands in Oceania, Ellison (1996) provides areal data for the largest coral reef systems in the Oceania region, notably Australia's 350 000 km² (35 million ha) Great Barrier Reef, New Caledonia's barrier reef which encloses a 16 000 km² (1.6 million ha) lagoon, and 40 000 km² (4 million ha) of coral reefs in Papua New Guinea.

The Planetary Coral Reef Foundation conducts inventory and other research upon coral reefs around the world, and is developing a satellite to monitor coral reefs at a global scale. The satellite will use spatial and spectral resolutions and wavelengths specific to coral reefs, enabling monitoring at species level, for which neither Landsat nor SPOT imagery is suitable (A Alling pers comm 1998).

3.2.2 Extent and distribution of seagrasses

Comprehensive area and distribution information for seagrasses appears to be lacking. There are apparently huge gaps in knowledge of seagrasses in the South Pacific, Southern Asia, South America and some parts of Africa (L McKenzie pers comm 1998). Attempts to remedy this are underway, but will take some time to complete. Well-researched areas include England, North America and the Netherlands (L McKenzie pers comm 1998).

The only regional seagrass project to come to the attention of this review to date is a proposed inventory of marine habitats, including seagrass beds, in the East Asian Seas region, to be conducted as part of the United Nations Environment Programme. This is in response to a deficiency in inventory data for marine and coastal habitats in this region (H Kirkman pers comm 1998). It involves the coordination of mapping activities in 10 countries in East Asia, the data to be incorporated into a Geographic Information System. The techniques proposed for this inventory rely on pattern recognition and field work, not an extensive algorithm program, and hence it is not an expensive or highly technical task (H Kirkman pers comm 1998).

On a continental scale, mapping of underwater features is underway in Australia, with the aim of mapping the entire coastline of the continent. To date, underwater features such as seagrass beds have been mapped along the south-western and south-eastern coastlines using Landsat TM imagery and ground-truthing (H Kirkman unpubl). In 1997, a National Seagrass Workshop provided recommendations for the establishment of a national approach to monitoring seagrass in Australia (Jacoby 1998). Following from this, a review is currently underway to report on the status of research and knowledge, distribution, monitoring and assessment of seagrasses in that country (A Butler pers comm 1998). The results of the seagrasses review are expected to become available in early 1999.

It should be possible to estimate, albeit roughly, the areal extent of seagrasses by collating existing national inventories, but it appears few, if any, continental or global estimates are available (to date none have come to the attention of this review). However, the World Conservation Monitoring Centre is seeking funding for a project to compile a seagrass dataset, to be added to existing Geographic Information System coverage of mangroves and coral reefs (R Luxmoore pers comm 1998).

3.2.3 Extent and distribution of mangroves

Global

The *World Mangrove Atlas* (Spalding et al 1997) represents the first attempt to prepare a global map of mangrove forests and provides a global overview of mangrove distribution. It contains areal estimates and other data, where available, for 114 countries, and case studies of particular sites. Spalding et al (1997) note that differences in definition, age, scale and accuracy of different national sources mean there are likely to be considerable margins of error in estimates of global mangrove area provided in the Atlas. They also recommend extreme caution in the use of global composite statistics as a baseline for monitoring changes in global mangrove area. Although serious inconsistencies exist in the data (J Ellison pers comm 1998), it nevertheless provides a basis for further research at a regional or national scale, and can assist in determination of priority areas for future mangrove inventory. Data from Spalding et al (1997) has been incorporated into the *Coral Reefs and Mangroves of the World* dataset on the World Conservation Monitoring Centre internet site (WCMC 1998), which ensures the information is accessible and enables it to be updated as knowledge gaps are addressed.

Spalding et al (1997) estimate the global area of mangroves as some 181 000 km^2 (18.1 million ha) (table 1). Approximately 43% of the world's mangroves are located in just four countries – Indonesia (42 550 km^2), Brazil (13 400 km^2), Australia (11 500 km^2) and Nigeria (10 515 km^2). Each has between 25% and 50% of the mangroves in their respective regions, hence Spalding et al (1997) predict that political and management decisions in these countries will have a significant effect on the global status of mangrove ecosystems in the future.

Regional

Mangrove areas for the regions of South and Southeast Asia, Australasia, The Americas, West Africa, and East Africa and the Middle East are presented in table 6 (adapted from Spalding et al 1997). The region of South and Southeast Asia is particularly significant, containing 41.5% of the world's mangroves. In this region Indonesia alone has 23% of the global mangrove forest area (Spalding et al 1997), and should therefore be considered of high priority for inventory efforts and monitoring of mangrove habitat loss.

In listing mangrove areas for individual countries, Spalding et al (1997) provide, where possible, both an estimate from map sources and an 'alternative estimate' from recent reliable sources. Assessment of area data provided highlights the inconsistent approach to mangrove inventory throughout the world to date, and reveals knowledge gaps that can be regarded as potential priority areas for future mangrove inventory effort (table 7). Spalding et al (1997) provide map-based area estimates for most countries, with the exception of Singapore, Solomon Islands, Western Samoa, Togo, Qatar and United Arab Emirates, for all of which no map data was available. No alternative mangrove inventory sources were available for China, Taiwan, Hong Kong, Aruba, Netherlands Antilles, Netherlands Antilles (windward group), British Virgin Islands, Dominica, Guadeloupe (including St Martin and St Barthelemy), Martinique, United States of America (Florida only), Comoros, Mayotte, Seychelles, Djibouti, Egypt, Eritrea, Somalia, Sudan and Yemen. An alternative estimate was provided for mangrove area in Sri Lanka, but the inventory source used for this estimate did not cover the entire country and was somewhat less than the map-based estimate (63 km^2 as opposed to 89 km^2). No information was available at all for British Indian Ocean Territory, Maldives, Sao Tome and Principe.

Other countries also have information gaps, shown by discrepancies (sometimes quite large) between their map and alternative areal estimates, indicating a need for further inventory to clarify the actual extent of mangrove habitat. In most of the 114 countries covered by the Atlas there is an urgent need for more accurate mapping of mangrove areas at higher levels of resolution (Spalding et al 1997).

Saenger et al (1983) gave area data for 65 countries, and noted that vast areas of mangrove forest had been and were continuing to be destroyed. This in itself poses a challenge for assessing mangrove areas, as inventories may date quite rapidly. Ellison (1994) expressed similar concern, noting that knowledge about the mangroves of the Pacific region is poor and, despite their traditional use by islanders, mangroves are rarely a valued resource. Mangrove forest inventory and mapping has been carried out in countries with larger mangrove areas, namely Papua New Guinea, Solomon Islands, Fiji, New Caledonia, Vanuatu, Western Samoa and the Federated States of Micronesia. However, reduction in mangrove area due to commercial logging and other human impacts means that some of these inventories are now out-dated. Ellison (1994) stresses the need for urgent action to promote mangrove conservation in the Pacific islands, the establishment of more mangrove protected areas, and development of a regional monitoring program of ecosystem health, which could be linked to monitoring for climate change and sea level rise impact.

3.2.4 Extent and distribution of salt marshes

The salt marshes of the Wadden Sea, though only a modest remainder of the extensive salt and brackish marshes, peatlands and lakes which covered the area some 2000 years ago, are still the largest contiguous area of salt marsh in Europe. The Wadden Sea is Europe’s largest intertidal wetland, with tidal flats, sandbanks, salt marshes and islands covering 8000 km^2 (800 000 ha). However, in 50 years up to 1987, 33% of their area was lost to embankments (Dugan 1993).

Some of the most extensive salt marshes in north America lie along the 800 km shoreline of the Alaskan Yukon–Kuskokwim Delta, one of the largest deltas in the world. Seaward of the marshes are sand and mud flats that cover some 530 km^2 (53 000 ha) (Dugan 1993). In Canada, British Colombia’s largest salt marsh complex is just 27 km^2 (2700 ha), the rest of the coastline dominated by fjords, with brackish and freshwater marshes. The most intensive arctic and subarctic salt marsh development is found on the Ontario shores of Hudson and James Bay. Salt and brackish marshes cover an estimated 85–90% of the 1100 km shoreline (Glooschenko 1982). In some areas of Canada, such as New Brunswick and the Saint Lawrence Estuary, salt marshes have been mapped as part of detailed wetland inventories (G Chmura pers comm 1999). The wetlands of Saint Lawrence Estuary have been mapped using remote sensing at 7 metres resolution, producing 43 coloured 1:20 000 maps of freshwater and saline wetlands, algal and eelgrass beds (Centre Saint-Laurent 1996).

Salt marshes have been mapped extensively in Europe (G Chmura pers comm 1999). Dijkema (1987) provides areas of salt marsh by marsh type for this region, and estimates that there are at least 2300 km^2 (230 000 ha) of coastal salt marshes in Europe, with insufficient data for Svalbard, Iceland, northwest Spain and Turkey.

No estimate for the global extent of salt marshes was discovered by this review, and it appears that there are large information gaps for this particular wetland habitat throughout the world.

3.2.5 Extent and distribution of coastal lagoons

No continental or international inventory of coastal lagoons was located for this review. However, Britton and Crivelli (1993) provide minimal estimated areas of Mediterranean wetlands including freshwater, saltwater, seasonal and saline coastal lagoons (summarised in table 3). John et al (1993) present some information on three large coastal lagoons in western Africa which, although they are interconnected with canals, each have a different hydrological regime.

3.3 Artificial wetlands

Reservoirs, dams, irrigation culverts and canals, fish farms, aquaculture ponds and rice fields are among the types of artificial wetlands contributing to the global wetland area, often providing habitat for flora and fauna as well as benefits to humankind.

Aselmann and Crutzen (1989) calculate the global area of rice paddies as 1.3 million km^2 (130 million ha), of which almost 90% is cultivated in Asia (table 1). It is likely this figure is now outdated. Matthews et al (1991), cited in NASA (1999), provide a map of rice harvest areas worldwide.

Gopal and Wetzel (1995) provide data on areas of reservoirs (858 311 ha in Ghana, >80 000 ha in Malaysia), dams (>92 145 ha in Malaysia), fish farms and ponds (223.02 ha in Ghana, 334 019.4 ha in Pakistan) and irrigation culverts (400 000 ha in Tunisia).

Michael (1987) provides areal estimates for fish farms and ponds, rice fields and other aquaculture sites around the world, but it is likely this information is now out of date and requires checking against national and regional sources.

4 Rate and extent of wetland loss and degradation

The loss of wetlands worldwide has been estimated at 50% of those that existed since 1900 (Dugan 1993, OECD 1996). Without further clarification of this estimate (a definition of wetlands and/or the source data was not provided in references obtained for this review), it is assumed that the 50% wetland loss estimate applies to inland wetlands and possibly mangroves, but is unlikely to include marine wetlands. Much of this wetland loss occurred in northern countries during the first 50 years of this century. Since the 1950s, tropical and sub-tropical wetlands are increasingly being degraded or lost through conversion to agricultural use. Agriculture is the principal cause for wetland loss worldwide. By 1985 it was estimated that 56–65% of available wetland had been drained for intensive agriculture in Europe and North America, 27% in Asia, 6% in South America and 2% in Africa, a total of 26% loss to agriculture worldwide (OECD 1996). As wetland loss to agriculture and other uses is continuing, indeed intensifying, in regions such as Asia, the Neotropics and Africa, these figures need to be updated with more quantitative studies.

Inextricably linked with the rate and extent of wetland loss and degradation worldwide is the issue of water allocation and distribution, which has become extremely important in recent times and is only to become more so in the future. Many rivers around the world have been heavily regulated by the construction of dams to satisfy the increasing demand for irrigation and hydropower. Impacts on the rivers and associated natural waterbodies, swamps and marshes include increased salinisation, diminishing underground water reserves, declining biodiversity and impoverishment of fish stocks due to impeded migration and degraded habitat (Bolen 1982, Gopal & Wetzel 1995, Liu 1984). Ironically, countries are now facing problems with siltation of reservoirs. Taub (1984) reports that water demand in Japan resulted in many large artificial lakes on almost all river systems, but that a decrease in water volume of 70–80% occurred due to silting over 20–30 years.

Growing populations and increased development is also resulting in more domestic and industrial pollutants being discharged into wetlands. Yet there has been little research on pollutants and their effects, especially on fisheries, in many developing countries (Gopal & Wetzel 1995).

Impacts are not limited to inland or coastal wetlands, with marine wetlands also under threat. A recent study of coral reefs (WRI 1998) indicated that 58% of the world’s reefs are at moderate to high risk from human disturbance. Globally, 36% of all reefs were classified as threatened by overexploitation, 30% by coastal development, 22% by inland pollution and erosion, and 12% by marine pollution.

Moser et al (1996) note that data provided by Ramsar Contracting Parties indicated that 84% of Ramsar-listed wetlands had undergone or were threatened by ecological change. Similar figures arose when major threats to wetlands were analysed for Asia (Scott & Poole 1989) and the Neotropics (Scott & Carbonell 1986). Threats were recorded at 85% of the 734 wetland sites for which information was available in Asia, and for 81% of 620 wetlands in the Neotropics. Hunting, pollution, drainage for agriculture, and settlements and urbanisation were all within the top five major threat categories in each region (Moser et al 1996).

Scott (1993b) recommended that considerable thought should be given as to how existing and new wetland inventories can be used as a basis for monitoring wetland loss, particularly by updating and standardising them. Outside Europe and North America, there is very little information available or attempt made to calculate wetland loss on a systematic basis. Even in Europe, the majority of wetland loss data are from western Europe. Few published quantitative studies are available for Africa, South America, small South Pacific islands and much of Asia (Moser et al 1996).

The information currently available for these regions is largely descriptive, with some areal estimates and other details provided. For example, wetland loss and degradation in developing countries such as Ghana, Tunisia, Sri Lanka, Bangladesh, Pakistan, Papua New Guinea and Malaysia is described in Gopal and Wetzel (1995). Scott (1995) provides some wetland loss data and causes of wetland degradation in the Middle East. Denny (1985) provides an overview of African swamps and shallow waterbodies, with some data on the extent of swamp drainage, and lakes degraded by aquatic weed infestations. Wetland-related volumes of the *Ecosystems of the World* series (Chapman 1977, Gore 1983, Taub 1984, Michael 1987, Cushing et al 1995) contain some wetland loss and degradation data on a national or regional basis. These sources and others reviewed recognise the urgent need for improvement of this knowledge base.

4.1 North America

In the United States of America some 54% of wetlands that once existed (originally >890 000 km^2) have been lost, with 80% of this loss due to drainage for agriculture. In some states the proportion lost is even higher (Dugan 1993), the nation’s historical attitude towards wetlands exacerbated by active encouragement of the conversion and destruction of wetlands by the United States federal government for over 200 years. Hofstetter (1983) reports that the President's address on Environment to the United States Congress in 1977 stated that over 40% of 48.6 million ha of wetlands inventoried in the 1950s had been lost, and that wetland area was being lost at the rate of 121 500 ha per year.

Although attitudes towards wetlands are changing, wetlands continue to be degraded and destroyed. Frayer (1991) outlines the status and trends of wetlands and deepwater habitats in the conterminous United States in the 1970s and 1980s. Average annual net losses have occurred for palustrine wetlands (283 500 acres, or 114 777 ha), palustrine vegetated (371 600 acres, or 150 445 ha) and palustrine forested (378 200 acres, or 153 117 ha), with a net loss of 3.4 million acres (1 376 518 ha) since the 1970s. Some of this loss is due to urban development, but the main reason was conversion to agriculture. Losses and gains have occurred for palustrine scrub/shrub wetlands, but deepwater habitats have increased in area in the United States, largely due to the formation of lakes and reservoirs (Frayer 1991). States with statistically significant wetland losses since the 1970s are identified, and Frayer (1991) warns that the importance of change in wetlands is not necessarily reflected by area alone. Some smaller wetlands, particularly along the coast, are extremely important habitats for plant and animal life. Newly created wetlands, such as lakes and reservoirs, must be studied further to determine their importance to fish and wildlife populations. Also, widespread degradation of wetlands may have consequences as serious as the loss of individual wetlands.

Of relevance to both Canada and the United States is concern over threats to the Great Lakes, which include sewage pollution, overfishing, water quality deterioration, destruction of breeding sites and depleting of fish stocks (Robertson & Scavia 1984).

In western Canada and Alaska, the freshwater wetlands have been subjected to little pressure from development to date. Some 800 km^2 (80 000 ha) of freshwater wetlands have been lost in Alaska since colonial times, approximately 0.1% of the original area (Dugan 1993). In eastern Canada 70% of wetlands are forested peatlands. Sustainable forestry practices in the region mean that the peatlands have experienced little development pressure until now, but recent proposals for major expansion of hydroelectric facilities are threatening diverse wetland and upland habitats, particularly coastal and estuarine wetlands (Dugan 1993). Zoltai and Pollett (1983) noted that utilisation of wetlands was rapidly expanding in Canada in the 1980s.

There are few details regarding wetland loss in Mexico, but Moser et al (1996) reports losses of approximately 35% of original wetland area. Neither the source data nor the original wetland estimate are provided.

4.2 Neotropics

There is a lack of reliable and quantitative data over large areas and over many years for the Neotropics, leading to difficulties in assessing the extent of wetland loss. However, the Neotropical directory revealed that over 80% of wetland sites in this region are under some threat from human activities, half of these under moderate to serious threat (Scott & Carbonell 1986).

Moser et al (1996) report that wetlands in the insular Caribbean show serious degradation due to long history of wetland reclamation and alteration, uncontrolled resource exploitation and neglect. A survey of 220 coastal wetlands, predominantly mangroves, in the eastern Caribbean between 1989 and 1991 revealed that every site visited on the 16 islands was degraded, with over 50% showing serious damage (Bacon 1993).

Wetlands in South America have remained relatively intact until recent decades, but small-scale studies have revealed the alarming rate at which wetlands are now disappearing in some parts of this region. Colombia's Cauca River Valley system lost 88% of its mapped wetlands between the 1950s and 1980s due to land reclamation, drainage, river regulation and pollution. Also in Colombia, changes in the hydrological cycle killed 80% of mangrove forests in the Magdalena River delta between 1970 and 1987 (Moser et al 1996). In Venezuela's Orinoco Delta, mangrove clearfelling operations have been approved in a 495 200 ha area.

One or two other sources of information on the Neotropics are known to exist but unfortunately copies have not been located in time for inclusion in this report. The data set is nevertheless scarce for this region.

4.3 Africa

Like South America, there is an extreme lack of published quantitative studies on wetland loss in Africa (Moser et al 1996). Dugan (1993) reports on the causes of wetland loss in Africa, and on the progress in protection and more sustainable use of wetlands in some areas, but no estimates are given. In west and central Africa there has been substantial loss and degradation of natural ecosystems due to population increase and other pressures over the last 80 years (Dugan 1993).

In Ghana, Gopal and Wetzel (1995) note that there has been poor documentation and research of contamination by domestic and municipal wastes, agrochemical pollution of rivers and groundwater, and effects of land degradation on water resources. Major waterbodies receiving such pollutants include the Volta, Birim, Densu, Ofin and Ankobra rivers, and Korle Lagoon. River waters and sediments in mining areas contain high concentrations of cyanide and arsenic.

In Tunisia, an overall loss of 15% of wetland area is reported, and an 84% loss of wetlands in the Medjerdah catchment (Moser et al 1996). Dams have been built on the three major oueds (rivers) flowing into Lake Ichkeul, causing progressive salinisation and decline in vegetation. Marshes surrounding the lake are dwindling due to drainage for agriculture. Other regions in Tunisia have been considerably altered due to agriculture, including the hills areas, where jessours (terrace-like dams) cover 400 000 ha (Gopal & Wetzel 1995).

In southern Africa, wetland loss figures are available for Natal, provided by Taylor et al (1995) in a review of wetland inventories in the region. In parts of the Tugela Basin over 90% of the wetland resources have been lost, and in the Mfolozi catchment 58% of the original wetland area has been lost (Taylor et al 1995, Moser et al 1996).

Denny (1985) provides some information on African wetlands which have been degraded by aquatic weeds. Lake Chad, for example, fluctuates in size from 600 000 ha to 2.5 million ha, but has been severely impacted by aquatic weeds, which cover 200 000 ha and interfere with transport and fishing on the lake. It is possible for such degraded wetlands to recover to some extent, and Denny (1985) gives the example of Lake Kariba, which was infested with 75 000 ha of the aquatic weed *Salvinia molesta* in the 1960s. Biological control measures were successful and the weed infestation decreased, stabilising at approximately 7700 ha.

4.4 Middle East

Scott (1995) notes that large-scale wetland degradation is occurring in the Middle East for various reasons including deforestation, overgrazing, reclamation, water diversion for irrigation, increased salinity, expanded urban and coastal development, overfishing, oil and other pollution, and war damage. In this region of scarce water resources, drainage, pollution and reclamation for industrial and urban development has put wetlands under particularly severe pressure. Flood control schemes, irrigation, and diversion of water for domestic and industrial consumption has resulted in significant loss and degradation of wetlands in the region. As in other regions, the fact that rivers such as the Jordan, Tigris and Euphrates flow independently of national borders means that proposed irrigation schemes in countries upstream can greatly impact upon water quality and scarce water supplies of the river and other remaining wetlands downstream. Almost all of the original freshwater wetlands in Syria, Lebanon and Israel were drained for agriculture in the early 1900s (Dugan 1993).

Drainage of marshes continues, one such example being the systematic drainage of the Al Huweizah marshes in a 30 000 km^2 (3 million ha) area of southern Iraq. Water diversion through dykes and a drainage canal has decreased the area of marshes by 50% since 1972 (INC 1998). Over a seven-year period (1985–1992), the area of permanent lakes and marshes, and seasonal and temporary marshes in Lower Mesopotamia had been reduced by over 25%, from 1.94 million ha to 1.44 million ha. To date, much of the Haur Al Hammar marshes and the greater part of the Central Marshes have been drained, with disastrous ecological, social and human consequences for the region (Scott 1995).

Few countries in the Middle East have made any serious attempt to conserve dwindling wetland resources (Dugan 1993). Yet water demand in the region has also led to the formation of a large number of artificial wetlands, including water storage reservoirs, sewage treatment ponds and artificial lagoons for containment of urban and industrial waste water. These artificial wetlands have become important habitats for wildlife, including migratory birds (Dugan 1993, al Wetaid & Faizi 1993).

4.5 Asia

Unlike Africa and South America, Asia has experienced wetland loss for thousands of years, with vast wetland areas drained for agriculture or settlement, or converted into rice fields (Moser et al 1996). In some areas, destruction of natural wetlands has been total, eg Vietnam's Red River delta floodplains originally covered 1.75 million ha, but are now non-existent. Much of the 40 million ha of rice fields in the central plains of India, and the 1.9 million ha of paddies in the central plains of Thailand must have been developed at the expense of natural wetlands (Moser et al 1996). Wetlands continue to be degraded or destroyed in Asia; in their overview of the Asian wetland directory, Scott and Poole (1989) report threats at 85% of the 734 sites in the directory for which information was available.

Of particular importance in this region is Indonesia, which contains 42 550 km^2 (4 255 000 ha) of mangrove habitat, 23% of the world's total mangrove area (Spalding et al 1997). This review has not obtained a quantitative estimate of mangrove loss in Indonesia to date, but Scott (1993b) reports the loss of 11.8 million ha of Indonesia's original 37.6 million ha (31%) of wetlands by 1981–82. Spalding et al (1997) detail mangrove losses in Malaysia, the Philippines, Thailand and Vietnam totaling 7445 km^2 (744 500 ha), over 4% of the current global total. It is considered that the 1% loss of mangrove habitat each year in Malaysia is a conservative estimate of mangrove loss in the Asia Pacific region (Spalding et al 1997, Ong 1995).

Indonesia also contains a significant proportion of the global tropical peatland resource, which totals 30–49 million ha and over half of which is located in southeast Asia (Maltby et al 1996). The highest estimate of tropical peatland loss is 27 million ha (Radjagukguk 1992). Maltby et al (1996) detail losses of pristine peat swamps in Indonesia (531 000 ha) and

Peninsular Malaysia (500 000 ha), due to drainage for agriculture and forest clearance. Peatland inventories for Malaysia and Thailand are already outdated and inaccurate due to recent, rapid decreases in the peatland area following forest removal, drainage and utilisation for land settlement and conversion to agriculture (Maltby et al 1996).

Many rivers in Asia are threatened by water impoundment and diversion, deforestation, industrial and domestic pollution. Almost all rivers in Japan have been impounded to create large reservoirs, and the agricultural use of large amounts of fertiliser is believed to be causing eutrophication and pollution of the waterways (Mori et al 1984).

In Malaysia, a total of 42 rivers are biologically dead due to domestic, agricultural and industrial wastes. Loss of fisheries has occurred in some of these rivers. The total reservoir area in Malaysia is 80 000 ha, and may escalate to 206 000 ha by the year 2000 as demand increases for irrigation and hydropower dams (Gopal & Wetzel 1995).

In Pakistan, the Layari, Malir, Soan and Kabul rivers are highly polluted due to unregulated flow of sewage and industrial effluents. Aquatic weed infestations affect 182 118 ha of wetlands in Pakistan, adversely affecting fish production (Gopal & Wetzel 1995).

Gopal et al (1982) note that rapid wetland reclamation and destruction of mangrove area is occurring in India, but no figures were provided.

In Sri Lanka most lentic waterbodies show increased eutrophication due to organic pollution. Wetland degradation is occurring due to river impoundment and diversion, water pollution, deforestation, gem and sand mining (Gopal & Wetzel 1995).

Bangladesh has 3 666 300 ha of wetlands, 90% of which are dependent on flow from three major rivers now threatened by diversion of water in India from the Ganga-Padma River. Rivers in Bangladesh are contaminated with industrial discharge, and increased monoculture of rice has resulted in greatly increased fertiliser and pesticide use. These chemicals are flushed into the rivers by monsoonal rains (Gopal & Wetzel 1995).

This review has not located any overall estimate of wetland loss in Asia. More quantitative data is required. Many wetlands of the region are poorly known, particularly in Bangladesh, China, Bhutan, Burma, Cambodia, Laos, Mongolia and the Democratic People's Republic of Korea (Scott & Poole 1989). Judging by the current rate of mangrove and peatland losses, more information is urgently required for all wetland types in order to determine the status of wetlands and total wetland loss in the region.

4.6 Oceania

4.6.1 Australia

No overall wetland loss figures were obtained by this review for the continent of Australia, although 50% loss of original area is often used as a general estimate (B Churchill pers comm 1998). Loss estimates for the state of Victoria (26.8%) and the southeastern part of South Australia (89%) show that in some areas loss of inland freshwater wetlands in particular has been considerable (Moser et al 1996). By 1970, 60% of the most valuable waterfowl habitat on the coastal lowlands of New South Wales had been destroyed or degraded, most of the wetlands drained for flood mitigation. Similar losses occurred on the Swan Coastal Plain of Western Australia. In Tasmania, the buttongrass mires have suffered the majority of human impacts on wetlands, adversely affected by grazing and burning over many years. More recent impacts have included the construction of roads, dams and canals, and flooding of vast areas. Peatlands in the Eastern Highlands of the Australia's mainland are also being degraded by burning, grazing and drainage (Campbell 1983). The wetlands of northern Australia have not been subject in the past to the same population and development pressures as those in southern Australia, but are now under increasing threat due to changes in the water regime, pollution, invasive species and physical alteration (Finlayson et al 1999).

One of Australia's largest and most important rivers, the Murray River, has been degraded by the construction of over 280 large dams, numerous small dams, weirs and locks, withdrawal of water, channelling of the stream and other flood mitigation activities.

The proposed national wetland inventory for Australia should provide data useful for estimating rate and extent of wetland loss in the future, although it is unlikely to include marine wetlands.

4.6.2 New Zealand

In New Zealand it is estimated that 90% of the original wetland area has been lost (Moser et al 1996), with wetlands now covering just 2% (5323.42 km^2 or 532 342 ha) of the country's total land area (266 171 km^2) (Dugan 1993, NZ Govt 1998). Loss has been due to drainage, gold mining, flood control, land clearance, agricultural development, kauri-gum digging and flax milling (Dugan 1993).

4.6.3 Papua New Guinea

The wetlands of Papua New Guinea are poorly known (Scott & Poole 1989) and research is needed into logging impacts (Gopal & Wetzel 1995). Mining impacts are monitored in the Ok Tedi and Fly River, and research has shown that the 120 ha Waigani Lake has been degraded by sewage effluents from Port Moresby(Gopal & Wetzel 1995).

4.6.4 Pacific Islands

Moser et al (1996) reports that little published quantitative information is available for wetland loss in south Pacific island nations, despite the wetland inventory by Scott (1993a). Ellison (1994) provides estimates of mangrove loss in New Caledonia (380 ha), Fiji (2457 ha or 6%), Western Samoa (1.8 ha) and American Samoa (~50 ha), and threatened mangrove areas in Guam and Northern Mariana Islands. Significant areas of mangroves have been lost or degraded in Tonga, Vanuatu and Papua New Guinea, but areal extent is unknown. There is an urgent need for management and conservation of mangroves in the Pacific islands, as they are increasingly threatened by coastal development and exploitation. In Tonga, for instance, many mangrove areas have been lost to reclamation at Popua and Sopu, and all other significant areas are now allocated for clearance (Ellison 1994).

4.7 Europe

Rates of wetland loss are less well documented in Europe than in the United States, but the conversion of natural ecosystems such as wetlands is believed to be greater due to Europe's high population density and longer history of economic development (Dugan 1993). Jones and Hughes (1993) provided an overview on the extent of wetland loss in Europe, the first attempt to collate information at a Pan-European level, but little information has been published since. Loss studies of particular wetland types, eg peatlands and lowland wet grasslands, provide some recent data, but the diversity of methodologies used to measure wetland loss, and the lack of coordination between studies in different countries or for different wetland types prohibits any regional overview (Moser et al 1996).

The considerable wetland losses in Europe are demonstrated by the example of Finland, which originally had 10.4 million ha of mires (30% of its land area), but has lost

5.5 million ha, largely due to forest drainage. Ruuhijärvi (1983) expected that the amount of mire lost in Finland would total 7 million ha by the mid-1990s.

European wetlands have been lost largely due to drainage and conversion to agriculture and grazing land, and urban and industrial development. Exploitation of wetlands, often leading to wetland degradation, includes water storage, fisheries and aquaculture, hunting, harvesting of wetland vegetation, tourism and water sports. Urban and industrial development has greatly contributed to wetland loss in recent years, while creating the added pressure of greater water demand to supply the increasing population (Dugan 1993).

4.7.1 Northern Europe

In northern Europe, peatlands are an important resource in the rural economy. Reindeer herds graze on peatlands, and wild fruits are harvested, some on a commercial basis. Yet while such traditional and largely sustainable practices continue, destructive use of peat is adding to the pressure from agriculture and forestry which has resulted in the drainage of extensive areas over the centuries. Interest in the energy potential of peat has increased in Europe, such that 400 new sites have been accepted for commercial exploitation in Sweden. Finland's annual peat fuel production is 4 million tonnes, as well as 300 000 tonnes of horticultural peat (Dugan 1993). Loss rates for peatlands in excess of 50% have been reported for 11 European countries (Immirzi et al 1992).

Lakes and watercourses are also coming under pressure in Scandinavia, with use of water resources becoming increasingly less sustainable. In Sweden, 75% of all suitable lakes and rivers have been regulated as part of hydroelectric developments, the result being irreversible ecological change (Dugan 1993). Several mires of high scientific value were destroyed during construction of hydroelectric reservoirs, and mires continue to be threatened by drainage for afforestation and large-scale extraction of fuel for town heating systems (Sjörs 1983).

Acid rain is contributing to the degradation of wetlands, with 40% of lakes in Norway and a significant proportion of lakes in Sweden and Finland showing serious acidification (Dugan 1993).

4.7.2 Western and Central Europe

In western and central Europe, the vast majority of natural wetlands were destroyed to make way for extensive industrialisation and agriculture (Dugan 1993). Overall wetland losses exceeding 50% of original area have occurred in the Netherlands, Germany, Spain, Greece, Italy, France and parts of Portugal. In the United Kingdom, 40% of wet grasslands, 23% of estuaries and 50% of saltmarshes have been drained since Roman times (Moser et al 1996). In the Mediterranean Basin and eastern Europe, many wetlands remained intact until the 1800s and 1900s, when most were drained for agriculture and to eradicate malaria. Deltas on the north shore of the Mediterranean support complex mosaics of wetland habitats, but riverine floodplain systems have been greatly altered, reduced to a few small isolated remnants. This destruction of the forest, dyking, grazing, agriculture and logging has also greatly reduced the riverine forest habitat, now present in just a few isolated stands.

4.7.3 Eastern Europe

In eastern Europe, change in the political environment has seen wetlands pass from state into private jurisdiction, resulting in their destruction to make way for agriculture (S Svazas pers comm 1998). Aselmann and Crutzen (1989) note that in Poland, over 95% of the estimated original mire area of 15 000 km^2 (1.5 million ha) has been exploited.

5 Wetland benefits and values

Over half (30) of the sources assessed provided information in some form or another on the values and benefits of wetlands. Of the 16 site-specific directories and inventories, only half (8) provided information on the values and benefits of particular wetland sites. These contain information, where available, on human utilisation and values and benefits to flora and fauna as part of each site description (eg Grimmett & Jones 1989, Hughes & Hughes 1992, Scott 1989, 1995). In other sources, values and benefits were summarised in a particular chapter (Dugan 1993, Saenger et al 1983, Ellison 1994), in country summaries (Scott 1993a, Spalding et al 1997, WCMC 1990), or interspersed throughout the text (Patten 1990).

Dugan (1993) and Patten (1990) detail the values and benefits of all wetlands to global ecology, flora, fauna, and humans. Scott (1993a) describes the values and benefits of wetlands in the Oceania region in summaries for each country, noting some unique aspects due to the extreme isolation of some Pacific islands, and the strong cultural attachment to mangrove wetlands in particular. The special significance of arid zone wetlands to people, flora and fauna is detailed by al Wetaid and Faizi (1993) and Scott (1995).

The values and benefits of mangroves, including coastal protection, flood reduction, sediment accumulation, nursery function for fish and crustaceans, and a vast number of human uses, are detailed in Saenger et al (1983), Spalding et al (1997) and Ellison (1994, 1996).

Legoe (1981) and Maltby et al (1996) describe the values and benefits of peatlands and peatland swamp forests, including their regulating effect on entry of water into drainage systems, nutrient reservoir, diverse human uses of the peat and plant resources, and an important role in biogeochemical cycles.

Grimmett and Jones (1989) provide descriptions of important wetland sites in Europe, on the basis of their value as breeding or feeding habitat for birds. Protected areas are valued by humans for various reasons, such as conservation of biodiversity, tourism and fishing (Grimmett & Jones 1989, IUCN 1994).

Schwartz and Bird (1990) approach the benefits of wetlands from a development perspective, noting the value of artificial beaches and coastal wetlands in protecting human values and uses, such as infrastructure, tourism and housing. Dugan (1993) also mentions the benefits of artificial wetlands, detailing the importance of salines to migratory bird populations in countries such as Portugal. Michael (1987) provides information on the productivity of rice paddies, fish farms and ponds around the world and oyster racks in coastal Japan.

6 Land tenure and management structures

Of the 16 site-based sources assessed in this review, at least 85% commonly or always covered issues related to land tenure (14), jurisdiction (15), conservation status (16) and proposed conservation measures (14), indicating a good coverage of these issues in past inventory projects. From these inventories and other sources, it is apparent that many wetland sites in Africa, Oceania, Asia and the Neotropics are unprotected or protection measures are ineffective.

Scott (1993b) recommends that all countries that have not yet done so conduct national wetland inventories, including all sites of national importance and perhaps local importance in the inventory. This would better enable quantification of the wetland resource at global, regional and national scale, and ultimately provide information for improved management and protection of wetlands.

Scott and Poole (1989) note that many wetland types and systems characteristic of southern and eastern Asia are under-represented in existing networks of protected areas, and that even legal protection is no guarantee that a wetland type will not remain under threat. While a significant proportion of Asia's wetlands of international importance have some form of legal protection, the enforcement of these protected areas leaves much to be desired, and over one third of them are still considered under moderate to severe threat.

Ellison (1996) reports a similar problem in the Oceania region, where more inventory, mapping and basic ecological research is needed. Despite some progress in implementing conservation legislation in Pacific countries, it is rarely enforced and wetlands continue to be degraded by increasing population pressures. Ellison (1996) lists urgent needs for mangrove conservation in the Pacific islands. Scott (1993a) believes the lack of effective wetland policies or legislation, if any at all, in countries of the Oceania region is due to difficulties in accommodating or overcoming traditional attitudes towards wetlands, their communal and private use, and government acquisition or regulation.

Spalding et al (1997) provides information on protection of mangrove habitat globally, noting that most countries with very large areas of mangroves have a significant number of protected areas, eg Australia (180), Indonesia (64) and Brazil (63). However some countries such as Nigeria contain very large areas of mangroves, but none within legally gazetted areas.

7 Extent and adequacy of updating programs

Of all the broad-scale inventories and directories assessed in this review, few have reported an updating process. Some inventories have been 'updated' as a more recent inventory or directory has been published, providing new or updated information (Wells et al 1988, WCMC 1998, WRI 1998). However, none apart from the Ramsar Convention Bureau's directories of Wetlands of International Importance (Jones 1993a,b,c) appear to be part of a program of regular updating; in this case summarising the more detailed information contained in the Ramsar Database and providing it to Contracting Parties on a regular basis. Some sources may have a plan or program for updating, but if so they are in the minority, and have not made this component of the inventory clear in their reporting. The overall result is a poorly updated knowledge base of wetland inventory worldwide, making it difficult to compare between studies and determine the overall extent of wetlands and wetland loss.

This situation of inadequate updating is perhaps understandable, given the overall cost and logistical effort of conducting and publishing (in hard copy) supra-regional, continental or international inventories on a regular basis. However, the recent development of 'user-friendly' database packages and increased availability and use of electronic systems such as GIS and the WWW is expanding the options available for scientific data storage and accessibility. It is possible to store wetland inventory information in an electronic database or GIS, link it to a web page, and make it accessible from anywhere in the world via the WWW. There are some promising new developments in this direction in wetland inventory, WCMC (1998) and WRI (1998) being two such examples. Hardcopy publications are certainly still useful, but more efficient and creative use of the WWW will improve the accessibility of inventory information and ease and efficiency of updating.

8 Standardising of inventory approaches

Gopal et al (1982) noted the serious lack of knowledge worldwide about wetland resources, their ecology and use, making important recommendations including that 'standardisation of methodology is required in all areas of wetland ecosystems, more particularly … wetland survey and inventorisation'. It was recognised that, as a first step for identifying the needs for conservation and management, national inventories of wetlands were required.

Now, almost twenty years later, it is evident that we still do not have adequate standardisation of inventory and enough completed national wetland inventories to be able to determine with confidence the status of wetlands worldwide. Of greatest concern, perhaps, is the recognition that, while this woeful situation continues, many wetlands are fast disappearing due to increased development and demands on water and other resources. We do not yet know what wetlands we have and how important they are, and if we do not strive now for improvement in our wetland inventory and assessment, it may soon be too late.

What must be done to remedy this situation? A few points to consider:

- **Reporting:** Careful attention should be paid to the comprehensiveness of reporting. Inventories too often lack basic information such as the objective or purpose of the inventory, the wetland definition and classification systems used, the method/s of data collection, source data for statistics of wetland area or wetland loss, name and affiliation of the compiler for individual site data, a program for updating the inventory, etc. Comprehensive reporting avoids confusion and ambiguity.
- **Standardised approach:** Standardisation of inventory approach is necessary. Development of a standardised framework for wetland inventory will help individual countries to prepare national wetland inventories in a process and format compatible with their objectives, and yet also compatible with the inventory of neighbouring countries. This would greatly improve the capacity for comprehensive wetland inventory on a regional, and ultimately global, scale.
- **Standardised framework:** A standardised framework may incorporate key data elements to be collected for a national inventory, while still allowing each country's implementing agency flexibility to determine the objectives of the inventory and the form its inventory will take, according to variables such as the climate, wetland type and classification, resources and management objectives.
- **Electronic data storage:** Use of electronic data storage systems such as databases and GIS, linked to the WWW will enhance the availability of data and related information (eg bibliographies) for particular countries and wetland sites. It will also allow for regular, cost-effective updating of inventory information.
- **Standardised database:** Development of a standardised or generic wetland inventory database, perhaps developed and distributed alongside the standardised framework for wetland inventory, may be extremely useful for countries with limited resources or expertise in wetland inventory.
- **Accessibility:** Wetland inventory metadata should be added to a globally accessible metadatabase such as the Biodiversity Conservation Information System (BCIS), to ensure details and contacts are available for others to access the inventory and its source data in the future. This will further enhance global accessibility of information and the capacity for determining inventory gaps and priorities.

Note that two models, the Mediterranean Wetland Inventory (Costa et al 1996), and the National Inventory of Wetlands conducted by the United States Fish and Wildlife Service using the classification system of Cowardin et al (1979), have been successfully adapted for use in other countries and could provide a basis for a standardised framework and/or generic wetland inventory database.

9 Priority areas for wetland inventory

9.1 Priority regions

The global wetland inventory resource is, on the whole, a woefully inadequate dataset. All regions of the world – Africa, Asia, Oceania, Neotropics, North America, Western and Eastern Europe – have information gaps and priority areas for wetland inventory. Some of these information gaps are already urgent, and will become increasingly so as wetland loss continues.

Priority is given here to regions in which the wetlands are least known and perhaps the most threatened – areas where rapid population growth and development are combining with ineffective or non-existent wetland protection and sustainable use legislation, to destroy and degrade wetlands at an alarming rate. These priority regions are:

- Neotropics
- Asia
- Oceania
- Africa
- Eastern Europe

All these regions urgently require further wetland inventory and wetland loss studies, to determine the current extent of wetlands, and the rate and extent of loss. In order to make the task more manageable, priority should be given to encouraging countries which do not yet have a national wetland inventory to commit resources to this endeavour. The great importance and urgency of national wetland inventories cannot be overstressed. They provide the base information for effective monitoring, management, sustainable use and conservation of wetlands at all levels – local, national, regional and international.

9.2 Priority habitats

Attention must also be given to inventory of priority wetland habitats, targeting those for which there is little or no information, and those at greatest risk of degradation and destruction.

Priority wetland habitats include:

- **Seagrasses:** The majority of seagrass habitat in southern Asia, South Pacific, South America and some parts of Africa has not been mapped, and yet is under increasing threat from pollution, coastal development, destructive fishing practices, recreational use, etc. Mapping can be done by remote sensing techniques with ground-truthing (eg H Kirkman unpubl).
- **Coral reefs:** There is increasing awareness of the importance of coral reefs in maintaining biodiversity and various ecosystem functions, and global mapping and monitoring efforts are underway. Loss and degradation continues, however, and in no small part due to the development, deforestation and pollution of coastal and inland wetlands.

- **Salt marshes and coastal flats:** There appear to be few international and continental sources that include these habitats, and the information available is sketchy with few areal estimates and no true global 'picture'. Salt marshes and coastal flats are under increasing threat worldwide, particularly in Africa, Asia and Oceania due to increasing coastal development, eg land reclamation and aquaculture activities such as shrimp farming.
- **Mangroves:** Mangal habitat is better mapped than other coastal and marine wetlands, but serious inconsistencies exist. There is a need for more comprehensive inventory in order to be better able to determine mangrove loss. Mangroves are being degraded and destroyed at an alarming rate in many parts of Africa, south-east Asia and Oceania through deforestation, land reclamation, and development for aquaculture.
- **Arid-zone wetlands:** Poorly mapped but increasingly important in the light of escalating population pressures and water demand, most notably in Africa and the Middle East. The impact of dams and trans-boundary sharing of limited water resources are already crucial issues, and wetlands in arid regions must be better mapped and understood to enable more effective management of their use by people, livestock, industry and ecosystems.
- **Peatlands:** In comparison with other wetland habitats there is a relatively good global 'picture' of the extent and distribution of peat resources. However, peatlands are threatened by drainage for agriculture and afforestation in Europe, Asia and North America in particular, despite their importance as a global carbon sink and valuable economic resource. Tropical peatlands are poorly known, especially in south-east Asia.
- **Rivers and streams:** It is difficult to obtain areal estimates of rivers and streams (their length is often provided but rarely their width) and the extent of associated swamps, marshes, ox-bow lakes and lagoons. Yet rivers in all regions of the world are seriously threatened by industrial and domestic pollution, water diversion and regulation by dams. Their effective management is only possible with better understanding of the full extent of the resources they provide, their values and benefits.
- **Artificial wetlands:** These include reservoirs, dams, salines, paddies, and aquaculture ponds, and are increasing in number in all regions of the world, notably Asia, Africa and the Neotropics. Artificial wetlands can become habitat for wildlife, particularly migratory birds, but the values and benefits of these wetlands relative to natural wetlands are little understood. Improved inventory of artificial wetlands such as salines, paddies, fish and shrimp ponds is necessary in order to determine their extent and distribution for management purposes, while providing some data also as to extent of loss and modification of natural wetlands.

10 Priority processes

The work required to establish, update or extend wetland inventory seems monumental when viewed at a global scale, but is eminently achievable if a genuine will exists and a few key processes are targeted for improvement (Finlayson & van der Valk 1995, Finlayson 1996, Scott & Jones 1995).

There is a need to improve:

- **Communication:** Wetland inventory information is useful to people at all levels, local through to global, and should be made available to as wide an audience as possible. Advertise the existence of inventories through interpersonal communication, e-mail forums, conferences and seminars, and by providing the metadata to relevant web-accessible databases such as the Biodiversity Conservation Information System Meta-database (BCIS 1998), *ReefBase* (ICLARM 1998), etc. Encourage feedback and approach new ideas and inventory techniques with an open mind, while retaining the integrity of data and outcomes.

- **Cooperation:** Improve cooperation, financial and otherwise, between countries, agencies and individuals, with the common aim of increasing the wetland inventory resource for all wetland habitats, particularly those most threatened. Resources and effort are often 'wasted' on numerous pilot studies or overly-ambitious projects which have little reward ultimately in terms of inventory and improved management or conservation of wetlands, indicating a need for even more careful prioritisation when allocating resources, especially in the light of the current dismal global dataset for wetland inventory.
- **Definition of purpose:** The purpose of an inventory influences the type of data collected and the analysis and conclusions reported. If the purpose is poorly defined at the outset, the result is often an unfinished inventory that tried to achieve too much with too little, or an unwieldy dataset difficult to compare with other inventories, its reliability, purpose and relevance to other applications being unclear. It is therefore crucial to define the purpose of the inventory clearly at the beginning, set achievable and relevant outcomes, and ensure that limitations of the dataset or approach are recognised and reported. Similarly, it is crucial that the objectives and limitations of an inventory are taken into consideration when the data is used for other purposes.
- **Standardisation:** There is a need for a standardised framework and a generic database for wetland inventory, to assist countries and agencies with limited resources and inventory expertise in conducting inventory. This would also better enable comparisons between inventories, thus improving the global 'picture' of the wetland resource, priority habitats for management and conservation, and extent of wetland loss and degradation.
- **Reporting content:** Published wetland inventories often lack basic information, eg the means of data collection and storage, names and contact details for compilers, wetland definition and classifications used. Broad-scale overviews containing areal estimates for wetlands or wetland loss rarely include the source data or references, making it difficult to assess the age and reliability of the information. Reporting therefore needs to be improved, eg a standardised framework for wetland inventory could include recommendations for reporting.
- **Reporting format:** Wetland inventories are often published in hardcopy only, which can be large and unwieldy, and prohibitively expensive to update and reprint. It is advised that all future wetland inventories are stored and published electronically in addition to hardcopy, and the metadata, at least, made available on the WWW.
- **Data storage:** Data storage and handling issues must be addressed at the outset of an inventory project, and systems established for storage, maintenance and updating of the dataset. Electronic methods such as GIS and databases are preferred, as they simplify data updating, accessibility and dissemination issues.

11 Specific recommendations

- All countries that have not yet conducted a national wetland inventory should do so, preferably using an approach that is comparable with other large-scale wetland inventories already underway or complete, and in line with recommendations from the Ramsar Wetland Convention.

- All countries currently without wetland protection and sustainable use legislation should introduce it as soon as possible, and take the necessary steps to ensure its effectiveness, again in line with recommendations from the Ramsar Wetland Convention.
- Wetland inventory information for particular countries and regions should be used to determine priority wetland habitats for conservation and intensive management, and action taken on the recommendations of such assessments.
- Quantitative studies of wetland loss and degradation are urgently required for much of Asia, Africa, South America, and the Pacific Islands.
- Improve the approach and effectiveness of all aspects of wetland inventory through standardisation, eg a standardised framework and a generic wetland inventory database, designed to be as flexible as possible for use in all regions of the world and to accommodate various inventory objectives.
- All wetland inventories in future should be stored and published electronically in addition to hardcopy. This improves accessibility and allows regular updating of information. Ideally the metadata at least should be published on the WWW to make it easily accessible to as wide an audience as possible.

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Table 1 Global area estimates obtained from wetland inventory sources

Source	Region	Wetland type	Global area (ha)
Matthews & Fung (1987)	Asia, Oceania, Africa, Europe, Neotropics, North America	Forested bog	207 800 000
		Nonforested bog	89 700 000
		Forested swamp	108 700 000
		Nonforested swamp	100 700 000
		Alluvial formations	19 400 000
		Total natural wetlands (excl. irrigated rice fields)	530 000 000
Aselmann & Crutzen (1989)	Asia, Oceania, Africa, Europe, Neotropics, North America	Rice paddies	130 000 000
		Bogs	190 000 000
		Fens	150 000 000
		Swamps	110 000 000
		Floodplains	80 000 000
		Marshes	27 000 000
		Lakes	12 000 000
		Total natural freshwater wetlands	570 000 000
Dugan (1993)	Asia, Oceania, Africa, Europe, Neotropics, North America	Wetlands (assumedly freshwater only)	560 000 000
Frazier (1996)	Asia, Oceania, Africa, Europe, Neotropics, North America	Wetland sites on the Ramsar List of Wetlands of International Importance.	52 334 339 *
Spalding et al (1997)	Asia, Africa, Oceania, Neotropics, North America	Mangroves only	18 100 000
WCMC (1998)	Asia, Oceania, Africa, Neotropics, North America	Coral reefs only	30 000 000 – 60 000 000
Dugan (1993)	Asia, Oceania, Africa, Europe, Neotropics, North America	Peatlands only	400 000 000
Aselmann & Crutzen (1989)	Asia, Oceania, Africa, Europe, Neotropics, North America	Artificial wetlands – rice paddies only (no other global areas located for artificial wetland types)	130 000 000

* Update (30/1/99): Ramsar now lists 965 wetland sites of international importance, covering 70 471 806 ha.

Table 2 Regional wetland area estimates by wetland type
(Note: Approximate only, refer to GRoWI regional reports and original sources for further detail)

Region	Wetland type	Continental area (ha)	Source
Africa	Freshwater wetlands	34 500 000	Dugan (1993)
	Freshwater wetlands	35 600 000	Aselmann & Crutzen (1989)
	Tropical swamps	>34 000 000	Thompson & Hamilton (1983)
	Headwater swamps	8 500 000	Thompson & Hamilton (1983)
	Floodplains[1]	10 980 000	Denny (1993)
	Swamps[1]	12 640 000	Denny (1993)
	Shallow waterbodies[1]	2 830 000	Denny (1993)
Asia	All wetlands	>120 000 000	Scott & Poole (1989)
	Mangroves	>7 517 300	Spalding et al (1997)
Oceania	No regional estimate available		
Europe	Freshwater wetlands	670 000	Aselmann & Crutzen (1989)
	Coastal salt marshes	230 000	Dijkema (1987)
Canada	All wetlands	127 200 000	Glooschenko et al (1993)
United States of America	Marine wetlands	31 741	Wilen & Tiner (1993)
	Estuarine wetlands	2 123 199	Wilen & Tiner (1993)
	Palustrine wetlands	37 949 958	Wilen & Tiner (1993)
North America total	All wetlands	>167 304 898	(author's calculations)
Caribbean	All wetlands	23 500 000	Dugan (1993)
South America	Freshwater wetlands	152 000 000	Aselmann & Crutzen (1989)
Central America	Freshwater wetlands	1 750 000	Aselmann & Crutzen (1989)
Neotropics total	All wetlands	>177 250 000	(author's calculations)

1 Author's calculations from figures provided in Table 3, Denny (1993).

Table 3 National wetland area estimates by wetland type; summary of information presented in 'Extent and distribution of wetlands' and GRoWI database

(Note: Some estimates highly approximate, refer to original sources for more detail. Where estimates differ (eg mangroves), both are reported. Some mangrove areas are listed here; see Spalding et al (1997) for more detail. Peatland estimates listed in more detail in table 4.)

Country	**Wetland type**	**Continental area (ha)**	**Source**
Alaska	Freshwater boreal wetlands	60 000 000	Dugan (1993)
	Mires (fens and bogs)	25–40 000 000	Aselmann & Crutzen (1989)
Albania	Freshwater lakes	<35 000	Britton & Crivelli (1993)
Algeria	Coastal lagoons	3700	Britton & Crivelli (1993)
	Freshwater lakes	>2000	
	Reservoirs	3300	
	Athalassic salt lakes	358 900	
	Freshwater marshes	29 000	
	Forested wetlands	<100	
Australia	Peatlands	15 000	Taylor (1983)
		307 292	Aselmann & Crutzen (1989)
	Coral reefs	>35 000 000	Ellison (1996)
	Mangroves	1 150 000	Spalding et al (1997)
Bangladesh	All wetlands	3 666 300	Gopal & Wetzel (1995)
	Rivers	217 135	
	Tributaries	262 600	
	Beels and haors	114 793	
	Oxbow lakes	5488	
	Seasonal floodplains	2 832 792	
	Artificial ponds	163 492	
Brazil	Peatlands	100 000	Junk (1983)
	Mangroves	1 340 000	Spalding et al (1997)
Canada	Freshwater wetlands	170 000 000	Zoltai & Pollett (1983)
	Wetlands (bogs and fens)	127 000 000	Aselmann & Crutzen (1989)
	Total wetlands	127 199 000	Cox (1993)
	Peatlands	111 327 000	Cox (1993)
China	Undeveloped peatlands	3.1–3.48 000 000	Aselmann & Crutzen (1989)
Finland	Peatlands	5 000 000	Ruuhijärvi (1983)
France	Coastal lagoons	93 800	Britton & Crivelli (1993)
	Non-tidal salt marsh	20 800	
	Freshwater lakes	500	
	Reservoirs	3600	
	Freshwater marshes	20 300	
	Forested wetlands	<1000	

Table 3 Cont

Country	Wetland type	Continental area (ha)	Source
Ghana	Lagoons	>4 786 400	Gopal & Wetzel (1995)
	Reservoirs	858 311	
	Fish ponds	223.02	
Great Britain and Ireland	Peatlands	2 684 291	Taylor (1983)
Greece	Coastal lagoons	29 200	Britton & Crivelli (1993)
	Non-tidal salt marsh	9400	
	Freshwater lakes	164 100	
	Reservoirs	12 500	
	Freshwater marshes	5300	
	Forested wetlands	300	
India	Mangroves	355 000	Gopal et al (1982)
		537 900–670 000	Spalding et al (1997)
Indonesia	Swamp forests	>17 000 000	Dugan (1993)
	Peatlands	27 000 000	Rieley et al (1996)
	Mangroves	4 255 000	Spalding et al (1997)
Italy	Estuaries	200	Britton & Crivelli (1993)
	Coastal lagoons	11 500	
	Freshwater lakes	3000	
	Athalassic salt lakes	<100	
	Freshwater marshes	1500	
	Forested wetlands	>300	
Malaysia	Reservoirs	>80 000	Gopal & Wetzel (1995)
	Dams	>92 145	
Mexico	Inland wetlands	650 000	Dugan (1993)
	Coastal wetlands	1 250 000	Dugan (1993)
	All wetlands	3 318 500	Olmsted (1993)
Morocco	Estuaries	>1700	Britton & Crivelli (1993)
	Intertidal flats	>3100	
	Intertidal salt marsh	3400	
	Coastal lagoons	21 600	
	Freshwater lakes	1400	
	Reservoirs	>7500	
	Athalassic salt lakes	41 600	
	Freshwater marshes	200	
	Forested wetlands	<100	
Nigeria	Mangroves	1 051 500	Spalding et al (1997)

Table 3 Cont

Country	Wetland type	Continental area (ha)	Source
Pakistan	Inland waters	>7 800 000	Scott (1989)
	Delta marshes	300 000	Scott (1989)
	Mangroves	250–283 000	Scott (1989)
	Lakes and reservoirs	472 070	Gopal & Wetzel (1995)
	Fish farms and ponds	334 019.4	Gopal & Wetzel (1995)
Papua New Guinea	Coral reefs	4 000 000	Ellison (1996)
	Mangroves	162–200 000	Ellison (1994)
		411 600–539 900	Spalding et al (1997)
Portugal	Intertidal flats	65 500	Britton & Crivelli (1993)
	Coastal lagoons	14 000	
former Soviet Union	Freshwater wetlands	150 000 000	Aselmann & Crutzen (1989)
	Bogs and fens	145 000 000	Aselmann & Crutzen (1989)
	Peatlands	83 000 000	Botch & Masing (1983)
	Swamps and marshes	6 500 000	Aselmann & Crutzen (1989)
South Africa	Wetlands in Natal region	111 427	Breen et al (1993)
Spain	Intertidal flats	20 400	Britton & Crivelli (1993)
	Athalassic salt lakes	>5500	
	Freshwater marshes	>6500	
Sri Lanka	Artificial reservoirs and marshes	169 940	Gopal & Wetzel (1995)
Sweden	Wooded wetlands	2 000 000	Sjörs (1983)
	Open mire (mostly treeless)	>5 000 000	
Tunisia	Irrigation culverts	400 000	Gopal & Wetzel (1995)
	Endorrheic salt depressions	600 000	Gopal & Wetzel (1995)
	Sebkhas	>56 500	Gopal & Wetzel (1995)
	Intertidal flats	28 100	Britton & Crivelli (1993)
	Intertidal salt marsh	5900	Britton & Crivelli (1993)
	Coastal lagoons	65 900	Britton & Crivelli (1993)
	Freshwater lakes	11 200	Britton & Crivelli (1993)
	Athalassic salt lakes	752 500	Britton & Crivelli (1993)
	Freshwater marshes	5100	Britton & Crivelli (1993)
	Forested wetlands	<500	Britton & Crivelli (1993)
Uganda	Swamps	1 180 000	Gopal et al (1982)
United States of America	Reservoirs (>202 ha)	3 900 000	Taub (1984)
Zambia	All wetlands	75 000 000	Gopal et al (1982)
	Swamps	2 400 000	Denny (1985)

Table 4 Percentage of national area covered by peat in rank order (adapted from Taylor 1983), with additional data from other inventory sources

Country	**Peat area (ha)**	**% land surface**	**Data from other inventory sources**
Canada	129 500 000	18.4	Peatland estimates vary from 5.9–30 million ha (Zoltai & Pollett 1983). More recently, peatlands estimated at 111 327 000 ha (Cox 1993).
former U.S.S.R.	71 500 000[1]	6.7	Peatlands 83 000 000 ha incl. 39 000 000 ha in western Siberia (50% land surface) (Botch & Masing 1983).
Finland	10 000 000	33.5	5 000 000 ha lost to development; expected loss of 7 000 000 ha by mid-1990s (Ruuhijärvi 1983)
United States of America	7 510 000	3.3	60 000 000 ha freshwater boreal wetlands in Alaska, predominantly peatlands (Dugan 1993)
China	3 480 000	0.4	
Norway	3 000 000	9.4	
British Isles (incl. Ireland)	2 684 291	8.6	
Malaysia	2 360 000	7.2	500 000 ha peat swamps drained (Maltby et al 1996)
Republic of Ireland	1 175 590	17.2	
United Kingdom	1 508 701	6.3	
Poland	1 500 000	4.4	
Sweden	1 500 000	17.1	~16% land surface covered by peat, incl. 2 000 000 ha wooded wetlands, >5 000 000 ha open mire (Sjörs 1983)
Iceland	1 000 000	9.7	
Scotland	821 381	10.4	
Indonesia	700 000	13.7	Highest recent estimate is 27 000 000 ha, placing Indonesia fourth in the world (Rieley et al 1996). 531 000 ha peat swamps drained (Maltby et al 1996).
Germany (G.D.R.)	489 000	5.1	
Germany (G.F.R.)	489 000	4.4	
England	361 690	2.8	
Cuba	200 000	3.9	
Japan	200 000	0.5	
Northern Ireland	166 860	12.4	
New Zealand	166 000	0.6	
Wales	158 770[2]	7.7	
Hungary	100 000	1.1	
Country (cont'd)	Peat area (ha)	% land surface	Data from other inventory sources
The Netherlands	100 000	7.4	
Yugoslavia	100 000	0.4	
Uruguay	100 000	0.5	
Brazil	100 000	0.01	This estimate from Junk (1983)
Denmark	60 000	2.8	
Italy	60 000	0.4	
France	60 000	0.2	

Table 4 Cont

Country	Peat area (ha)	% land surface	Data from other inventory sources
Switzerland	55 000	1.3	
Argentina	45 000	0.016	
Czechoslovakia	33 000	0.2	
Austria	22 000	2.8	
Belgium	18 000	0.6	
Australia	15 000	0.002	Legoe (1981) estimates peatlands cover 0.04% land surface area (307 292 ha).
Romania	6 000	0.03	
Spain	6 000	0.012	
Israel	5 000	0.25	
Greece	5 000	0.04	
Bulgaria	1 000	0.001	

1 These are exploitable reserves and substantially underestimate peatland areas especially in the tundra and adjacent territories of northern Siberia.

2 This figure includes extensive areas of thin (<0.9m) hill peat

Table 5 Regional estimates of tropical peatland area, adapted from Rieley et al (1996)

Region	Area (ha) – mean	Area (ha) – range
Central America	2 438 000	2 276 000–2 599 000
South America	4 037 000	4 037 000
Africa	2 995 000	2 995 000
Asia (mainland and south)	2 351 000	1 351 000–3 351 000
Asia (southeast)	26 435 000	9 932 000–32 938 000
The Pacific	19 000	19 000
Total	**38 275 000**	**30 610 000–45 939 000**

Table 6 Regional estimates of mangrove area, adapted from Spalding et al (1997)

Region	Mangrove area (ha)
South and Southeast Asia	7 517 300 (41.5%)
Australasia	1 878 900 (10.4%)
The Americas	4 909 600 (27.1%)
West Africa	2 799 500 (15.5%)
East Africa and the Middle East	1 002 400 (5.5%)

Table 7 Gaps in mangrove inventory data in the World Mangrove Atlas (Spalding et al 1997)
(Note: 'Alternative' estimates are extracted from mangrove inventory sources other than maps)

Region	Mangrove inventory gaps
South and Southeast Asia	Map data available for all countries except Singapore. No alternative estimates available for China, Taiwan and Hong Kong. Sri Lanka's alternative estimate does not include the entire country and is therefore likely to be an underestimation.
Australasia	No map data available for Solomon Islands and Western Samoa. All countries have alternative estimates.
The Americas	Map data available for all countries. No alternative mangrove inventory sources for Aruba, Netherlands Antilles, British Virgin Islands, Dominica, Guadeloupe (including St Martin and St Barthelemy), Martinique, Netherlands Antilles (windward group) and United States of America (Florida only).
West Africa	No map data for Togo. No information at all on presence of mangroves in Sao Tome and Principe.
East Africa and the Middle East	No map data available for Qatar and United Arab Emirates. No alternative mangrove inventory sources for Comoros, Mayotte, Seychelles, Djibouti, Egypt, Eritrea, Somalia, Sudan, Yemen. No data at all for British Indian Ocean Territory and Maldives.

Review of wetland inventory information in Africa

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Contents

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1 Introduction

The African countries covered by this review are listed below in table 1.1. These countries constitute the Ramsar Region of Africa that encompasses some fifty-five countries. This includes all the countries in continental Africa, bordered by the Red Sea in the north east of Africa, and includes Madagascar, the Seychelles, the Cape Verde Islands, Mauritius, Sao Tome and Principe and Comoros Islands.

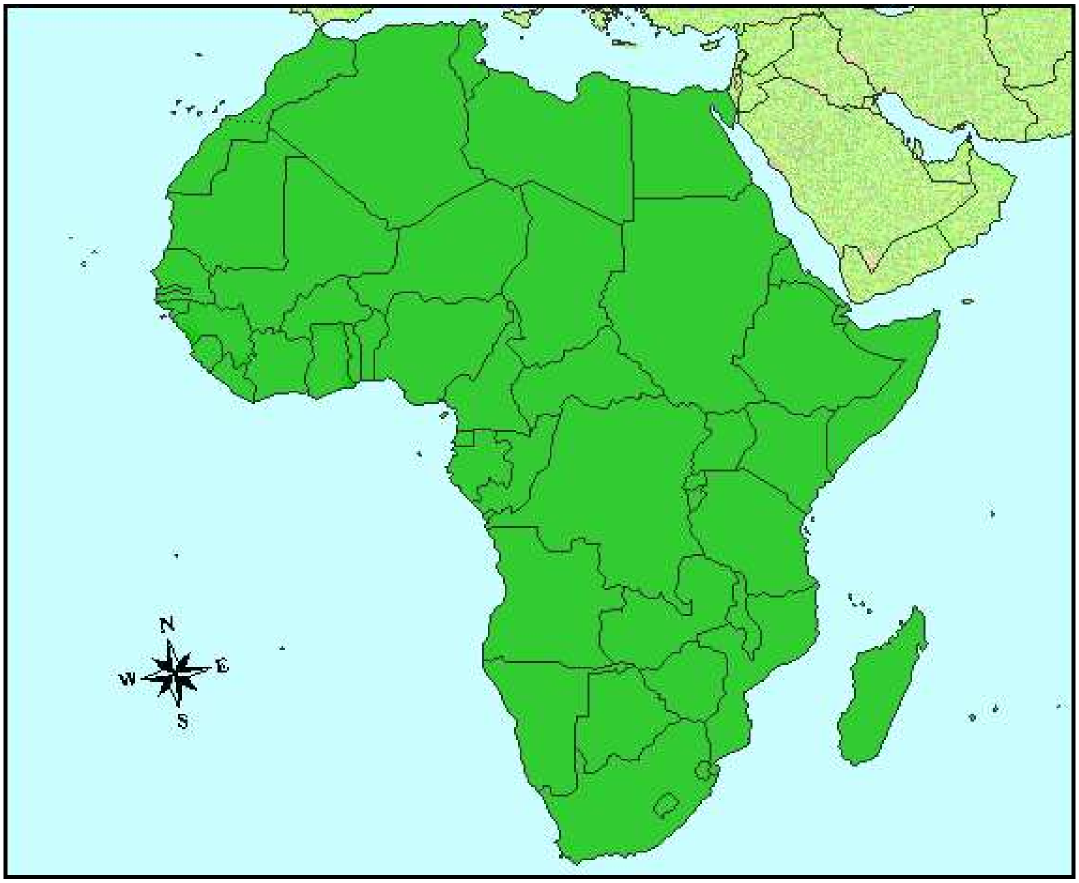
Table 1.1 Countries included in the Ramsar region of Africa

East Africa	North Africa	West Africa	Central Africa	Southern Africa
Djibouti	Algeria	Benin	Burundi	Angola
Eritrea	Egypt	Burkina Faso	Cameroon	Botswana
Ethiopia	Libya	Cape Verde	Central African rep.	Comoros
Kenya	Morocco	Cote d'Ivoire	Chad	Lesotho
Seychelles	Tunisia	Gambia	Congo – Dem. Republic.	Madagascar
Somalia	Western Sahara	Ghana	Congo – republic of	Malawi
Sudan		Guinea	Equatorial Guinea	Mauritius
Tanzania		Guinea-Bissau	Gabon	Mozambique
Uganda		Liberia	Rwanda	Namibia
		Mali	Sao Tome & Principe	South Africa
		Mauritania		Swaziland
		Niger		Zambia
		Nigeria		Zimbabwe
		Senegal		
		Sierra Leone		
		Togo		

[Note: a duplicate entry for Somalia was removed and the above table was sorted, after publication of the 2nd ed. GRoWI CD-ROM]

This review was based on national datasets (including the possibility that a composite national dataset could be amalgamated by equivalent, e.g. provincial, data subsets). From the beginning, the assumption was made that significant (national) information on wetland extent, health, attributes and values might be found in many other information sources besides conventional wetland inventories or directories. It is believed that this constitutes a divergence from previous studies. While this broadened the scope and potential of the material examined, it also meant that all studies were effectively judged as if they were undertaken with wetland inventory objectives in mind. Often, of course, this was not the case.

Furthermore the authors acknowledge the following deficiencies in this study. The dataset is incomplete, for some countries this is more of a concern than for others. The compressed time frame and limited resourcing for a project of this nature probably promoted certain biases (for example, over-reliance on English language studies, and on the more-familiar elements of contact networks), and was likely heavily influenced by the lag time between requests for study material, and its ultimate receipt. At the time of writing, material suitable for assessment continues to be identified and arrive, and the knowledge of other as yet unobtained resources which should be evaluated, increases. Finally, due to time and resource constraints, spatial information datasets have not been adequately reviewed; this constitutes a large gap in this preliminary study.



Boundaries are not authoritative

Figure 1.1 Map of the Africa region

2 Information sources

2.1 Search strategy

This review can simply be described as an inventory of wetland inventories based on national datasets (including composite national datasets that were amalgamated from equivalent, e.g. ‘provincial’, data subsets).

Potential sources of wetland inventory data were identified through communications with an extensive network of contacts (Annex 1), and using the World Wide Web, external (e.g. Wageningen Agriculture University databases) and in-house libraries, Ramsar National Reports and IWRB National Reports. Key words used in literature searches included combinations of the more obvious terms such as:

> *wetland, wetlands, inventory, extent, status, distribution, classification, directory, overview, review*

and habitat names including the following:

> *coral, reef, mangrove, mangal, grasslands, peat, peatland, bog, marshes, swamp, lakes, dambos, water, reservoirs, pond*

and less obvious terms such as:

> *survey, area, intertidal, subtidal, riparian, aquatic, coastal, evaluation, mapping, floodplain, census, state, waterfowl, waterbirds*

also non-English search terms included:

> *Les zones humid, Le zone umide, zones humides d'importance, Flussordnungszahlen, los manglares, Le Littoral, los Humedales, resources cotieres*

Where the above terms did not prove successful for any individual country, a search by country name was conducted followed by a lengthy examination of the resulting ‘hits’.

In addition, the reference lists of material obtained were scanned for possible wetland inventory sources. In many cases this proved to be a more successful approach for identifying potential information sources than database or web searching, particularly for unpublished sources.

2.2 Evaluation of the African dataset

The methodology used to identify and evaluate material for the African dataset follows.

2.2.1 Evaluation of inventory material for inclusion in the AFRICA dataset

Many potential sources were obtained, and their suitability for inclusion in the database was assessed. Those that were deemed as useful were included in this review.

The decision whether to include or exclude certain sources depended on several factors. Poor quality material was not usually included except where no alternative data for a country could be obtained. Sub-national data were excluded except where no national information existed. In cases where material was encountered which contained no area data but did contain other useful information, it was considered if no other information for that country was identified.

2.2.2 Meta-data recording

Each assessed information source was evaluated using a *Wetland Inventory Assessment Sheet* (WIAS) designed to permit rapid assessment and compilation of information about each identified inventory and to compile summary information about the wetland resource contained in each inventory. A set of guidelines for the completion of the sheet was also developed to facilitate consistent handling and coding of relevant information. Derivation of wetland coverage estimates and other wetland parameters are discussed in later sections.

A database was created to include information about each information source that was reviewed and recorded on a WIAS datasheet. Another database was also created to serve as a data dictionary of the codes (and their descriptions) which was used to represent various categories of information in the primary database.

Computer programs were written to analyse the majority of coded fields in the database. The analyses report on the presence or absence of codes or logical values (by use of a filtering system), and produced printed outputs. These outputs provide the meta-data breakdowns given in this report.

2.3 Materials sourced

Some 28 wetland inventory sources were included in the Africa (AFRICA) dataset. The number of inventories examined per country are given in table 2.1 and are graphically represented in figures 2.1–2.5.

The materials examined included both published (including World Wide Web articles, journal articles and books) and unpublished material, academic material (including peer reviewed material, MSc and PhD theses), governmental and non-governmental material, draft reports, newsletter articles, conference proceedings and consultancy reports (see section 2.4 for further details).

As such, conventional wetland inventories and directories were examined, also natural resource inventories or habitat surveys (which either directly or indirectly included wetlands) and sources which contained wetland extent information merely as a by-product of some other activity (e.g. waterfowl counts).

Table 2.1 Numbers of material sourced per country in the African region

West Africa	**No. of Materials Sourced**
Mauritania	6
Senegal	7
Gambia	6
Ghana	5
Guinea	7
Guinea-Bissau	5
Sierra Leone	3
Liberia	4
Cote d'Ivoire	4
Benin	3
Togo	2
Niger	2
Nigeria	4
Burkina Faso	2
Mali	3
Cape Verde	0
Southern Africa	
South Africa	5
Botswana	3
Lesotho	1
Swaziland	1
Namibia	4
Angola	3
Mozambique	2
Malawi	2
Madagascar	4
Zambia	2
Zimbabwe	1

Southern Africa cont	
Mauritius	0
Comoros	2
Central Africa	
Central African Republic	1
Congo – Republic of	3
Congo – Democratic Republic.	3
Burundi	1
Rwanda	1
Equatorial Guinea	2
Gabon	6
Cameroon	4
Sao Tome & Principe	0
Chad	2
North Africa	
Algeria	3
Morocco	3
Egypt	3
Libya	2
Western Sahara	1
Tunisia	6
East Africa	
Tanzania	3
Somalia	2
Eritrea	1
Ethiopia	1
Djibouti	2
Kenya	4
Seychelles	1
Uganda	3
Sudan	2

[Note: a duplicate entry for Somalia was removed above after publication of the 2nd ed. GRoWI CD-ROM]

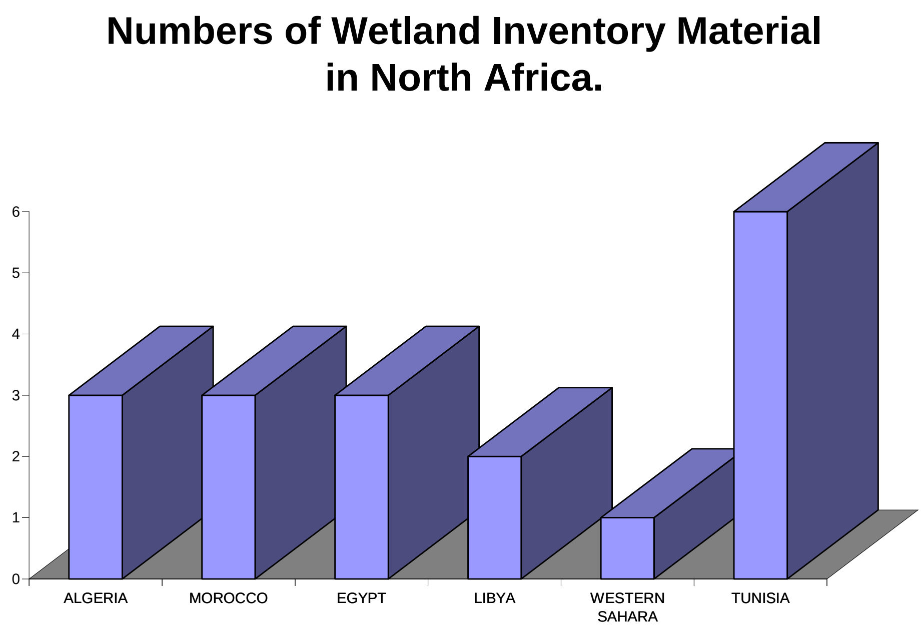


Figure 2.1 Numbers of wetland inventory material examined for the North African countries of the African dataset

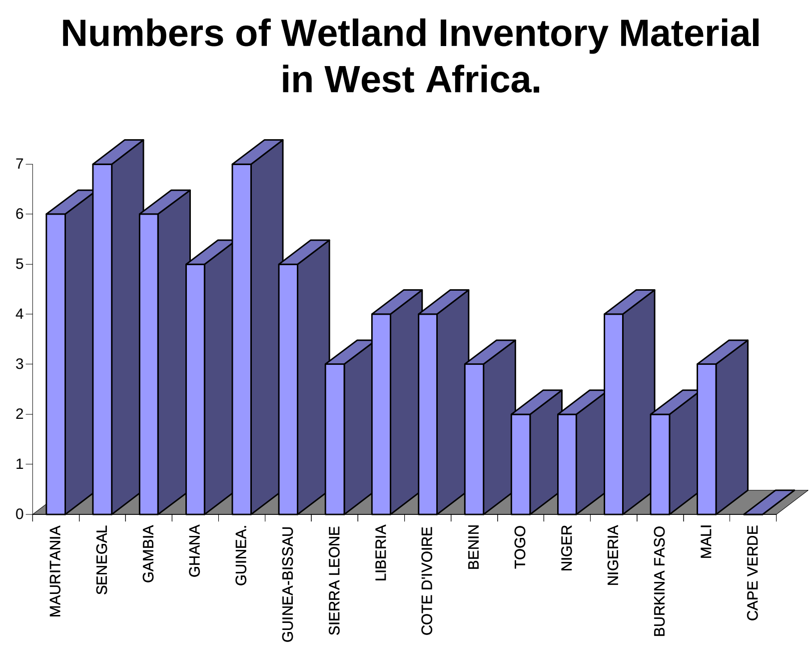


Figure 2.2 Numbers of wetland inventory material examined for the West African countries of the African dataset

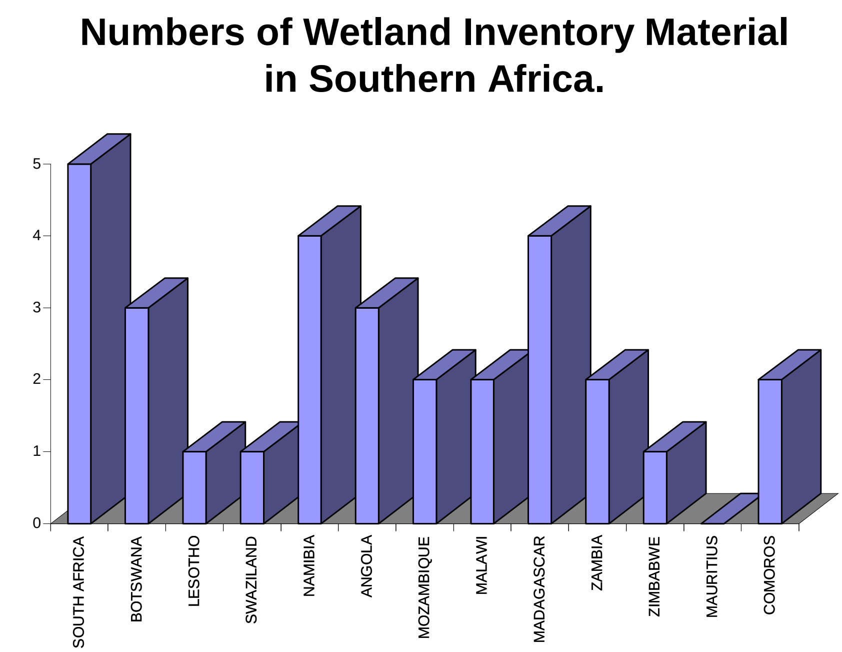


Figure 2.3 Numbers of wetland inventory material examined for the Southern African countries of the African dataset

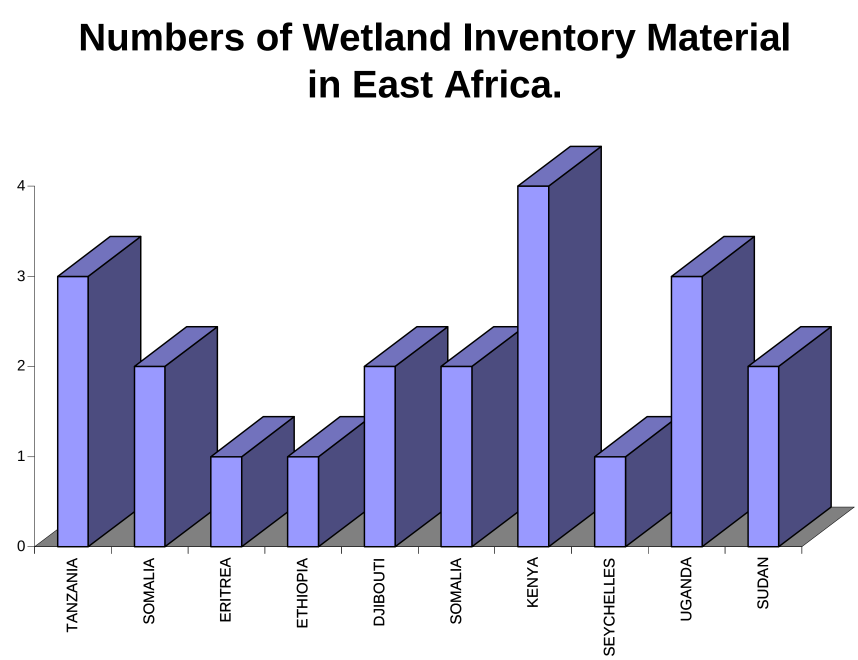


Figure 2.4 Numbers of wetland inventory material examined for the East African countries of the African dataset

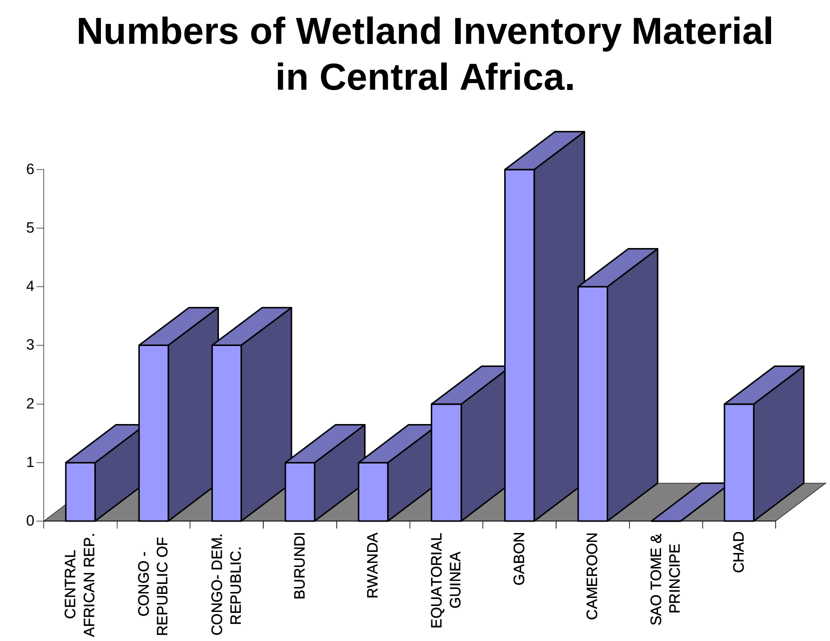


Figure 2.5 Numbers of wetland inventory material examined for the Central African countries of the African dataset

Since a degree of selection occurred in choice of material included in the Africa (AFRICA) dataset, it cannot be stated that 'x' countries have more wetland inventory material than 'y' countries. In some cases, several sources of material were required in order to make a best estimate of wetland coverage for a specific country, whereas, for other countries, one source alone was comprehensive and detailed enough to provide a best estimate of wetland coverage.

An example of the former would be Mauritania; five separate source materials were examined for Mauritania and, yet, no values for wetland area by type were possible, and the value for total wetland coverage is very approximate. An example of the latter would be 'A directory of South African wetlands' in Cowan (1997). Therefore, it must be noted that the bar graphs above cannot be taken as representative of all the material available per country, simply the material which was included in the AFRICA dataset.

2.4 Summary of information sources reviewed

The majority of materials examined (75%) were national level material and some 11% were at the global scale, and some 11% were at the sub-regional scale (ie covering several countries within the Africa Ramsar region, though not covering every country in the region).

Scale of inventory of material	
Global scale	11%
Supra-regional scale	7%
Regional scale	4%
Sub-regional scale	11%
National scale	75%
Single country studies	68%
National scale references including more than one country	7%

Sub-national scale	0%
National and other scale combination	7%

A large percentage of materials (32%) was produced by non-government organisations (NGOs), composed of 11% of formal NGO publications and 21% NGO reports. Government produced material amounted to a further 32% of material (25% formal government publications and 7% internal government reports). Some 7% of material came from peer review journals, 4% came from chapters in published books and a further 7% were academic theses (both PhD and MSc).

Type of source material	
Peer review journals	7%
Peer review books	0%
Chapters in books	4%
Conference or keynote presentation	0%
Article in conference proceedings	0%
Internal government reports	7%
Government formal publications	25%
Other government material	4%
NGO reports	21%
NGO formal publications	11%
Consultancy reports	0%
Newsletter articles	0%
Practitioner periodical article	0%
Database manual	0%
Electronic database	4%
World Wide Web article	0%
Thesis	7%
Other	11%
Unknown	4%

Most of the information sources examined were not conventional wetland directories or inventories (71%); the majority of information sources were other kinds of studies, and not wetland inventories *per se*.

Source is a directory/inventory or equivalent?	
Yes	29%
No	71%

The majority of studies examined were in English (86%), with the remaining sources being mainly in French.

Language of study	
English	86%
Other	14%

Nearly all the material was in paper format (96%) and, notably, none of the material was produced electronically on the World Wide Web. This should be compared to Western and Eastern Europe which both produced some information on the World Wide Web (Stevenson & Frazier 1999a,b). Similarly, most information (82%) was stored in paper format, and some 11% in electronic databases.

Format of study	
Paper	96%
Electronic text	0%
Electronic database	7%
Personal communication	0%
Web presentation	0%
Part of GIS or GIS output	4%
Map based	0%
Other format	0%
More than one format	4%
Data storage media	
Paper	82%
Web (electronic)	0%
Other electronic (not web or database)	4%
Electronic database	11%
GIS	4%
Hard copy map	0%
Digitised map	0%
Other	18%
Unknown or ambiguous	21%
More than one medium	11%

Only 43% of the material was published, but 46% of the material was classed as ‘unpublished but unrestricted’.

Circulation of study	
Published	43%
Interdepartmental (unpublished)	4%
Internal (unpublished)	7%
Restricted (unpublished)	0%
Unrestricted (unpublished)	46%
Other types	4%
Unknown	4%
More than one type	7%

2.5 Reliability of data

It is difficult to make judgements on the reliability of the individual data sources examined and included in this review when much of the material did not provide basic information. For instance, basic information such as the date of survey or date ranges of material featuring in a compilation/review, methodologies used, or contact information was frequently omitted. The tendency is to judge material as unreliable if it does not contain such basic information, but this judgement is by no means certain. The variety of classification schemes and definitions of wetlands used (often not defined) serves to further hamper any attempts to judge the reliability of the material. However, as material for individual countries is judged collectively, it becomes (subjectively) more clear which information sources are likely to be more reliable.

By examining the methods, the date ranges and inclusion (or exclusion) of particular wetland types it is possible to at least generate best estimates of wetland coverage for any particular country, by consolidating the estimates from several sources. For example, one source may provide an estimate of wetlands in a country comprising an estimate of coastal wetlands which appears to be accurate, but an estimate of freshwater wetlands which noticeably excludes (for example) floodplains. The estimate for coastal wetlands would then be consolidated with the estimate of freshwater wetlands provided by another source that purports to include floodplain wetlands (providing it was a greater area than the other source).

Section 3.3 provides a more detailed description of how wetland area estimates by type were generated for this review, and provides guidance for interpreting the summary sheets of wetland coverage and extent (Annex 2), and material reviewed. Comments on the age of data, methods used and exclusions in coverage (e.g. the estimate excludes floodplain wetlands and ephemeral wetlands).

Several generic difficulties emerged throughout the evaluation process that should be noted when judging the reliability of data. These are summarised below.

- usage of different wetland definitions/classifications and the inclusion or exclusion of some wetland types, e.g. lakes and open water, in inventories. Certain wetland types are frequently excluded from wetland assessments such as dune slacks, humid sands, dambos, wet mesotrophic grasslands, seagrass beds, maerl beds, ephemeral wetlands, and coral reefs;
- artificial wetlands were also often largely ignored in many national inventories and therefore national inventories are often incomplete in their coverage;
- the date of data collection and inventory productions were often not recorded, and it should be noted that review compilations by their very nature use different sources of widely differing ages (the dates of which are rarely stated);
- recent changes in political/national boundaries made older sources difficult to interpret;
- defined boundaries of wetlands were often not provided, making comparisons between different sources difficult, as did the variable treatment of individual wetlands in wetland complexes;
- many sources lacked a summary, making extracting national-level information time-consuming; some of the material which did provide a summary contained summary information that did not always match the text of the report;
- many potential wetland inventory information sources were unpublished material which proved to be difficult to obtain or access; much of the information which was accessed

were also draft reports written up to 5 years ago which have never progressed beyond draft report stage;

- often the areas provided in many sources of information were site areas, e.g. national park areas and not actually wetland areas, (these sources were excluded from the analysis, with the exception of Ramsar sites which were recorded separately for interest);
- contradiction of information about some sites *between* different references was found to occur. With a little detective work, in most cases it was possible to identify erroneous material, but this was not always possible;
- contradictions within *one individual* source document were also noted. This meant that some detective work was required to identify errors and rectify errors, resulting in slow assessment.

This project has identified several cases where source material has quoted wetland area estimates taken from studies that had been comprehensively updated by more recent studies, and therefore their estimates were out of date, and had been supplanted by more recent and accurate data. This creates a misinformation trail, which makes it difficult to assess the accuracy of reports that yield conflicting data.

Some less accessible inventories have been missed in this review. Additional material has been identified since the analysis phase was completed and some key sources of material were therefore not incorporated in this preliminary analysis. Further additional sources may be revealed during the consultation phase and after circulation of the completed report. An update of the dataset is recommended after the consultation process has been completed.

3 Extent and distribution of wetlands

3.1 Definition and classification of wetlands

A major consequence of using the rather broad Ramsar definition of wetlands in this review (Annex 3) is that the estimates of wetland coverage generated by this project cannot strictly be regarded as estimates of true or actual wetland cover, but are instead estimates of *described* wetland cover. Consequently the area values given in this review should be viewed as underestimates, and do not represent estimates of the entire wetlands resource, but only those for which coverage estimates already exist in their many disparate forms.

Differing wetland definitions and classification schemes were used in different studies and these definitions are not always stated, making it difficult to assess the degree of completeness of cover (and thereby the estimates of wetland extent). For instance, many inventories include or exclude some wetland types, e.g. open water bodies, and estuaries.

A definition of the terms ‘marine wetlands’, ‘coastal wetlands’ and ‘inland wetlands’, was almost without exception absent, and yet separate authors used them to mean different things. Extracting information on even broad wetland categories was found to be difficult. Particularly when some authors use, for example, the term ‘coastal wetlands’ to mean strictly saline and brackish habitats and others use it to mean wetlands in the coastal zone (which often for practical purposes means coastal lowlands and incorporates wetlands which experience no tidal inundation). Similarly the term ‘inland wetlands’ to some authors meant freshwater wetlands, to others it meant all wetlands except those in the coastal plain, to others it meant all wetlands except those wetlands under tidal influence.

It was apparent (though not defined) that many authors utilised a more narrow definition of wetlands than that given by the Ramsar definition. For instance, many authors may argue that wetlands must be vegetated, (therefore mudflats and sand flats and open water would be excluded). Others may argue that coral reefs, seagrass beds and subterranean karst are not wetlands, and others may also exclude artificial or created wetlands from their definition of wetlands. Similarly, forested wetlands are often regarded as forests and not wetlands, and are therefore excluded from wetland assessments (and yet may also be excluded from forestry assessments for exactly the opposite reason).

It is therefore not surprising that certain wetland types were noted to be commonly excluded from wetland assessments. These include dune slacks, humid sands, dambos, wet mesotrophic grasslands, seagrass beds, maerl beds, coral reefs, and artificial wetlands (especially reservoirs, fish ponds, rice paddies, dams etc).

A definition of wetlands was provided in only 32% of studies, and only 50% of studies used the Ramsar definition of wetlands, (though it was unknown for 43% of studies, so the true value may be much higher). The Ramsar classification system for wetland type was used in 21% of studies; it was unknown for 36% of studies and not applicable for some 29% of studies (these were usually reviews or collations of material).

Wetland definition	
Definition provided	32%
Definition implied	36%
No definition provided or implied	29%
Unknown/ambiguous	4%
Ramsar definition	
Ramsar definition used	50%
Ramsar definition not used	7%
Use of Ramsar definition unknown	43%
Ramsar classification	
Ramsar wetland types used	21%
Other wetland classification used	7%
Wetland classification varies	7%
Unknown	36%
Not applicable	29%

3.2 Overall extent of wetlands in Africa

In 64% of studies, part of the wetland resource was examined, whereas all wetland resources were included in just 36% of studies; for some 4% of the studies it was ambiguous whether all or part of the national wetland resources were included. Where only part of the wetland resource was assessed by a study, (64% of studies) the basis for selection was varied, and included landform type (e.g. coastal wetlands, or inland wetlands), or habitat type (e.g. mangrove, peat, marsh), or floral/faunal groups (e.g. wetlands of importance to birds, crocodiles, fisheries).

Extent of coverage	
All wetlands	36%
Part of wetland resource	64%
Ambiguous	4%

Wetland type coverage	
Sources providing area values per wetland type	39%
Sources partially providing area values per wetland type	39%
Sources not providing area values per wetland type	14%
Not known	7%
Basis of selection (if not complete wetland coverage)	
Geography/jurisdiction	25%
Land cover or remotely sensed data	0%
Landform type	25%
Supra-habitat	4%
Habitat type	11%
Floral/faunal groups or species	14%
Climate	4%
Wetland function	0%
Hydrology	7%
Biodiversity value	4%
Cultural value	0%
Artefact of data collection	11%
Other basis	11%
Unknown or ambiguous	0%
More than one basis	43%

A summary of wetland coverage in Africa is presented in tables 3.1 and 3.2 below. The total area calculated by the AFRICA dataset amounted to some 121 322 000–124 686 000 ha, covering 4% of the land surface. As would be expected, more than 85% (107 051 000–107 546 000 ha) of these were inland wetlands, with less than 10% described as marine/coastal wetlands (8 981 000–11 256 000 ha) and a further 5% described as artificial wetlands (4 591 000–4 658 000 ha).

Since the scope and coverage of most inventory material did not state whether total wetland estimates included Ramsar sites, it is not possible to state whether this value includes, partially includes or excludes these sites. It must also be noted that the area values shown for Ramsar sites given in table 2.2 are the site area and not the wetland area. A good example of this would be the Okavango Delta Ramsar site, which is larger in extent than the estimate for total wetland area in the whole of Botswana.

Table 3.1 Wetland coverage in Africa as identified by the Africa dataset

Africa	Estimate of area in hectacres (ha)
Marine/coastal wetlands	8 981 376 – 11 256 398
Inland wetlands	107 050 527 – 107 545 899
Manmade wetlands	4 590 892 – 4 657 892
Area of unspecified types of wetland	698 888 – 1 226 000
Total area of wetlands identified in this study	121 321 683 – 124 686 189
# of national datasets per Region	121
# of national datasets which can be regarded as	33*

comprehensive in cover

[*Note: the value “33” above represents a correction effected after publication of the 2nd ed. GRoWI CD-ROM]

Table 3.2 Wetland coverage in Africa as a percentage of land cover, and Ramsar site information

Africa	
# of countries	54*
Total land area of region (ha)	3 033 500 000
% of land area covered by these wetlands	4.05%
Total area of Ramsar sites (ha)	13 964 807
# of Ramsar sites	74

(Source of Ramsar site information: Ramsar Database, date of data extraction 17/8/98)
[*Note: the value “54” above represents a correction effected after publication of the 2nd ed. GRoWI CD-ROM]

3.3 Wetland extent in African countries

Best estimates of wetland extent by broad wetland type (‘inland’, ‘marine/coastal’ and ‘artificial’) for the African countries are given in table 3.4. A description of how best estimates of wetland coverage per country were derived is outlined below.

3.3.1 Derivation of country ‘best estimates’ of wetland coverage

The estimates of wetland coverage cited in the material examined in this review (and included in the African dataset) were entered into a system of *country coverage files* (in spreadsheet format). An individual wetland coverage file for each country within the region was created to facilitate the generation of best estimates of wetland area coverage per country and to serve as a summary and provide an ‘audit trail’ of material included.

Each file (workbook) consisted of several components (worksheets) broken down by Ramsar wetland type and also by broad wetland category (marine/coastal, inland and artificial) as follows:

1 Sheet one contains area statistics for marine/coastal wetlands broken down by Ramsar wetland type (*types: A, B, C, D, E, F, G, H, I, J, K).*

2 Sheet two contains area statistics for inland wetlands broken down by Ramsar wetland types (*types: L, M, N, O, P,Q, R, Sp, Ss, Tp, Ts, U, Va, Vt, W, Xf, Xp, Y, Zg, Zk)*.

3 Sheet three contains area statistics for artificial wetlands broken down by Ramsar wetland types (*types: 1, 2, 3, 4, 5, 6, 7, 8, 9,).*

4 Sheet four contains ‘notes and comments’ which provides an indication of the reliability of the data (subjective assessment), and notes about methodology and or original sources of data.

5 Sheet five ‘summary’ contains the *total* values for ‘marine/coastal’, ‘inland’ and ‘artificial’ wetlands (not broken down per Ramsar wetland type) and the ‘notes and comments’ sheet. This sheet is generated automatically from sheets 1–4. Changes made to sheets 1–4 will update in the summary sheet.

The summary sheet (sheet five) for each country can be found in Annex 2. Where possible, approximate estimates per Ramsar wetland type were entered in the appropriate columns (in sheets 1–3. Where this was not feasible, approximate values for broad wetland type were entered and where this was not feasible, a total value was entered. This created a hierarchical system where it was possible to examine the quality of wetland coverage and extent information per country, which was assessed in the African dataset.

Each file provided wetland estimates, along with brief notes as to scope, and in particular, exclusions in coverage (e.g. open water bodies), and gave an indication as to the reliability of the data (sheet 4). This provided a convenient means of auditing all the material included in the dataset, and provides an 'at a glance' summary of the material examined.

Once all the wetland area values had been entered into a coverage file for each country, along with the appropriate notes on method and reliability, a subjective assessment of all material for each country was made. Best estimates were composed according to broad wetland category (marine/coastal, inland and artificial), and a justification of the rationale entered into sheet 5. Once the coverage files were completed for all the countries within a region, the estimates were compiled into a summary table (given in table 3.4).

It should be noted that several wetland inventories included information on more than one country, and hence these documents featured in many country coverage. The number of materials (referred to as datasets) examined per country were totalled and also entered into the summary document for each region.

Please note: there are some notes which will appear on summary sheet five which refer to specific Ramsar wetlands or values shown on sheets 1–4 (in the individual country coverage files as described above). In a small number of cases the notes appearing on the summary sheet are not self-explanatory when viewed independently of sheets 1–4. This is regrettable but unavoidable given the time constraints associated with the production of national overviews.

The summaries of wetland coverage for each African country deemed to have sufficient material to generate a 'best estimate' of wetland coverage either in total or by category type (inland, marine/coastal, artificial) can be found in Annex 2. Notes on the reliability of the assessment are included with each summary. Countries that were omitted from the 'best estimate' and reliability assessment due to lack of data in the AFRICA dataset are given below in table 3.3.

Table 3.3 Countries omitted from the 'best estimate' and reliability assessment due to lack of data in the AFRICA dataset

Africa	
Cape Verde Islands	Mauritius
Comoros	Sao Tome and Principe
Ethiopia	Seychelles

3.3.2 'Best estimates' of wetland coverage per country

'Best estimates' of Wetland coverage per broad wetland category for countries in the Africa region are given in table 3.4

Table 3.4 Best estimates of wetland coverage per broad wetland category for countries in the Africa region*

AFRICA REGION		BEST ESTIMATES				COVERAGE INFO		RAMSAR INFO	
	Marine/coastal (ha)	Inland (ha)	Artificial (ha)	Unspecified wetland type (ha)	Total (ha)	# of datasets accessed per country[1]	# of datasets which can be regarded as comprehensive in cover per country	Total area of Ramsar sites	# of Ramsar sites
ALGERIA	121 380–134380	585 500	8 000		714 880–727 880	3	2	4 900	2
ANGOLA	70 000–110 000	400 000	unknown		470 000–510 000	3	1	0	0
BENIN	175 790	129 000	unknown		304 790	3	1	0	0
BOTSWANA	None	2 243 250	4 405		2 247 655	2	1	6 864 000	1
BURKINA FASO	Unknown	364 958	unknown		364 958	1	1	299 200	3
BURUNDI	None	499 000	unknown		499 000	1	1	0	0
CAMEROON	300 000	2 255 613	unknown		2 555 613	4	1	0	0
CAPE VERDE	no data	no data	no data		No data	0	0	0	0
CENTRAL AFRICAN REPUBLIC	None	3 150 000	unknown		3 150 000	1	0	0	0
CHAD	None	12 983 390	1 666 000		14 649 390	1	1	195 000	1
COMOROS	no data	no data	no data		No data	0	0	30	1
CONGO - DEM. REPUBLIC OF	37 400	14 551 095	unknown		14 588 495	3	1	866 000	2
CONGO - REPUBLIC OF	740 000	11 686 500	unknown		12 426 500	2	0	438 960	1
COTE D'IVOIRE	292 330	unknown	105 000–172 000		397 330–464 330	3	0	19 400	1

*Please consult 3.3.1 for a description of how these estimates were generated

Table 3.4 cont

		BEST ESTIMATES				COVERAGE INFO		RAMSAR INFO	
AFRICA REGION	**Marine/coastal (ha)**	**Inland (ha)**	**Artificial (ha)**	**Unspecified wetland type (ha)**	**Total (ha)**	# of datasets accessed per country[1]	# of datasets which can be regarded as comprehensive in cover per country	Total area of Ramsar sites	# of Ramsar sites
DJIBOUTI	1 000	37 200	unknown		unknown	2	0	0	0
EGYPT	2 634 550	711 200	unknown		3 345 750	2	0	105 700	2
EQUATORIAL GUINEA	27 700	unknown	unknown		27 700	2	0	0	0
ERITREA	58 100	unknown	unknown		58 100	1	0	0	0
ETHIOPIA[2]								0	0
GABON	175 900–257 500	3 968 875	unknown		4 144 775–4 226 375	5	0	1 080 000	3
GAMBIA	74 700	106 608	unknown		181 308	5	0	20 000	1
GHANA	117 800	460 050	895 225		1 473 075	4	1	178 410	6
GUINEA	250 000	121 500	unknown		371 500	5	0	225 011	6
GUINEA-BISSAU	200 000–364 900	unknown	unknown		200 000–364 900	4	0	39 098	1
KENYA	96 100	2 641 690	unknown		2 737 790	3	1	48 800	2
LESOTHO	None	unclear	unclear	20 000	20 000	2	0	0	0
LIBERIA	42 700	unknown	9 000		51 700	3	0	0	0
LIBYA	Unknown	unknown	unknown		unknown	1	0	0	0

1 Excluding the Ramsar sites and GLCC databases

2 Data exist but for pre-Eritrean independence only; substantial map work would be required to ascertain coverage data for Ethiopia.

Table 3.4 cont

		BEST ESTIMATES				COVERAGE INFO		RAMSAR INFO	
AFRICA REGION	**Marine/Coastal (ha)**	**Inland (ha)**	**Artificial (ha)**	**Unspecified wetland type (ha)**	**Total (ha)**	# of datasets accessed per country1	# of datasets which can be regarded as comprehensive in cover per country	Total area of Ramsar sites	# of Ramsar sites
MADAGASCAR	340 300–371 747	340 000	32 300		712 600–744 047	4	0	0	0
MALAWI	None	2 248 150	unknown		2 248 150	1	0	224 800	1
MALI	None	3 560 400	69 000		3 629 400	2	1	162 000	3
MAURITANIA	Unknown	unknown	unknown	668 888–1 196 000	668 888–1 196 000	5	2	1 188 600	2
MAURITIUS	no data	no data	no data		No data	0	0	0	0
MOROCCO	29 300-33 200	27 800–43 800	7 500		64 600–84 500	2	2	10 580	4
MOZAMBIQUE	345 900	1 950 785	266 500		2 563 185	2	1?	0	0
NAMIBIA	6 500*-9 850	1 322 160–1 353 660	7 533		1 336 193–1 371 043	3	0	629 600	4
NIGER	None	1 764 950	unknown		1 764 950	1	0	220 000	1
NIGERIA	1 346 775–3 238 000	5 527 060	123 000		6 996 835–8 888 060	4	1	0	0
RWANDA	Unknown	348 100	unknown		348 100	1	0	0	0
SAO TOME & PRINCIPE	no data	no data	no data		No data	0	0	0	0
SENEGAL	508 000	663 000	unknown		1 171 000	5	2	99 720	4
SEYCHELLES	no data	no data	no data		No data	0	0	0	0
SIERRA LEONE	170 600	108 820	unknown		279 420	2	1	0	0
SOMALIA	91 000	600 000	unknown		691 000	2	1	0	0
SOUTH AFRICA	276 367	276 911	201 262		754 540	3	2	489 998	16

Table 3.4 cont

		BEST ESTIMATES				COVERAGE INFO		RAMSAR INFO	
AFRICA REGION	**Marine/Coastal (ha)**	**Inland (ha)**	**Artificial (ha)**	**Unspecified wetland type (ha)**	**Total (ha)**	# of datasets accessed per country1	# of datasets which can be regarded as comprehensive in cover per country	Total area of Ramsar sites	# of Ramsar sites
SUDAN	93 700	4 155 900	311 500		4 561 100	2	1	0	0
SWAZILAND	–	unclear	unclear	10 000	10 000	1	0	0	0
TANZANIA	200 000–245 600	8 389 286	85 000		8 674 286–8 719 886	4	2	0	0
TOGO	44 400	73 200	unknown		117 600	1	1	194 400	2
TUNISIA	113 084	1 182 915–1 207 915	20 787		1 316 786–1341 786	3	2	12 600	1
UGANDA	None	4 451 703–4 874 575	unknown		4 451 703–4 874 575	2	1	15 000	1
WESTERN SAHARA	Unknown	72 430	unknown		72 430	1	0	0	0
ZAMBIA	None	11 733 028	454 200		12 187 228	2	1	333 000	2
ZIMBABWE	None	1 358 500	324 680		1 683 180	2	1	0	0
Total estimated wetland cover	**8 981 376–11 256 398**	**107 050 527–107 545 899**	**4 590 892–4 657 892**	**698 888–1 226 000**	**121 321 683–124 686 189**	**121**	**33**	**13 964 807**	**74**

[*Note: the value for Marine/Coastal hectares for Namibia in the above table has been corrected by removal of an extraneous “0” since publication of the 2nd ed. GRoWI CD-ROM. This change was cosmetic, having no impact on related calculations].

4 Rate and extent of wetland loss and degradation

The majority of sources examined (86%) did not provide any details of wetland loss and/or degradation. This does not mean that loss values do not exist, simply that the material sought for this review was wetland inventory material, which as it turned out, rarely dealt with these issues in any detail. No specific tasks were performed to identify material which specifically outlined as wetland loss (in isolation of inventories/directories). Thus, wetland inventory material within the Africa region does not normally include any appreciable data on wetland loss. This may, however, be directly related to the time scale of most wetland inventory activities, which are largely discrete surveys, which have not yet been repeated.

Of the 11% of material in the Africa region which did provide some information, this was almost exclusively descriptive, rather than quantitative. It was therefore not possible to either refute or support the values given by OECD (1996) which suggest that overall wetland loss in tropical and sub tropical Africa is 2%. However, in certain areas it is known that wetland loss is much greater than this. For instance, Taylor et al (1995) provide loss figures for two areas in South Africa: firstly for the Tugela Basin (in Natal), where over 90% of the wetland resources have been lost in parts of the basin; and secondly for the Mfolozi catchment (10,000 km^2), where 58% of the original wetland area (502 km^2) was estimated to have been lost. Similarly, Hollis (1993) reports an overall loss of 15% of wetland area and 84% loss in the Medjerdah catchment in Tunisia.

Wetland loss and degradation	
Sources providing information on wetland loss and or degradation	11%
Sources not providing information on wetland loss and /or degradation	86%
Not known	4%

More recent information on wetland loss may have emerged since the work by Hollis (1993), and Taylor et al (1995). However, the important thing to note is that if the AFRICA dataset is representative of the wetland inventory material that exists in Africa, then we can conclude that wetland loss is rarely measured or recorded during wetland inventory activities in the region. Studies that specifically set out to measure wetland loss may have been undertaken, but loss values do not feature in inventory assessments.

Wetland status description	
Overall wetland status description included	43%
Overall wetland status description not included	57%
Unknown	0%

Similarly, of the material examined for Africa, only 43% of material included a description of overall wetland status in a country (though these descriptions were of course totally generic in nature). Overall those that did provide such information often provided detailed individual site information (often the ‘study site’ subject to scientific research), and some studies provided an overview or summary of such information. These latter studies were generally not conventional wetland inventories or directories *per se*, and were frequently academic peer review publications, which are necessarily short in length. Where wetland loss information was provided it must be noted that the rates or amounts identified on a local scale do not necessarily reflect national trends in wetland loss. Overall it can be said that the information on wetland loss was usually lacking, but where it was included it was highly variable and inconsistent in its detail.

Details of the major threats to wetlands are also lacking from most inventory material in the Africa region. Some site based studies do provide very brief descriptions of threats to individual wetlands; usually these studies are ones undertaken to designate or describe wetlands of 'international importance' (according to the Convention on Wetlands, Ramsar, 1971). Standard site descriptions are recorded on a Convention-approved form, the 'Ramsar Information Sheet' (RIS) and this *proforma* includes an information category called 'Adverse factors'. This subject is recorded in the Ramsar Database according to an ad hoc set of past (but still influential), present and/or potential wetland threats (both in and around the site). These were based on the data that have been provided, rather than fitting incoming data to a pre-existing structured classification.

Due to this historical legacy, the urgency, extent and character of any threat at any site listed has never been codified in the current (to be supplanted) database. Such information, if it exists, might be found in individual site files which support the database. Frequently, the level of detail provided is very low. Example statements include 'timber extraction from the mangrove is common at the site', 'charcoal production occurs on a large scale', 'livestock grazing is causing physical damage to the wetland', and 'water extraction for agricultural purposes is leading to a lowering of the water table'. Quantification of threats or losses was not given in any of the studies examined.

5 Wetland benefits and values

Wetland values as defined under the Ramsar Convention are:

> the perceived benefits to society, either direct or indirect, that result from wetland functions. These values include human welfare, environmental quality, and wildlife support (Ramsar Convention Bureau 1996).

A large proportion of material examined for the review was not a conventional inventory /directory (see section 2.4) and did not contain site by site information. These sources did not usually contain details of wetland values and/or benefits (other than generic statements), since they usually referred to wetlands at a national level (or at least above a local or provincial level) and would therefore not contain detailed management information.

Very few studies contained information on wetland values and benefits. Studies which were not site based inventories (rather general overviews) only contained some level of values and benefits information in 4% of cases.

Africa	**Inclusion of wetland values and benefits information (site based studies only)**
Some level of information (non site based studies only)	4%
Always	4%
Most of the time	11%
Commonly	4%
Sometimes	7%
Rarely	25%
Never	46%
Unknown	0%

Site based studies (usually wetland inventories *per se*) were treated differently in the evaluation process to non-site based studies, and were evaluated against Ramsar Information Sheet (RIS) categories, and the frequency (ie never, rarely, sometimes, commonly etc) of the inclusion of the RIS category recorded. The frequency of inclusion of values and benefits information for *each and every site* described within (site based) studies was assessed. The results showed that 46% 'never' contained any values and benefits information; 'rarely' 25%; 'sometimes', 7%; 'commonly', only 4%; 'most of the time' 11%; and 'always' 4%. In the majority of non-site based studies, a paragraph or two describing values and benefits of wetlands in general was usually all that was provided. None of the material examined included any financial or economic estimates.

In the majority of site based studies (wetland inventories *per se*), values and benefits information amounted to one or two sentences per site (e.g. 'the site experiences pressure from artisanal fisheries', 'the wetland provides flood buffer and water storage capabilities', 'the area is a tourist destination for wildlife viewing'). In the majority of non-site based studies, a paragraph or two describing values and benefits of wetlands in general was usually all that was provided. None of the material examined included any financial or economic estimates.

6 Land tenure and management structures

A large proportion of material examined for the review was not a conventional inventory /directory (see section 2.4) and did not contain site by site information (ie they were 'non-site based studies). These sources did not contain information on land tenure, management authority or jurisdiction, since they usually referred to wetlands at a national level (or at least above a local or provincial level) and would therefore not contain detailed management information.

When material did contain site by site information, the material was evaluated against Ramsar Information Sheet (RIS) categories and the frequency (ie never, rarely, sometimes, commonly, etc) of the inclusion of the RIS category was recorded. As can be seen below, 89% of the time land tenure or ownership information details were never recorded.

Africa	**Inclusion of land tenure/ownership information (site based studies only)**
Some unknown level (non site based studies only)	0%
Always included	0%
Most of the time included	7%
Commonly included	0%
Sometimes included	4%
Rarely included	0%
Never included	89%
Unknown	0%

Similarly, some 89% of the material 'never included' jurisdiction information, or any management authority information.

Africa	Inclusion of jurisdiction information (site based studies only)
Some unknown level (non site based studies only)	4%
Always included	0%
Most of the time included	4%
Commonly included	0%
Sometimes included	4%
Rarely included	0%
Never included	89%
Unknown	0%

NB The Ramsar information sheet states 'Jurisdiction (territorial e.g. state/region and functional e.g. Department Agriculture/ Department of Environment)'

On the whole it can be said very few sources in the Africa region contained information on land tenure, management authority or jurisdiction.

Africa	Inclusion of management authority information (site based studies only)
Some unknown level (non site based studies only)	4%
Always included	0%
Most of the time included	4%
Commonly included	0%
Sometimes included	4%
Rarely included	0%
Never included	89%
Unknown	0%

NB The Ramsar information sheet states 'Management authority: (name and address of local body directly responsible for managing the wetland)'

7 Extent and adequacy of updating programs

The majority (64%) of information examined in this review was published or dated between 1991 and 1995, 14% was published or dated after 1995 and 14% was published or dated between 1986 and 1990. Most of the information (61%) was judged to not have a temporal scale (generally these studies were reviews and collations), and only 32% had defined temporal scale (ie were discrete 'one-off' surveys, or ongoing surveys) with a further 7% unknown.

This at first appears very low, but compares well with the material examined for both Western and Eastern Europe for which only 22% and 7% (respectively) of studies had a defined time scale (whether that meant studies were part of a long-term project or were discrete one-off surveys) (Stevenson & Frazier 1999a,b). It could be that review material (ie secondary material) generally emerges once primary data are more established and available.

Publication date	
After 1995	14%
Between 1991–1995	64%
Between 1986–1990	14%
Between 1981–1985	0%

Unknown / ambiguous	7%
Temporal scale	
Studies with a temporal scale *	32%
Partly include a temporal scale	0%
No temporal scale (e.g. review)	61%
Unknown	7%
** Broken down further:*	
Discrete surveys	29%
Surveys updated on an ad-hoc basis	4%
Update purpose to add sites	4%
Update purpose to review status	0%
Update purpose to make corrections	4%
Other update purpose	0%
Unknown purpose	0%
Current /ongoing surveys	4%
Updated on ad-hoc basis	4%
Updated on annual basis	0%
Frequency of update unknown	0%

It could be argued that low resolution, comprehensive national field surveys should be undertaken (whether remotely or as part of ground surveys) as a priority to at least identify wetland locations for more detailed study later. However, in terms of resource conservation, repetition of detailed surveys at sites thought to be at risk should also be a priority undertaking. One-off surveys for previously unsurveyed areas are critically important in terms of resource assessment, but few surveys examined in this review were found to be part of a long-term assessment or monitoring program.

None of the inventories identified in the region (with the exception of the Ramsar database) have been updated after any given time interval after the first inventory. Wetland inventories must be regularly reviewed and updated otherwise data are likely to be lost, become out of date and become of historical interest only.

It would be overly critical to state that the updating procedures of wetland inventory in Africa are grossly inadequate, since 78% of the studies examined were published after 1991. The wetland inventory process in Africa is still at an early stage of development, and therefore it is unsurprising that no wetland inventories were identified that have been updated.

8 Standardising of inventory approaches

This section outlines the broad types of wetland inventory that have been included in this review, followed by notes on some relevant findings from the analysis of the African material which have bearing on wetland inventory approaches. Standardisation of inventory approaches must be developed in accordance with the objectives of those organisations carrying out wetland inventory. The ‘who’, ‘how’ and ‘why’ must be examined before any attempts to standardise procedures are made. Finally, generic suggestions for the standardisation of wetland inventory approaches are outlined.

8.1 Types of wetland inventory

As stated by Scott (1993) in his review of wetland inventories and their role in the assessment of wetland loss, there are three main types of inventory:

- comprehensive national wetland inventories
- regional or global inventories of specific wetland types
- national or international inventories of wetlands of special conservation importance

This review of wetland inventory material in Africa included material in each of these categories, which were defined by Scott (1993) as follows:

comprehensive national wetland inventories:

these constitute an accurate account of the location and extent of all wetland resources: they usually included detailed mapping and may or may not include an evaluation. Such inventories are time consuming and costly, and require a precise wetland classification system. However they provide and ideal basis for a comprehensive assessment of wetland loss over time.

regional or global inventories of specific wetland types:

such inventories are usually too crude and contain too many gaps in coverage to provide a baseline assessment of wetland loss.

national or international inventories of wetlands of special conservation importance

these focus on specific sites or systems with high conservation values, rather than wetland types, and on the whole exclude wetland habitat that is too small, fragmented or degraded to merit special attention. The Ramsar Convention provides and agreed set of criteria for the identification of sites of international importance, and these have been, or are being used in the compilation of wetland inventories in most parts of the world. Inventories of this type can be carried out relatively quickly and cheaply, and are of considerable value in focusing conservation effort where it is most required. While far too superficial to be used to measure total wetland loss, they constitute a sound basis for the monitoring of rates of loss of key habitat, especially those in countries which are unable to conduct comprehensive wetland inventories in the foreseeable future.

To this list, a further group could be added:

landscape level mapping of land use and land cover

these focus on the landscape from an anthropogenic perspective, and provide information on land use and land cover. They usually utilise satellite remote sensing technologies in combination with topographic maps, and soil maps. The resolution is frequently low (100x100ha) and does not distinguish between many wetland types, (this can be due to limitations in the spectral capabilities of the sensor, or may be due to operator preference). Wetlands are usually lumped into very broad generic categories. These may be categories such as 'open water', 'forested wetlands', and 'agriculturally improved wetlands', or may simply be one very broad category 'wetlands'. In such inventories wetland habitat is quantified in terms of approximate area, and the distribution mapped. There is potential for monitoring total national wetland loss or change if the spatial resolution of the satellite sensor is high, or if rates of loss or change are very high. Assessments of wetland quality do not feature in these landscape maps.

8.2 Wetland inventory approaches in Africa – results from the analysis of the dataset

8.2.1 Who is conducting wetland inventory and who is funding it?

Non-governmental organisations (NGOs) and governmental organisations (GOs) were each responsible for implementing 29% of studies in Africa. Private agencies or individuals implemented a further 25%; academic institutions implemented 11% of studies and consultancies conducted 7%. Compare this with the figures in Western Europe where most studies were implemented by government agencies. Similarly, NGOs and GOs each funded 57% of studies (including some studies funded by both). This equal weighting of NGO and GO could mean that governments in Africa are beginning to establish national wetland programs, though it is not possible to say whether historically most studies were implemented by agencies other than governmental ones.

Study Implementation	
International NGO	18%
National NGO	11%
Sub National NGO	0%
Local NGO	0%
International GO	0%
National GO	29%
Sub National GO	0%
Local GO	0%
Private agency/individual	25%
Consultancy agency	7%
Academic institution	11%
Other body	0%
Unknown	11%
More than one agency or body	7%
Study funding	
International NGO	39%
National NGO	18%
Sub National NGO	0%
Local NGO	0%
International GO	18%
National GO	39%
Sub National GO	0%
Local GO	0%
Private agency/individual	0%
Consultancy agency	0%
Academic institution	4%
Other body	0%
Unknown	18%
More than one agency or body	32%

8.2.2 Why is wetland inventory being carried out?

Considering the wide variety of organisations and individuals (NGOs, GOs, universities, consultants etc) undertaking wetland inventories in Africa, there is likely to be a variety of purposes. This study examined the objectives of wetland inventory activities. The objectives were stated in 61% of studies. The most common objectives (including those explicitly stated and surmised) were general biodiversity related (46%), for baseline inventory purposes

(50%), to examine wetland services (e.g. as bird habitat) (25%), public education (18%), land use planning (18%), international site designation (14%) and academic research (14%).

Note that most studies had several objectives. In the Africa region, only 27 out of the 54* countries are contracting parties to the Ramsar Convention (Source of Ramsar site Information: Ramsar Database, date of data extraction 17/8/98). It is therefore not so surprising that the objectives of wetland inventory activities were rarely international designation, and were most frequently for baseline inventory purposes.

Of the three complete regions examined for this review, Africa has the fewest number of Ramsar sites. There are only 74 Ramsar sites distributed through 54* countries (an average of 1.3 sites per country) (Source of Ramsar site Information: Ramsar Database, date of data extraction 17/8/98), which is much lower than the average for Western Europe (which is 21.3 Ramsar sites per country) and much lower than Eastern Europe (which has an average of 6.7 Ramsar sites per country). However, many of the African Ramsar sites are extremely large.

[*Note: the value "54" above represents a correction effected after publication of the 2nd ed. GRoWI CD-ROM]

Statement of objectives	
Objectives explicitly stated	61%
Objectives not explicitly stated	21%
Unknown	18%
Main objectives of study	
General biodiversity	46%
Biodiversity research	0%
Baseline biodiversity	0%
Repeat survey/surveillance	0%
Management tool for biodiversity	0%
Biodiversity monitoring	0%
Wetland products	0%
Geographical	0%
International designation	14%
Baseline inventory	50%
Academic research	14%
Land use planning	18%
Wetland services	25%
Public education	18%
Other research	0%
Other	43%

8.2.3 How are wetland inventory studies conducted?

Some 64% of studies examined for the Africa dataset were reviews and collations. Of the remainder, 32% undertook ground surveys and 14% utilised remote sensing techniques which were largely dependent on aerial photography (none of those examined, somewhat surprisingly, utilised satellite imagery).

However, it must be noted that there are studies that have utilised satellite imagery in Africa, (notably some studies undertaken in Zimbabwe and Zambia and carried out by the Food and Agriculture Organisation), though these were at the sub-national level and were not incorporated in this review. Of those studies that did conduct ground surveys, 4% of these were total or near comprehensive in their coverage, and 18% undertook ground surveys which were partial in their coverage. For 11% of studies it was not known (either not stated, or not translated) how they were conducted.

Data collection methodology	
Collation or review	64%
Ground survey	32%
Remote sensing	14%
Questionnaire survey	0%
More than one methodology	21%
Unknown methodology	14%
Extent of ground survey	
Total	4%
Partial	18%
Type of remote sensing	
Satellite imagery	0%
Aerial photography	14%
Videography	0%
Radar imagery	0%
Lidar imagery	0%
Map product	4%
Unknown	0%

8.2.4 What definitions and classifications are used?

There are many definitions of wetlands, as others have noted (e.g. Davies & Claridge 1993, Dugan 1990). Dugan (1990) stated that over 50 separate wetland definitions were (even then) currently in use. Differing wetland definitions and classification schemes were used in different studies in Africa, and these definitions were generally not stated, making it difficult to assess the degree of completeness of cover (and thereby the estimates of wetland extent).

For example, the term ‘coastal wetlands’ can mean strictly saline and brackish habitats, or to mean wetlands in the coastal zone, (which often for practical purposes means coastal lowlands and incorporates wetlands which experience no tidal inundation). Sorensen (1997) provides six different and commonly used definitions for the term ‘coastal area’ which demonstrate the enormous difference between various meanings. Great improvements in the efficiency and accuracy of wetland evaluation could be achieved if common but imprecise terms were more precisely defined.

A definition of wetlands was provided in only 32% of studies, and only 50% of studies used the Ramsar definition of wetlands (though it was unknown for 43% of studies, so the true value may be much higher). The Ramsar classification system for wetland type was used in 21% of studies; it was unknown for 36% of studies and not applicable for some 29% of studies (these were usually reviews or collations of material). The use of the Ramsar classification system and definition of wetlands was much less than that in either eastern or western Europe (Stevenson & Frazier 1999a,b). This means that the information fields recorded and the approach used have generally not been standardised. This of course is probably directly due to the fact that few African countries are contracting parties to the Ramsar Convention.

8.3 Generic suggestions for the standardisation of inventory approaches

1. Mechanisms to develop indices and scorecards of wetland value/benefits and site quality (status) should be developed to enable easy communication of the trends to be made to the decision-makers and the public.
2. The presentation of data in wetland inventories should become more accessible by inclusion of summaries and the avoidance of poorly organised bulky text descriptions in favour of tabulated results.
3. The scope of data coverage in wetland inventory activities should attempt to incorporate the information fields used in Ramsar Information sheets. This would aid management of trans-boundary wetlands and would facilitate regional and international wetland assessments which can be utilised in African (and global) policy and planning initiative.
4. Every effort should be made to cover all wetland types, particularly those types which are currently under-represented in wetland inventories. This includes artificial wetlands, dune slacks, wet mesotrophic grasslands, coral reef, dambos, ephemeral wetlands, seagrass beds, maerl beds, and wetlands of less than 50 ha in size. An attempt to systematically collect information on the current extent of different wetland types in different countries in the region should be carried out as a priority.
5. A program should be established to monitor changes in the areal extent of widespread rare and threatened wetland types once a baseline of the original or current extent is determined.
6. Standardised methodologies should be developed and linked to the objectives of wetland inventory studies, such that for any given objective, standard information fields should be gathered using standard methodologies.
7. A standardised (generic) database format (and software) should be developed for storage and extraction of local, national, and international wetland information that can be applied throughout the African region.
8. More effort should be made to integrate wildlife surveys (especially waterfowl) and wetland surveys to avoid duplication of effort and to increase the wider applicability of information.
9. Regional and national inventories should be made available in digital form as CD-ROMS or downloadable files from the World Wide Web to enhance access to the information and to encourage greater levels of feedback on changes at the sites.
10. A review should be undertaken on the applicability of land-use and land cover mapping information for the monitoring of changes in wetland extent in the region.

9 Priority areas for wetland inventory

9.1 Status of national level wetland inventory information in African countries

Although it was possible to generate estimates of the national wetland resource in all but a few African countries, much of the data was noted to be of poor quality and likely to be currently out of date. The majority of wetland area estimates examined by this report (though by no means all) were approximations based on often-dated aerial photography, soil and vegetation maps, and limited reconnaissance studies. The resulting best estimates must also be viewed with caution since accurate results cannot be generated from inaccurate data.

Countries that have experienced or are currently in civil conflict are notably among those with the greatest scarcity of data. In many of these cases, the only information identified in this review was that provided by Hughes and Hughes (1992), who made it clear that their estimates were very approximate and probably underestimates. These countries include Angola, Central African Republic, Chad, Ethiopia, Eritrea, Liberia, Libya, Mauritania, Niger, Rwanda and Western Sahara. Other countries which appear to have a paucity of information, most probably due to capacity problems, are Benin, Burkina Faso Burundi, Cape Verde, Sao Tome & Principe, Lesotho, Comoros, Mauritius, Mali, Equatorial Guinea, Somalia, Sudan, Swaziland and Togo.

Countries which have a low to intermediate level of wetland inventory information include Cameroon, Democratic Republic of Congo, Republic of Congo, Côte d'Ivoire, Djibouti, Ghana, Guinea Bissau, Guinea, Madagascar, Malawi, Morocco, Nigeria, Senegal and Sierra Leone (see table 9.1).

A number of countries have marginally more information, and can be regarded as having an intermediate level of wetland inventory information, though the scope and coverage greatly varies. In these cases, there are generally *significant* gaps in either information about specific wetland types or in national coverage; examples include Algeria, Ghana, Uganda, Malawi, Zimbabwe, Zambia, Tanzania, Kenya, Botswana, and Gabon (see table 9.1). Countries which have information largely focusing on internationally and nationally important wetlands include the Gambia, South Africa and Ghana.

Many specific types of wetlands are frequently ignored in wetland inventory activities in Africa. Wetlands of less than 10 ha in size were frequently underestimated in countries such as South Africa, Zimbabwe and Zambia. Endorheic pans and seasonal wetlands (particularly those which develop on a less than annual basis) are similarly underestimated. Hughes and Hughes (1992) note that the area of wetlands (especially water bodies) can be difficult to assess since the size can vary seasonally, annually and intra-annually. Artificial wetlands are also frequently ignored in wetland inventories, except in a few cases where they are of importance to waterbirds. These gaps should receive attention in future wetlands inventory activities in the region.

It should be noted that additional materials for Africa have been identified since the analysis stage of this review, and it is likely that these will reveal new information. Our findings must therefore be viewed as preliminary.

The majority of wetland area estimates examined by this report were approximations, (often based on dated aerial photography, soil and vegetation maps, and limited field studies). The resulting best estimates must therefore be viewed with caution since accurate results cannot be generated from such approximate data.

Out of the 55 countries in the African region examined in this review, only two of these can be said to have quasi-adequate inventory data on wetlands, and these are South Africa and Tunisia. However, several countries have plans to update their wetland inventory information, including Namibia, Uganda (to be confirmed), South Africa and Kenya. In Kenya, wetland inventory courses and waterbird identification and counting techniques courses have been conducted (and more are planned for 1999) in preparation for a planned national wetland inventory which will be coordinated by the Kenyan Wildlife Service and the National Environment Secretariat (Ministry of Environment). They are currently preparing a national wetlands database utilising the methodologies incorporated by the MedWet Initiative.

Table 9.1 Status of national wetland inventory information in African countries based on the GRoWI-Africa dataset [1]

Little or no national wetland inventory information	Some, but inadequate national wetland inventory information	Adequate information available, but requires updating and more detailed surveys
Angola	Algeria	South Africa
Benin	Botswana	Tunisia
Burkina Faso	Cameroon	
Burundi	Republic of Congo	
Cape Verde	Democratic Republic of Congo	
Central African Republic	Côte d'Ivoire	
Chad	Djibouti	
Comoros	Egypt [2]	
Equatorial Guinea	Gabon	
Ethiopia [3]	Gambia	
Eritrea	Ghana	
Lesotho	Guinea	
Liberia	Guinea-Bissau	
Libya	Kenya [4]	
Mali	Madagascar	
Mauritania	Malawi	
Mauritius	Morocco	
Niger	Mozambique	
Rwanda	Namibia [5]	
Sao Tome & Principe	Nigeria	
Somalia	Senegal	
Sudan	Sierra Leone	
Swaziland	Tanzania	
Togo	Uganda [6]	
Western Sahara	Zambia	
	Zimbabwe	

1 Note: these are preliminary assessments only

2 It has emerged that considerably more information on Egyptian wetland may exist than was included in the preliminary analysis of the GRoWI dataset, however, it has proved to be very difficult to obtain this information.

3 There are plans for the development of a wetlands program in Ethiopia, and this may ultimately lead to national wetlands inventory work. No further information is currently available.

4 The Kenyan Wildlife Service have been working on a Wetland Conservation and Training Programme, in preparation for a planned national wetland inventory program (1999–2002) to be undertaken by the KWS and the National Environment Secretariat (Ministry of Environment).

5 A national wetland database is being established by the Ministry of Environment and Tourism, Namibia. It currently contains a GIS and Namibian wetlands bibliography, information on Ramsar Sites, and shadow Ramsar sites, as well as rudimentary information on other wetlands, totalling approximately 3000 records. A working version should be available for the Ramsar Contracting Parties meeting planned for Costa Rica in May 1999.

6 It is known that Uganda has undertaken a preliminary national wetland inventory, however, obtaining the relevant information has proved difficult. The current status of wetland inventory work in Uganda is uncertain.

9.2 Relevance to previous studies

Taylor et al (1995) produced a review of wetland inventories in southern Africa, which outlined the main wetland inventory activities in the region and provided estimates of the national wetlands resources in 10 countries. Table 9.2 (below) compares the wetland area values reported by Taylor et al (1995), and the values estimated by the current study. The values produced by the GRoWI review are comparable with those given by Taylor et al (1995) with a few exceptions, notably Botswana, South Africa and Namibia.

The estimate of the national wetland resource in Botswana was estimated to be lower than that given by Taylor et al (1995), despite the fact that both studies drew heavily on Hughes and Hughes (1992). Moyo (1993) formed the basis of our best estimates for Botswana, but the figures provided by Moyo were based on Hughes and Hughes (1992). Perhaps this serves to demonstrate that the extraction of values from bulky textual sources is problematic, and is open to subject bias and error. In this case, Moyo (1993), Taylor et al (1995) and this study examined the same source of wetland information and derived different values.

The value provided by this study for South Africa is almost double that given by Taylor et al (1995). Although this may seem to be a significant increase, the study by Cowan (1997) on which the best estimates were based, is very comprehensive and comprises the most recent and detailed review of wetland inventory information in South Africa, and is likely to be accurate. The estimate for Namibia is also higher than that given by Taylor et al (1995) even though Taylor et al (1995) uses the same source materials as were utilised in this study. These were Simmons et al (1991), Hughes and Hughes (1992) and data from the Ministry of Wildlife and Tourism (personal communication).

Table 9.2 Comparison of wetland resource estimates in Southern Africa

Country	National wetland resource (ha): This study	National wetland resource (ha): Taylor et al 1995
Angola	470,000–510,000	475,000
Botswana	2,247,655	2,831,000
Lesotho	20,000 [1]	20,000
Malawi	2,248,150	1,500,000–2,891,000 [2]
Mozambique	2,563,185	2,412,200
Namibia	1,336,193– 1,371,043	1,180,700
South Africa	754,540 [3]	460,000
Swaziland	10,000 [4]	10,000
Zambia *	12,187,228	11,329,720 [5]
Zimbabwe *	1,683,180	1,280,000

1. The values in this study are based on those given by Taylor et al (1995) since no other estimates were identified.
2. Two estimates of wetland cover are given: 15.9% of land area (based on Agnew 1973) and 24.4% of land area (based on Hughes & Hughes 1992).

3. The estimate of wetland cover is based on work by Cowan (1997), and is the most recent and comprehensive work on South African wetlands to date.

4. The values in this study are based on those given by Taylor et al (1995) since no other estimates were identified.

5. Approximately 5% of land area, stated as 3,800,000 ha, is estimated to be large wetlands and shallow water bodies, and a further 10% of land area is dambo wetlands (approx. 7,529,720 ha) which combined, result in a total of 11,329,720 ha

* Taylor et al (1995) values were used in the best estimate process (subjective comparison of data), for these countries, although the values provided by Taylor et al (1995) were not themselves used as the best estimates.

10 Priority processes

This section provides brief recommendations pertaining to wetlands inventory activities as a whole. It proved beyond the scope of this study to recommend particular field survey methods, or to provide instructions for wetland inventory activities. Taylor et al (1995) covers the relative merits and disadvantages of wetland inventory methods used in southern Africa and these are equally applicable throughout the Africa region.

Similarly, it would not be appropriate to enter the debate on traditional field survey techniques versus remote sensing techniques (again these are discussed admirably by Taylor et al (1995), and Grainger (1993), from analogous forestry studies). However, the process of extracting and analysing data from the sources examined in this review, has revealed common problems that could be easily avoided. For example, if wetland inventory data were presented in a particular fashion, and if certain specific data were routinely recorded for the benefit of the reader (such as date of survey, objectives, and wetland definition and coverage).

10.1 Establishing inventories

10.1.1 Preparatory activities

- A thorough review of previous studies and surveys undertaken should be conducted prior to any wetland inventory activity, to delineate gaps and to benefit from lessons learned or mistakes made. This should also include less obvious sources such as academic material and conference material, as well as conventional wetland inventories.

- Adequate time and resources should be allocated (by funding bodies and implementing agencies) to review, and obtain existing wetland inventory material for any given region or country. As stated by Taylor et al (1995), it requires time and effort to establish the existence of sources of information already available, and often there is repetition of previous survey work because adequate efforts to assess the existing information base have not been undertaken. This project has identified several cases where source material has quoted wetland area estimates taken from studies that had been comprehensively updated by more recent studies, and therefore their estimates were out of date, and had been supplanted by more recent and accurate data.

10.1.2 Background and setting to wetland inventory activities

- Information such as the history, development and rationale of wetland inventories is crucial for understanding the context of these studies and should be described briefly within reports. Information detailing contact persons and addresses is very helpful to successive workers, as are plans for future activities. If the surveys are part of a longer-term study, this should also be stated.

10.1.3 Objectives

- The objectives of wetland inventories should be identified prior to the commencement of wetland inventory activities (particularly those involving fieldwork). The objectives of wetland inventory activities should play a key role in choice of the most suitable wetland inventory methodology to be used in any given particular inventory program.

- Wetland inventory activities should aim to make provision for regular updating of wetland information, and where appropriate should make provision for monitoring changes in extent, distribution and loss of wetlands.
- The objectives should be clearly stated in wetland inventory reporting and published material.
- Those coordinating wetland inventory activities should specifically aim to widely disseminate wetland inventory material, and should aim to permit ready access to wetland inventory information. This objective should feature in all future wetland inventory activities.

10.2 Updating or extending inventories

10.2.1 Wetland coverage

- Certain wetland types were commonly excluded from wetland assessments and these included artificial wetlands (e.g. fish ponds, rice paddy, reservoirs and dams) and natural wetlands including dune slacks, humid sands, dambos, wet mesotrophic grasslands, seagrass beds, maerl beds, coral reefs, glacial and alpine wetlands. More attention should be paid to these and similarly overlooked wetland types in future inventory studies.

10.2.2 Wetland definitions and classification of wetlands

- Clear distinction should be made between the description of ‘marine wetlands’ and ‘coastal wetlands’, and ‘inland wetlands’. Extracting information on even broad wetland categories is difficult when authors use the terms that are ill defined or easily confused. For example, some authors use the term ‘coastal wetlands’ to mean strictly saline and brackish habitats and others use it to mean wetlands in the coastal zone (which often for practical purposes mean coastal lowlands and incorporates wetlands which experience no tidal inundation).
- A definition of wetlands should be always be given, and it should be expressly stated whether habitats such as floodplains, and open water bodies have been included in the definition and whether they have been included in a wetland survey.
- Where wetland classification systems are used, these should be stated and adequately referenced.

10.3 Inventory content

10.3.1 Minimum information fields

- Wetland area estimates and identification of whether wetland area estimates are minimal, maximal or average values (stating number of years and which years the average value is based on).
- The geographical coordinates and general location of wetlands should always be included, so that discrepancies involving the names of wetlands can be identified by location. (For countries which are newly independent, it is very difficult identifying wetlands which have been renamed, and adequate geo-referencing may reduce this difficulty.)

10.3.2 Recommended information fields

- Objectives of study.
- Dates of field work (including season) and collation should always be included, as well as the known dates of any compiled information.
- Description of methodologies used in fieldwork.
- Resolution capabilities of remotely sensed data.
- Definition of wetland used.
- Classification scheme used (e.g. Ramsar, Cowardin, Corine etc).
- Inclusions/exclusions in coverage (e.g. excluding wetlands of less than 100 ha, or excluding open water bodies etc).
- A *summary* of the coverage and characteristics of the wetland resource including tabulations where possible.
- Contact points for data custodians or publishers and their institutional details.
- Contact details of persons undertaking fieldwork should always be provided.
- Full referencing of primary source material should always be provided in reviews/collations.
- Ramsar Information Sheet data fields.

10.4 Wetland values and benefits

- Information on wetland values and benefits should be included in wetland inventories. As a minimum this should constitute a textual description of benefits, but preferably should indicate the economic values for wetland goods and services.
- A structure to aid the assessment of wetland benefits and values using simple means and local knowledge of wetland sites should be developed for use in conjunction with wetland inventories. This could take the form of a key or questionnaire which could be spilt into sections under the headings of fisheries, water supply, tourism, education, hydrological functions etc, and the assessor answer general questions under the appropriate headings. Or it could take the form of a table which should be completed, with sections containing questions such as 'approximately how many artisanal fishermen use this site? Is this seasonal? Approximately what is their daily/weekly catch? Or this could take the form of a matrix, which the assessor simply adds tick marks where a particular good or service is important. More effort should be put into developing simple ways of calculating the approximate total economic value of a wetland site in a standardised manner.
- The findings of wetland inventories that complete preliminary assessments of the values and benefits of a particular wetland site, should be widely disseminated in order to demonstrate the values and benefits to policy makers and management authorities.

10.5 Temporal scale/updating programs

- It could be argued that low resolution comprehensive national surveys should be undertaken as a priority to at least identify wetland locations for more detailed study later. However, in terms of resource conservation, repetition of detailed surveys at sites thought to be at risk should also be a priority undertaking.

- Wetland inventories must be regularly reviewed and updated otherwise data are likely to be lost, become out of date and become of historical interest only.

10.6 Presentation of data

- A summary of the coverage and characteristics of the wetland resource, should preferably be included in all wetland inventory reference material. It is exceedingly difficult to construct a useful overview of an inventory reference by extracting values and statistics from reams of text entries.
- Local naming conventions of wetlands or locations are often ignored, and authors may use their own ‘version’ of a local name for a particular wetland. There are obviously difficulties in translation, but more efforts should be made to ensure that the local and English (and French etc as appropriate) version names are included in inventory material if it is intended for use beyond the local area. A guide to the pronunciation of local names may also be useful, (particularly where these names have not previously been recorded, and are perhaps only known by local names) although this may not be practicable for directory type inventories.
- Key quantitative wetland inventory information should preferably not be presented in block text format (where data such as coverage and loss estimates lay hidden in sentences, perhaps with imprecise wording leading to an ambiguous interpretation). This would aid the input of existing and future inventory information into database format.
- Maps of habitats and atlases should also present summary area and type by area information. Many maps examined did not contain a scale and/or other fundamental spatial reference information such as geographic co-ordinates. It is very difficult to manually extract useful inventory or management information out of most of the maps examined for potential inclusion in the African dataset.

10.7 Handling and storage of wetland inventory information

- Every effort should be made to store both the paper and electronic versions of wetland inventory information with both those coordinating or conducting wetland inventory, and also with international organisations such as the Ramsar Bureau and Wetlands International or a central clearing house (if one is developed).
- Electronic forms should preferably be stored in some format which is readily translatable into either word processing packages or databases.
- A standardised (generic) database format (and software) should be developed for storage and extraction of local, national, and international wetland information that can be applied throughout the African region.

10.8 Availability and dissemination of inventories

- Much material is currently available in draft format, remains unpublished or has a limited distribution. Considerably more effort should be devoted to ensuring that existing draft reports are finalised, and resources permitting, published, preferably with some or all of the information made available on the World Wide Web.
- Those undertaking to produce national bibliographic databases, should also be aware that the usefulness of such information is severely limited if there is no provision for supplying the references to those who need them. Funding should be made available to

ensure that national bibliographic databases don't simply supply a list of references, but can also provide copies of the material upon request. The existence of such databases should also be more widely advertised.

- More emphasis should be directed toward publishing electronic format material (e.g. World Wide Web presentations) as well as any paper versions of reports.
- A central clearinghouse or structured information retrieval system for wetland inventory material should be put in place. It should be noted that identifying and obtaining wetland inventory material for a particular country may be largely dependent on a network of contacts and may chiefly rely on key individuals and/or organisations to supply or provide access to data. It is likely that these persons and organisations receive repeated requests for information and a positive result often depends on the goodwill and resources of these key individuals and organisations. The current situation is that a person or agency seeking information must first identify the 'key players', which in itself is often a time consuming process. The retrieval of information can occasionally be restricted due to deliberate actions on the part of some individuals who see a request for information as an opportunity to offer their services for substantial fee rates, and who it appears deliberately withhold information to increase their bargaining power.

11 Specific recommendations

The reader should also consult sections 8 and 10 for more detailed recommendations:

- National wetland policies should be established, and national wetland inventory programs commenced as a priority. These should be organised in such a way as to enable easy updating and review.
- Existing preliminary wetland inventories should be expanded upon to form national wetland inventories.
- Existing wetland inventory material should be updated in order to assess changes (especially loss or gain). Where it does not already exist, a baseline should be established for measuring future changes in wetland area, function and values, and more baseline wetland inventory activities should be undertaken.
- Dambos, and other specific wetlands types which are currently under represented (e.g. wetlands of less than 10 ha in size, artificial wetlands, endorheic and temporary wetlands) should be included in any inventory activities.
- More efforts to integrate wetland surveys with bird surveys should be made, and basic wetland characteristics and function should be recorded. Much bird count related material was identified in this study, but often these contained little useful wetland information. For countries known to have few wetland assessment or management initiatives, it is especially important that ornithologists also examine and provide basic wetland inventory information. The African Waterfowl Census database, which is maintained by WI-AEME, has enormous potential to assist with this particularly in certain West African and Central African countries.
- The results of wetland inventory activities should be adequately advertised and published, particularly on the World Wide Web, or at least disseminated to a wide audience (including libraries).
- Bibliographic databases set up to list information sources of wetlands within a given country should also provide details of where to obtain reference material, and provide

contact details. Preferably, a system should be established where persons requiring particular information could contact one agency for this information. A clearing house or document supply centre would be very useful, and would improve information accessibility in Africa enormously. Information availability should not depend on the goodwill and resources of those in possession of particular material, unless they were the original authors.

- Where only specific wetland types are included in a survey this should be stated, and a definition of this type provided. Inclusions and exclusions should be clearly identified.
- Geographic co-ordinates, general location and names (local and other) should be included in wetland inventories, and where possible also a map. This was frequently lacking for much of the material examined for Africa.
- Tomàs Vives (1993) cited in Costa et al (1996) stated that all wetlands, independent of their importance, should be covered by a national wetlands inventory. This is particularly true in African countries, since the identification and designation of internationally important wetlands under the Ramsar Convention is either in its early stages, or has not yet begun, (only 27 out of 55 countries in this region are contracting parties to the Ramsar Convention).
- Wetland inventories should aim to closely follow the format given in the Ramsar Information Sheets (RIS). This should serve to aid management of trans-boundary wetlands and should facilitate regional and international wetland assessments that can be utilised in African (and global) policy and planning initiatives.

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Our sincerest apologies to any person or institute we may have inadvertently omitted from this list.

Annex 2 Best Estimates of Wetland Coverage

(see section 3.3 for a list of countries omitted from this section)

	Country name (& Code) ALGERIA ALG		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	0	4,900	0	4,900	Date of extraction 14 August 1998; area of man-made type is very small, could not be separated from inland
2	Hughes and Hughes 1992	001	121,380- 134380	585,500	8,000	714,880-727,880	figures for inland are mainly chotts (salt pans). Coastal values vary due to annual variation in winter rainfall
3	Britton & Crivelli 1993	505	3,000	390,800	3,300	397,100	Values are likely to be reliable, but scope and definition of marine/coastal wetlands is obviously different to Hughes and Hughes 1992.
4	Chown & Linsley 1994	024	0	127,701	200	127,901	Inventory was of northern wetlands only. Inland lakes (saline and fresh water) =25,941 ha & wetlands (muddy basins, flats & marshes) =101,760 ha. Areas have been calculated from dimensions & therefore approximate.
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			121,380- 134380	585,500	8,000	714,880-727,880	

Notes/comments on best estimate

Hughes and Hughes estimates are fairly comprehensive including vegetated and open water bodies, and floodplains, hence the higher values. Likely to be roughly accurate.

Date of best estimate 21-Aug-98

	Country name (& Code) ANGOLA AGO		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Spalding, Blasco and Field 1997	501	60,700	0	0	60,700	Estimate of mangrove only. Data based on Hughes and Hughes 1992
2	Hughes and Hughes 1992	001	70,000	397,500	0	467,500	I) It is noted by the author that the value for coastal wetlands is probably much less than this figure. ii) Values for inland are an underestimate: author provides descriptions of many wetland complexes, but the figures are not available.
3	Wenban Smith 1993	002	110,000	0	0	110,000	Estimate of mangrove only. Based on WCMC 1992 data
4	GLCC www database	none	0	55,000	0	55,000	Date of extraction 22 July. Value is sum of Lake Gove 30,000 and Lake Calueque 25,000 ha only
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			70,000-110,000	400,000	?	470,000-510,000	

Notes/comments on best estimate

Hughes and Hughes state that coastal value is likely to be an underestimate and yet Wenban Smith provides a higher value for mangrove alone, therefore a range for coastal is provided. For inland, the only estimate available is Hughes and Hughes

Date of best estimate 21-Aug-98

Country name (& Code) BENIN BEN		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Spalding, Blasco and Field 1997	501	1,700	0	0	1,700	Estimate of mangrove only. Data based on Hughes and Hughes 1992
2 Hughes and Hughes 1992	001	175,790	129,000	0	304,790	Estimate for 'marine /coastal' includes seasonally & high tide innundated lakes in the coastal plain. Estimate for inland is mainly floodplain & permanent swamp .
3 European Commission 1992	101	3,000	0	0	3,000	Estimate of mangrove only. Estimate by Baglo-M pers comm. Note: loss has been severe since the 1970's, though to be due to changes in water regime and human pressure.
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		175,790	129,000	0	304,790	

Notes/comments on best estimate

Hughes and Hughes estimates are fairly comprehensive including vegetated and open water bodies, and floodplains, hence the higher values.
Likely to be roughly accurate.

Date of best estimate 21-Aug-98

	Country name (& Code) BOTSWANA BWA		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	0	6,864,000	0	6,864,000	Date of data extraction: August 14th 1998.
2	Hughes and Hughes 1992	001	0	2,243,250	4,405	2,247,655	Estimates should be fairly reliable
3	Moyo 1993	013	0	1,600,000	2,148		i) Inland value = Okavango delta (probably inc dry areas) . ii) Manmade values = mainly dams. Author describes other sites inc mining pools and sewage ponds, but areal values not provided.
			0	200,500	0		Values for pans,lakes,marshes & rivers
				1,800,500	*2,148*	1,802,648	Total wetlands value.Arguably Moyo's inventory could be regarded as comprehensive in its coverage.
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			none	2,243,250	4,405	2,247,655	

Notes/comments on best estimate

Hughes and Hughes 1992 are in fair agreement with Moyo 1993. Note that the Ramsar site area is much bigger than the area of the Okavango wetland itself

Date of best estimate 21-Aug-98

Country name (& Code)		Area (ha) Wetland				
BURKINA FASO						
BFA		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Ramsar database	none	0	299,200	0	299,200	Date of extraction 14 August 1998
2 Hughes and Hughes 1992	001	0	364,958	?	364,958	Ts = floodplain (total = approx 173100 ha) and floodplain wetlands (total = approx 29650 ha). Several reservoirs & other artificial impoundments are described but unquantified in terms of area. Lakes values are approximate.
3 0	0	0	0	0	0	0
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		0	364,958	?	364,958	

Notes/comments on best estimate

Hughes and Hughes is the only estimate located that lists wetlands specifically. The Ramsar database also includes non-wetland area.

Date of best estimate 21-Aug-98

	Country name (& Code) BURUNDI BDI		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Hughes and Hughes 1992	001	0	499,000	0	499,000	Ts = riverine swamps and floodplains combined. Value for lakes covers only Burundi's proportion where these lakes are transboundary (eg Tanganyika & Tshohoha south)
2	0		0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			none	499,000	unknown	499,000	

Notes/comments on best estimate

Hughes and Hughes is the only estimate for inland, presumably there are manmade wetlands, but these remain undescribed.

Date of best estimate 21-Aug-98

	Country name (& Code) CAMEROON CMR		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Spalding and Field 1997	501	249,400	0	0	249,400	estimate of mangrove only
2	Wenban Smith 1993	002	306,000	0	0	306,000	estimate of mangrove only
3	European Commission 1992	101	272,500	0	0	272,500	estimate of mangrove only. Values based on FAO 1980
4	Hughes and Hughes 1992	001	300,000	2,255,613	0	2,555,613	i. Estimate for marine/coastal is area of 'tidal forest'. ii Estimate for inland lakes inc. CMR's proportion of lakes Barombi Mbo, Chad, Fianga, & Ossa. iii Type inland 'Ts' in this case is fldplain wetlands.
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	
10							
Best estimates (ha)			300,000	2,255,613	?	2,555,613	

Notes/comments on best estimate

Most sources of information broadly agree on the extent of coastal wetlands, with Hughes and Hughes incorporating all tidal forest not just mangrove.
Hughes and Hughes provide the only estimate for inland wetlands

Date of best estimate 21-Aug-98

Country name (& Code) CENTRAL AFRICAN REPUBLIC CAF							
			Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Hughes & Hughes 1992	001	-	3,150,000	?	3,150,000	Hughes & Hughes provide a short description of the wetlands, and an approximate coverage value, however it appears that little hard data exists for CAF, and it is uncertain whether the value given here is comprehensive.
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)				3,150,000		3,150,000	

Notes/comments on best estimate

No other estimates other than Hughes & Hughes were identified and therefore must be used for the best estimate

Date of best estimate 28-Aug-98

	Country name (& Code) CHAD TCD		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	-	195,000	0	195,000	Date of extraction 14 August 1998
2	Hughes and Hughes 1992	001	-	12,983,390	1,666,000	14,649,390	A comprehensive estimate with the exception of a few small lakes. A large floodplain near N'Djamena described by Hughes & Hughes as '440 km long & between 25-125 km wide' has been estimated to have a mean area of 3,000,000ha to improve the assessment
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			-	12,983,390	1,666,000	14,649,390	

Notes/comments on best estimate

No other estimate other than Hughes and Hughes 1992 has been identified.

The Ramsar database does not cover wetlands exclusively, and does not cover the entire country

Date of best estimate 21-Aug-98

Country name (& Code) DEMOCRATIC REPUBLIC OF CONGO ZAR			*Area (ha) Wetland*				NOTES
	Reference author	**Reference code**	MARINE/COASTAL	INLAND	MANMADE	TOTAL	
1	Ramsar database	none	66,000	800,000	0	866,000	Date of extraction 14 August 1998
2	Spalding, Blasco and Field 1997	501	37,400	0	0	37,400	Estimate of mangrove only. Data based on NASA/GSFC & Uni Maryland data from NOAA/AVHRR (1km pixel) 1988 satellite images.
3	Hughes and Hughes 1992	001	0	14,551,095	0	14,551,095	No estimate for coastal wetlands is given, otherwise the estimate is comprehensive
4	Ministere de l'environnement 1995	020	[66,000]	[2,573,000]	0	[2,639,000)	These are the areas of national parks containing wetlands, the actual wetlands areas are not specified.
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			37,400	14,551,095	?	14,588,495	

Notes/comments on best estimate

Spalding et al 1997 provide the only estimate for coastal wetlands. Both estimates are combined to derive a total best estimate
Hughes and Hughes provide the only estimate for inland wetlands
The Ramsar database areas cover more than just wetland area.

Date of best estimate 21-Aug-98

Country name (& Code) CONGO (Republic of) COG		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Ramsar database	none	0	438,960	0	438,960	Extraction date 14 August 1998; no wetland types available yet
2 Spalding, Blasco and Field 1997	501	18,800	0	0	18,800	Estimate of mangrove only. Data based on Hughes and Hughes 1992
3 Hughes and Hughes 1992	001	740,000	11,686,500	0	12,426,500	Only COG's proportionof wetlands are included in transboundary wetlands. ii many mosaic wetland types, so difficult to classify type by area.
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		740,000	11,686,500	?	12,426,500	

Notes/comments on best estimate

Hughes & Hughes 1992 estimate for marine includes mangrove, mud flats & water bodies, & possibly estuarine area. Inland area includes floodplain wetlands. No areas for manmade were identified.

Date of best estimate 21-Aug-98

	Country name (& Code) COTE D'IVORIE CIV		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	19,400	0	0	19,400	Date of extraction 14 August 1998; although inland types are listed, the sites are completely coastal/marine
2	Spalding, Blasco and Field 1997	501	64,400	0	0	64,400	Estimate of mangrove only. Data based on Hughes and Hughes 1992 with some additonal info added by authors.
3	Hughes and Hughes 1992	001	173,470	?	105,000-172,000	278,470-345,470	ii Detailed values are given for coastal lagoons (separated into swamp and open water values) total here = swamp & o/w. ii Range of values given for inland impoundments. iii) Values for inland riverine wetlands not provided, but thought to be significant
4	Nicole et al 1994	014	292,330	0	0	292,330	Values cover coastal wetlands only (includes 9000 ha open water lagoon/estuary)
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			292,330	?	105,000-172,000	397,330-464,330	

Notes/comments on best estimate

Nicole et al 1994 was comprehensive in its coverage of coastal wetlands. Inland values are not known, Manmade values are only provided by Hughes and Hughes 1992.

Date of best estimate 21-Aug-98

	Country name (& Code) DJIBOUTI DJI		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	Reference code					
1	Spalding, Blasco and Field 1997	501	1,000	0	0	1,000	i) Estimate of mangrove only. ii) Data based on 1985 Landsat MSS satellite imagery and Forgiarini & Cesar 1987. Vegetation et resources pastorales 1: 250,000
2	Hughes & Hughes 1992	001	0	37,200	0	37,200	R = salt pans/flats and Q= saline lakes which vary in size according to season. Tidal wetlands inc mangrove & saltmarsh are also described, but unquantified
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			1,000	37,200	?	38,200	

Notes/comments on best estimate

Spalding and Blasco present estimates of mangrove , whereas Hughes and Hughes provides no coastal wetland values, and vice versa for inland wetlands.
No data for manmade wetlands were identified

Date of best estimate 21-Aug-98

	Country name (& Code) EGYPT EGY		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	105,700	?	?	105,700	Date of data extraction August 14th 1998.
2	Spalding, Blasco and Field 1997	2998	86,100	0	0	86,100	i) Estimate of mangrove only. ii) Data based on a regional skletch map by Sheppard (1992) ie unreliable data.
3	Hughes and Hughes 1992	001	2,634,550	711,200	0	3,345,750	Does not include Suez canal, lower nile irrigated area, and new valley oases, otherwise fairly comprehensive
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			2,634,550	711,200	0	3,345,750	

Notes/comments on best estimate

Hughes and Hughes is the only comprehensive assessment identified to date.

Date of best estimate 21-Aug-98

	Country name (& Code) EQUATORIAL GUINEA GNQ		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	Reference code					
1	Spalding, Blasco and Field 1997	501	27,700	0	0	27,700	Estimate of mangrove only. Data based on Hughes and Hughes 1992
2	Hughes and Hughes 1992	001	27,700	0	0	27,700	Very little information is provided. No mention of freshwater wetlands or manmade wetlands
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			27700	?	?	27700	

Notes/comments on best estimate

No other information is available, and therefore Hughes and Hughes aproximate estimate must be used

Date of best estimate 21-Aug-98

	Country name (& Code) ERITREA ERI		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Spalding, Blasco and Field 1997	2998	58,100	0	0	58,100	i) Estimate of mangrove only. ii) Data based on personal communications with Chris Hillman and Liz Ross.
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			58,100	0	0	58,100	

Notes/comments on best estimate

Due to boundary changes when Eritrea declared independance from Ethiopia in 1993, information appears to be scant.
However, information on wetlands is available but is difficult to extract from wetlands which fall within the existing Ethiopia boundaries.
This task requires more time than the GRoWR project could provide, and should be examined more thoroughly in the future.

Date of best estimate 21-Aug-98

	Country name (& Code) GABON GAB		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	648,000	432,000	0	1,080,000	Date of data extraction August 14th 1998
2	Schepers et al 1993	003	257,500	0	0	257,500	Values are derived from fieldwk in 1992 and map studies. Other values also given-total length= 615km sandy beach habitat: 49km coastal brackish lagoons. Data not given for area of estuarine waters (which is significant area)
3	GLCC www database	none	0	20,000	0	20,000	Values for Lake Onangue only. Data for other lakes not provided.Unsure of wetland type.
4	Spalding, Blasco and Field 1997	501	175,900	0	0	175,900	Estimate for mangrove only.Estimate based on 1:150000 1993 &1994 vegetation maps by Fontes & Fromard, with minor corrections by Blasco.
5	Wenban Smith 1993	002	250,000	0	0	250,000	Estimate of mangrove only. Based on WCMC 1992 data
6	Hughes and Hughes 1992	001	350,000	3,968,875	0	4,318,875	Estimate for marine = "tidal forest in broadest sense" ie not just mangrove. Estimate for inland includes rivers, streams, floodplain,riverine swamp & 'swampy rain forest"
7	European Commission 1992	010	250,000	0	0	250,000	Estimate of mangrove only. Basis of estimate or reference not provided.
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			175,900-257,500	3,968,875	?	4,144,775-4,226,375	

Notes/comments

Schepers and Marteijn 1993 estimates based on field wrk & map wrk.
Spalding, Blasco and Field 1997 estimates based on map work also
Schepers and Marteijn 1993 also provide estimates of total length of sandy beach habitat= 615km and coastal brackish lagoons =49km .
Hughes and Hughes 1992 is the nearest estimate we have for inland that is comprehensive.

Date of best estimate 22-Jul-98

	Country name (& Code) GAMBIA GMB		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	10,000	10,000	-	20,000	Date of data extraction August 14 1998
2	European Commission 1992	010	60,000-67,000	0	0	60,000-67,000	Based on Saenger at al 1983.Values for Gambian River basin.
3	De Bie 1990	009	?	?	?	13,627	Total Value incs: Gambia Saloum, Gambia River Natl Pk: Kiun West, Jakhaly Swamp, but NOT mangrove areas, or Bund Road Lagoon, Banjul. Therefore value is likely to be underestimate.
4	Spalding, Blasco and Field 1997	501	74,700	0	0	74,700	Estimate for mangrove only
5	Hughes and Hughes 1992	001	45,000	?	?	45,000	Very little information is provided.
6	Dep Parks & Wildlife Mgt 1997	015	0	0	0	181,308	Total value given encompasses "uncultivated and cultivated swamps" covering 81,276 ha & 33,344 ha respectively, & mangrove 66,688ha. Figures are based on FAO data 1994 (which in turn are based on 1983 aerial photos)
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			74,700	106,608	?	181,308	

Notes/comments

Based on the assumption that Spalding, Blasco & Field 1997 have accurate estimates for mangrove, and that the Department Parks and Wildlife Management have a good overall estimate of wetlands (probably not including open water bodies), then inland wetlands probably account for approximately 106,000 ha

Date of best estimate 21-Aug-98

	Country name (& Code)		Area (ha) Wetland				
	GHANA GHA		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	171,150	6,534	726	178,410	Date of data extraction 14th August 1998
2	European Commission 1992	101	0	0	0	0	No figures given due "to lack of recent data". Good ecological description provided though.
3	0	0	0	0	0	0	0
4	Spalding, Blasco and Field 1997	501	21,400	0	0	21,400	Estimate for mangrove only. Based on undated UNEP-GRID project AVHRR (1 km pixel) satellite imagery
5	Hughes and Hughes 1992	001	117,800	460,050	895,225	1,473,075	Fairly comprehensive.
6	Piersma & Ntiamoa-Baidu 1995	117	64,500	0	0	64,500	Open water areaof Songor lagoon and Keta lagoon, (Volta estuary) only.
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			117,800	460,050	895,225	1,473,075	

Notes/comments

Hughes and Hughes 1992 provides the nearest to a comprehensive assessment available

Date of best estimate 21-Aug-98

	Country name (& Code) GUINEA GIN		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	225,011	-	-	225,011	Date of data extraction August 14th
2	Spalding, Blasco and Field 1997	501	308,300	0	0	308,300	Estimate of mangrove only. Data derived from 1979-80 aerial photos, updated using Landsat MSS 1984-1985-1986 imagery.
3	Hughes and Hughes 1992	001	200,500	121,500	?	322,000	Areas for several small lakes and manmade were not available. Status of some coastal mangroves is also uncertain, and one area that did exist in 1980 is now thought to have been reduced significantly (and not included here)
4	Wenban Smith 1993	002	223,000	0	0	223,000	Estimate of mangrove only. Based on WCMC 1992 data
5	European Commission 1992	010	260,000	0	0	260,000	No basis of estimate or reference given.
6	Altenburg and van der Kamp 1991	011	290,500-310,000	0	31,200	321,700 - 341,200	Values for manmade are rice fields in freshwater swamp areas. Also approx 4,200km of tidal creek in mangrove areas (260,000ha). All values are based on late 1980's data updated by arial reconnaissance & ground survey between 1988-1990
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			250,000	121,500	?	371,500	

Notes/comments on best estimate

A conservative estimate for coastal wetlands is given due to likely conversion to rice culture.
Hughes and Hughes provides the only estimate for inland wetlands.

Date of best estimate 21-Aug-98

Country name
(& Code)
GUINEA-BISSAU

GNB

			Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	39,098	-	-	39,098	Date of data extraction August 14th 1998
2	Spalding, Blasco and Field 1997	501	364,900	0	0	364,900	Estimate of mangrove only. Data taken from a generalised map hand drawn by Scott Jones in 1990 based on IGN (1981) map data, but updated to show forest loss.
3	Hughes and Hughes 1992	118	200,000	?	0	200,000	Very little information is provided and the estimate for coastal wetlands approximate since losses are known to have occurred due to clearance, but no figures are available
4	Wenban Smith 1993	002	236,000	0	0	236,000	Estimate of mangrove only. Based on WCMC 1992 data
5	European Commission 1992	10	?	0	0	0	Values not available due to transboundary description of wetlands (not per country estimates)
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			200,000-364,900	?	?	200,000-364,900	

Notes/comments on best estimate

All values are approximate and so at best only a range of values can be suggested.

Date of best estimate 21-Aug-98

	Country name (& Code) KENYA KEN		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	Reference code					
1	Ramsar database	none	-	48,800	-	48,800	Date of data extraction August 14 1998
2	Spalding, Blasco and Field 1997	501	96,100	0	0	96,100	Estimate of mangrove only. Based on Desol (1995) " a vegetation map of kenya".
3	Crafter, Juguna & Howard 1992	008	53,000	87,000	?	140,000	i) Marine value for mangrove only. ii) inland value may also included manmade wetlands,but not stipulated by Crafter et al 1992. Types of wetland included in inland estimate not given.
4	Hughes and Hughes 1992	001	69,000-90,000	2,641,690	0	2,710,690-2,731,690	TS =cumulative total for 'grassy' & 'swampy flooplains', & Tp =cumulative total for 'swamps' and 'pans'. Several wetlands, flplains & swmps are described but not quantified & values for I are for Tana River only, ie values may be an underestimate.
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			96,100	2,641,690	?	2,737,790	

Notes/comments on best estimate

Spalding et al 1997 & Hughes and Hughes 1992 have good agreement on mangrove area.
Hughes and Hughes inland wetlands include floodplains & this is probably why the estimate is so much larger than that of Crafter et al 1992
No estimates for manmade wetlands have been identified.

Date of best estimate 21-Aug-98

	Country name (& Code)		Area (ha) Wetland				
	LESOTHO						
	LSO		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Hughes and Hughes 1992	001	-	?	?	?	No area values are provided however it is noted that "there are extensive bogs & spongelands in the high rainfall areas of the mountains…montane bogs cover tens of thousands of hectares, mostly above 2300m..small swamps & fldplains occur in the lowlands"
2	Taylor, Howard & Begg	025	-	?	?	20,000	This is given as 'approximate wetland area'.
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			?	?	?	20,000	

Notes/comments on best estimate

The total value from Taylor Howard and Begg has been used for the best estimate, though it must be noted that this value is approximate

Date of best estimate 21-Aug-98

Country name (& Code) Liberia LBR		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Gatter 1988	004	33,140	0	9,000	42,140	Other values: length (km) of A:streams in i) coastal areas=140 ii) hill areas=505: B rivers in i)coastal areas=185 ii) hill areas=435 iii) mtn areas=80: C creeks in i) coastal areas 380 ii) hill areas=1335 highland areas=600. sml coastal lagoons=429
2 Gatter 1988(b)	006	33,140	0	0	33,140	article in german,but appears to be based totally on work from Gatter 1988 (ICPB)
3 GLCC www database	none	12,000	0	0	12,000	value for Lake Piso only
4 Spalding, Blasco and Field 1997	501	42,700	0	0	42,700	Estimate for mangrove only. Value based on undated UNEP-GRID project AVHRR (1 km pixel) satellite imagery
5 Hughes & Hughes 1992	001	39,750	0	0	39,750	Many wetland sites are described but remain unquantified and therefore the values must be an underestimate
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		42,700	?	9,000	51,700	

Notes/comments on best estimate

Although Spalding et al 1997 could be an over estimate due to the large pixel size of the satellite imagery, there should be reasonable accuracy. Gatter 1988 provides the only estimate of manmade wetlands.

Date of best estimate 22-Jul-98

Country name (& Code) LIBYA LBY		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Meininger, Wolf et al 1994	018	3,150	0	0	3,150	This source covers only coastal wetlands and only some of these. Several freshwater wetlands are noted, but no area values are provided. Information is slim.
2 0	0	0	0	0	0	
3 0	0	0	0	0	0	0
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		?	?	?	?	

Notes/comments on best estimate

A best estimate is not possible

Date of best estimate 21-Aug-98

	Country name (& Code) MADAGASCAR MDG		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Spalding, Blasco and Field 1997	501	340,300	0	0	340,300	Estimate of mangrove only. Data based on Faramala Miadana Harisoa (1996) data which is based mainly on 1972-79 Landsat satellite imagery.
2	Hughes and Hughes 1992	001	371,747	340,000	32,300	744,047	Estimates for f/w & b/w coastal lagoons are approximate. Total value is correct.
3	Wenban Smith 1993	002	326,000	0	0	326,000	Estimate of mangrove only. Based on WCMC 1992 data
4	European Commision 1992	010	327,000	0	0	327,000	Estimate of mangrove only. Based on Kiener 1966, though authors state " it is likely that present are of mangroves does not differ widely from Kiener 1966" NJS disagrees.
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10							
Best estimates (ha)			340,300-371,747	340,000	32,300	712,600-744,047	

Notes/comments on best estimate

All estimates for coastal wetlands are in approximate agreement, however, Spalding et al 1997 is likely to be accurate due to use of satellite imagert (albeit in 1972-70) and Hughes and Hughes provides a higher estimate and therefore a range has been suggested for coastal wetlands.
Only Hughes and Hughes provide an estimate for inland and manmade wetlands and is therefore used as a best estimate.

Date of best estimate 21-Aug-98

	Country name (& Code) MALAWI MWI		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	0	224,800	0	224,800	Date of data extraction : August 14th 1998
2	Hughes & Hughes 1992	001	0	2,248,150	0	2,248,150	Value for Tp inland probably alos includes some seasonal/intermittent wetlands. There are several sites which are described but are unquantified.
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)				2,248,150		2,248,150	

Notes/comments on best estimate

Although Taylor, Howard and Begg 1995 also contained wetland area information, it was based on Hughes & Hughes, with mention of earlier (1980's) work which we have been unable to obtain for this review. It seems that there are additional wetland areas of dambos, (Taylor et al 1995), but there is discrepancy over the area of dambos. It should be noted that the Hughes & Hughes estimate which has been used for the best estimate is probably an underestimate

Date of best estimate 28-Aug-98

	Country name (& Code) MALI MLI		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	Reference code					
1	Ramsar database	none	-	162,000	-	162,000	Date of data extraction: August 1998
2	De Bie 1990	831	0	2,162,000	0	2,162,000	Estimate includes Lakes Oualado, Debo, & Horo, the Seri Plain and the inner delta of the Niger river
3	Hughes and Hughes 1992	001	0	3,560,400	69,000	3,629,400	TS = river floodplains.Many floodplains are mentioned but unquantified. R actually refers to wet /humid sands ('daias') (ie not really wetland type R).
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)				3,560,400	69,000	3,629,400	

Notes/comments on best estimate

The estimate by Hughes and Hughes includes floodplain wetlands which proabbaly accounts for the higher estimate that De Bie 1990.
Hughes and Hughes is the only estimate for manmade and therefore must be used as a best estimate

Date of best estimate 21-Aug-98

	Country name (& Code) MAURITANIA MRT		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	Reference code					
1	Ramsar database	none	1,180,800	7,800	0	1,188,600	Date of data extraction August 14th 1998
2	Spalding, Blasco and Field 1997	501	1,040	0	0	1,040	Estimate of mangrove only. Data based on Hughes and Hughes 1992
3	Hughes and Hughes 1992	001	63,000	568,388	37,500	668,888	The coastal estimate includes mud flats as well as mangrove. Several pans are descirbed but not included in the estimate of inland, since no area values were given.
4	De Bie 1990	009	?	?	?	1,196,000	Estimate included the Banc A'rguin, Senegal river delta system, Aftout es Sahel & several lakes. Value given does not include some sites for which coverage is unknown & therefore likely to be an underestimate.
5	Van Wetten et al 1990	021	0	83,895	0	83,895	This inventory gives detailed decsriptions of inland wetland sites in the south of Mauritania only.
6	Lamarche & Gowthorpe yr=?	022	?	?	?	?	This is not an inventory, and contains no area information, however, it does list 90 wetlands with a rating score of biodiversity and conservation importance. Useful for planning inventory activities.
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			?	?	?	668,888-1,196,000	

Notes/comments on best estimate

It is difficult to make a best etsimate since De Bie 1990 appears to be comprehensive, but provides a total estimate almost twice that given by Hughes and Hughes 1992. An approximate range estimate is suggested.

Date of best estimate 22-Jul-98

	Country name (& Code) MOZAMBIQUE MOZ		Area (ha) Wetland				NOTES
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Hughes and Hughes 1992	001	260,530	1,950,785	266,500	2,477,815	Many lakes, floodplains, pans, lagoons & swamps are described without quantification, and therefore the values provided here must be an underestimate
2	Spalding, Blasco and Field 1997	501	345,900	0	0	345,900	Estimate of mangrove only. Based on Ministerio da Agricultura (1980) Mapa Florestal.
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			345,900	1,950,785	266,500	2,563,185	

Notes/comments on best estimate

It is not clear in all cases whether some of the swamps described in Hughes & Hughes in certain lowlands are f/w or brackish water, & may have been attributed to inland when they are in fact coastal. Many inland wetlands & lakes are not quantified which may redress this imbalance. Therefore the value for coastal wetlands given by Spalding is retained as the best estimate for marine. The Hughes & Hughes values for inland and manmade are used for best estimates of those types. The estimates must be regarded as approximate.

Date of best estimate 28-Aug-98

	Country name (& Code) MOROCCO MAR		*Area (ha) Wetland*				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	10,200	380	-	10,580	Date of data extraction August 14 1998
2	Hughes and Hughes 1992	001	33,200	27,880	?	61,080	25 artificial impoundements occur but are not quantified. Ts inland encompasses marshland and floodplain.
3	Britton & Crivelli 1993	505	29,300	43,800	7,500	80,600	Values are likely to be reliable
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			29,300-33,200	27,800-43,800	7,500	64,600-84,500	

Notes/comments on best estimate

Both Britton & Crivelli 1993 & Hughes & Hughes1992 give apparently reliable estimates. They are in close agreement for the coastal wetlands, but not for inland, and unusually the Hughes and Hughes estimate is lower than that of another.
There is no reason to assume that one is more accurate than the other and so a range for inland has been given.

Date of best estimate 21-Aug-98

	Country name (& Code) NAMIBIA NAM		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	29,600	600,000	-	629,600	Date of data extraction August 14 1998
2	Hughes and Hughes 1992	001	9,850	1,073,003	2,500	1,085,353	R inland = pans, & Tp =swamps. Several manmade sites and inland pans are described, but areas not quantified, therefore total value is an underestimate
3	Ministry Environment & Tourism database	016	?	?	?	0	A national wetland inventory is underway utilising aerial photos, ground survey and collation/review. No area values available at present.
4	Simmons , et al 1991	023	6,500-7,000	1,322,160-1,353,660	7,533	1,336,193-1,368,193	Data is taken from a wetlands workshop in which authors presented info on various wetland types. Overall it seems comprehensive though some area values were absent, eg karst wetlands,some river mouths & manmade.
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			6,500-9,850	1,322,160-1,353,660	7,533	1,336,193-1,371,043	

Notes/comments on best estimate

It is difficult to judge which is more accurate for coastal Hughes and Hughes 1992 or Simmons et al 1991, so a range of values has been chosen.
Hughes and Hughes 1992 inland and manmade estimates are underetsimates and therefore the values given by Simmons et al 1991 have been chosen for inland and manmade best estimates

Date of best estimate 22-Jul-98

	Country name (& Code) NIGER NER		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	-	220,000	0	220,000	Date of extraction August 14th 1998
2	Hughes and Hughes 1992	001	-	1,764,950	?	1,764,950	Values given are underestimates since many wetlands are described but no area values are given. Salt pans and irrigation waters are described but not quantified
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			-	1764950	?	1764950	

Notes/comments on best estimate

No other estimates were identified and therefore Hughes and Hughes is used for the best estimate.

Date of best estimate 14-Aug-98

	Country name (& Code) NIGERIA NGA		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Spalding, Blasco and Field 1997	501	1,113,400	0	0	1,113,400	Estimate of mangrove only. Based on undated UNEP-GRID project AVHRR (1 km pixel) satellite imagery
2	Hughes and Hughes 1992	001	828,775	946,460	123,000		Total area of particular wetland types identified by Hughes & Hughes I,K, Sp Ts & O (type O=lake Chad)
			518,000	4,580,600	0		Total area of broad types including the Niger Delta, the Niger/Benue river system, the Komadugu Yobe, the Ngadda, Yederam and El Beid rivers, & the Cross river ie mostly swamp, floodplain & riverine forests.
			1,346,775	*5,527,060*	*123,000*	6,996,835	Total area of wetlands described in Hughes and Hughes 1992
3	Wenban Smith 1993	002	3,238,000	0	0	3,238,000	Estimate of mangrove only. Based on WCMC 1992 data
4	European Commission 1992	010	1,824,000	0	0	1,824,000	Estimate of mangrove only. Based on 1960's and 1970's data.
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
Best estimates (ha)			1,346,775 - 3,238,000	5,527,060	123,000	6,996,835 - 8,888,060	

Notes/comments on best estimate

Total area given by Hughes and Hughes for marine coastal all types is much less than that given by Wenban Smith for mangrove alone.
There is no obvious explanation for this. Therefore a range between the 2 values is suggested for marine and coastal wetlands
The only estimates for inland and manmade wetlands are those given by Hughes and Hughes and therefore these have been used for best estimates.

Date of best estimate 28-Aug-98

	Country name (& Code) RWANDA RWA		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	Reference code					
2	Hughes and Hughes 1992	001	0	348,100	0	348,100	Values are approximate.
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)				348,100		348,100	

Notes/comments on best estimate

No other wetland area estimates other than Hughes and Hughes 1992 have been identified

Date of best estimate 22-Jul-98

Country name (& Code) SENEGAL SEN		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Ramsar database	none	73,720	26,000	-	99,720	Date of data extraction August 14th 1998
2 Spalding, Blasco and Field 1997	501	183,000	0	0	183,000	Estimate of mangrove only. Data based on USGS (1985) with some modifications
3 Hughes and Hughes 1992	001	371,000	16,000	0		Areas for individual wetland types at sites where the areas are quantified
		137,000	647,000	-		Values given for each category (inland and marine/coastal) are very approximate since for areas such as the Senegal Delta it is difficult to quantify these areas as separate types.
		508,000	*663,000*		1,171,000	Total area of wetlands
4 Wenban Smith 1993	002	169,000	0	0	169,000	Estimate of mangrove only. Based on WCMC (1992) data
5 European Commission 1992	010	?	?	?	?	Values not available due to transboundary description of wetlands (not per country estimates)
6 De Bie 1990	009	?	?	?	277,266	Total value incl: the Natl Pks Casamance, Djoudj, Iles dela Madeleine, Langue de Barbarie: the Biosphere Reserve Saloum: the reserves Point de Kalissaye, Popenguine & Guembeul: Gurer Lake: the delta & upper Senegal river: not coastal lakes.Underestimate.
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		508,000	663,000	?	1,171,000	

Notes/comments on best estimate

Spalding et al 1997 and Wenban Smith 1993 cover only mangroves. De Bie 1990 also includes coastal islands within the estimate & therefore Hughes and Hughes provides the most comprehensive estimate currently available

Date of best estimate 21 Aug 1998

	Country name (& Code)		Area (ha) Wetland				
	SIERRA LEONE						
	SEL		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	Reference code					
1	Spalding, Blasco and Field 1997	501	169,500	0	0	169,500	Estimate of mangrove only. Based on undated UNEP-GRID project AVHRR (1 km pixel) satellite imagery
2	Hughes and Hughes 1992	001	170,600	108,820	0	279,420	No area values are provided for the riverine wetlands and several lakes which are described and therefore the value will be a underestimate
3	Wenban Smith 1993	002	250,000	0	0	250,000	Estimate of mangrove only. Based on WCMC 1992 data
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
Best estimates (ha)			170,600	108,820	?	279,420	

Notes/comments on best estimate

Spalding et al 1997 and Hughes and Hughes 1992 are in agreement for the coastal wetlands, Wenban Smith is based on coarse data, and so Hughes and Hughes has been chosen as the best estimate for coastal wetlands.
Hughes and Hughes provide the only estimate for inland wetlands

Date of best estimate 21-Aug-98

	Country name (& Code) SOMALIA SOM		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Spalding, Blasco and Field 1997	501	91,000	0	0	91,000	i) Estimate of mangrove only. ii) Data based on Hughes and Hughes (1992) with additions by Blasco. Noted as unreliable estimate
2	Hughes and Hughes 1992	001	?	600,000	?	600,000	Many tidal marsh & mangrove sites are listed but unquantified. Karst lakes & sinkholes & small endorheic depressions are listed as common & numerous, but also unquantified. Therefore total value is underestimate.
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			91,000	600,000		691,000	

Notes/comments on best estimate

Since only one estimate per wetland type has been identified, we can only use those figures.

Date of best estimate 21-Aug-98

	Country name (& Code) SOUTH AFRICA ZAF		***Area (ha) Wetland***				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	223,068	266,930	-	489,998	Date of data extraction August 14th 1998
2	Spalding, Blasco and Field 1997	501	33,500	0	0	33,500	Estimate of mangrove only. Based on Hughes and Hughes 1992 but noted as approximate estimate
3	Cowan 1997	019	276,367	276,911	201,262	754,540	very comprehensive review of wetland coverage in South Africa
4	Hughes and Hughes 1992	001	0	0	0	0	(to be calculated yet)
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			276,367	276,911	201,262	754,540	

Notes/comments on best estimate

Cowan 1997 conducted a very thorough review of wetlands in S Africa,and his data has been used for the best estimate,
though Cowan has stated that many smaller wetlands are not included in this estimate. Therefore, value given here must be an underestimate

Date of best estimate 21-Aug-98

	Country name (& Code)		Area (ha) Wetland				
	SUDAN SDN		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	Reference code					
2	Spalding, Blasco and Field 1997	501	93,700	0	0	93,700	i) Estimate of mangrove only. ii) Data based on a regional sketch map in Sheppard (1992). Data noted as likely to be unreliable.
3	Hughes and Hughes 1992	001	0	4,155,900	311,500	4,467,400	Estimate for inland & manmade wetlands appears to be comprehensive, though there is no estimate for coastal wetlands, & there are a number of floodplains & water bodies which are described but not quantified.
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			93,700	4,155,900	311,500	4,561,100	

Notes/comments on best estimate

Spalding et al 1997 provide the only estimate of coastal wetlands & Hughes and Hughes provide the only estimate of inland and manmade wetlands.

Date of best estimate 22-Jul-98

Country name
(& Code)
SWAZILAND

SWZ

			Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Hughes and Hughes 1992	001	0	?	?	0	there are no wetlands of major importance however the existence of small areas of swamp, peat bog, pools & reed filled dam ponds and dam lakes are mentioned but unquantified.
2	Taylor, Howard & Begg	025	-	0	?	10,000	Value is approximate since there are no reliable data for Swaziland.
3	0	0	0	?	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			-	?	?	10000	

Notes/comments on best estimate

The best estimate is still likely to be very approximate

Date of best estimate 21-Aug-98

	Country name (& Code)		Area (ha) Wetland				
	TANZANIA TZA		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	Reference code					
1	Spalding, Blasco and Field 1997	501	245,600	0	0	245,600	Estimate of mangrove only. Data based on summary map of a more detailed mangrove forest inventory supported by NORAD, based on aerial photos taken in 1988/89
2	Kamukala& Crafter 1993	005	200,000	2,700,000	85,000	2,985,000	re inland: wetland types uncertain, but quoted as "permanent or seasonal f/w swamps & seasonal fldplains"= 2.7 million ha. In adddition shoreline figures are given = coast length 1000km, Lake Nyasa 305km. Lake Tanganyika 650km : lake Victoria 1420km.
3	Wenban Smith 1993	002	134,000	0	0	134,000	Estimate of mangrove only. Based on WCMC 1992 data
4	Hughes and Hughes 1992	001	196,000	8,389,286	83,300	8,668,586	Ts =cumulative floodplain area Tp = swamp/wetland/papyrus. O=lake open water area. Some sites are described but not quantified, ie underestimate. Some areas have been calculated from average length x breadth dimensions.
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
Best estimates (ha)			200,000-245,600	8,389,286	85,000	8,674,286-8,719,886	

Notes/comments on best estimate

Hughes and Hughes 1992 coastal wetlands estimate is an underestimate and therefore Kamukala &Crafter's estimate (which is similar) for coastal wetlands is possibly also an underestimate. A range of values for coastal has been suggested using the Spalding et al 1997 estimate as a maximum value

Hughes and Hughes 1992 inland wetlands estimate is comprehensive and includes floodplains.

Kamukala &Crafter's 1993 estimate and Hughes and Hughes 1992 estimate for manmade is very closely matched.

The higher value has been chosen since the source material for Kamukala &Crafter is more recent

Date of best estimate 28-Aug-98

Country name (& Code)		Area (ha) Wetland				
TOGO						
TGO		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	**Reference code**					
1 Ramsar database	none	0	194,400	0	194,400	Date of data extraction August 14th 1998
2 Hughes and Hughes 1992	001	44,400	73,200	?	117,600	Estimates are approximate and mid range values where annual differences occur
3 0	0	0	?	0		0
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		44,400	73,200	?	117,600	

Notes/comments on best estimate

Hughes and Hughes 1992 provides the only estimate of wetland area in Togo found to date

Date of best estimate 21-Aug-98

	Country name (& Code)		Area (ha) Wetland				
	TUNISIA TUN		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	-	12,600	-	12,600	0
2	Britton & Crivelli 1993	505	96,100	819,000	0	915,100	Values are likely to be reliable
3	Chown & Linsley 1994	024	29,960	830,830	0	860,790	Includes important bird areas only.
4	Hughes et al 1994	007	113,084	1,182,915-1,207,915	20,787	1,316,786-1341,786	Inventory is comprehensive & (probably) includes all wetlands, however, many area values have been calculated from dimensions, some areas are not given, some are average values (wet/dry values), & some data is from 1928.
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			113,084	1,182,915-1,207,915	20,786.50	1,316,786-1341,786	

Notes/comments on best estimate

Hughes et al 1994 was very comprehensive and is the most recent study, however some data is rather dated, but is probably the best estimate of wetland area currently available.

Date of best estimate 21-Aug-98

Country name (& Code)		Area (ha) Wetland				
UGANDA UGA		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Ramsar database	none	-	15,000	-	15,000	Date of data extraction August 14th 1998
2 Scott, Omoding et al 1993	012	0	3,590,770	0		There are 45 wetland sites listed., 21 of these have unknown areas. The 45 sites are sites proposed for inventory, and therefore this is not a comprehensive listing of wetlands in UGA. Value provided here is open water lakes.
		0	860,933 - 963,323	0		Value provided here is for fldplain wetlands and swamps (not lakes).
			4,451,703-4,554,093		4,451,703-4,554,093	Total value in summary sheet =open water + wetland area.
3 Hughes and Hughes 1992	001	0	4,874,575	0	4,874,575	O=open water lakes Tp = lacustrine swamps Ts mainly riverine swamps & floodplains
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
Best estimates (ha)		none	4,451,703-4,874,575	?	4,451,703-4,874,575	

Notes/comments on best estimate

The lower value suggested by Scott et al and the higher value suggested by Hughes and Hughes 1992 have been combined to produce a range of values for a best estimate of inland wetlands.

Date of best estimate 21-Aug-98

	Country name (& Code) WESTERN SAHARA ESH		*Area (ha) Wetland*				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Hughes and Hughes 1992	001	?	72,430	0	72,430	Figures are approximate. Tidal marshes are said to occur, but there is no quantification.
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			?	72430	0	72430	

Notes/comments on best estimate

Hughes and Hughes is the only source of information on wetlands in the Western Sahara as yet identified.

Date of best estimate 21-Aug-98

	Country name (& Code) ZAMBIA ZMB		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	0	333,000	0	333,000	Date of data extraction August 14th 1998
2	Hughes amd Hughes 1992	001	-	4,133,028	454,200	4,587,228	Area for manmade includes Lake Kariba (241,200ha). Type Ts inland includes 986,500ha of wetland described as 'swamps & floodplains' & 1,674,100ha of floodplain. Value for P inland is actually a combination of floodplain lakes & floodplain
3	Taylor, Howard, & Begg 1995	025	-	?	?	11,400,000	The total estimate is not sub divided into types, but described as follows: large wetlands including 'shallow open waters' =3,800,000ha. A further 7,600,000ha are dambos
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)				11,733,028	454,200	12,187,228	

Notes/comments on best estimate

It is difficult to make a best estimate where estimates differ so widely. However, it appears that Taylor et al 1995 & Hughes & Hughes are in broad agreement for large wetland areas (3,800,000ha & 4,587,228ha respectively) However Taylor et al provide a further figure of 7,600,000ha for thousands of dambos, suggested by Chidumayo 1992 which increases the area substantially. So, the figures for dambos have been added to the Hughes & Hughes inland estimate to derive a comprehensive value for wetlands. Dambos do not appear to have been assessed by Hughes and Hughes so the best estimate should not be an overestimate/duplication

Date of best estimate 28-Aug-98

	Country name (& Code) ZIMBABWE ZWE		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Hughes and Hughes 1992	118	-	58,500	324,680	383,180	Ts inland = mid Zambezi valley & Mana pools only. R inland = seasonal pans (though noted as difficult to estimate). 6 manmade = Zim's proportion of Lake Kariba.
2	Taylor, Howard & Begg 1995	025	-	?	?	1,280,000	Value given is total areaof wetlands
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			none	1,358,500	324,680	1,683,180	

Notes/comments on best estimate

Taylor, Howard & Begg's figures are based on a survey by Whitlow 1985 who suggested that there are approximately 1.3 m ha of dambos in Zimbabwe, Hughes & Hughes suggest that there are some 58,500 ha of inland natural wetlands (not including dambos) therefore the best estimate for inland is comprised of a combination of these two estimates. It is uncertain whether manmade wetlands were included in Whitlow's assessment of wetlands, but it is assumed they are not. Therefore the manmade estimate from Hughes & Hughes is also incorporated in the total best estimate

Date of best estimate 21-Aug-98

Annex 3 Definitions and Abbreviations

Ramsar Region The Ramsar Bureau has adopted a system whereby countries are assigned to one of the following administrative and reporting regions: Africa, Asia, Eastern Europe, Neotropics, North America, Oceania and Western Europe.

Regional Scale A scale which encompasses all or the vast majority of countries within one Ramsar region.

Supra-regional Scale A scale which is greater than the Regional scale which normally encompasses several countries within any *two or more* Ramsar regions but not covering each and every country within those Ramsar regions.

Sub-regional Scale A scale which is greater than the national scale which normally encompasses several countries within any *one* Ramsar region but not covering each and every country within that Ramsar region.

Wetland Inventory Assessment Sheet

This consists of a series of sheets designed to evaluate and summarise wetland inventory material. These are completed for each and every inventory source which contains useful coverage and attribute data. The details from these sheets are then entered into the GRoWI database. Wetland Inventory Assessment Sheets are not completed for sources which are deemed to be of little use for inventory purposes.

Wetland According to the Ramsar Convention, wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres. In addition, the Ramsar Convention (Article 2.1) provides that wetlands: 'may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands'.

Wetland Inventory For the purposes of this project the definition of 'wetland inventory material' is necessarily broad, and encompasses standard wetland inventories carried out specifically for this purpose, but also includes material, which does not constitute a wetland inventory *per se* (e.g. Hughes et al 1994, A Preliminary Inventory of Tunisian Wetlands). Relevant NGO material, GO material, conference proceedings, workshop material and academic/research material were also considered as wetland inventory material.

eriss	Environmental Research Institute of the Supervising Scientist
GO	Governmental organisation
NGO	Non-governmental organisation
WI-A	Wetlands International–Americas
WI-AEME	Wetlands International–Africa, Europe, Middle East
WI-AP	Wetlands International–Asia Pacific
WIAS	see *Wetland Inventory Assessment Sheet*
GRoWI	Global Review of Wetland Resources and Priorities for Wetland Inventory

Review of wetland inventory information in Asia

D Watkins[1] & F Parish[2]

[1] Wetlands International–Oceania
GPO Box 787, Canberra, ACT, 2601, Australia

[2] Global Environment Network
7A, Jalan 19/29, 46300 Petaling Jaya, Selangor Darul Ehsan, Malaysia

Contents

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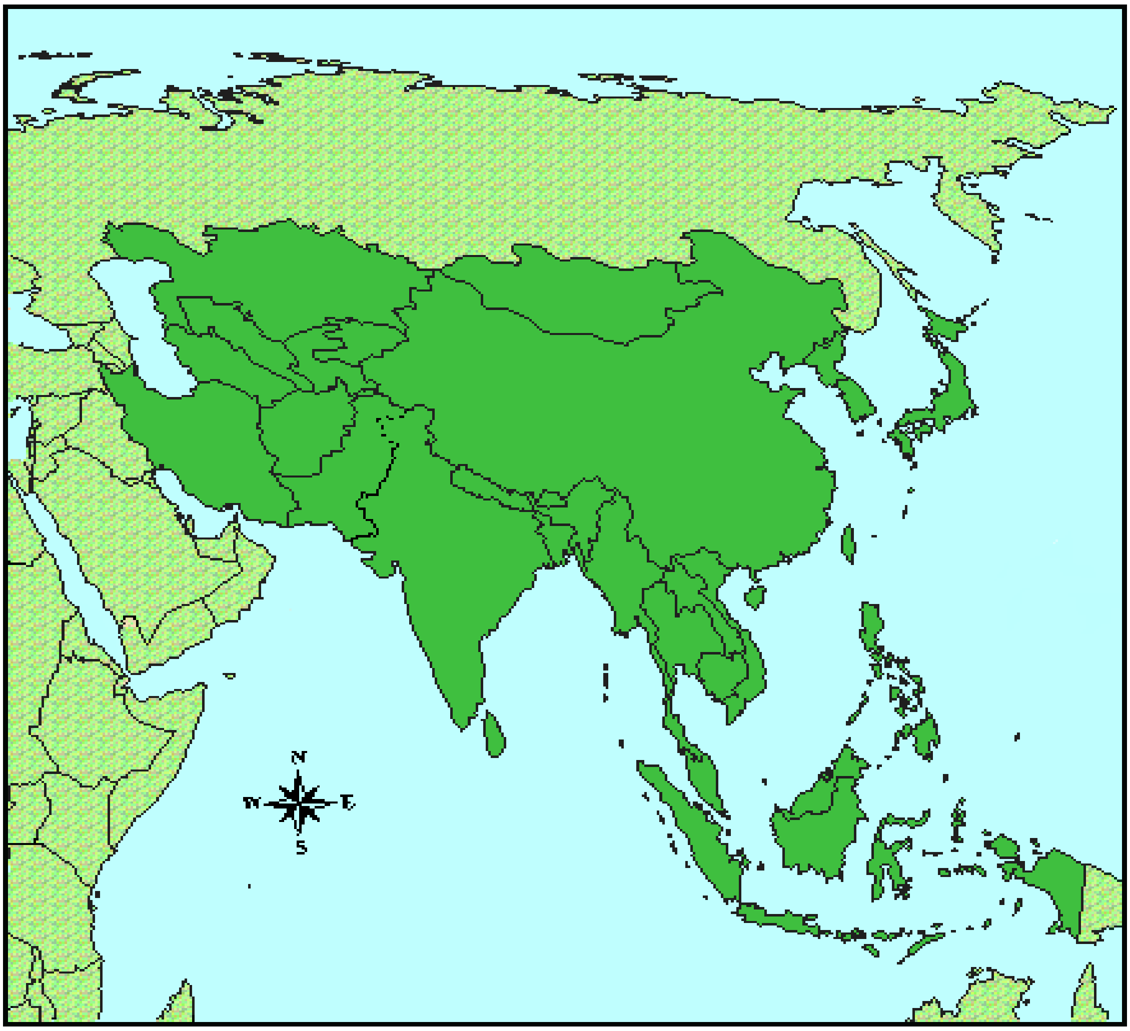
1 Introduction

The objectives of this review were to assess the extent and adequacy of the information given in national and regional inventories of wetlands in the Asia region, especially for their use in assessing the global status of wetland resources. The study was undertaken by Wetlands International–Oceania in association with Global Environment Network. Since the work was a component of the global study described elsewhere in this publication, the overall objectives and background to the study are not given here.

This report analyses the extent and adequacy of the wetland inventory information in the Asia Region, which for the purposes of this report has been defined as stretching from Pakistan in the west to Japan and China in the east and Indonesia in the south. It follows the boundaries of the Asia Region for the Wetlands Convention, except that the countries to the west of Pakistan (Central/West Asia/Middle east) are excluded as they are covered in a separate chapter. Figure 1 is a map showing the boundary of the region.



Boundaries are not authoritative

Figure 1 Map of the Asia region

2 Information sources

2.1 Methods used to obtain wetland inventory information

The objective of this project was to review published inventories of wetlands at the national and supra-national (regional) levels to determine their value as a baseline for studies on the trends of wetland degradation and loss. However, because most of the inventories examined did not give a complete picture on the area of wetlands in the respective countries, some supplementary reference material was also examined.

Five approaches were used to identify wetland inventories and other materials:

- review of materials held by Wetlands International offices in Asia and Oceania
- computerised library search in Australia and Asia
- Internet search
- questionnaires (Annex 1) sent to each Ramsar authority and/or other governmental and non-governmental agencies in each Asian country seeking details on national wetland inventories
- correspondence and other communication with wetland experts in the region.

The analysis presented in this report is based on the available published inventories and the additional information obtained from questionnaires and correspondence. The study focused on material at the national and regional level.

2.2 Summary of information sources reviewed

Wetland inventory information at the national and supra-national scale was found to be very limited. In Asia, 27 inventories were reviewed (table 1). However, because some of the inventories were multi-country reports, a total of 95 country reports were reviewed.

Eighteen replies were received to the questionnaire circulated.

The analysis of information on wetland inventory shows the diversity of materials and approaches that have been used (Annex 3). Key points from the analysis are detailed in table 2. It is notable that most of the inventories were of recent age (less than 10 years old), that a substantial proportion were not in English, and that few were stored in electronic (readily accessible) form.

Table 1 Wetland Inventory reports used in the analysis for the Asia rgion

Title	States included (see Annex 2 for codes)	Date
Supra-national Inventories of Important Sites		
A Directory of Asian Wetlands	BGD, BTN, BRN, MMR, CHN, IND, IDN, JPN, KHM, PRK, KOR, LAO, MYS, MNG, NPL, PAK, PHL, SGP, LKA, THA, VNM	1989
A Status Overview of Asian Wetlands	BGD, BTN, BRN, MMR, CHN, IND, IDN, JPN, KHM, PRK, KOR, LAO, MYS, MNG, NPL, PAK, PHL, SGP, LKA, THA, VNM	1989
A Directory of Wetlands of the Middle East	IRN, AFG	1995
National Inventories of Important Sites		
Wetlands in China	CHN	1990
Indonesian Wetland Inventory	IDN	1986
Indonesian Wetland Inventory – Update 1997	IDN	1997
Malaysian Wetland Directory	MYS	1987
An Inventory of Nepal's Wetlands	NPL	1996
A Directory of Wetland of DPR Korea	PRK	1996
An Inventory of Wetlands of the Lao PDR	LAO	1996
A Directory of Philippines Wetlands: A Preliminary Compilation of Information on Wetlands	PHL	1990
Japanese Wetland Inventory of International Importance, especially as habitat for waterbirds	JPN	1989
Directory of Indian Wetlands	INO	1993
Wetland Ecosystems and its Importance in PR Korea	KOR, PRK	1995
Report on Conservation Measures for Important Areas of Crane in East Asia	PRK	1996
Wetland Type Inventories		
World Mangrove Atlas	BHR, BGD, BRN, MMR, KHM, CHN, IND, IDN, IRN, JPN, MYS, PAK, PHL, SGP, LKA, THA, VNM	1997
Japan Marine Coastal Survey 1980	JPN	1981
Tideland Reclamation in Korea	KOR, PRK	1995
Japan Marine Biotic Environment Survey in the 4 National Survey. Vol. 1. Tidal Flats	JPN	1994
Mudflats in Korea	KOR	1998
Data Book on World Lake Environments – Asia and Oceania	MMR, CHN, IND, IDN, JPN, KHM, MYS, NPL, PHL, THA, VNM	1995
Other Inventories		
Land Use Map of Peninsular Malaysia	MYS	1979/90
Reservoirs of Sri Lanka and their Fisheries	LKA	1988
Inventory of Goose Habitat in Japan	JPN	1994
A Survey of Coastal Wetlands and Shorebirds in South Korea, Spring 1988	KOR	1988
Surveys for large waterbirds in Cambodia March–April 1994	KHM	1995

Table 2 Key attributes of the wetland inventories reviewed

Attribute	Analysis (n = 28)
Inventory type:	73% of the inventories were classified as site directories.
Publication date:	Most of the information has been published since 1990 (70%).
Publication format:	Information has been published by a diversity of organisations, the most common being NGO formal publications (44%).
Language:	59% of the information was in English. Information in other languages included Japanese (4), Korean (3) and Chinese (1). Two publications contained information in three languages.
Publication format:	The most common format of accessed information was paper documents (81%).
Availability of information:	Most of the information reviewed was from published sources (93%).
Data storage:	Most of the inventory information was stored as paper products (74%). Electronic storage accounted for 8%.
Implementation agencies:	Inventory studies had been implemented by inter-governmental organisations (11%), national governments (11%), more than one agency (41%), international NGOs (15%) and academic institutions (15%).
Funding sponsor:	The most common primary funder of inventory information was national government organisations (26%).

3 Extent and adequacy of wetland inventory information

3.1 Objectives

The most important attribute of the inventories is their objective/s. The review showed that inventories could be divided into four different categories based on their primary objective and hence the type and coverage of the data included. The three categories are discussed below (table 3).

Table 3 Summary of the number and types of inventories reviewed

Inventory Type	Number reviewed	Number country records
Important site inventories	16	58
Wetland type inventories	7	33
Other inventories	4	4
Total	**27**	**95**

The first class of inventories included wetlands primarily on the basis of their biodiversity value. These have been termed 'important site inventories'. In Asia, 60% (n=27) of the inventories reviewed were of this nature. The majority of these inventories were compiled to identify or describe wetlands of national and international importance based on the criteria of the Ramsar Convention. These inventories are presented in the form of 'site directories' which contain an account of each wetland site. Important site inventories include only a sample of the wetlands in the country and are biased towards larger less modified wetlands and protected areas.

In Asia, the 'important site inventories' were primarily initiated to contribute to or build on the regional publications *A Directory of Asian Wetlands* (Scott 1989) and *A Directory of*

Wetlands in the Middle East (Scott 1995). Much of this information has also been published as national inventories, eg Democratic People's Republic of Korea (North Korea) (Chong Jong-Ryol et al 1996), Japan (IWRB Japan Committee 1989), Philippines (Davies et al 1990), Indonesia (Silvius et al 1987). Overview documents have also been developed using this inventory information (eg Scott & Poole 1989, Han Sang-hoon 1995).

The second group of seven inventories covering 33 country records focused on a particular wetland ecosystem or habitat type such as mangroves, lakes or tidal flats, and records the total area of the habitat in a particular country or region. Examples include the *World Mangrove Atlas* (Spalding et al 1997) and the *Second National Survey on the Natural Environment: Marine Coastal Survey Report* (Environment Agency of Japan 1981). These inventories have been called 'wetland type inventories'.

Seven 'other' inventory types were reviewed. These were all national in scope and developed in response to a variety of objectives, from a focus on land use (Wong 1975, 1979) to waterbird surveys (Miyabayashi 1994, Mundkur et al 1995), to potential inland fisheries (De Silva 1988). These inventories vary in the wetland types covered (eg mangroves, freshwater lakes, reservoirs, coastal wetlands) and comprehensiveness (important sites for waterbirds, a sample of lakes, wetland protected areas).

3.2 Wetland definitions and classifications

3.2.1 Definition of wetlands

Approximately half of the inventories contained a definition of the wetland resource being inventoried, while in a further quarter of cases it could be inferred. The definitions and classifications used in the inventories varied according to the objectives and the implementing agencies.

The Ramsar Convention on Wetlands defines wetlands as:

> areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres (Ramsar Convention Bureau 1997).

Almost all of the important site inventories use a wetland definition that is compatible with that of the Convention. Some inventories used a qualified Ramsar definition, such as the Directory of Asian Wetlands which excluded coral reefs and other exclusively marine systems (Scott 1989).

3.2.2 Classification of wetlands

Over two thirds of the inventories used a wetland classification system.

The Ramsar Wetland Classification was developed in 1990 (Matthews 1993). In 1996 the Conference of Parties to the Ramsar Convention agreed to modify and extend the Ramsar classification system (Ramsar Convention Bureau 1997; Annex 4). The changes made to the classification systems are shown in Box 1.

While none of the inventories reviewed applied the full Ramsar classification, most used a classification that had complementarity elements. Much of the inventory information draws from the classification system developed for the Directory of Asian Wetlands (Scott 1989). This project pre-dated the development of the Ramsar classification. The classification used by Scott (1989) has 22 classes of which 15 are complementary with the Ramsar classification. There are considerable differences with the classification of six of the wetland types (Box 2).

Box 1 Differences between the 1990 and 1996 Ramsar Wetland Classification Systems

1. 'Riverine Floodplains' (Inland Wetlands – 4) are recognised as a complex of wetland types and described by their component parts (R , Ss, Ts, W, XF, XP).
2. 'Permanent and seasonal, brackish, saline or alkaline lakes, flats and marshes' (Inland Wetlands – 7) are described in terms of seasonality of flooding and physical characteristics (Q, R, Sp, Ss).
3. 'Alpine and tundra wetlands' (Inland Wetlands – 14) are divided into 'alpine' (Va) and 'tundra' (Vt).
4. 'Subterranean karst wetlands' have been added (Zk).
5. 'Irrigated land and irrigation channels: rice fields, canals , ditches' are divided into irrigated lands (including rice fields) (3) and 'canals and drainage channels' (9).

Box 2 Differences in wetland classification between Scott (1989) and the Ramsar Convention Bureau (1997)

1. 'Small offshore islands, islets' are not covered in the Ramsar classification. However, parts of these sites would be described as 'rocky marine shores' and 'sand, shingle or pebble beach' in the Ramsar classification.
2. The 'estuaries and deltas' class only includes 'estuarine waters' under the Ramsar classification.
3. There are major differences in the classification used for 'oxbow lakes, riverine marshes; freshwater lakes and associated marshes (lacustrine); and freshwater ponds (under 8 ha), marshes, swamps (palustrine)'. Under Ramsar these wetlands are classified in terms of 'permanent freshwater lakes (over 8 ha), includes large oxbow lakes'; 'seasonal/intermittent freshwater lakes (over 8 ha)'; 'permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils'; 'seasonal/intermittent freshwater marshes/pools on inorganic soil'.
4. 'Seasonally flooded grasslands, savanna, palm savanna' are described under the Ramsar classification as 'seasonal/intermittent freshwater marshes/pools on inorganic soil, includes sloughs, potholes, seasonally flooded meadows, sedge marshes'; 'shrub-dominated wetlands, shrub swamps, shrub-dominated freshwater marsh, shrub carr, alder thicket; on inorganic soils'; 'freshwater, tree-dominated wetlands, includes freshwater swamp forest, seasonally flooded forest, wooded swamps; on inorganic soils'.
5. 'Flooded arable land, irrigated land' is classified under Ramsar as 'irrigated land; includes irrigation channels and rice fields' and 'seasonally flooded agricultural land'.
6. The Scott (1989) classification did not include 'subterranean karst and cave hydrological systems'.

More elaborate wetland classification systems have been developed in national inventories. For example, the Indonesian Wetland Database classification system divides wetlands into 3297 possible types (Wibowo & Suyatno 1997). This classification system accommodates other systems such as the Ramsar Classification (Ramsar Convention Bureau 1997) and the classification system used for the Directory of Asian Wetlands (Scott 1989).

The Ramsar classification has not been used in the inventories of specific wetland types (eg tidal flats, lakes, mangroves). However, in many cases the classification is comparable. For mangroves there is a recognised problem with the inclusion or exclusion of *Nypa* (Spalding et al 1997). The inclusion of 'tidal freshwater swamp forests' in the Ramsar classification may compromise direct comparison with information from mangrove inventories.

3.3 Geographic scale

The 'geographical scale' of each inventory has been classified into four groups:

- 1 global (covers global extent of wetland type)
- 6 supra-national (more than one country, but not global)
- 19 national (complete country)
- 1 sub-national (only part of the country).

The global inventory included in this analysis was the *World Mangrove Atlas* (Spalding et al 1997) which included reviews of the areal extent of mangroves in all countries in the region, (except the Maldives). Some other global information sources were referred to, such as *Reefs at Risk* (World Resources Institute 1998) and Web based information sources from the World Conservation Monitoring Centre (World Conservation Monitoring Centre 1998). However, none of these provided precise information on status at the national level in a comprehensive manner.

The regional inventories were primarily inventories of important wetlands which included individual country reports of important sites (according to Ramsar related criteria). Scott (1989) and (1995) are the best examples of a systematic approach to such regional inventories. The national reports covered either inventories of important wetlands according to Ramsar or other related criteria, or inventories of the areal extent of specific habitat types, such as mangroves or coastal mudflats.

3.4 Inventory methods

The methods for undertaking the inventories were significantly different according to the objectives of the inventory.

3.4.1 Important site inventories

The compilation of *A Directory of Asian Wetlands* (Scott 1989) involved the collection of data through four main channels:

- establishment of 'wetland working groups' or 'wetland committees' in almost every country to coordinate the preparation of inventories at the national level (in some cases a researcher was employed for several months to compile the data)
- establishment of national networks of contacts, each with a 'national coordinator' who was responsible for the compilation of data in his/her country
- direct contact with individuals or institutions with expertise on particular sites or species
- a review of recent literature.

Emphasis was placed on obtaining recent information from individuals who were at the time working on wetlands in the respective country and little attention was given to older literature. In a few countries (Mongolia, Cambodia and Bhutan) it was not possible to set up working groups or identify a coordinator. In these cases the information was based on the literature and expatriate experts' knowledge of the respective country.

The various national inventories of important wetlands were mostly expanded versions of the country section in the regional inventory. In most cases the initial report was circulated as it was (or in translated form) to a broad range of national contacts with a request for updated information on existing sites or new sites for inclusion in a national inventory.

Following the completion of the Directory of Asian Wetlands a number of countries translated their country report and sought additional comment from national experts. In China the translated text was circulated to about 80 Chinese organisations and experts, of which over 50 sent new information. Another major source for updating was information in over 220 papers and books published in China over the preceding five years together with unpublished information from several major conferences. The resulting publication (Lu 1990) contained more than twice the information in the Directory of Asian Wetlands and added 19 extra sites.

In other expanded national inventories extra fieldwork was undertaken to check or supplement the initial work (eg Indonesia and Philippines).

3.4.2 Wetland type inventories

Mangrove and tidal flats inventories made extensive use of Landsat and other satellite imagery.

The *World Mangrove Atlas* (Spalding et al 1997) project developed a GIS of the extent of mangroves from data obtained at the national level. The original sources of data included satellite imagery, aerial photography, topographic and other maps.

By contrast, the information in the *Data Book on World Lake Environments – Asia and Oceania* (Kira 1995) and the *Inventory of goose habitat in Japan* (Miyabayashi 1994) were generated from collation of information and fieldwork at each site.

3.4.3 Other inventories

Methodology varied according to the objectives – for example land-use inventories used similar methods to the wetland type inventories but gathered information on all land uses rather than the extent of a particular wetland type.

3.5 Extent and adequacy according to inventory types (objectives)

3.5.1 Overview

Wetland inventory information was reviewed covering 23 of the 29 countries in the Asian Region (as defined for this review). In some cases original inventory information has been published in several forms. For example the Philippines inventory information developed for the *Directory of Asian Wetlands* has been published in three forms: the regional directory (Scott 1989), an expanded national report (Davies et al 1990) and reviewed in the regional status overview (Scott & Poole 1989). This needs to be taken into account when considering the number of 'inventory records' for each country.

Overviews of national wetland inventory were identified for India (Gopal & Sah 1995) and China (Lu 1995).

No national or supra-national inventories were identified that assessed the total area of all wetlands within the geographic extent of the inventory. As such the inventory data reflects only a sample of the extent and number of wetlands within each country.

The lack of comprehensive coverage within the geographic scope of inventories was primarily because the inventories had other foci, such as wetlands of high or special biodiversity value (56%), special habitat (11%), or more than one basis (11%).

A profile of the wetland inventory information reviewed according to main objectives (type) of the inventory is shown in table 4. In the case of supra-national and global inventories the inventory type is recorded against each country in the inventory.

Table 4 Summary of wetland inventory information reviewed for the Asian region

Country	Number of inventory records	Inventory type		
		Important wetlands	Wetland type	Other
Afghanistan	1	1		
Bangladesh	3	2	1	
Bhutan	2	2		
Brunei	3	2	1	
Cambodia	5	2	2	1
China	2	4	2	
India	5	3	2	
Indonesia	6	4	2	
Iran	2	1	1	
Japan	8	3	4	1
Kazakstan	0			
Kyrgyzstan	0			
Laos	3	3		
Malaysia	6	3	2	1
Maldives	0			
Mongolia	2	2		
Myanmar	4	2	2	
Nepal	4	3	1	
North Korea	4	3	1	
Pakistan	3	2	1	
Philippines	5	3	2	
Singapore	3	2	1	
Republic of Korea (South Korea)	8	5	2	1
Sri Lanka	4	2	1	1
Tajikistan	0			
Thailand	4	2	2	
Turkmenistan	0			
Uzbekistan	0			
Vietnam	4	2	2	
Total	**95**	**58**	**32**	**4**

3.5.2 Important wetland site inventory

The most common type of inventory in the region is the inventory of important wetlands according to the criteria of the Ramsar Convention. A total of 58 country reports are included in the various documents of this type in the region. The number of important wetland sites identified in the countries of Asia, according to evaluations at different levels, are shown in table 7.

The major inadequacy of these inventories is the lack of detail on the boundaries and extent of each wetland type within the sites. This means that it is not possible to derive data on the extent of wetland types. It will also not be possible to conduct an update of the inventory to assess changes in the extent and distribution of wetland types at each site.

3.5.3 'Wetland type' inventory

For discussion purposes these inventories have been divided into studies of the area of natural and human-made wetlands.

Natural wetlands

Information on the extent of wetlands has been generated in 'wetland type' specific studies. This information generally relates to wetlands of direct economic value such as mangroves, swamp forests, coastal wetlands and artificial wetlands. Table 5 gives details on the status of wetland type inventories for selected habitats.

'Human-made' wetlands

Detailed information is available on 'human-made' wetlands. However, much of this information has not been reviewed during the study as the study has focused on national level inventories of natural wetlands. In addition the information on human-made sites is generally found in different formats from a wide variety of agencies.

Potential sources of information are listed below:

- Aquaculture (eg fish/shrimp) ponds – national and sub-national data held by government agencies involved in agriculture and fisheries and international governmental organisations such as the Food and Agriculture Organisation (FAO) and World Bank.
- Ponds; includes farm ponds, stock ponds, small tanks; (generally below 8 ha) – national and sub-national data held by government agencies involved in agriculture and fisheries.
- Irrigated land; includes irrigation channels and rice fields – national and sub-national data held by government agencies involved in agriculture and water resources and international governmental organisations such as FAO and World Bank. Summary information is published by FAO on the area of rice field harvested (as shown in table 9).
- Seasonally flooded agricultural land – national and sub-national data held by government agencies involved in agriculture and international governmental organisations such as FAO and World Bank.
- Salt exploitation sites; salt pans, salines, etc – national and sub-national data held by government agencies involved in agriculture.
- Water storage areas; reservoirs/barrages/dams/impoundments (generally over 8 ha) – national and sub-national data held by government agencies involved in water resources.
- Excavations; gravel/brick/clay pits, borrow pits, mining pools – limited information.
- Wastewater treatment areas; sewage farms, settling ponds, oxidation basins, etc – national and sub-national data held by government agencies involved in water resources.
- Canals and drainage channels, ditches – national and sub-national data held by government agencies involved in water resources.

Table 5 Status of inventories on specific wetland types in the countries of the Asian region

Country	Mangrove*	Coral**	Intertidal flats+	Lakes#	Peatland
Bangladesh	C	C			NA
Bhutan	NA	NA	NA		
Brunei	C	C		C	
Cambodia	C	C			
China	C	C	C	C	C
India	C	C		C	
Indonesia	C	P			C
Iran	C	C			NA
Japan	C	C	C	C	C
Laos	NA	NA	NA	C	NA
Malaysia	C	C		C	C
Maldives	C	C		NA	NA
Mongolia	NA	NA	NA		
Myanmar	C	C			NA
Nepal	NA	NA	NA		
North Korea	NA	NA	C		
Pakistan	C	C			NA
Philippines	C	C			
Singapore	C	C			NA
South Korea	NA	NA	C		NA
Sri Lanka	C	C			NA
Thailand	C	C			
Vietnam	C	C			

Key

C – Complete, P – In Progress, N – None, Blank – Unknown, NA – wetland type is not in the country

* indicates that mangrove area information is included in Spalding et al (1997)

** indicates that information is included in UNEP-IUCN Reports on status of the world's Coral Reefs (Wells et al 1988)

+ indicates that specific references were reviewed giving the total area of intertidal flats in the country.

# indicates that lakes over a certain size class have been identified in national inventories or that the (few) lakes in the country are included in the directory of important sites

3.5.4 Other inventories

The other inventories reviewed were of a range of different types. Those most useful for determining wetland areas were land use inventories which have been used to generate information on the areas of wetlands in several countries. Estimates tend not to be precise because of the problems of wetland definition and the scale of these studies. Examples of the wetland definition problems are that freshwater or shrub swamp may be classified as wetland, but freshwater swamp forest may be classified as forest. Boundary delineation also tends to be problematic in areas such as river floodplains or ephemeral wetlands.

Land use inventories have been used to generate information on wetland areas in Peninsular Malaysia (Wong 1975, 1979; Malaysian Wetland Working Group 1987) and China (Lu 1995). The advantage of using such data is that it is periodically updated and this enables trends in change in wetland area to be calculated. In Malaysia inventories have been repeated at intervals of 8–10 years although there has normally been a lag of 3–4 years before publication.

3.6 Extent and adequacy of updating activities

Based on the inventory material and other information from questionnaires and consultations, an assessment has been made on the extent and adequacy of the various activities to update the inventories. Three types of action in this area have been recorded in the region:

- enhancing data on particular wetland sites by including results of recent surveys or studies
- identifying additional wetland sites to include in the directories of important sites
- making a formal comparison between the status of the wetland site at the time of the previous study and the status at the time of the more recent study.

While all three of these actions could be called updating, only the last category of action could be used to generate trend information.

3.6.1 Important site inventories

Table 6 gives the status of updating of directories of important wetlands in parts of the Asian region between 1988 and at the present time.

Table 6 Status of 'Important Wetland Site' Inventories for the Asian region

Country	**Status of inventory ***		**Comments on recent activities ****
	1988	1998	
Bangladesh	Poor	Partial	Surveys of coast and NE region
Bhutan	Nil	Partial	Some surveys
Brunei	Partial	Partial	Additional surveys of peatlands
Cambodia	Nil	Partial	Large scale program underway
China	Poor	Fair	Expanded directory published in 1990
India	Partial	Fair	Expanded directory published in 1993
Indonesia	Partial	Good	Regularly updated database
Japan	Good	Good	
Laos	Nil	Good	National inventory published in 1996
Malaysia	Partial	Fair	New survey data, directory not yet updated
Mongolia	Nil	Poor	Surveys of some areas undertaken
Myanmar	Nil	Nil	
Nepal	Partial	Good	National inventory published in 1996
North Korea	Nil	Fair	National inventory published in 1996
Pakistan	Good	Fair	Little change
Philippines	Partial	Fair	National inventory published in 1990
Singapore	Good	Good	Additional information on some sites
South Korea	Partial	Fair	Additional data on some sites
Sri Lanka	Good	Good	Many extra surveys
Thailand	Good	Good	New inventory published in 1998
Vietnam	Partial	Partial	Some progress

Key
Poor little recent inventory data
Partial fair or good data from some regions and little data from others
Fair better data from most parts of the country
Good good data from all parts of the country

Note
* Comments on the status of wetland inventory are from Scott & Poole (1989)
** Comments based on current review

In almost all of the cases, the additional work undertaken has been to enhance the quality and quantity of the data on the sites identified, or to add additional sites to the directories. It is understood that in most cases, the updating did not yield significant information on the environmental trends as the initial inventories did not include sufficient quantitative data on key site characteristics to permit a clear measurement of the trends. In some instances qualitative information was gathered on the change in the environmental quality or conservation status of the sites. However, now that more complete inventories of important sites have been prepared, it will be easier to assess in the next 5–10 years the ongoing trends of the site status.

3.6.2 Wetland type inventories

The most complete assessment of a wetland type is the mangrove atlas project (Spalding et al 1997). This inventory has been designed to create a baseline against which future changes in status can be measured. Spalding et al (1997) point out that because of inconsistent data collection techniques used in previous studies, most of the earlier estimates of mangrove area cannot be used as an effective baseline with which to monitor changes. However, a few countries were identified (eg Thailand) where time series at a national or sub-national level had been obtained which demonstrated the change in mangrove area, but that these could not be expanded or extrapolated to the overall or regional resource.

3.6.3 Other inventories

The only category of inventory which has been able to generate clear information on trend in aerial extent of wetlands has been the land-use inventories such as that for Malaysia, which has been repeated at about ten year intervals using the same classification system and has permitted statistics of trend in wetland loss to be prepared (Wong 1975, 1979; Malaysian Wetland Working Group 1986).

4 Use of inventory information to assess the status of wetlands

4.1 Extent and distribution

The provision of information on the extent and distribution of wetlands varies considerably according to the objectives of the inventories.

4.1.1 Important wetland sites

Inventories of important wetland sites can only yield information on the number and area of the identified important sites in a particular country. The number and extent will vary considerably according to the specific criteria used for the selection of sites and the resources available for the survey. Most inventories of important wetlands model their criteria on those of the Ramsar Convention. The number and areas of important wetlands tend to be listed at three levels – national, international and those listed under the Ramsar Convention (table 7).

As can be seen from table 7 the area of important wetlands varies considerably between the different levels of inventory and selection criteria. The area and number of wetlands tend to decrease as the level of importance increases from national importance to Ramsar listed wetlands (see Indonesia in table 7). This demonstrates the inappropriateness of using the area of important wetlands as an estimate of the total area of wetlands in a country.

In the case of North Korea some wetlands covered in the international inventory by Scott (1989) are not included in the national inventory by Chong Jong-Ryol et al (1996).

Table 7 Area and number of sites included in inventories of important wetlands in the Asian region

Country	National*		International**		Ramsar Sites***	
	Number	Area(ha)	Number	Area(ha)	Number	Area(ha)
Bangladesh			12	6 770 000	1	596 000
Bhutan			5	8 500		
Brunei			3	138 000		
Cambodia			4	3 650 000		
China	217	18 385 000	198	16 320 300	7	588 380
India	170		93	5 470 000	6	192 973
Indonesia	256	21 752 000	137	8 780 000	2	242 700
Japan			85	475 000	10	83 530
Laos	30	434 275	4	222 000		
Malaysia	116	6 942 556	37	3 120 000	1	38 446
Mongolia			30	1 550 000	4	264 220
Myanmar			18	5 490 000		
Nepal			17	35 600	1	17 500
North Korea	34	265 465	15	322 000		
Pakistan			48	858 000	8	61 706
Philippines	148	1 401 643	63	1 290 346	1	5 800
Singapore			7	220		
South Korea			21	107 000	2	960
Sri Lanka			41	274 000	1	6 210
Thailand			42	2 510 000	1	494
Vietnam			25	5 810 000	1	12 000

* Data from national inventories of important sites
** Data from Scott & Poole (1989) (area in the Philippines recalculated)
*** Data from list of Wetlands of International Importance designated under the Ramsar Convention (@ 10/98)

4.1.2 Wetland type specific

Mangroves

Mangroves are one of the most comprehensively inventoried wetland types in the Asia region according to Spalding et al (1997). This publication resulted from a global project to inventory mangrove resources on a country by country basis. Data were obtained from a wide variety of sources and entered into a GIS system at the World Conservation Monitoring Centre. Previous national estimates of the extent of mangroves are also reviewed in the publication along with details on loss of mangroves at selected sites.

'Mangroves' are defined on the basis of occurrence of plant species. Spalding et al (1997) recognise that the list of plants included under the term mangroves varies, but suggested the use of a list of 70 species (Duke 1992).

Mangroves are one of the few wetland types that have a plant-specific definition as opposed to a geomorphological or hydrological definition. Remote sensing methods can be readily used to survey the extent of mangroves as the stands tend to be clearly defined by their canopy cover. However, there is some difficulty in interpretation in arid regions where the density of mangroves may be low, and also in other areas where the mangrove is contiguous with dry land or freshwater swamp forest.

Table 8 presents the 'best estimates' of the area of mangroves in the countries of the Asia region (from Spalding et al 1997). While this project did develop new estimates for 15 of the 16 countries, Spalding et al (1997) considered that other studies had produced a better estimate of the extent of mangroves for nine of the countries. They considered that the maps that they have prepared as part of the study provide an effective baseline for the future assessments of the resource and can be used as a baseline to determine trends.

Table 8 Best estimates of mangrove extent for the Asian region (from Spalding et al 1997)

Country	Best estimate (ha)	Reference
Bangladesh	576 700	Spalding et al (1997)
Brunei	17 100	Spalding et al (1997)
Cambodia	85 100	Mekong Secretariat (1994)
China	36 880	Spalding et al (1997)
India	670 000	WWF India pers com to Spalding et al (1997)
Indonesia	4 255 000	Soemodihardjo et al (1993)
Japan	750	Spalding et al (1997)
Malaysia	642 400	Spalding et al (1997)
Myanmar	378 600	Htay 1994
Pakistan	168 300	Spalding et al (1997)
Philippines	160 700	Spalding et al (1997)
Singapore	600	Chou (1990)
Sri Lanka	8900	Spalding et al (1997)
Thailand	264 100	Spalding et al (1997)
Vietnam	252 500	Hong & San (1993)
Total	**7 517 630**	

Note: The identification of other sources as giving the best estimate of mangrove area is made by Spalding et al (1997)

Freshwater swamp forest and forested peatlands

Data on the extent of forests are available for selected countries in South East Asia and include information on peat swamp forests, primarily from forestry inventories prepared by forest management agencies. However, estimates of the coverage of peat forest vary considerably because of differences in definition. In Sumatra, Kalimantan and Irian Jaya (Indonesia) estimates vary between 16.5 million ha and 27 million ha (Silvius et al 1987).

The extent of peat swamps in tropical Asia have been reviewed by Rieley et al (1996) and the estimates are shown in table 9. The authors note that there are great variations in estimates for extent of peatlands mainly because estimates of extent in large countries have been made from aerial photographs and, more recently, satellite imagery. With these methods it is impossible to accurately determine the boundaries between peat and adjacent waterlogged mineral soils, since both support forests of similar structure and vegetation composition.

Table 9 Estimates of the extent of peat swamps (from Rieley et al 1996)

Country	Area (ha)
Bangladesh	60 000
Brunei	10 000
China	1 000 000–3 000 000
India	32 000
Indonesia	17 000 000–27 000 000
Malaysia	2 250 000–2 730 000
Philippines	104 000–240 000
Sri Lanka	3 000
Thailand	68 000
Vietnam	183 000

Lakes

A ‘Global Lake and Catchment Conservation Database’ is being developed as a World Wide Web site by Mullard Space Science Laboratory (MSSL) and the World Conservation Monitoring Centre (WCMC) (MSSL et al 1998, WCMC 1998). The database will contain information on large lakes (greater than 100 km^2 in area) and it aims to support the monitoring and management of both inland water resources and biological resources. The site will contain information for the MSSL Global Lakes Database, the MSSL Remote Sensing Lakes Database and the WCMC lake conservation databases.

Tidalflats and shallow marine areas

In Japan and the Republic of Korea (South Korea) detailed studies have been conducted to quantify the area of mudflats and shallow coastal waters.

In Japan the objective has been to monitor the extent and condition of tidal flats, submerged macrophyte beds and coral reefs (Environment Agency of Japan 1994). The report concludes that in 1991 there was 51 443 ha of tidal flats and 194 030 ha of submerged macrophyte beds.

In South Korea data on the area of tidal flats has been collected by the Rural Development Corporation (1995) and the Ministry of Maritime Affairs and Fisheries (1998). An analysis of Landsat imagery has concluded that the area of mudflat in 1998 on the west and south coast was 239 300 ha.

Coral reefs

An atlas of the coral reefs of the world has been compiled by UNEP/IUCN and describes the extent and quality of coral reef in the different countries of the region (eg the area of coral reefs in the Philippines is estimated to be 2 700 000 ha) (Wells et al 1988). However, total areas are not given for all countries and it is believed that differing methods have been used to estimate areas. Examples are variations in the extent to which the areas of enclosed lagoons are included, and the depth of marine water in which the reef is measured.

Rice field

Detailed information on the extent of harvested rice field in each country is collated by the Food and Agriculture Organisation on an ongoing basis (table 10).

Table 10 Harvest area of rice field in Asia (data from FAOSTAT 1998)

Country	1988	1997	1998
Afghanistan	180 000	180 000	180 000
Bangladesh	10 224 230	10 177 400	10 200 000
Bhutan	26 030	30 000	30 000
Brunei	890	450	450
Cambodia	1 735 000	1 928 689	1 928 689
China	32 458 540	31 347 800	31 847 800
India	41 735 810	42 200 000	42 500 000
Indonesia	10 138 160	11 071 900	11 200 000
Iran	467 233	604 300	605 000
Japan	2 110 000	1 953 000	1 953 000
Kazakstan		85 200	80 000
Kyrgyzstan		5 000	5 000
Laos	524 828	572 000	572 000
Malaysia	671 755	655 000	645 000
Myanmar	4 527 300	5 768 380	5 600 000
Nepal	1 450 470	1 511 230	1 511 230
North Korea	700 000	611 000	700 000
Pakistan	2 041 700	2 315 900	2 330 000
Philippines	3 392 670	3 842 270	3 514 000
South Korea	1 260 129	1 045 000	1 045 000
Sri Lanka	815 561	660 079	660 079
Tajikistan		12 000	12 000
Thailand	9 905 932	9 932 160	9 210 000
Turkmenistan		38 000	38 000
Uzbekistan		174 000	150 000
Vietnam	5 726 380	7 091 200	7 091 200
Total	**130 092 618**	**133 811 958**	**133 608 448**

4.1.3 Other inventories

Wong (1975, 1979) gives information on the area of freshwater wetlands and mangroves (combined) in Peninsular Malaysia in 1966 and 1974 from land use inventories and hence the change in area between these times. These surveys have been repeated from 1981–89 to enable the trends to be updated. This is one of the few examples in the region of a 'complete' inventory which has created a baseline to enable future monitoring of trends.

The country accounts in *A Directory of Asian Wetlands* present information relating to the status of wetlands in the introduction under the heading of 'Summary of Wetlands Situation' (Scott 1989). The content of this section varies. Details are given on the extent of some wetland types for the following countries: Japan, South Korea, China, Pakistan, India, Nepal, Bangladesh, Sri Lanka, Myanmar, Cambodia, Philippines and Indonesia. Much of this information has been obtained from land use inventories or by calculating the total of wetland type inventories. However, several of the reports note significant variations between various estimates of total wetland area, for example, the area of wetlands in India has been estimated as being between 4 and 18 million ha (De Roy & Hussain 1993) with the variation linked primarily to definition.

Regional conferences on wetlands in recent years have also provided information on the status of wetlands at the national and sub-national level (listed below).

Bangladesh	Katebi (1993)	Mangrove wetlands and forest management; discussion on the values, importance and management.
	Hussain (1993)	Management of Sundarbans forest; management.
	Rashid (1993)	Details on extent (no details on derivation), general comments on status.
	Wallace (1993)	Seasonal floodplains, lakes and marshes; details on extent (no details on derivation), economic values, comments on management.
China	Yan (1993)	Some data on extend no details on derivation.
India	Trisal (1993)	Details on extent, comments on threats.
	Gole (1993)	'Human-made' wetlands; detail on extent, management and management problems.
Indonesia	Silvius & Syarifudin (1992)	Details on extent (no details on derivation), general comments on status.
Malaysia	Malaysian Wetlands Working Group (1986)	Details on the extent and status.
	Burhanuddin (1993)	Riverine wetlands and rice fields in Peninsular Malaysia; used extent data from Malaysian Wetland Working Group 1986. Economic value of rice and fish production. Other values. Management problems.
Nepal	Bhandary (1993)	Some information of extent of wetlands, no information on wetlands loss or condition.
Pakistan	Shirazi (1993)	General comments on wetlands and threats, no data on extent.
Philippines	Molinyawe (1992)	General comments on threats.
South Korea	Seo (1992)	Comment on reclamation.
Thailand	Tunhikorn (1992)	General comments on threats.

4.2 Wetland benefits and values

The wetland inventories examined included very few overall quantitative estimates of wetland benefits or values of the wetlands described. A notable exception is the 'Inventory of Wetlands of the Lao P.D.R.' which contains a comprehensive qualitative listing for each site (Claridge 1996). Directories for important sites did include categories for description of land-use, economic and social values, important fauna, and special floral values.

In most cases the entries are qualitative rather than quantitative, except in the case of numbers of waterbirds or endangered species. Occasionally data on levels of fishery yields are included. It is therefore not possible to make any overall assessment of the values of the wetlands or to extrapolate to their importance within a country. The only analysis possible would be to summarise the number of sites of importance for different benefits, but as the data sheets vary in the level of information on values, this may not yield meaningful outcomes.

It is more likely that inventories of human made wetlands, such as rice fields or reservoirs, will contain quantitative information on direct values, but this will also depend on the nature of the inventory. For example, inventories of rice fields may only record species of rice grown and yields. They are unlikely to record fish or waterbird species present.

4.3 Land tenure and management structure

Information on land tenure and management was recorded only in important site inventories. However, details included on the management structure are normally very brief and focused on conservation and research management/facilities. One item of information from these inventories which can be extracted and analysed is the degree of protection. The proportion of the area of wetlands included in the Directory of Asian Wetlands which were partially or totally protected in 1988 are shown in table 11.

Table 11 Protection status of sites listed in the Directory of Asian Wetlands (Scott & Poole 1989)

Country	Number	Area (ha)	Totally protected (%)	Partially protected (%)
Bangladesh	12	6 770 000	9	<1
Bhutan	5	8 500	77	6
Brunei	3	138 000	11	11
Cambodia	4	3 650 000	<1	<1
China	207	16 320 100	13	12
India	93	5 470 000	30	28
Indonesia	137	8 780 000	35	33
Japan	85	475 000	41	16
Laos	4	222 000	0	0
Malaysia	37	3 120 000	53	<1
Mongolia	30	1 550 000	<1	0
Myanmar	18	5 490 000	<1	<1
Nepal	17	35 600	77	73
North Korea	15	322 000	4	4
Pakistan	48	858 000	61	16
Philippines	63	1 410 000	7	5
Singapore	7	220	43	7
South Korea	21	107 000	12	5
Sri Lanka	41	274 000	30	28
Thailand	42	2 510 000	8	2
Vietnam	25	5 810 000	1	<1
Total	**914**	**63 320 420**	**25**	**12**

4.4 Rate and extent of wetland loss and degradation

Very few of the inventories were designed to assess changes in the extent and condition of the wetland resource. Notable exceptions were inventories of tidal flats and rice paddies.

In Japan in the 13 year period between 1978 and 1991 the area of tidal flats decreased by 7.0% and the area of macrophyte beds by 3.3% (Environment Agency of Japan 1994). In South Korea during the period 1987 to 1998 the tidalflat area decreased by 15% (Ministry of Maritime Affairs and Fisheries 1998).

Detailed data is maintained on agricultural crops such as rice paddies. The FAO compilations in table 10 show that in the past ten years the total area of rice field in Asia has remained relatively constant (2% increase). However, at the national level there have been considerable changes with increases of over 1 000 000 ha in Indonesia, Myanmar and Vietnam. In China and Thailand the area has decreased by more than 500 000 ha (FAOSTAT 1998).

Land use mapping in Peninsular Malaysia has also yielded broad scale information on changes in the area of swampland. Between 1966 and 1974 the area decreased by 9.2% to 1 067 977 ha (Wong 1979).

Qualitative information on threats to wetland sites given in the inventories of important sites can be used to identify the major pressures on wetlands at the national level.

The *Status Overview of Asian Wetlands* (Scott & Poole 1989) provides quantitative data on the level of protection and threats to wetlands in the region, based on information from the *Directory of Asian Wetlands*. Scott and Poole (1989) estimated that the *Directory of Asian Wetlands* covers approximately half of the total wetland habitat in the region, however no justification is given for this statement. The analysis was based on information contained in the Directory, rather than it having been systematically collected for this purpose. The analysis does identify the main reported threats and identifies key differences between sub-regions in relation to the dominant threats. Since the data are not quantitative it is not possible to easily determine any trends.

During the examination of other literature, some case studies of particular sites or habitat types were identified which did document the changes in area of wetlands over time (eg. studies in Thailand on the decrease in mangrove area from 1960–1999 based on remote sensing). However, these studies were generally not part of the national wetland inventory process.

A recent study to identify the threat category for a wetland type is the *Reefs at Risk* project of the World Resources Institute (WRI), the International Centre for Living Aquatic Resources Management and the World Conservation Monitoring Centre (WRI 1998, WCMC 1998). This project has mapped reefs on a 4 km grid and overlain that with a series of distance based threat zones or surfaces. As a result of this analysis it has been determined that over 80% of the reefs in South East Asia (representing 25% of the global resource) are at risk.

5 Discussion and conclusions

5.1 Adequacy of information base

No wetland inventories were identified in the Asian region that fully assess the extent of wetland resources at the national or supra-national scale.

Inventories of wetlands were found to have been undertaken for a range of other objectives that included identifying wetlands of national or international importance, determining the extent of particular wetland types such as mangroves or tidal flats, mapping wetlands as a component of land-use assessment, and identifying waterbird or fish habitat.

As such, the existing information base cannot be used to develop ‘best estimates’ of the wetland resource. However, some inventories were identified that provide valuable information on selected wetland types (mangroves across the region, and tidal flats in some countries). The reasons for these conclusions are discussed under each inventory type.

5.1.1 Important site inventories

All countries in the region, except for the Maldives and the independent states of the former USSR, have country sections included in published regional inventories of wetlands of international importance (Scott 1989, 1995). More than half of the countries have produced, or are producing, inventories of wetlands of national importance. As there are no comprehensive (ie documenting the entire area of all wetland types) national or supra-national inventories of the wetland resource it is not possible to objectively assess the comprehensiveness of these inventories.

The work of the Ramsar Bureau and Wetlands International in promoting wetland inventory (of important sites) has been very successful in that more than half of the readily available inventory information has been generated to identify important wetlands.

A number of countries in the Asian region have recently produced new or updated national inventories (Thailand, North Korea, Nepal, South Korea) or are currently conducting fieldwork for national wetland inventories (China, Vietnam, Cambodia and India).

Information in the Directory of Asian Wetlands is generally more than 15 years old. In view of the value of the Directory in promoting recognition of important sites, and the rapid changes occurring to wetlands in the Region, there is value in regularly updating the publication.

A major limitation of the 'important site inventories' is that they only cover a portion of the national wetland resources. They are also biased towards the larger wetlands and those that have a protected status. As such, this group of sites is not likely to reflect the real trends in the loss of wetland extent.

A second major limitation of the 'important site inventories' is that areal information is not presented on a site basis and not by wetland type. The site also may include non-wetland areas. Therefore it is not possible to develop summaries of the extent of wetland types.

Wetland site inventories generally include qualitative information on (certain) values and benefits of each wetland site and also information on land tenure and principal threats. Although this information cannot be used to determine quantitative trends in such matters, it can be analysed to produce certain indices (ie. protection or threat level) which can be updated to show trends.

5.1.2 Wetland type inventories

The only comprehensive regional inventory of natural wetland types in Asia is for mangroves. This is attributable to the ability to readily identify mangrove stands from aerial/satellite imagery, interest in harvesting of mangrove timber, and the focus of a number of international programs on this ecosystem over the past 20 years.

An economic interest in timber harvesting from freshwater and peat forests has contributed to the development of inventory material of these types of wetlands. However, estimates of the extent of swamp forest vary by up to an order of magnitude because of differing definitions and the difficulty of interpretation of remotely sensed data.

Comprehensive inventories have been developed for tidal flats in Japan and South Korea.

Global inventories have been prepared of coral reefs (WCMC 1998) and lakes (larger than 10 000 ha) (eg MSSL et al 1998) but generally do not have detailed information required for management or determining trends.

Geographic data are available for many countries on characteristics of wetlands (such as length of rivers and coastlines, number of lakes) but these are of limited value in quantifying wetland extent.

Wetland type inventories appear to provide the most suitable basis for accurately monitoring the changes in areal extent of wetlands. Constraints still exist due to difficulties of resolution and interpretation of remote sensing imagery. Such monitoring is best for distinctive habitats such as mangroves or lakes and is less useful for habitats such as mudflats, seagrass beds or freshwater swamp forests which are hard to distinguish from adjacent habitat types.

5.1.3 Other inventories

Land use inventories may also generate time series information on changes in the extent of wetlands. However these inventories exist for only a few countries and the large scale and broad classification of wetlands limit their usefulness. Land use inventories also do not normally include information on the benefits, management or quality of the wetlands.

The various other inventories examined are generally of limited value for determining the extent and status of wetlands in the region as they have been prepared for widely differing objectives.

5.1.4 Summary of wetland extent information

There is insufficient information to estimate the areal extent of the wetland resources in Asia. Information is available for selected wetland types as discussed above. Extent information is also available on samples of wetlands of high biodiversity value for most countries. A summary of wetland extent information is given in table 12.

Table 12 Summary of wetland extent information

Inventory	Area (ha)	Key reference	Comments
Mangrove	7 517 630	Spalding et al (1997)	‘best estimate’
Peat swamps	20 710 000	Rieley et al (1996)	minimum estimate
Tidalflats	290 743	Environment Agency of Japan (1994), Ministry of Maritime Affairs and Fisheries (1998)	‘best estimate’ for Japan and west and south coasts of South Korea
Submerged macrophyte beds	194 030	Environment Agency of Japan (1994)	‘best estimate’ for Japan
Rice fields	133 608 448	FAOSTAT (1998)	area harvested
National wetland inventories	49 180 939	see table 7	inventories produced for only a small number (6) of countries; these include only a sample of wetlands; sample is biased towards wetlands of high biodiversity value; the area may include non-wetland habitat; inventories may overlap with ‘wetland type’ inventories
International wetland inventories	63 200 966	see table 7	include a smaller sample of wetlands than the national inventories; sample is biased towards wetlands of high biodiversity value; the area may include non-wetland habitat; inventories may overlap with ‘wetland type’ inventories
Ramsar-listed sites	2 110 919	see table 7	include a smaller sample of wetlands than the international inventories; sample is biased towards wetlands of high biodiversity value; the area may include non-wetland habitat; inventories may overlap with ‘wetland type’ inventories

It is inappropriate to sum the area figures in table 12 due to:

- incompleteness of the dataset (inventories cover a sample of the wetland resources)
- the overlapping nature of some of the inventory information
- bias towards wetlands of high biodiversity value
- inclusion of non-wetland habitat

5.2 Methodologies (strengths and weaknesses)

The 'Ramsar type' inventory is the current guiding methodology used in the Asian Region. The approach caters well for the initial identification of important wetlands for biodiversity conservation. Further reviews and inclusion of additional wetlands in these inventories should be encouraged. An objective national assessment of the comprehensiveness of these inventories needs to be encouraged.

The wise use of wetlands would be assisted by the development of more comprehensive wetland inventories. 'Ramsar type' inventories will not deliver the information needed to assess changes to the extent and condition of wetlands. Additional objectives need to be identified for wetland inventory and methodologies developed to meet each objective.

There is potential for remote sensing methods to increase the comprehensiveness of inventories and lower costs.

5.3 Use of inventory information to identify sites for monitoring trends in wetland condition

5.3.1 Inventories of important sites

Existing inventories in the region do not contain the information needed to monitor quantitative trends in wetland condition.

Site based inventories do include qualitative information on values and conditions (protection/degradation status) and can be used to generate broad indices of quality. Further, they provide a basis for selecting important or representative sample sites for monitoring changes in condition.

It will be necessary to undertake more detailed baseline studies at selected sites to enable quantitative monitoring of site condition. Such monitoring should make use of appropriate indicator species together with key physico-chemical features.

It should be noted that for sites already designated as Ramsar sites, the management authorities have the obligation to monitor and record any change in ecological character. As such Ramsar sites could form the basis of an initial set of monitoring sites (although they are likely to be better protected than the rest of the sites in a particular country and so trends may be underestimated).

The monitoring network should include rare or threatened wetland sites, where the trend information generated may be critical in supporting control or mitigation action.

5.3.2 Wetland type inventories

These inventories are generally prepared from remote sensing information and do not usually include information on wetland condition, so probably are not very useful for monitoring changes in condition.

The remote sensing techniques may, however, be of some value in monitoring changes in the condition of certain sites, ie monitoring changes in water temperature, turbidity and quality in lake systems, or tree cover in forested wetlands, or occurrence of major fires, flooding or drainage.

5.3.3 Other inventories

These inventory types are of limited use for monitoring site condition.

5.4 Use of inventory information as a baseline for monitoring wetland loss

The existing wetland inventory information has only limited potential to provide a baseline for monitoring wetland loss.

5.4.1 Important site inventories

Inventories of important sites can only be used for monitoring the loss of the important sites in the inventories rather than the total extent of wetlands in the country. Such an approach is only useful in those countries where the rate of loss is so high that entire sites are lost on a regular basis.

5.4.2 Wetland type inventories

Wetland type inventories are the most useful to determine a baseline for monitoring the loss in extent of wetlands.

The *World Mangrove Atlas* has been specifically developed for purpose of providing a baseline to monitor changes in extent of mangroves (Spalding et al 1997). Inventories of tidal flats also exist for Japan (Environment Agency of Japan 1994) and South Korea (Ministry of Maritime Affairs and Fisheries 1998). A global database for large lakes has recently been developed by the World Conservation Monitoring Centre and University College London using remote sensing data to list all lakes over 10 000 ha in area (MSSL et al 1998).

However, for the other wetland types there are generally no comprehensive inventories which can be used to determine trends on a national and supra-national scale.

5.4.3 Other inventories

Other types of inventory appear to be of limited value for establishing a baseline for monitoring wetland loss. Land use inventories do provide information on gross changes in landscape but the large scale and broad classification preclude their use as baseline information on wetland extent and condition.

6 Specific recommendations

6.1 Standardising of inventory approaches/priority actions (processes)

6.1.1 Inventories of important sites

There is an ongoing role for directories of wetlands of international importance to provide information on and to assist in standard approaches to monitoring of key sites.

Where possible national inventories of important sites should be compatible with regional inventories to enable easy updating of the regional inventories.

There should be more standardisation of information on key attributes such as value/benefits, protection and threat status, and site quality, so that data can be compared between sites and trends over time determined.

Important site inventories should present extent information for each wetland type within the site.

Certain quantitative attributes of site quality (eg. water quality indices or vegetation cover) should be recorded in the inventories together with the methodologies used, to enable repetition of the measurements and hence monitoring of trends to be undertaken.

Mechanisms to develop 'site quality indices' (such as a pollution index – ie. unpolluted, slightly polluted, moderately polluted, very polluted; or a protection status index – ie. unprotected, partly protected, fully protected etc.) should be developed to enable easy communication of the trends to decision makers and the public. It is suggested that 'scorecards' (lists to show the trends of positive or negative changes in the indices for sites in a particular country or region) based on the above-mentioned site quality indices should also be developed (eg. 90% of all wetlands have become more polluted in the past 10 years or 20% have become better protected).

Regional and country inventories should be made available in digital form as CD-ROMs or down-loadable files to enhance access to the information and encourage greater levels of feedback on changes at the sites.

A network of monitoring sites (for site condition) should be established as a subset of important wetlands identified by the inventories.

6.1.2 Wetland type inventories

An attempt to systematically collect information on current extent of different wetland types in countries in the Asia region should be carried out as a priority.

The review of the global extent of mangroves (Spalding et al 1997) should be taken as a model for other wetland types.

A program should be established to monitor changes in the areal extent of widespread rare and threatened wetland types once a baseline of the original or current extent is determined.

Documented trend data for changes in extent of mangroves and other wetland types should be made widely available to assist in public awareness and conservation efforts.

Standardised methodologies should be developed to map and monitor changes in areal extent and condition of wetland types.

Land use and other inventories

A review should be undertaken on the applicability of land-use mapping information for the monitoring of changes in wetland extent in the region.

Standardised methodologies for other inventory types should be promoted to enable comparison of data sets.

6.2 Priorities for enhanced wetland inventory in Asia

Some of the specific priorities identified for wetland inventory in Asia include:

- Undertake a project to map and otherwise determine the extent of key wetland habitats in Asia.

- Develop a methodology to more systematically gather information on the benefits of wetlands to local communities and initiate pilot implementation.
- Establish a pilot project to monitor the changes in quality at wetland sites.
- Develop a wetland monitoring network. This has potential to linked or parallel existing projects such as the Asian Waterfowl Census or using the experience of Waterwatch Australia.
- Develop a program to update the Directory of Asian Wetlands every 10 years, starting in the year 2000.
- Support the preparation of national inventories to fill gaps in coverage.
- Select an appropriate sample of Ramsar sites to monitor changes in wetland condition and extent.

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Annex 1 The questionnaire used in this project

Questionnaire on Wetland Inventories

Name: ____

Contact Address:

____

____

____

Phone: ______________ **Fax**: ________________ **Email**: __________________

1 Is there a national inventory/ies of wetlands in your country (other than the Directory of Asian Wetlands published by IUCN)?

YES NO

If YES, does the inventory/ies cover: (*Tick all that apply*)

.... only internationally important sites

.... sites of national and international importance

.... sites of regional, national and international importance

.... sites of local, regional, national and international importance

.... wetland values for people

.... wetland values for flora and fauna

.... wetland loss and degradation

2 Has the inventory/ies been published? YES NO

If YES, please give full reference/s:

____

____

____

____

3 **Are there significant sub-national wetland inventories?** These may cover only a small portion of the country or particular wetland types (eg swamp forests, mangroves, coral reefs, rivers).

YES NO

If YES, please give details:

____

____

____

____

4 **Are there plans to develop or enhance wetland inventories in your country?**

YES NO

If YES, please give details:

____

____

____

____

5 **It is OK to contact you again for additional details on wetland inventories in your country?**

YES NO

6 **If there are other people in your country that you recommend we contact for additional information, could you please provide their contact details?**

____

____

____

____

If possible, please send a copy of any wetland inventories to Wetlands International–Oceania to enable a detailed analysis. If a charge is necessary, please send details.

Please send the completed questionnaire to:

Doug Watkins

Wetlands International–Oceania, PO Box 636 Canberra 2601, AUSTRALIA

Fax: **+61 2 6250 0799** E-mail: **doug.watkins@ea.gov.au**

All contributions will be acknowledged in the final report.

Annex 2 Index to Country Codes in Asia

ISO Code	Name	Long Name
AFG	Afghanistan	Islamic State of Afghanistan
AZE	Azerbaijan	Azerbaijani Republic
BGD	Bangladesh	People’s Republic of Bangladesh
BTN	Bhutan	Kingdom of Bhutan
BRN	Brunei	Negara Brunei Darussalam
MMR	Burma	Union of Burma
KHM	Cambodia	Kingdom of Cambodia
CHN	China	People’s Republic of China
IND	India	Republic of India
IDN	Indonesia	Republic of Indonesia
IRN	Iran	Islamic Republic of Iran
JPN	Japan	Japan
KAZ	Kazakstan	Republic of Kazakstan
KGZ	Kyrgyzstan	Kyrgyz Republic
LAO	Laos	Lao People’s Democratic Republic
MYS	Malaysia	Malaysia
MDV	Maldives	Republic of Maldives
MNG	Mongolia	Mongolia
NPL	Nepal	Kingdom of Nepal
PRK	North Korea	Democratic People’s Republic of Korea
PAK	Pakistan	Islamic Republic of Pakistan
PHL	Philippines	Republic of the Philippines
SGP	Singapore	Republic of Singapore
KOR	South Korea	Republic of Korea
LKA	Sri Lanka	Democratic Socialist Republic of Sri Lanka
TJK	Tajikistan	Republic of Tajikistan
THA	Thailand	Kingdom of Thailand
TKM	Turkmenistan	Turkmenistan
UZB	Uzbekistan	Republic of Uzbekistan
VNM	Vietnam	Socialist Republic of Vietnam

Annex 3 Analysis of the Wetland Inventory Data Set for Asia

	Attribute	Number	% 27
Scale of Inventory of Material			
	Global Scale	1	4
	Supra-Regional Scale	4	15
	Regional Scale		
	Sub-Regional Scale	1	4
	National Scale	21	78
	Single country studies		
	National Scale refs including more than one country		
	Sub-National Scale		
	National and other Scale Combination		
Source is a Directory/Inventory or equivalent?			
	Yes	19	73
	No	7	27
Type of Source Material			
	Peer Review Journals	1	4
	Peer Review Books	6	22
	Chapters in Books		
	Conference or Keynote Presentation		
	Article in Conference Proceedings		
	Internal Government Reports		
	Government Formal Publications	6	22
	Other Government Material		
	NGO reports	1	4
	NGO Formal Publications	12	44
	Consultancy Reports	1	4
	Newsletter Articles		
	Practitioner Periodical Article		
	Database Manual		
	Electronic Database		
	World Wide Web Article		
	Thesis		
	Other		
	Unknown		
Language of Study			
	English	16	59
	Other	10	37
	Unknown	1	4

Format of Study			
	Paper	22	81
	Electronic text		
	Electronic Database		
	Personal Communication		
	Web Presentation		
	Part of GIS or GIS Output		
	Map Based		
	Other Format		
	More than one format	3	11
	NA	2	7
Circulation of Study			
	Published	26	93
	Interdepartmental (unpublished)		
	Internal (unpublished)		
	Restricted (unpublished)		
	Unrestricted (unpublished)		
	Other types		
	Unknown	1	4
	More than one type		
	NA	1	4
Data Storage Media			
	Paper	20	74
	Web (electronic)		
	Other Electronic (not web or DB)	1	4
	Electronic Database	1	4
	GIS		
	Hardcopy map		
	Digitised Map		
	Other		
	Unknown or Ambiguous	3	11
	More than one medium	2	7
Study Implementation			
	International NGO	4	15
	National NGO	3	11
	Sub National NGO		
	Local NGO		
	Inter GO		
	National GO	3	11
	Sub National GO		
	Local GO		

	Private Agency/Individual	1	4
	Consultancy Agency	1	4
	Academic Institution	4	15
	Other body		
	Unknown		
	More than one Agency or Body	11	41
Study Funding			
	International NGO	4	15
	National NGO		
	Sub National NGO		
	Local NGO		
	Inter GO	2	7
	National GO	7	26
	Sub National GO		
	Local GO		
	Private Agency/Individual	3	11
	Consultancy Agency		
	Academic Institution		
	Other body		
	Unknown		
	More than one Agency or Body	5	19
Statement of Objectives			
	Objectives Explicitly Stated	25	93
	Objectives Not Explicitly Stated		
	Unknown	2	7
Main Objective of Study			
	General Biodiversity		
	Biodiversity Research		
	Baseline Biodiversity	24	89
	Repeat Survey/Surveillance		
	Management Tool for Biodiversity		
	Biodiversity Monitoring		
	Wetland Products	1	4
	Geographical		
	International Designation		
	Baseline Inventory		
	Academic Research		
	Land Use Planning	2	7
	Wetland Services		
	Public Education		
	Other Research		

	Other		
	NA		
Wetland Definition			
	Definition Provided	12	44
	Definition Implied	6	22
	No Definition Provided or Implied	1	4
	Unknown/Ambiguous	8	30
Ramsar Definition			
	Ramsar Definition Used	17	63
	Ramsar Definition NOT used	8	30
	Use of Ramsar Definition Unknown	2	7
Ramsar Classification			
	Ramsar Wetland Types Used	14	52
	Other Wetland Classification Used	6	22
	Wetland Classification Varies		
	Unknown	2	7
	Not Applicable	5	19
Extent of Coverage			
	All Wetlands		
	Part of Wetland Resource	27	100
	Ambiguous		
Basis of Selection			
	Geography / Jurisdiction		0
	Land Cover or RS Data		
	Landform Type		
	Suprahabitat	2	7
	Habitat Type	3	11
	Floral / Faunal Groups or Species		
	Climate		
	Wetland Function		
	Hydrology		
	Biodiversity Value	15	56
	Cultural Value		
	Artefact of Data Collection		
	Other Basis	3	11
	Unknown or Ambiguous	2	7
	More than One Basis	2	7
Data Collection Methodology			
	Collation or Review	9	33
	Ground Survey	1	4
	Remote Sensing	1	4

	Questionnaire Survey		
	More Than One Methodology	14	52
	Unknown Methodology	2	7
Extent of Ground Survey (if remote?)			
	Total	4	
	Partial	16	
	Unknown	7	
Type of Remote Sensing			
	Satellite Imagery		
	Aerial Photography		
	Videography		
	Radar Imagery		
	LIDAR Imagery		
	Map Product		
	Unknown		
Summary Provided			
	Summary Provided	22	81
	Summary NOT Provided	4	15
	Not Known if Summary Provided	1	4
Extent of Wetlands			
	Yes	14	52
	No	12	44
	Not known	1	4
Area by Wetland Type			
	Full details on area per Wetland Type	9	33
	PARTIALLY on area per Wetland Type		0
	No info. on area values per Wetland Type	17	63
	Not known	1	
Wetland Loss and Degradation			
	Sources providing info. on Loss &/or Deg.	11	41
	Sources NOT providing info. on Loss &/or Deg.	15	56
	Not known	1	4
Wetland Status Description			
	Overall Wetland Status Description Included	14	52
	Overall Wetland Status Description NOT Included	12	44
	Unknown	1	4
Values and Benefits			
	Some Level of Information	5	19
	Always		
	Most of the time		
	Commonly		

	Sometimes		
	Rarely		
	Never	14	52
	Unknown	7	26

Annex 4 Ramsar Wetland Types

The codes are based upon the Ramsar **Classification System for 'Wetland Type'** as approved by Recommendation 4.7 and amended by Resolution VI.5 of the Conference of the Contracting Parties. The categories listed herein are intended to provide only a very broad framework to aid rapid identification of the main wetland habitats represented at each site.

Ramsar Wetland Type

Marine/Coastal

A – Permanent **shallow marine waters** less than six metres deep at low tide; includes sea bays and straits.

B – Marine **subtidal aquatic beds**; includes kelp beds, sea-grass beds, tropical marine meadows.

C – **Coral reefs**.

D – **Rocky marine shores**; includes rocky offshore islands, sea cliffs.

E – **Sand, shingle** or **pebble shores;** includes sand bars, spits and sandy islets; includes dune systems.

F – **Estuarine waters**; permanent water of estuaries and estuarine systems of deltas.

G – **Intertidal mud**, **sand** or **salt flats**.

H – **Intertidal marshes**; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes.

I – **Intertidal forested wetlands**; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests.

J – **Coastal brackish/saline lagoons**; brackish to saline lagoons with at least one relatively narrow connection to the sea.

K – **Coastal freshwater lagoons**; includes freshwater delta lagoons.

Inland Wetlands

L – **Permanent inland deltas**.

M – **Permanent rivers/streams/creeks**; includes waterfalls.

N – **Seasonal/intermittent/irregular rivers/streams/creeks**.

O – **Permanent freshwater lakes** (over 8 ha); includes large oxbow lakes.

P – **Seasonal/intermittent freshwater lakes** (over 8 ha); includes floodplain lakes.

Q – **Permanent saline/brackish/alkaline lakes**.

R – **Seasonal/intermittent saline/brackish/alkaline lakes and flats**.

Sp – **Permanent saline/brackish/alkaline marshes/pools**.

Ss – **Seasonal/intermittent saline/brackish/alkaline marshes/pools**.

Tp – **Permanent freshwater marshes/pools**; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season.

Ts – **Seasonal/intermittent freshwater marshes/pools** on inorganic soil; includes sloughs, potholes, seasonally flooded meadows, sedge marshes.

U – **Non-forested peatlands**; includes shrub or open bogs, swamps, fens.

Va – **Alpine wetlands**; includes alpine meadows, temporary waters from snowmelt.

Vt – **Tundra wetlands**; includes tundra pools, temporary waters from snowmelt.

W – **Shrub-dominated wetlands**; Shrub swamps, shrub-dominated freshwater marsh, shrub carr, alder thicket; on inorganic soils.

Xf – **Freshwater, tree-dominated wetlands**; includes freshwater swamp forest, seasonally flooded forest, wooded swamps; on inorganic soils.

Xp – **Forested peatlands**; peatswamp forest.

Y – **Freshwater springs; oases**.

Zg – **Geothermal wetlands**

Zk – **Subterranean karst and cave hydrological systems**.

Note: '**floodplain**' is a broad term used to refer to one or more wetland types, which may include examples from the R, Ss, Ts, W, Xf, Xp, or other wetland types. Some examples of floodplain wetlands are seasonally inundated grassland (including natural wet meadows), shrublands, woodlands and forest. Floodplain wetlands are not listed as a specific wetland type herein.

'Man-made' wetlands

1 – **Aquaculture** (eg, fish/shrimp) **ponds**

2 – **Ponds**; includes farm ponds, stock ponds, small tanks; (generally below 8 ha).

3 – **Irrigated land**; includes irrigation channels and rice fields.

4 – **Seasonally flooded agricultural land**.*

5 – **Salt exploitation sites**; salt pans, salines, etc.

6 – **Water storage areas**; reservoirs/barrages/dams/impoundments; (generally over 8 ha).

7 – **Excavations**; gravel/brick/clay pits; borrow pits, mining pools.

8 – **Wastewater treatment areas**; sewage farms, settling ponds, oxidation basins, etc.

9 – **Canals and** drainage **channels**, ditches.

* To include intensively managed or grazed wet meadow or pasture.

Review of wetland inventory information in the Middle East

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Contents

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Finally, we'd like to thank Mike Smart who, while at the Ramsar Bureau, was always asking the question 'Just how much wetland is there in the world?'

1 Introduction

This report summarises the findings of a preliminary review of wetland inventory information from the ‘Middle East’. Asia was the only Ramsar region within the Global Review of Wetland Resources and Priorities for Wetland Inventory (GRoWI) that was divided for assessment. As ‘Middle East’ is a term with differing interpretations, we have used the 13 countries covered in our primary reference, Scott (1995), namely Afghanistan, Bahrain, Iraq, Islamic Republic of Iran, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates and Yemen, and added Israel, to constitute the ‘Middle East’. These are shown in Map 1.

The Middle East, defined another way, occupies extreme southwestern Asia (excluding Turkey and the Sinai Peninsula) and for the purposes of this study, also includes Afghanistan. In it widest extent it reaches from Rafah, Gaza, at 34°15’E along the Mediterranean Sea in the west to approximately 74°55’E where the tip of the narrow Wakhan Corridor reaches the border with China in the east. From the west, the region extends southward along the Gulf of Aqaba and Red Sea, and eastward along the Gulf of Aden, circumscribing the Arabian peninsula and reaching its southernmost extent at Darsa Island, Yemen at 12°05’N in the Arabian Sea. The northernmost point of the Middle East is approximately 39°40’N, north of Mākū in extreme northwestern Iran along the border with Turkey. The southern shore of the Caspian Sea forms a significant part of the northern boundary of the study area. Other major Middle East seas include the Persian Gulf and the Gulf of Oman. Afghanistan, centered on the world’s second highest mountain range, the Hindu Kush, is the only country in the region without a connection to the sea. Inland, the Middle East is largely semi-arid to arid. There are vast expanses of desert. Some coastal or lowland areas receive greater rainfall. Severe extremes of both hot and cold temperatures have been recorded within the region. The Tigris and Euphrates Rivers are the major riverine arteries.

2 Information sources

Only four wetland inventory sources were included in the Middle East dataset. The countries and the respective number of applicable wetland inventory references appear in tabular form in table 1 and graphically in figure 1.

Though there were a total of four references for the region, the bulk of the information evaluated and reported in this study came from only one – Scott (1995). This single source might sufficiently characterise the wetland inventory in certain countries, but for other countries it may not have been comprehensive and detailed enough to yield an accurate estimate of wetland coverage. Therefore, table 1 and figure 1 cannot be taken for granted as representative of all the material available or existing per country. The companion study covering the bulk of Asia (Watkins & Parish 1999) must also be consulted to enable a more comprehensive view of the state of wetland inventory information across Asia.

2.1 General information

In any kind of compilation it is a logical imperative to consider previous similar efforts. Perhaps there are lessons that have been, or should have been, learned. Similar previous studies include Matthews (1993), Scott (1993), Hughes (1995) and Hecker and Tomàs Vives (1995). Of these, the latter is the most comprehensive review of wetland inventories (within its respective scope) and the one with the closest affinity to the Middle East (although treating only four of the countries included in the present study).

Boundaries are not authoritative

Map 1 Map of the Middle East region

Table 1 Numbers of wetland inventory references evaluated for the countries of the Middle East

Middle East	No. of References
Afghanistan	2
Bahrain	4
Iran	4
Iraq	2
Israel	2
Jordan	3
Kuwait	2
Lebanon	2
Oman	3
Qatar	2
Saudi Arabia	3
Syria	2
United Arab Emirates	2

Yemen	3

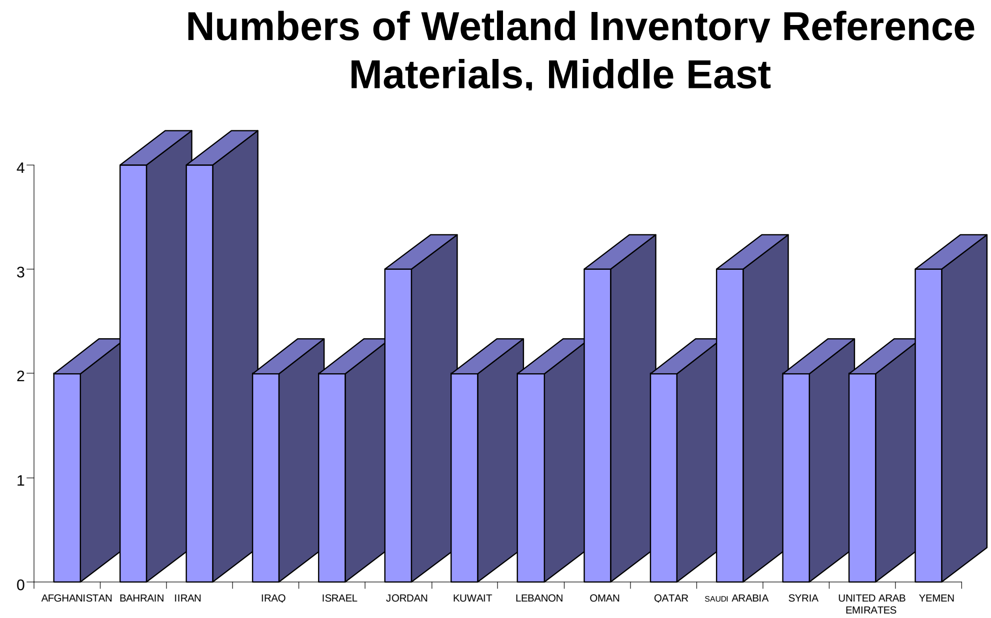

Figure 1 Graphical depiction of the wetland inventory references evaluated for the countries of the Middle East

In fact, this latter work examined some sources that were omitted by the present study (and should be included in a subsequent phase). All of these studies gave predominant emphasis to describing the wetland inventory attributes of each reference, on a case by case basis. By virtue of the near total reliance on Scott (1995), this review of the Middle East is, by default, much the same. Had more sources been identified and utilised during the assessment phase, a different character to the result would have been apparent. Ideally, the emphasis of such a review should be a 'global' analysis of a complete dataset, rather than providing a list of specific characteristics of individual wetland inventories.

Assessments were based on national datasets (including the possibility that a composite national dataset could be amalgamated from equivalent, eg 'provincial', data subsets). From the beginning there was an assumption that significant (national) information on wetland extent, health, attributes and values might be found in many other information sources besides conventional wetland inventory directories. Unfortunately for the Middle East dataset, we did not uncover any particularly useful unconventional wetland inventory information sources.

2.2 Evaluation of the Middle East dataset

The methodology used to identify and evaluate material for regional datasets within this project, including the Middle East, follows.

2.2.1 Evaluation of Inventory Material

Potential sources of wetland inventory data were identified using the World Wide Web, external and in-house libraries, and through communications with an extensive network of contacts. Many potential information sources were obtained, and their suitability for inclusion in the database was assessed. Those deemed useful were included in this review (Convention on Wetlands 1998, Evans 1994, Scott 1995, Spalding et al 1997).

The decision whether to include or exclude certain sources depended on several factors. Material tangential to bona fide wetland inventory was not usually included except where no alternative data for a country could be obtained. Sub-national data were to be excluded except where no national information existed. In cases where material would be encountered which contained no areal data but did contain other useful information, it might be considered if no other information for that country had been identified. Some countries had two (or more) 'inventories', but these varied in scope and coverage. Scott (1995) usually provided the most comprehensive wetland account for the Middle East dataset, and often the other source was not included because it did not effectively supplement the information presented in Scott (1995).

2.2.2 Meta-data recording

Each assessed information source was evaluated using a *Wetland Inventory Assessment Sheet* (WIAS), designed to permit rapid assessment and compilation of information about each identified inventory, and to compile summary information about the wetland resource reported in each inventory. A set of guidelines for completing the sheet was also developed to facilitate handling and coding of relevant information. Derivation of wetland coverage estimates and other wetland parameters are discussed below.

2.2.3 Meta-data entry

A database was created in FoxPro® (version 2.6) to include information about each information source that was assessed, and recorded on a WIAS datasheet. Another database was also created to serve as a data dictionary of the codes (and their descriptions) that were used to represent various categories of information in the primary database.

2.2.4 Analysis of meta-data

Six computer programs were written to analyse the majority of coded fields in the database. Three of these programs were adapted to allow single-country analyses.

The programmed analyses report on the presence or absence of codes or logical values (by use of a filtering system), and derived outputs issue as quickly as a printer can process them. These outputs provide the meta-data breakdowns reported herein.

2. 3 Results of meta-data review

There were, ultimately, only (the aforementioned) four references evaluated for the Middle East dataset. Of these, only Evans (1994) and Scott (1995) offered Pan-Middle East coverage. Evans (1994), as its title indicates (ie *Important Bird Areas of the Middle East*), was concerned with avian (IBA) sites, however, 'Wetlands dominate[d] the inventory, comprising half of all IBAs…'. Wetland descriptions in this work were, however, sparse, and since Scott (1995) indicated which wetland sites in his directory also had IBA status, this more recent reference was used in lieu of Evans (1994). There were some IBAs with wetland components in Evans (1994) which were not listed in Scott (1995). However, these wetlands seemed to represent only a small part of the IBAs in question, and discrete wetland area was usually not specified. Evans (1994) was only used to provide an estimate wetland extent for one country (Israel) which was not covered in Scott (1995).

Ultimately Scott (1995), a conventional wetland directory composed of separately compiled national accounts, proved to be the only or predominant source of information used in the evaluation of 13 of the 14 (or ~93%) countries in this dataset. Scott (1995) stated '*A Directory of the Wetlands in the Middle East* seeks to [provide] a comprehensive review of existing knowledge of the *most important* [emphasis added] wetlands in thirteen nations in the Middle East'. While accepting the Ramsar definition of wetlands, some 'exclusively marine systems' including (some) coral reefs (a Ramsar wetland type) were not included in this reference. Several country datasets may have been incomplete, or reflect situations which are now drastically altered (eg in Afghanistan and Iraq), owing in part to recent conflicts. For these reasons we did not consider any of the country datasets as *necessarily* comprehensive in coverage (see fig 3.1), although Scott (1995) is clearly the most comprehensive source of wetland site information for the Middle East as a whole.

A standard set of meta-data analyses was conducted on this dataset and summaries from the Middle East outputs appear in Annex 1. The small number of only four assessable references makes individual topic discussion here moot.

3 Extent and distribution of wetlands

3.1 Methodology for derivation of wetland extent estimates

The estimates of wetland coverage cited in or derived from the material included in the Middle East dataset were entered into a system of country coverage files. An individual wetland coverage file was created for each country in order to summarise any multiple estimates given in the material examined, and to facilitate the generation of national 'best estimates' of wetland area.

Each coverage file incorporated areal data columns for Ramsar 'wetland type' (see Annex 4) and broad wetland category (marine/coastal, inland and artificial). Where possible, approximate estimates per Ramsar wetland type were entered in the appropriate columns; where this was not feasible, approximate values for broad wetland type were entered, and where this was not feasible, only a provisional total wetland value was entered. These coverage files provided a clear overview of the quality and quantity of wetland extent information per country.

Each file provided wetland estimates, along with brief notes as to scope, and in particular, exclusions in coverage (eg open water bodies). This provided a convenient means of auditing all the material included in the dataset, and provides an 'at a glance' summary of the material examined.

Once all the values had been entered into a coverage file for each country, along with the appropriate notes, a subjective assessment of the material was made. Best estimates were composed according to broad wetland category (marine/coastal, inland and artificial), and a justification of the rationale entered into the file. Once the coverage files were completed for all the countries within a region, the estimates were compiled into a summary document.

The directory reference Scott (1995) included information on 13 of 14 countries examined herein, and therefore features predominantly in these country coverage files. The total number of national datasets examined per country was also entered into the each regional summary document.

3.2 Estimate of the extent of wetlands in the Middle East

A summary of wetland coverage in the Middle East is presented in tables 2 and 3 (below). The total area calculated from the Middle East dataset amounted to some 7 434 790 ha, covering approximately 1.3% of the land surface of the 'Middle East' (as it is defined by the 14 countries of this dataset). Only a small percentage (~3%) of the wetlands included in this estimate could not be categorised as 'marine/coastal', 'inland' or 'artificial' wetlands, based on the evaluated inventory materials.

Scott (1995), the main reference for this dataset, does mention applicable Ramsar Site status for site entries (for those Ramsar Sites designated prior the compilation of his directory). However, it must be remembered that Ramsar site area figures typically refer to 'site' extent and not necessarily 'wetland' area.

Table 2 Combined wetland extent in the Middle East dataset

Asia	Estimate of area (ha)
Marine/coastal wetlands	3 849 076
Inland wetlands	3 331 101
Manmade wetlands	40 653
Area of unspecified types of wetland	213 960
Total area of wetlands identified in this study	7 434 790
# of national datasets per region	20
# of national datasets which can be regarded as comprehensive in cover	0

Table 3 Wetland extent in the Middle East dataset as a percentage of land cover; plus Ramsar site information

Asia	
# of countries	14
Total land area of region (ha)	587 416 800
Total area of wetlands identified in this study (ha)	7 434 790
% of land area covered by these wetlands	1.27%
Total area of Ramsar sites (ha)	1 364 890
# of Ramsar sites	24

(Source of Ramsar site information: Ramsar database, date of data extraction 17/8/98)

Best estimates of wetland area for countries in the Middle East are provided in table 4. The summaries of wetland coverage for each of the 14 Middle East countries listing the sources used to generate a 'best estimate' of wetland coverage either in total or by category type (inland, marine/coastal, artificial) can be found in Annex 2. Notes on the reliability of the assessment are included with each summary.

4 Rate and extent of wetland loss and degradation

Wetland loss, degradation and threats information for the Middle East dataset derives almost exclusively from Scott (1995). Most country summaries included such information, but it was almost always descriptive, with few quantitative data. Relevant excerpts from these accounts follow.

Afghanistan: Extensive floodplain wetlands have been lost. Most serious threats include drainage for agriculture and urban development, and diversion of water for irrigation.

Bahrain: Depletion of aquifer has occurred, lowering the water table. Wetlands are under threat from various human activities, including oil spills, but mostly from the reclamation of land for development, which has destroyed many biologically rich areas such as muddy shores and mangroves.

Table 4 Best estimates of wetland coverage per broad wetland category for countries in the Middle East

ASIA REGION: Middle East	BEST ESTIMATES					COVERAGE INFO		RAMSAR INFO	
	Marine/Coastal (ha)	**Inland (ha)**	**Artificial (ha)**	**Unspecified Wetland Type (ha)**	**Total (ha)**	# of datasets accessed per country*	# of datasets which can be regarded as comprehensive in cover	Total area of Ramsar sites (ha)	# of Ramsar sites
AFGHANISTAN	None	100 291	200		**100 491**	1	0	0	0
BAHRAIN	8 500	Unknown	240		**8 740**	2	0	2	2
IRAN, ISLAMIC REPUBLIC	861 627	997 535	4 600		**1 863 762**	2	0	1 357 150	18
IRAQ	56 000	1 936 500	32 500		**2 025 000**	1	0	0	0
ISRAEL	1 363	17 000	512		**18 875**	2	0	366	2
JORDAN	Unknown	110 550	1 800		**112 350**	1	0	7 372	1
KUWAIT	6 523	Unknown	unknown	2 700	**9 223**	1	0	0	0
LEBANON	Unknown	Unknown	unknown	780	**780**	1	0	0	0
OMAN	325 650	Unknown	unknown		**325 650**	2	0	0	0
QATAR	Unknown	Unknown	51	15 065	**15 116**	1	0	0	0
SAUDI ARABIA	796 273	168 525	750	17 050	**982 598**	2	1?	0	0
SYRIA	Unknown	Unknown	unknown	154 900	**154 900**	1	0	unknown	1
UNITED ARAB EMIRATES	1 715 740	700	unknown		**1 716 440**	1	0	0	0
YEMEN	77 400	Unknown	unknown	23 465	**100 865**	2	0	0	0
Total estimated wetland cover	**3 849 076**	**3 331 101**	**40 653**	**213 960**	**7 434 790**	20	0	1 364 890	24

*Excluding the Ramsar Database

Iran (Islamic Republic of): The level of exploitation of wetlands is high in Iran. Undoubtedly the most serious threats to wetlands have been the drainage and 'reclamation' of wetlands for agriculture, industry and urban development, and diversion of water supplies for irrigation purposes. One of the major environmental threats to wetlands came from the prolonged military conflict between Iran and Iraq in the 1980s.

Iraq: The destruction of the wetlands of Lower Mesopotamia continues at an accelerating pace, and their continued survival as one of the finest and most extensive natural wetland ecosystems in western Eurasia is now in grave doubt.

Israel: By 1948, the main wetlands of the country were partially or completely drained. Some flooding restoration has been undertaken (Ortal, chapter 4.16 *Israel*, Hecker & Tomàs Vives 1995).

Jordan: The water resources situation is now precarious. All water bodies are looked upon as a source of exploitation for urban, agricultural and industrial uses, and many are affected by increasing salinity, pollution and eutrophication due to intensive agricultural practices.

Kuwait: Continuous human activities along the coastline have resulted in considerable disturbance to marine ecosystems. Dredging and landfill, sand removal, disposal of untreated sewage and industrial effluents, as well as the perennial threat of oil spills adversely affect Kuwait's coastal wetlands.

Lebanon: During the early part of the 20th century lakes, swamps and seasonally flooded marshes of the central Beka'a Valley were drained for agriculture. The once extensive swamps on the coastal plain were also drained at this time. The only large natural wetland which survives in Lebanon is Ammiq Swamp, and it is unprotected and under threat from drainage schemes.

Oman: No summary loss or threat data available from the Middle East dataset.

Qatar: While almost all of the interior of the peninsula has been modified or degraded by human activity, Qatar's wetlands are predominantly marine and coastal. No summary loss or threat data available from the dataset.

Saudi Arabia: With the exception of artificial water bodies, wetlands are under severe threat in Saudi Arabia. Coastal zones are now subject to high pressure from expanding commercial and industrial fisheries, and many former fish nurseries have been lost to coastal reclamation from industrial, residential and recreational facilities. The Gulf has lost over 40% of its inter-tidal area to development, and the Red Sea 8% (Sambas & Symens 1993 *cited in* Scott 1995).

Syria: Most of those wetlands that did exist have been degraded or destroyed by drainage for agriculture and diversion of water supplies for irrigation purposes.

United Arab Emirates: Large-scale losses of intertidal area have been brought about either by dredging or by burial ie reclamation. It is mostly *sabkha* that has suffered from alteration, although various *khors* have been lost, or reduced to some extent. Possibly no site exists that has not already been altered or presently receives no form of adverse human activity or development.

Yemen: *Wadi* systems throughout Yemen are being adversely affected by severe degradation of the catchments as a result of deforestation for fuelwood and the charcoal industry, and overgrazing by domestic livestock. The Ta'izz marshes are critically threatened by excessive extraction of groundwater and conversion to agriculture.

5 Wetland benefits and values

Again, the present study relied heavily on *A Directory of Wetlands of the Middle East* (Scott 1995). This reference contained only two appreciable *national* summaries of wetland value information (described below). Otherwise, wetland values (if reported) were listed descriptively, on a site-by-site basis in the accounts. No other references with national summaries of wetland values were found in this study.

In the United Arab Emirates values were summarised, but pelagic and demersal fishing were noted to be most important, and these are marine rather than wetland values *per se*.

The account for Iraq noted that a report by the Wetland Ecosystems Research Group at the University of Exeter, United Kingdom, had summarised available information on the faunal, floral, ecological, economic and cultural values of the recent environmental and ecological study of the (formerly extensive) marshlands of Mesopotamia. It also had provided an environmental impact assessment of past, ongoing and proposed developments on the system (*citing* Maltby 1994). While values of this large *complex* were discussed, national wetland values were not summarised.

6 Land tenure and management structures

Information on land tenure and management structures are derivable for some sites on a site-by-site basis (per country chapter) from Scott (1995), but the worth of this information is questionable given the age of many of the data and the conflicts that prevail in some countries.

7 Extent and adequacy of updating programs

According to Motalebbi-Pour (1993, *cited in* Scott 1995), Iran was the first country in the Middle East to carry out a national wetland inventory. This was undertaken during the early 1970s. The inventory identified a total of 286 wetlands of which 33 were considered to be of international importance (*citing* Scott 1976a, 1976b). In 1990, Iran's Department of the Environment launched a major update of the wetland inventory. The purpose of this was to describe the key wetlands in Iran, giving emphasis to aquatic plants, waterbirds and mammals. During the initial phase of the project (1990–1994), some 58 of the most important wetlands were investigated.

As far as we have been able to ascertain, Iran is the only Middle Eastern country to have undertaken or to possess a conventional national inventory of its wetlands. Hecker and Tomàs Vives (1995) also found an absence of *bona fide* national wetland inventories for the four countries of the Middle East (ie Israel, Jordan, Lebanon and Syria) which were included in their study. Certain wetland types (eg corals, UNEP/IUCN 1988) and wetland biota (eg in Saudi Arabia, Newton, chapter in Scott 1995) have been either widely or well covered in the region, but these do not constitute national wetland inventories *per se*. Nor does Evans (1994) which includes important bird areas that correspond to many wetlands listed in every Middle East country chapter covered in Scott (1995). So the most relevant issue for the region is not one of the extent and adequacy of inventory updating, but rather the dearth of initial national scale, wetland inventory work.

Thus *A Directory of the Wetlands of the Middle East* (Scott 1995) for many countries represents the sole national wetland inventory (compilation), and its coverage extends only to 'the most important wetlands'. There are no formal plans to update the inventory at present.

8 Standardising of inventory approaches

Scott (1995) describes his study as follows:

> The Directory consists of a series of national chapters describing the principal wetlands in thirteen countries … Over fifty individuals and organizations have contributed to the Directory, many of them providing hitherto unpublished information on wetlands in the Middle East. Two hundred and twenty-three sites of international importance are described. These have been selected on the basis of criteria developed in relation to the Ramsar Convention. Although special attention is paid to the importance of the wetlands for wildlife, all wetland values, including water storage, flood control, coastal protection and fisheries production, have been taken into consideration.

From this characterisation it is evident that our primary source in this present review of Middle East wetland inventory is taken from a multiplicity of disparate sources, but with a strong bias towards 'important' wetlands, based on a standard set of selection criteria (the Ramsar Criteria). However, these accounts do not reveal, collectively or singly, a recommended standard approach to wetland inventory in general. This, coupled with the fact of having such a small number of collateral information sources in this review, precludes an in depth analysis of the standard approach issue.

However, if we can look across to an adjacent and partly overlapping region – the Mediterranean – then there already is a well-developed standard approach to wetland inventory to examine. The 'MedWet' project (phase I) was launched in late 1992 for the purpose of developing tools and methodologies for the conservation of Mediterranean wetlands. In a unique arrangement, governments of the five EU Mediterranean countries, international NGOs, and the Ramsar Convention cooperated in the initiative that comprised five sub-projects. The sub-project on inventory and monitoring developed a suite of tools for an inventory methodology that today is seen as providing an example that could be emulated in other regions to facilitate national wetland inventories. See Costa et al (1996), Hecker et al (1996), Farinha et al (1996), Zalidis et al (1996) and Tomàs Vives et al (1996) for the five volume set describing the tools and wetland inventory methodology.

9 Priority areas for wetland inventory

Certain specific types of wetlands may be bypassed during wetland inventory activities. In the case of the Middle East dataset, some coral formations were not included (eg Bahrain), although the reference (ie Scott 1995) cites use of the Ramsar definition of wetlands (a 'Ramsar wetland type'). Hughes and Hughes (1992), in their treatment of African wetlands, noted that the area of wetlands (especially water bodies) can be difficult to assess since the size can vary seasonally, annually and intra-annually. Ephemeral wetlands (eg *sabkha*) are certainly a phenomenon common to large areas of the Middle East. Some smaller or more remote *wadi* systems may be very important in the context of arid landscapes, but may not have been comprehensively inventoried. These potential gaps should receive more attention in future wetlands inventory activities in the Region.

Although it was possible to calculate estimates of the national important wetland resource in all of the Middle Eastern states, many of the data are 'old' and therefore suspect in a number of countries. This is particularly true for several countries in the region that have recently undergone, or are currently experiencing civil conflict or war. In these countries there may have been older wetland inventory data, or virtually none at all. Whatever the previous situation, conflict and its long-lasting effects present formidable constraints to the acquisition of additional data on the current state of wetlands. Middle East countries where such conflict has had the most direct negative impact on wetlands and the acquisition of current wetland inventory information include Afghanistan and Iraq, and perhaps Lebanon. Information on Iran's wetlands, on the other hand, seems to be more current and more comprehensive, despite recent conflicts, according to Mansoori's chapter 'Islamic Republic of Iran' in Scott

(1995). Besides the detrimental effect that strife has on collection of wetland information, it also obviously contributes directly to the loss and degradation of wetlands. However, the most significant changes to wetlands in the region have been land use changes. In several countries drainage, reclamation and over-abstraction are known to have occurred on a large scale, resulting in what appears to be major losses of wetland area. Quantification of this loss has not usually been possible, either logistically and/or politically, especially in the aforementioned strife-torn areas.

The wetland area estimates for the Middle East were, for the most part, painstakingly calculated from individual wetland site areal figures supplied in Scott (1995). Oftentimes area data were ambiguous between ‘sites’ and ‘wetlands’, and between wetland types. In this latter instance, some area figures could be definitely attributed to a single wetland type (at a site) while other figures (for the same site) were split in an unknown proportion between other wetland types; some wetland types (and wetlands) had no area data. The resulting best estimates must be tempered with this in mind. In most cases, the only information identified in this review was that provided by Scott (1995). (Additionally, Hecker and Tomàs Vives (1995) provide a general overview of wetland inventory in four Mediterranean Middle East countries.)

Middle Eastern countries with the apparent gravest shortage of current and/or comprehensive wetland information are Afghanistan, Iraq, Lebanon and Syria. Scott (1995) reported that information on Afghanistan and Syria (as well as Yemen) presented in the *Directory* is based entirely on expatriate sources and the literature, because no local contact could be established during the compilation period. Additionally, Jordan’s acute water shortage problems exacerbate the effects of a relative paucity of information. A number of countries have marginally more information, and are tentatively regarded as having an intermediate level of wetland inventory information, though the scope and coverage greatly varies. In these cases, there are generally *significant* gaps in either information about specific wetland types or in national coverage; examples include Israel, Kuwait, Oman, Qatar, Saudi Arabia, the United Arab Emirates and Yemen.

Out of the 14 countries of this Middle East dataset, only two might be said to have partially-adequate inventory data on (important) wetlands, but this is tentative. These are Bahrain and the Islamic Republic of Iran. Table 5 presents the general state of wetland inventory information as derived from the Middle East dataset.

Table 5 Status of national wetland inventory information in Middle Eastern countries based on this study

Little or no recent national wetland inventory information	Some, but inadequate national wetland inventory information	Adequate information available, but requires updating and more detailed surveys
Afghanistan	Israel[1]	Bahrain[2]
Iraq	Kuwait	Iran[3]
Jordan	Oman	
Lebanon	Qatar	
Syria	Saudi Arabia[4]	
	United Arab Emirates	
	Yemen	

Note: these are preliminary assessments only.

1 Significant information on wetlands included for protected areas exists, but not inventories of wetlands as a habitat type (Ortal, *Israel*, chapter *in* Hecker & Tomàs Vives (1995)).

2 The principal wetlands in Bahrain are coastal mudflats which cover a large area in relation to the size of the country. In 1985, detailed surveys of all critical habitats in the intertidal and sub-littoral zones around the major islands of the Bahrain and Hawar archipelagos were conducted (Vousden (1986) *cited in* Scott (1995)).

3 A great deal of information is available on the wetlands of Iran (particularly their importance for birds). Iran carried out a national wetlands inventory (during the early 1970s) and began an update in 1990. During the first phase of the project (1990-1994), some 58 of the most important wetlands were investigated (Motalebbi-Pour (1993) cited in Scott (1995)).

4 Eight wetland systems were identified in the Kingdom by Tinley (1994) (*cited in* Scott (1995)). With the exception of artificial water bodies, wetlands are under severe threat in Saudi Arabia.

The area figures included in this assessment of the Middle Eastern part of Asia, are based predominantly on calculations of area figures extracted from Scott 1995 (see Annex 3). No other studies including detailed areal figures for wetland extent in the Middle East were assessed or identified thus far.

10 Specific recommendations

The first part of this section provides brief recommendations pertaining to wetland inventory activities as a whole. It proved beyond the scope of this limited Middle East study to recommend particular field survey methods, or to provide instructions for wetland inventory activities. The relative merits and disadvantages of wetland inventory methods used in southern Africa are covered by Taylor et al (1995) and these are equally applicable to other regions, including this one.

Similarly, it would not be appropriate to enter the debate on traditional field survey techniques versus remote sensing techniques (again these are discussed admirably by Taylor et al 1995 and Grainger 1993, from analogous forestry studies). However, in the course of extracting and analysing data from the disparate inventory sources covered in this and companion reviews, common problems have been revealed which could be easily avoided. Certain core or key data need to be recorded during wetland inventory so as to benefit the data user. These would include, for example, the date of survey, the study objectives and the wetland definition and coverage employed. Furthermore, data must be presented to maximise their utility. Accessibility goes to the heart of this.

The second part of this section contains recommendations pertaining to any future updates of the Middle East dataset. Whilst evaluation of the methods used and the analyses developed were carried out regularly throughout the duration of this project, there still remain some areas which could be improved upon in future updates.

Finally, recommendations are provided which stem from and pertain to the review of Middle East wetland inventory materials.

10.1 Wetland Inventory recommendations

10.1.1 Preparatory and background research

- Undertake a thorough review of previous studies and surveys prior to any wetland inventory activity, to delineate gaps and to benefit from lessons learned or mistakes made. This should also include less obvious sources such as academic material and conference material, as well as conventional wetland inventories.
- Record information such as the history, development and rationale of wetland inventories. These are crucial elements for understanding the context of these studies, and this information should be described briefly within reports. Also record details of contact persons and addresses to assist successive workers. Note any plans for future inventory activities, especially if the surveys are part of a longer-term study.

10.1.2 Objectives

- Delineate the objectives of wetland inventories prior to the commencement of wetland inventory activities (particularly those involving fieldwork). The objectives of wetland inventory activities should play a key role in choice of the most suitable wetland inventory methodology to be used in any given particular inventory program.

- Include updating provisions when planning wetland inventory activities. Where feasible and appropriate, include monitoring for changes in extent, distribution and loss of wetlands.
- Include clearly stated objectives in wetland inventory reporting and published material.
- Widely disseminate wetland inventory material in accessible formats.

10.1.3 Data management

- Design and employ well structured data recording sheets to facilitate data entry into an electronic database.
- Store and update inventory information in a modern easy to use computerised database, thereby ensuring the longevity of the data.

10.1.4 Wetland coverage

- Don't overlook wetland types which are often commonly excluded from wetland assessments (including such artificial wetlands as fish ponds, rice paddy, reservoirs and dams, and natural wetlands including dune slacks, humid sands, dambos, wet mesotrophic grasslands, seagrass beds, maerl beds, coral reefs and alpine wetlands).

10.1.5 Wetland definitions and classification of wetlands

- Incorporate in any inventory work unequivocal descriptions of what is meant by 'marine wetlands' and 'coastal wetlands', and 'inland wetlands'. Imprecise definition hampers interpretation by others.
- Always include a definition of wetlands in inventory documentation. It should expressly address whether habitats such as floodplains, and open water bodies have been included in the definition, and whether they have been included in a wetland survey.
- Adequately describe and cite any wetland classification system that is used.

10.1.6 Wetland values and benefits

- Record information on wetland values and benefits as part of wetland inventories. As a minimum this should constitute a textual description of benefits, but preferably should indicate the economic values for wetland goods and services.
- Employ a simple structure to aid the assessment of wetland benefits and values. Take advantage of local knowledge. This could take the form of a well-organised key or questionnaire.
- Disseminate the findings of wetland inventory assessments of the values and benefits of a particular wetland site widely to demonstrate the values and benefits to policy makers and management authorities.

10.1.7 Inventory frequency

- Prioritise the advantages offered by low resolution comprehensive national surveys (to identify wetland locations for more detailed study later) versus the implementation of replicate detailed surveys at sites thought to be at risk. Assess first time reconnaissance of new sites against periodic surveillance of known sites. Few first-time surveys examined in this (project-wide) review were found to be part of a long-term assessment and monitoring program. If wetland loss and degradation is to be addressed, it must first be quantified. This necessitates longer-term study.
- Update the wetland inventory lest the data are likely to become lost or dated.

10.1.8 Presentation of data

- Summarise results in any presentation of the coverage and characteristics of the wetland resource. It is exceedingly difficult to construct a useful overview of an inventory reference by extracting values and statistics from reams of text entries.
- Record and list local names and variants of wetlands or their locations, along with any translations. Also include a guide to pronunciation.
- Record and present geographical coordinates and general location of wetlands so that discrepancies involving the names of wetlands can be resolved by accurate location.
- Always include dates of field observations, collations, and compilations of wetlands/wetland information.
- Include contact points for data custodians or publishers, and institutional details. 'Date stamp' this information so that its apparent relevance can be assessed by others.
- Fully reference all primary information.

10.1.9 Availability, accessibility and dissemination of wetland inventory material

- Publish results and reports of wetland inventory work; also present them on the World Wide Web. Much material that is currently available in draft format remains unpublished or has a limited distribution.
- Include provision for the sustainability of bibliographic and meta- wetland inventory databases, before they are developed, otherwise their usefulness is transient.
- Ensure that wetland habitat maps are adequately keyed, and impart clear and adequate information. Summary texts are quite useful. Include fundamental cartographic elements such as scale and geographic coordinates.

10.2 Recommendation for updating this study

- The Review of Middle East wetland inventory information base should be updated since it relied on only a couple of information sources.
- The tools used in this review, namely the WIAS (wetland inventory assessment datasheet), the meta-database and the analysis programs should be refined in any updating scenario.

10.3 Recommendations relevant to the Middle East

- In several countries of the Middle East wetland inventory data are obsolete, but updating of information has been delayed or precluded by hostilities or civil strife. In the meantime, land use changes have added to substantial wetland loss and degradation. At the earliest reasonable opportunity, countries in the region should update or undertake wetland inventories in order to assess changes (especially loss or gain), or establish a baseline for measuring future changes in wetland area, function and values.
- National wetland policies should be established which include national wetland inventory and monitoring programs. In a region with an underlying dearth of baseline wetland information, where acquisition of field information can be difficult or impossible (eg due to conflicts), where water is typically scare and/or ephemeral, and where competition for water is increasing, this must be seen as a priority.

- Wetland inventories should be conducted and documented in such a way (eg stored in a database) so as to promote and enable easy updating and review.
- Efforts to increase membership of the Middle East in the Convention on Wetlands (Ramsar, 1971) should be emphasised. Only five of the 14 states of the Middle East are Contracting Parties (these are mostly recent accessions). Membership would help to increase general knowledge of the importance of wetlands and would provide access to a common forum to address wetland issues.
- Sabkhas, wadis, coral reefs, karst wetlands and other specific types that may be currently under-represented should be emphasised in future wetland inventories.
- More efforts to integrate wetland surveys with faunal surveys should be made, and basic wetland characteristics and functions should be recorded. A major inventory of Important Bird Areas of the Middle East (Evans 1994) highlighted wetlands as the dominant IBA habitat, yet little useful wetland information was provided. If additional wetland data exist from the IBA study, but were not published or incorporated in other studies, they should be made available as a published or unpublished report. For countries known to have few wetland assessment or management initiatives, it is especially important that ornithologists, mammalogists and other faunal specialists examine, collect and provide basic wetland inventory information.
- Bibliographic databases set up to list information sources of wetlands within a given country should also provide details of where to obtain reference material, and provide contact details. Ideally, a system should be established where persons requiring particular information could contact one source for this information. A clearing house or document supply centre would be very useful, and would improve information accessibility in the Middle East enormously. Information availability should not have to depend on the goodwill and resources of those in possession of particular material.
- Tomàs Vives (1993) *cited in* Costa et al (1996) stated that *all* wetlands, irrespective of their importance, should be covered by a national wetlands inventory. This is particularly true in Middle Eastern countries where water is often ephemeral, and generally a scarce to rare resource.

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Annex 1 Outputs from the meta-data analysis of the Middle East dataset

Scale of Inventory of Material	
Global Scale	50%
Supra-Regional Scale	0%
Regional Scale	0%
Sub-Regional Scale	50%
National Scale	25%
Single country studies	0%
National Scale refs including more than one country	25%
Sub-National Scale	0%
National and other Scale Combination	25%
Source is a Directory/Inventory or equivalent?	
Yes	50%
No	50%
Type of Source Material	
Peer Review Journals	0%
Peer Review Books	0%
Chapters in Books	0%
Conference or Keynote Presentations	0%
Article in Conference Proceedings	0%
Internal Government Reports	0%
Government Formal Publications	0%
Other Government Materials	0%
NGO reports	0%
Formal NGO Publications	75%
Consultancy Reports	0%
Newsletter Articles	0%
Practitioner Periodical Articles	0%
Database Manuals	0%
Electronic Databases	25%
World Wide Web Articles	0%
Theses	0%
Other	0%
Unknown	0%
Language of Study	0%
English	100%
Other	0%
Format of Study	
Paper	75%
Electronic text	25%
Electronic Database	25%
Personal Communication	0%
Web Presentation	0%
Format of Study, continued	
Part of GIS or GIS Output	0%
Map Based	0%
Other Format	0%
More than one format	25%

Circulation of Study	
Published	75%
Interdepartmental (unpublished)	0%
Internal (unpublished)	25%
Restricted (unpublished)	0%
Unrestricted (unpublished)	0%
Other Types	25%
Unknown	0%
More than one type	25%
Data Storage Media	
Paper	75%
Web (electronic)	0%
Electronic Database	50%
Other Electronic (not web or DB)	50%
GIS	0%
Hard Copy Map	25%
Digitised Map	0%
Other	25%
Unknown or Ambiguous	25%
More Than One Medium	75%
Study Implementation	
International NGO	100%
National NGO	0%
Sub National NGO	0%
Local NGO	0%
International GO	25%
National GO	0%
Sub National GO	0%
Local GO	0%
Private Agency/Individual	0%
Study Implementation, continued	
Consultancy Agency	0%
Academic Institution	0%
Other body	0%
Unknown	0%
More than one Agency or Body	25%
Study Funding	
International NGO	75%
National NGO	25%
Sub National NGO	0%
Local NGO	0%
International GO	0%
National GO	25%
Sub National GO	0%
Local GO	0%
Private Agency/Individual	0%
Consultancy Agency	0%
Academic Institution	0%
Other body	0%
Unknown	0%
More than one Agency or Body	25%

Statement of Objectives	
Objectives Explicitly Stated	75%
Objectives Not Explicitly Stated	0%
Unknown	25%
Main Objectives of Study	
General Biodiversity	25%
Biodiversity Research	0%
Baseline Biodiversity	0%
Repeat Survey/Surveillance	0%
Management Tool for Biodiversity	0%
Biodiversity Monitoring	0%
Wetland Products	0%
Geographical	0%
International Designation	75%
Baseline Inventory	0%
Academic Research	0%
Land Use Planning	0%
Wetland Services	0%
Public Education	50%
Other Research	0%
Other	75%
Wetland Definition	
Definition Provided	50%
Definition Implied	50%
No Definition Provided or Implied	0%
Unknown/Ambiguous	0%
Ramsar Definition	
Ramsar Definition Used	50%
Ramsar Definition NOT used	0%
Use of Ramsar Definition Unknown	50%
Ramsar Classification	
Ramsar Wetland Types Used	25%
Other Wetland Classification Used	0%
Wetland Classification Varies	0%
Unknown	0%
Not Applicable	75%
Extent of Coverage	
All Wetlands	0%
Part of Wetland Resource	100%
Ambiguous	0%
Basis of Selection (if not complete wetland coverage)	
Geography / Jurisdiction	25%
Land Cover or RS Data	0%
Landform Type	0%
Suprahabitat	0%
Habitat Type	25%
Floral / Faunal Groups or Species	25%
Climate	0%
Wetland Function	0%
Hydrology	0%
Biodiversity Value	75%
Cultural Value	0%
Artefact of Data Collection	0%

Basis of Selection (if not complete wetland coverage), continued	
Other Basis	25%
Unknown or Ambiguous	0%
More than One Basis	75%
Temporal Scale	
Studies With a Temporal Scale	0%
Partly Include a Temporal Scale	0%
No Temporal Scale (eg Review)	100%
Unknown	0%
Discrete Surveys	0%
Not Discrete Surveys	100%
Ad Hoc Surveys	50%
Not Ad-Hoc Surveys	50%
Update Purpose to Add Sites	50%
Update Purpose to Review Status	0%
Update Purpose to Make Corrections	50%
Other Update Purpose	0%
Unknown Purpose	0%
Current /Ongoing Surveys	0%
Updated on Ad-hoc Basis	0%
Updated on Annual Basis	0%
Frequency of Update Unknown	0%
Data Collection Methodology	
Collation or Review	100%
Ground Survey	0%
Remote Sensing	0%
Questionnaire Survey	25%
More Than One Methodology	25%
Unknown Methodology	0%
Extent of Ground Survey	
Total	0%
Partial	0%
Unknown	0%
Type of Remote Sensing	
Satellite Imagery	0%
Aerial Photography	0%
Videography	0%
Radar Imagery	0%
LIDAR Imagery	0%
Map Product	0%
Unknown	0%
Summary Provided	
Summary Provided	50%
Summary NOT Provided	50%
Not Known if Summary Provided	0%
Wetland Type Coverage	
Sources Providing Area Values per Wetland Type	50%
Sources PARTIALLY Providing Area Values per Wetland Type	0%
Sources NOT Providing Area Values per Wetland Type	50%
Not known	0%

Wetland Loss and Degradation	
Sources Providing Information on Wetland Loss &/or Degradation	0%
Sources NOT Providing Information on Wetland Loss &/or Degradation	100%
Not known	0%
Wetland Status Description	
Overall Wetland Status Description Included	50%
Overall Wetland Status Description NOT Included	50%
Unknown	0%
Values and Benefits	
Some Level of Information	0%
Always	0%
Most of the time	25%
Commonly	0%
Sometimes	0%
Rarely	50%
Never	25%
Unknown	0%

Annex 2 Best estimates of Wetland Coverage

Country name (& Code) AFGHANISTAN AFG		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Scott 1995	301	0	25,291	200	25,491	Area of specific wetland types stipulated
2 0	301	0	*75,000*	*0*		Area of a combination of wetland types given
3 0	0	0	*0*	*0*		Total area for Afghanistan
4 0	0	0	75,000	0	75,000	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		0	100,291	200	100,491	

Notes/comments on best estimate

No other estimates other than Scott identified for Afghanistan

Date of best estimate 27-Aug-98

	Country name (& Code) BAHRAIN BHR		***Area (ha) Wetland***				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	2	0	0	2	Date of extraction 14 August 1998; data available for only one site (out of two)
2	Spalding, Blasco and Field 1997	501	300	0	0	300	i) Estimate of mangrove only. ii) Data based on Abbott (1995) unpublished report for WCMC and Reefbase.
3	Scott 1995	301	8,500	0	240	8,740	Marine/Coastal is overestimation based on records which included areas of whole islands. Man-made figure includes some Tp inland, and does not include a type 7 mentioned but without area…
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			8,500	0	240	8,740	

Notes/comments on best estimate

No other estimates for Bahrain identified other than Scott 1995, therefore values must be used for best estimate.

Date of best estimate 21-Aug-98

	Country name (& Code)		*Area (ha) Wetland*				
	IRAN						
	IRN		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	635,500	721,650	-	1,357,150	Date of data extraction August 14th 1998
2	Spalding, Blasco and Field 1997	501	74,900	0	0	74,900	i) Estimate of mangrove only. ii) Data based on Mobayen and Tregubove (1970) Carte de la vegetation naturelle de l'Iran. 1: 2,500,000
3	Scott 1995	301	39,370	67,953	4,000		Value for specific wetland types
4	0	0	822,257	929,582	600		Values for wetland complexes which cannot be easily spilt into wetland areas per wetland type
5	0	0	*861,627*	*997,535*	*4,600*	1,863,762	Total value for Scott 1995 entry for Iran
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			861,627	997,535	4,600	1,863,762	

Notes/comments on best estimate

Scott 1995 is the only comprehensive estimate identified and is therefore used as a best estimate

Date of best estimate 27-Aug-98

	Country name (& Code) IRAQ IRQ		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	Reference code					
1	Scott 1995	301	*56,000*	*616,650*	*32,500*		Specified wetland type area
2	0	0	*0*	*1,319,850*	*?*		Lumped (mostly inland) wetland types' area
3	0	0	56,000	1,936,500	32,500	2,025,000	Total area of wetlands according to Scott 1995
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			56,000	1,936,500	32,500	2,025,000	

Notes/comments on best estimate

No other estimates other than Scott 1995 were identified and therefore values used for best estimate.

Date of best estimate 27-Aug-98

Country name (& Code) ISRAEL ISR		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Ramsar database	none	0	?	366	366	Date of data extraction August 14th 1998
2 Spalding, Blasco and Field 1997	501	300	0	0	300	i) Estimate of mangrove only. ii) Data based on Abbott (1995) unpublished report for WCMC and Reefbase.
3 Evans 1994	302	1,363	17,000	512	18,875	Values are underestimate and placed in wetland types very approximately.
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		1,363	17,000	512	18,875	

Notes/comments on best estimate

No other estimates other than Evans were identified, and therefore values must be used for best estimate

Date of best estimate 27-Aug-98

Country name (& Code) JORDAN JOR		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	**Reference code**					
1 Ramsar database	none	0	7,372	?	7,372	Date of data extraction : August 14th 1998
2 Scott 1995	301	0	*250*	*1,800*		Values for specific wetland types
3 0	0	0	*110,300*	*0*		Values for wetlands complexes which cannot be separated out into area per wetland type
4 0	0	0	110,550	1,800	112,350	Total value for Scott 1995 for Jordan
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		0	110,550	1,800	112,350	

Notes/comments on best estimate

No other estimates other than Scott identified for Jordan

Date of best estimate 27-Aug-98

	Country name (& Code) KUWAIT KWT		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	Reference code					
1	Scott 1995	301	6,523	450	0	9,223	Total area is much higher than sum of coastal, inland and man-made, since many times areas are mixed and cannot be split.
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4		0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			6,523	?	?	9,223	

Notes/comments on best estimate

The inland area of Scott 1995 is a large underestimation of the real situation, therefore it has not been used.
The coastal area is also an underestimation, the total area includes figures for mixed coastal/inland/man-made wetland types.
Therefore 2700 ha is undescribed, in terms of wetland type

Date of best estimate 26-Aug-98

Country name (& Code) LEBANON LBN		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Scott 1995	301	?	280	?	780	Total area which is provided by Scott 1995 is more than the partial areas, since some is described as "mixed inland and coastal" wetlands but the area values not quantified.
2 0	0	0	0	0	0	0
3 0	0	0	0	0	0	0
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		?	?	?	780	

Notes/comments on best estimate

see notes with Scott, 1995: only total can be used. It is probably an underestimation.

Date of best estimate 26-Aug-98

	Country name (& Code) OMAN OMN		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	Reference code					
1	Spalding, Blasco and Field 1997	2998	3,400	0	0	3,400	i) Estimate of mangrove only. ii) Data based on IUCN (1986), (1988) & (1988) Oman Coastal Zone Management plans.
2	Scott 1995	301	325,650	0	0	325,650	Included in the figure for coastal is 288.800 ha classified as "mixed coastal with minor inland"
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			325,650	?	?	325,650	

Notes/comments on best estimate

Scott's figure for coastal area may be an overestimation, see notes with Scott 1995.

The figure for total area probably is an underestimation, since no inland or man-made wetlands were included at all.

Date of best estimate 27-Aug-98

	Country name (& Code) QATAR QAT		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Scott 1995	301	3,065	0	51	15,116	There is 12.000 ha mixed coastal/marine with some inland that could not be split.
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			?	?	51	15,116	

Notes/comments on best estimate

The estimate for man-made is probably low (only two sites included).

The estimate for coastal could not be made, since 12.000 ha of mostly coastal wetland area could not be split into coastal and inland.

(note: some 15065 ha are included in the total area estimate, but not attributed to a wetland type)

Date of best estimate 27-Aug-98

	Country name (& Code) SAUDI ARABIA SAU		***Area (ha) Wetland***				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Spalding, Blasco and Field 1997	2998	29,200	0	0	29,200	i) Estimate of mangrove only. ii) Data based on IUCN/MEPA maps (1984/1985)
2	Scott 1995	301	796,273	168,525	750	982,598	The overall total does not match the subtotals for coastal, inland and man-made, since there was some limited area defined as "mixed coastal/inland" and "mixed inland/man-made".
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			796,273	168,525	750	982,598	

Notes/comments on best estimate

The best estimates are at least a little underestimation, see notes with Scott 1995.
(some 17050ha are included in the total for best estimate but not accorded to a wetland type)

Date of best estimate 27-Aug-98

Country name (& Code) SYRIA SYR		*Area (ha) Wetland*				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	**Reference code**					
1 Ramsar database	none	0	0	0	0	no data yet, Syria is a new Contracting Party that has not submitted data yet for its one Ramsar site.
2 Scott 1995	301	50	40,050	68,300	154,900	Although a marine area is given, no marine wetland types are known. An additional 46,500 ha are classified as "mixed inland and man-made"
3 0	0	0	0	0	0	0
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		?	?	?	154,900	

Notes/comments on best estimate

All values under Scott are a clear underestimation; marine because of the length of Syria's coastline, and inland and man-made because of the 46.500 ha mixed area mentioned in the notes.

Date of best estimate 27-Aug-98

Country name
(& Code)
YEMEN

YEM

	Reference author	**Reference code**	MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
1	Spalding, Blasco and Field 1997	501	8,100	0	0	8,100	i) Estimate of mangrove only. ii) Data based on IUCN (1987) , plus additions from Sheppard (1992).
2	Scott 1995	301	77,400	832	8	100,865	Additional information: 500 ha mixed type M/N; mixed inland/coastal 22.500 ha; mixed coastal/man-mde 50 ha; mixed inland/man-made 75 ha.
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			77,400	?	?	100,865	

(Column group heading over MARINE/COASTAL, INLAND, MANMADE and TOTAL: ***Area (ha) Wetland***)

Notes/comments on best estimate
The marine/coastal estimate is an underestimation, see notes with Scott 1995.
Inland and man-made estimates cannot be made from these data, see notes with Scott 1995
(note: Some 23465 ha are included in the best estimate of the total, but not attributed to a wetlands type)

Date of best estimate 27-Aug-98

Country name (& Code) United Arab Emirates ARE		*Area (ha) Wetland*				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	**Reference code**					
1 Scott 1995	301	1,715,740	700	0	1,716,440	Wetland types N+M listed for 700 ha; mixed coastal/inland 19,550 ha; mixed man-made/coastal 2.250 ha; mixed inland/man-made 7.200 ha.
2 0	0	0	0	0	0	0
3 0	0	0	0	0	0	0
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		1,715,740	700	?	1,716,440	

Notes/comments on best estimate

In the total coastal/marine area, some open sea is included. The total is still a little underestimation (see notes Scott 1995)
For inland this is an underestimation, for man-made, no estimate could be made.

Date of best estimate 27-Aug-98

Annex 3

Extraction of data from: Scott 1995, A Directory Of Wetlands In The Middle East

NOTE: Figures in the Area column have been imported from original word-processed files via macro. NOT all figures necessarily apply to *wetland* area. In the Wetland Description column an attempt has been made to assign codes for Ramsar Wetland Type (See Annex 4).

AFGHANISTAN	**Dir. ID**	**Wetland Description**	**AREA**
	1a	O	Area: Zor Kol c.3,500 ha;
	1b	O	Chaqmatin Lake c.2,500 ha.
	(2)		(Area: Present area unknown; formerly at least 40,000 ha.)
	2a	FloodPlain wetlands	20,000 ha
	2b	Riverine wetlands	20,000 ha
	3	6x Lakes [O]	Area: Combined area of lakes 600 ha; area of National Park 41,000 ha.
	4	Brackish Lake [Q] +marshes	Area: 191 ha.
	5a	Barrage [6]	Area: Lake Sarobi 200 ha;
	5b	Lake [O]	Area: Lake Duronta 2,000 ha.
	6	Brackish Lake [Q]	Area: Ab-I Nawar 3,500 ha; Waterfowl Sanctuary 7,500 ha; Dashte Nawar plain 70,000 ha.
	7	Alkaline Lake [Q]	Area: Maximum area of lake c.13,000 ha; Waterfowl Sanctuary 27,000 ha.
	8	O & (extensive) Tp/Ts marshes	Area: c.35,000 ha.
BAHRAIN	**Dir. ID**	**Wetland Description**	**AREA**
	1	A,G,I,(Tp,9)	Area: Approximately 2,500 ha.
	2	Artificial lake [7, Tp]	Area: 240 ha.
	3	E,G	Area: 200 ha.
	4	G,B	Area: 500 ha.
	5	A,E,B	Area: Approximately 5,300 ha of islands.

IRAN	Dir. ID	Wetland Description	AREA
	1	Q/R & T/S marshes	Area: 600 ha.
	2	3,M,W,Tp/Ts	Area: 3,000 ha.
	3	O/P,Tp	Area: 120 ha.
	4	Q (hypersaline), Sp	Area: 483,000 ha.
	(5)		(Area: 2,500 ha)
	5a	Q + marshes	Area: Shur Gol 2,000 ha;
	5b	O + marshes	Area: Yadegarlu 350 ha;
	5c	O + marshes	Area: Dorgeh Sangi 150 ha.
	6	Tp	Area: 500 ha.
	7	Tp & Ts	Area: 400 ha.
	8	O-Q + marshes	Area: 1,200 ha.
	9	6	Area: 1,000 ha.
	10	A,E,J,K + marshes	Area: 650 km of shoreline.
	11	Xf,Tp	Area: Area of wetland unknown; within a Protected Area of 949 ha.
	12	6,Xf	Area: 45 ha.
	13	O,Tp	Area: 200 ha.
	14	Complex of K, Tp, Ts, E, 6 types [for retaining irrigation water, thus not really “3”]	Area: Approximately 15,000 ha.
	15	Complex of A, Tp, Ts, E types	Area: 500 ha.
	16	Lake [O], some Tp	Area: 1,230 ha.
	17	Several 6 types [for retaining irrigation water, thus not really “3”]	Area: 1,000 ha.
	(18)		(Area: 1,600 ha)
	18a	6, 3	Area: Seyed Mohalli and Zarin Kola 600 ha;

	18b	Ts	Area: Larim Sara 1,000 ha.

IRAN	Dir. ID	Wetland Description	AREA
	19	(2x) K with Tp	Area: 950 ha.
	20	A, E, Tp?, Ts	Area: 97,200 ha. [Gorgan Bay is 23,800 ha]
	21	J 4,850 ha + Sp(?) 150 ha????	Area: c.20,000 ha including 4,850 ha of lagoons.
	(22)		(Area: 1,540 ha; Ramsar Site 1,400 ha.)
	22a	R-P	Area: Alagol 900 ha;
	22b	O-P, Tp	Area: Ulmagol 280 ha;
	22c	O-P, Tp	Area: Ajigol 360 ha;
	23	O, Tp	Area: 50 ha.
	24	6	Area: 500 ha.
	(25)		(Area: 550 ha) (Bibishervan 300 ha; Eymar 250 ha).
	25a	O, Tp	Area: Bibishervan 300 ha;
	25b	O, Tp	Area: Eymar 250 ha.
	26	O, Tp	Area: 1,550 ha.
	27	Tp	Area: 400 ha.
	28	6	Area: 1,500 ha.
	29	Tp, Xf	Area: c.15,000 ha (3,500 ha of permanent wetlands).
	30	Tp, Ts, O, Xf	Area: c.20,000 ha (8,000 ha of permanent wetlands).
	31	4, Tp	Area: 2,500 ha.
	32	Tp (4)	Area: 12,000 ha.
	33	Ts, 4, (O = 3 ha)	Area: 20,000 ha.
	34	Sp,Ss,Tp,Ts,4	Area: c.30,000 ha.
	35	F,G,Tp,Ts,Sp,H,E,J?	Area: 425,140 ha. Ramsar Site 400,000 ha.
	(35a)		Area: Shadegan Marshes 282,500 ha;

	(35b)		Area: Khor-al Amaya 19,200 ha;

IRAN	Dir. ID	Wetland Description	AREA
	(35c)		Area: Khor Musa 123,440 ha.
	36	2x O + Tp	Area: 1,400 ha.
	37	Tp (Ts)	Area: 1,600 ha.
	38	Ts	Area: 1,500 ha. {Site “will disappear” pers comm. J. Mansoori, 20/08/98}
	(39)		(Area: 63,300 ha. Ramsar Site 43,000 ha.)
	39a	Q	Area: Gavekhoni Lake 12,000 ha (13,000 including about 1,000 ha of marsh).
	39b	Tp? (delta marshes)	Area: about 1,000 ha of marsh.
	39c	Ts	Area: about 50,300 ha (63,300 - 13,000 ha).
	40	6	Area: Unknown.
	41	O/P (“semi-permanent”) + marshes	Area: 4,700 ha.
	42	2x O, 5x P, + marshes	Area: 70 ha. {Site “is gone” pers. comm. J. Mansoori, 20/08/98}
	(43)		(Area: Ramsar Site 6,600 ha [Dasht-e Arjan 2,400 ha; Lake Parishan 4,200 ha]).
	43a	P+Ts, Y	Area: Dasht-e Arjan 2,200 ha;
	43b	Q (almost O), Sp (almost Tp)	Area: Lake Parishan 4,000 (4,200 max) ha.
	44	Q, Tp-Sp (400 ha at max),Y	Area: 21,600 ha at maximum extent of flooding.
	(45)		(Area: Ramsar Site 108,000 ha.)
	45a	2x Q,Tp,Ts,Y	Area: Lake Bakhtegan and Lake Tashk 136,500 ha;
	45b	Tp,Ts,3	Area: Kamjan Marshes 5,250 ha.
	46	O (?)	Area: Unknown.
	(47)		Area: c.170,000 ha. Ramsar Site 50,000 ha.
	47a	O/P(“semi-permanent”),L,Ts/Tp,Sp,Q	Area: Hamoun-i Sabari 101,300 ha;
	47b	O/P(“semi-permanent”),L,Ts/Tp,Sp,Q	Area: Hamoun-i Hirmand 65,600 ha.
	48	O,(P,Tp,Ts)	Area: 14,900 ha. Ramsar Site 10,000 ha.

	49	C,E,(A?)	Area: 312 ha.

IRAN	Dir. ID	Wetland Description	AREA
	50	K,J,G,F,H,Tp	Area: 35,600 ha.
	51	A,G,E	Area: 27,000 ha.
	52	F,G,Tp,M,0,H	Area: 26,870 ha.
	53	D,E,Sp,F	Area: 2,045 ha (Nakhilu 15 ha; Morghu 2,000 ha; Ummal Korm 30 ha).
	54	C,D,E (A?)	Area: 160 ha.
	55	D	Area: 2,620 ha.
	56	F,I (6,800 ha),G,E	Area: 100,000 ha.
	57	F,I (300 ha),G,E,A,N	Area: 11,800 ha of wetlands. Ramsar Site 20,000 ha.
	58	F,I (900 ha),G,E,N	Area: 15,000 ha.
	59	F,I (100 ha),G,E,(N?)	Area: 11,500 ha.
	60	F,I,G,E,N	Area: c.14,000 ha.
	61	A,B,C,E,F,G	Area: 9,000 ha.
	62	A,B,C,E,F,G	Area: 33,500 ha.
	63	N/M,F,Tp,I,G	Area: Lower Sarbaz River 2,900 ha; Khor Govater 11,560 ha.
IRAQ	**Dir. ID**	**Wetland Description**	**AREA**
	1	Tp? O? [“complex of marshes and lakes”] M	Area: Unknown.
	2	Q (Tp,9)	Area: c.230,000 ha.
	3	6,Tp,Xf,7	Area: c.20,000 ha.
	4	Q/R,(Tp,5)	Area: 5,000-8,000 ha.
	5	“remnants” of 6,O,Tp	Area: c.2,000 ha.
	6	Ss,R,Q,3	Area: c.40,000 ha. (Q=50 ha)
	7	R/Q,Sp/Ss,M	Area: c.40,000 ha.
	8	Q (or 6?),(9)	Area: At least 20,000 ha.

	9	Q,O,Tp	Area: c.150,000 ha. (O=100 ha)

IRAQ	Dir. ID	Wetland Description	AREA
	10	Ts	Area: At least 1,000 ha.
	11	6,Tp	Area: Unknown.
	12	Tp,Ts,3	Area: c.10,000 ha.
	(13-31)		(Area: Between 1,500,000 and 2,000,000 ha.)
	13	O	Area: c.20,000 ha.
	14	O	Area: c.100,000 ha.
	15	Q	Area: c.50,000 ha.
	16	2x O “with extensive marshes”	Area: Haur Um Al Baram 5,000 ha; Haur Al Abjiya 5,000 ha.
	17	Tp/O	Area: 8,000 ha.
	18	Tp/Ts	Area: Unknown. Approximately 125 km in length.
	19	O/Tp	Area: c.32,500 ha.
	20	O (Tp)	Area: c.140,000 ha.
	21	Tp/O	Area: Unknown.
	22	2 [14x artificial ponds]	Area: Unknown.
	23	O/Tp	Area: c.27,500 ha.
	24	O	Area: c.40,000 ha.
	25	Tp,O	Area: c.25,000 ha.
	26	O	Area: 7,500 ha.
	27	Tp,O	Area: c.300,000 ha.
	28	O,Tp	Area: At least 350,000 ha.
	29	Tp,M,O/P,Ts	Area: c.15,000 ha.
	30	Ts,Tp	Area: c.220,000 ha.
	31	M	Area: Unknown. About 165 km in length.

	32	F, including G	Area: 20,000 ha.

IRAQ	Dir. ID	Wetland Description	AREA
	33	Tp/Sp? (90,000ha), G (36,000ha)	Area: c.126,000 ha.
	****	4 “new” reservoirs	Area: Unknown. Max 65 x 15km; Unknown. >30km long; c25,000 ha; c7,500 ha.
JORDAN	**Dir. ID**	**Wetland Description**	**AREA**
	Dir. ID	Wetland Description	AREA
	1	M,Tp,Y	Area: c.3,000 ha.
	2	6 (N)	Area: 26,700 ha.
	3	6 (N,Y)	Area: 10,600 ha.
	4	6 (M)	Area: Area of river basin 402,500 ha.
	5	8	Area: 300 ha.
	6	Sp/6/Tp/N	Area: Wadi Damia 18,600 ha; Kibed Pool 50 ha; Kafrein Dam 800 ha; Shu'eib Dam 600 ha; area of Swaimeh Pool unknown.
	7	N,M,Y	Area: Area of wetlands unknown; area of catchment 659,600 ha.
	8	O	Area: 200 ha.
	9	R/Ss	Area: c.3,000 ha.
	10	Ss/R (6,127ha), TP (50ha),1 (100ha), 5	Area: c.12,000 ha.
	11	Ss/R	Area: c.35,000 ha.
	12	Ss/R	Area: c.1,500 ha.
	13	D,C,E,B	Area: Unknown; 27 km of coastline.
KUWAIT	**Dir. ID**	**Wetland Description**	**AREA**
	1	8,Tp	Area: 250 ha.
	2	A (770 ha),G (890 ha)	Area: 1,660 ha.
	3	A (2595 ha), G (2250 ha), R/Ss (450 ha)	Area: Sulaibikhat Bay 4,845 ha; Doha Peninsula Nature Reserve 450 ha.
	4	C,E,D	Area: 18 ha.

	5	G,F,J,N,R/Ss	Area: c.2,000 ha.

LEBANON	Dir. ID	Wetland Description	AREA
	1	Ts,N	Area: 280 ha.
	2	D,E,U?,Tp	Area: c.500 ha.
OMAN	**Dir. ID**	**Wetland Description**	**AREA**
	1	E,I,N [The Khawrs here, have major type I components]	Area: Approximately 9,000 ha of wetlands along 300 km of coast, including Khawr Kalba 100 ha, Khawr Shinas 1,200 ha and Khawr Nabr 300 ha. {Khawr= "the mouths of wadis which flood occasionally"}
	2	G,A,J,(I),E,R/Ss,(C)	Area: Barr Al Hikman 290,000 ha (coastline 160 km, greatest area of exposed mudflats at least 22,000 ha). Masirah Island 109,500 ha (coastline 170 km, greatest area of exposed mudflats 2,000 ha).
	3	A,J,F,G,E	Area: Approximately 1,000 ha.
	4	K,E	Area: 100 ha.
	5	F,E,G	Area: Approximately 1,000 ha.
	6	F,Y,E,J,K,(I),(Tp? "from reeds")	Area: Total area unknown. Khawr Rawri 1,100 ha [K/J]; Khawr Hassan 300 ha[K/J]; Khawr ad Dahariz 150 ha [K/J]; Khawr Salalah 200 ha [K].
QATAR	**Dir. ID**	**Wetland Description**	**AREA**
	1	A,I,G,H,E	Area: 3,000 ha. [Max of 1,000ha = type I]
	2	G,D,E,(C)	Area: 65 ha.
	3	8	Area: c.50 ha.
	4	8	Area: About one hectare.
	5	A,F,G,E,D,C,R/Ss	Area: c.12,000 ha.
SAUDI ARABIA	**Dir. ID**	**Wetland Description**	**AREA**
	1	A,E,R/Ss,D,G,H,I,B,(C)	Area: 20,000 ha.
	2	E,R/Ss,(C)	Area: Approximately 12,500 ha.
	3	8	Area: Approximately 500 ha.
	4	C,E	Area: Approximately 190 ha, excluding surrounding reefs. (Harqus 2 ha, Karan 128 ha, Kurain 8 ha,

			Jana 33 ha and Juraid 20 ha).

SAUDI ARABIA	Dir. ID	Wetland Description	AREA
	5	A,E,G (+remnant I,B,H)	Area: Approximately 41,000 ha.
	6	N,Tp,R/Ss	Area: Approximately 7,500 ha.
	7	G,E,D,A,B	Area: 62,500 ha.
	8	Y,R/Ss	Area: 40 ha.
	9	Tp,3,6	Area: Approximately 2,500 ha (covering the original marsh plus the new reservoir). [new reservoir=150ha]
	10	8,6 [100ha],Tp	Area: Not defined.
	11	N,Tp	Area: 160,000 ha.
	12	O,Y,Tp	Area: 35 ha.
	13	9 (8),Tp	Area: 2,500 ha.
	14	O	Area: 3,000 ha.
	15	9 (8),Tp	Area: Approximately 300 ha.
	16	N/M	Area: Approximately 5,000 ha.
	17	Tp	Area: Approximately 200 ha.
	18	N/M	Area: Approximately 250 ha.
	19	6,N,Tp	Area: 2,500 ha.
	20	D,E,A,I,B,(C)	Area: Approximately 288,000 ha.
	21	I,F,E,C,H,R/Ss	Area: Approximately 700 ha.
	22	A,G,J?,E, R/Ss	Area: Approximately 900 ha.
	23	J,E?,I,B	Area: Approximately 40,000 ha.
	24	D	Area: 14.7 ha.
	25	G,J,E,I,B	Area: Approximately 150 ha.
	26	D,E,C	Area: Approximately 8 ha.
	27	A,G,I	Area: Approximately 200 ha.

	28	E,G	Area: 200 ha.

SAUDI ARABIA	Dir. ID	Wetland Description	AREA
	29	J?,G,R/Ss,I,Sp/Tp	Area: Approximately 1,000 ha.
	30	C,D,E,G,I,(B)	Area: The main archipelago lies within an area of 75 by 50 km; the site includes approximately 70,000 ha of land with 605 km of coastline; the proposed Marine Protected Area covers 331,000 ha.
SYRIA	**Dir. ID**	**Wetland Description**	**AREA**
	1	4	Area: Area of wetlands unknown; entire region 48,000 ha.
	2	O,1	Area: 800 ha (formerly 1,200 ha).
	3	O/P,Tp,Ts	Area: Area of wetlands unknown; entire region c.30,000 ha. {Wetlands may be gone. Evans 1994 ME IBAs}
	4	M,Tp,Xf,O,1	Area: Unknown; c.420 km of river.
	5	6	Area: 63,000 ha.
	6	6,Tp	Area: c.100 ha.
	7	Q,Tp/Sp,5	Area: 37,500 ha; maximum extent of flooding in recent years c.10,000 ha.
	8	R,Y	Area: c.20,000 ha.
	9	6	Area: 5,300 ha.
	10	coastal wetland	Area: c.50 ha.
	11	P,Ts	Area: Unknown.
	12	M,O,Tp	Area: Yarmuk Valley 20,000 ha; Lake Muzayrib 50 ha.
UNITED ARAB EMIRATES	**Dir. ID**	**Wetland Description**	**AREA**
	1	G,E,I,R/Ss,(C)	Area: 263,000 ha.
	2	G,E,I,R/Ss,H,A,B,C	Area: 478,000 ha, including sea area.
	3	D,E,C	Area: 455,000 ha, including sea area.
	4	D,C	Area: 380,000 ha, including sea area.
	5	A,D [a wetland?]	Area: 3,500 ha. The site excludes that part of the island which is developed.

	6	E,G,I,H,R/Ss	Area: 99,500 ha.
	7	R/Ss,8	Area: At least 3,000 ha.

UNITED ARAB EMIRATES	Dir. ID	Wetland Description	AREA
	8	D [a wetland?]	Area: 1,500 ha.
	9	F,G,8,E,I (introduced)	Area: Approximately 2,000 ha.
	10	8,H?,J	Area: c.250 ha.
	11	G,E,F,I	Area: Approximately 3,000 ha.
	12	G,E,I,J	Area: 5,000–7,500 ha.
	13	E,G,I,C,F,J	Area: 1,000–1,500 ha.
	14	J,G,F,E	Area: 4,600 ha.
	15	J,I,G,F,E,H,Y,Tp	Area: 19,550 ha.
	16	A,E	Area: 27,780 ha. About half of the site lies in UAE territory, the remainder being in Oman.
	17	6,Tp	Area: c.500 ha.
	18	N,F,G,E,H,	Area: Unknown.
	19	N/M	Area: Approximately 500 ha (including the main wadi system, cultivated areas and village).
	20	F,E,I,G,R/Ss	Area: 7,750 ha.
	21	N/M	Area: 200 ha.
	22	6,N	Area: Over 800 ha.
	23	Y/O,9,Tp	Area: c.1,400 ha.
	24	8,Tp,R/Ss	Area: 1,500 ha.
YEMEN	**Dir. ID**	**Wetland Description**	**AREA**
	1	E,G,D,I,(B)	Area: 30,000 ha.
	2	E,C,(I,B),D	Area: c.5,000 ha.
	3	A,E,G,I,C,B	Area: c.35,000 ha.
	4	M/N	Area: Unknown.

	5	G,I,E,A,R/Ss,C,B	Area: Unknown.
	6	8,Tp,A,G	Area: c.50 ha.

YEMEN	Dir. ID	Wetland Description	AREA
	7	A,G,J,I,R/Ss,Tp,B,C,N	Area: c.12,500 ha.
	8	G,I,R/Ss,B,C	Area: c.7,000 ha.
	9	J,R/Ss	Area: 100–200 ha.
	10	8 (8ha),Tp	Area: c.250 ha.
	11	Tp,M/N	Area: 90 ha.
	12	G,E,Tp,R/Ss	Area: c.10,000 ha.
	13	M/N	Area: c.500 ha.
	14	M/N,6,Tp	Area: 50–100 ha.
	15	E,J	Area: c.100 ha.
	16	J,E	Area: c.50 ha.
	17	E,F	Area: c.100 ha.

Annex 4

Ramsar Wetland Type [†]

Marine/Coastal

A – Permanent **shallow marine waters** less than six metres deep at low tide; includes sea bays and straits.

B – Marine **subtidal aquatic beds**; includes kelp beds, sea-grass beds, tropical marine meadows.

C – **Coral reefs**.

D – **Rocky marine shores**; includes rocky offshore islands, sea cliffs.

E – **Sand**, **shingle** or **pebble shores**; includes sand bars, spits and sandy islets; includes dune systems.

F – **Estuarine** waters; permanent water of estuaries and estuarine systems of deltas.

G – **Intertidal mud**, **sand** or **salt flats**.

H – **Intertidal marshes**; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes.

I – **Intertidal forested wetlands**; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests.

J – **Coastal brackish/saline lagoons**; brackish to saline lagoons with at least one relatively narrow connection to the sea.

K – **Coastal freshwater lagoons**; includes freshwater delta lagoons.

Inland Wetlands

L – **Permanent inland deltas**.

M – **Permanent rivers**/**streams**/**creeks**; includes waterfalls.

N – **Seasonal/intermittent/irregular rivers**/**streams**/**creeks**.

O – **Permanent freshwater lakes** (over 8 ha); includes large oxbow lakes.

P – **Seasonal/intermittent freshwater lakes** (over 8 ha); includes floodplain lakes.

Q – **Permanent saline/brackish**/**alkaline lakes**.

[†] The Ramsar *Classification System for 'Wetland Type'* was approved as Rec. 4.7. Annex 2 B., at the Fourth Meeting of the Conference of the Contracting Parties of the Ramsar Convention, Montreux, 1990 (Ramsar Convention Bureau, 1990). At the Sixth Meeting of the Parties, Brisbane, 1996, an additional wetland type 'subterranean karst wetlands' was added to the classification by Res. VI.5.

The actual codes used for data recording and input of Ramsar Wetland Type into the Ramsar Database, were developed subsequently to the Montreux Conference. The wetland type codes presently in use have evolved slightly but continue to accommodate the original 'classification'. This coding system is intended only to provide a very broad framework to aid swift identification of the principal wetland habitats represented at each site. This has ensured its global applicability. The framework was and is *not* intended as an attempt at a comprehensive wetland classification.

Literature cited: Ramsar Convention Bureau 1990. Proceedings of the fourth meeting of the conference of contracting parties. Montreux, Switzerland, 27 June to 4 July 1990. Vol. I. Gland, Switzerland.

R – **Seasonal/intermittent saline/brackish/alkaline lakes and flats**.

Sp – **Permanent saline/brackish/alkaline marshes/pools**.

Ss – **Seasonal/intermittent saline/brackish/alkaline marshes/pools**.

Tp – **Permanent freshwater marshes/pools**; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season.

Ts – **Seasonal/intermittent freshwater marshes/pools** on inorganic soil; includes sloughs, potholes, seasonally flooded meadows, sedge marshes.

U – **Non-forested peatlands**; includes shrub or open bogs, swamps, fens.

Va – **Alpine wetlands**; includes alpine meadows, temporary waters from snowmelt.

Vt – **Tundra wetlands**; includes tundra pools, temporary waters from snowmelt.

W – **Shrub-dominated wetlands**; Shrub swamps, shrub-dominated freshwater marsh, shrub carr, alder thicket; on inorganic soils.

Xf – **Freshwater, tree-dominated wetlands**; includes freshwater swamp forest, seasonally flooded forest, wooded swamps; on inorganic soils.

Xp – **Forested peatlands**; peatswamp forest.

Y – **Freshwater springs**; oases.

Zg – **Geothermal wetlands**

Zk – **Subterranean karst and cave hydrological systems**.

Note : 'floodplain' is a broad term used to refer to one or more wetland types, which may include examples from the R, Ss, Ts, W, Xf, Xp, or other wetland types. Some examples of floodplain wetlands are seasonally inundated grassland (including natural wet meadows), shrublands, woodlands and forest. Floodplain wetlands are not listed as a specific wetland type herein.

Man-made wetlands

1 – **Aquaculture** (eg, fish/shrimp) **ponds**

2 – **Ponds**; includes farm ponds, stock ponds, small tanks; (generally below 8 ha).

3 – **Irrigated land**; includes irrigation channels and rice fields.

4 – **Seasonally flooded agricultural land**.*

5 – **Salt exploitation sites**; salt pans, salines, etc.

6 – **Water storage areas**; reservoirs/barrages/dams/impoundments; (generally over 8 ha).

7 – **Excavations**; gravel/brick/clay pits; borrow pits, mining pools.

8 – **Wastewater treatment areas**; sewage farms, settling ponds, oxidation basins, etc.

9 – **Canals and** drainage **channels**, ditches.

* To include intensively managed or grazed wet meadow or pasture.

Review of wetland inventory information in Eastern Europe

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Contents

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1 Introduction

The Eastern European countries covered by this review are listed below in table 1.1. These countries constitute the Ramsar Region of Eastern Europe, which encompasses some twenty-two countries. This includes the Baltic Sea countries of Estonia, Latvia, Lithuania and Poland in the north. It also includes the land locked countries of the Czech Republic, Belarus, the Slovak Republic, Hungary and Armenia, and the Black Sea countries of Ukraine, Moldova, Romania, Georgia, the Russia Federation (extending across central and Eastern Asia) and Bulgaria, and the Caspian Sea country of the Republic of Azerbaijan. It encompasses the countries of Albania, Slovenia, Croatia, Bosnia and Herzegovina and the former Yugoslav Republic of Macedonia and Serbia and Montenegro in the south.

Table 1.1 Countries included in the Ramsar region of Eastern Europe

Countries included in Eastern Europe	
Albania	Latvia
Armenia	Lithuania
Azerbaijan, Republic of	Macedonia, the former Yugoslav Republic of
Belarus	Moldova
Bosnia and Herzegovina	Poland
Bulgaria	Romania
Croatia	Russian Federation
Czech Republic	Serbia and Montenegro
Estonia	Slovak Republic
Georgia	Slovenia
Hungary	Ukraine

This review was based on national datasets (including the possibility that a composite national dataset could be amalgamated by equivalent, eg provincial, data subsets). From the beginning, the assumption was made that significant (national) information on wetland extent, health, attributes and values might be found in many other information sources besides conventional wetland inventories or directories. It is believed that this constitutes a divergence from previous studies. While this broadened the scope and potential of the material examined, it also meant that all studies were effectively judged as if they were undertaken with wetland inventory objectives in mind. Often, of course, this was not the case.

Furthermore the authors acknowledge the following deficiencies in this study. The dataset is incomplete – for some countries this is more of a concern than for others. The compressed time frame and limited resourcing for a project of this nature probably promoted certain biases (for example, over-reliance on English language studies and on the more-familiar elements of contact networks) and was likely heavily influenced by the lag time between requests for study material, and its ultimate receipt. Finally, due to time and resource constraints, spatial information datasets have not been adequately reviewed; this constitutes a large gap in this preliminary study.

Boundaries are not authoritative

Figure 1.1 Map of the Eastern Europe region

2 Information sources

2.1 Search strategy

This review can simply be described as an inventory of wetland inventories based on national datasets (including composite national datasets that were amalgamated from equivalent, eg 'provincial', data subsets).

Potential sources of wetland inventory data were identified through communications with an extensive network of contacts (Annex 1), and using the World Wide Web, external (eg Wageningen Agriculture University databases) and in-house libraries, Ramsar National Reports, and IWRB National Reports. Key words used in literature searches included combinations of the more obvious terms such as:

> *wetland, wetlands, inventory, extent, status, distribution, classification, directory, overview, review*

and habitat names including the following:

> *grasslands, peat, peatland, bog, marshes, swamp, lakes, water, reservoirs, pond*

and less obvious terms such as:

> *survey, area, intertidal, subtidal, riparian, aquatic, coastal, evaluation, mapping, census, state, waterfowl, waterbirds*

also non-English search terms including:

> *Les zones humid, Le zone umide, zones humides d'importance, Flussordnungszahlen, Le Littoral, los Humedales, resources cotieres*

Where the above terms did not prove successful for any individual country, a search by country name was conducted followed by a lengthy examination of the resulting ‘hits’.

In addition, the reference lists of material obtained were scanned for possible wetland inventory sources. In many cases this proved to be a more successful approach for identifying potential information sources than database or web searching, particularly for unpublished sources.

2.2 Evaluation of the Eastern Europe dataset

The methodology used to identify and evaluate material for the Eastern European dataset follows.

2.2.1 Evaluation of inventory material for inclusion in the EEUR dataset

Many potential sources were obtained, and their suitability for inclusion in the database was assessed. The decision whether to include or exclude certain sources depended on several factors. Poor quality material was not usually included except where no alternative data for a country could be obtained. Sub-national data were excluded except where no national information existed. In cases where material was encountered which contained no area data, but did contain other useful information, it was considered if no other information for that country was identified.

2.2.2 Meta-data recording

Each assessed information source was evaluated using a *Wetland Inventory Assessment Sheet* (WIAS) designed to permit rapid assessment and compilation of information about each identified inventory and to compile summary information about the wetland resource contained in each inventory. A set of guidelines for the completion of the sheet was also developed to facilitate consistent handling and coding of relevant information. Derivation of wetland coverage estimates and other wetland parameters are discussed in later sections.

A database was created to include information about each information source that was reviewed and recorded on a WIAS datasheet. Another database was also created to serve as a data dictionary of the codes (and their descriptions) which was used to represent various categories of information in the primary database.

Computer programs were written to analyse the majority of coded fields in the database. The analyses report on the presence or absence of codes or logical values (by use of a filtering system), and produced printed outputs. These outputs provide the meta-data breakdowns given in this report.

2.3 Materials sourced

Some 28 wetland inventory sources were included in the Eastern European (EEUR) dataset. The number of inventories examined per country is given in table 2.1 and graphically represented in figure 2.1.

The materials examined included both published (including World Wide Web articles, journal articles and books) and unpublished material, academic material (including peer reviewed material, MSc and PhD theses) governmental and non-governmental material, draft reports, newsletter articles, conference proceedings and consultancy reports.

Table 2.1 Numbers of material sourced per country in the Eastern European Ramsar region

Eastern Europe	**No. of materials sourced**
Albania	5
Armenia	1
Azerbaijan, Republic of	1
Belarus	2
Bosnia & Herzegovina	1
Bulgaria	4
Croatia	4
Czech Republic	3
Estonia	6
Georgia	3
Hungary	4
Latvia	6
Macedonia	5
Moldova	2
Poland	4
Romania	4
Russian Federation	7
Serbia & Montenegro	2
Slovak Republic	3
Slovenia	2
Ukraine	4

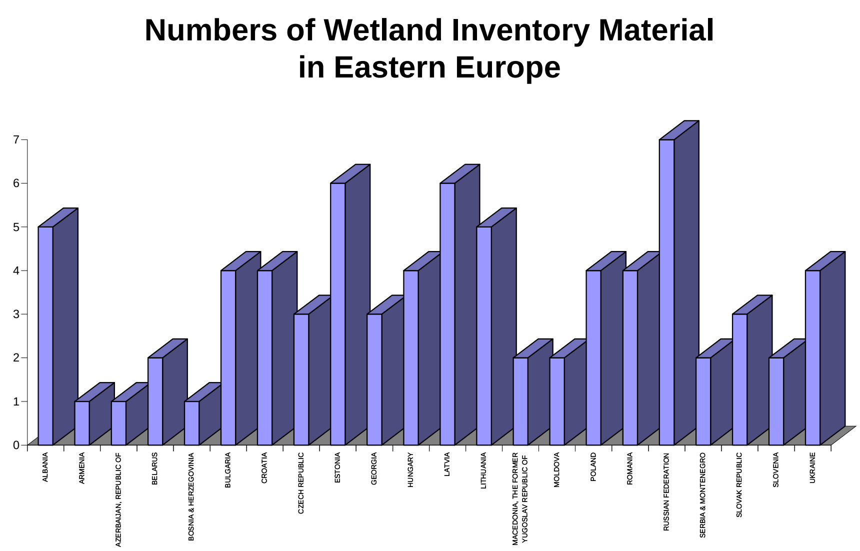

Figure 2.1 Numbers of wetland inventory material in Eastern European countries

As such, conventional wetland inventories and directories were examined, also natural resource inventories or habitat surveys (which either directly or indirectly included wetlands), and also sources which contained wetland extent information merely as a by-product of some other activity (eg waterfowl counts).

Since a degree of selection occurred in choice of material included in the Eastern Europe (EEUR) dataset, it cannot be stated that 'x' countries have more wetland inventory material than 'y' countries. In some cases, several sources of material were required in order to make a best estimate of wetland coverage for a specific country, whereas, for other countries, one source alone was comprehensive and detailed enough to provide a best estimate of wetland coverage.

2.3 Summary of information sources reviewed

The majority of materials examined (78%) were national level material and some 15% were supra-regional (ie covering more than one Ramsar region, though not covering every country in the regions).

Scale of inventory of material	
Global scale	4%
Supra-regional scale	15%
Regional scale	0%
Sub-regional scale	7%
National scale	78%
Single country studies	74%
National scale references including more than one country	4%
Sub-national scale	0%
National and other scale combination	4%

Non-governmental publications comprised 49% of material examined in the region (comprised of some 30% non-governmental organisation (NGO) produced reports and some 19% formal publications). Governmental organisation (GO) produced material comprising some 15% of material examined (comprised of some 45 internal government reports, 7% governmental formal publications and 4% other governmental material). This was similar to the material examined for Africa but differed greatly from Western Europe (Stevenson & Frazier 1999a,b) where most wetland inventory material was generated from governmental sources. Some 19% of material were published on the World Wide Web, and for these it was often not possible to identify whether this resulted from governmental or non-government efforts.

Type of source material	
Peer review journals	4%
Peer review books	4%
Chapters in books	4%
Conference or keynote presentation	0%
Article in conference proceedings	0%
Internal government reports	4%
Government formal publications	7%
Other government material	4%

NGO reports	30%
NGO formal publications	19%
Consultancy reports	0%
Newsletter articles	0%
Practitioner periodical article	0%
Database manual	0%
Electronic database	4%
World Wide Web article	19%
Thesis	0%
Other	4%
Unknown	7%

Some 63% of sources examined were either conventional inventories or directories, or their equivalent, a higher percentage than found in either Africa or Western Europe (Stevenson & Frazier 1999a,b).

Source is a directory/inventory or equivalent?	
Yes	63%
No	37%

The majority of studies were in English (78%), with the remaining sources in a variety of languages including Czech, Russian, Estonian and Latvian.

Language of study	
English	78%
Other	22%

Nearly all the materials were in paper format (78%), although 19% of the material was available on the World Wide Web, and some 7% were in electronic database format. Interestingly Eastern Europe had more wetland inventory information on the World Wide Web than material examined for the Western Europe, the Middle East and Africa region (Stevenson & Frazier 1999a,b), although in many cases the information was slim, often amounting to only a paragraph or less, and often part of the well publicised ‘State of the Environment’ reports. One notable exception to this was the Georgia State of the Environment World Wide Web report that contained excellent coverage of the Kolkhetti Lowland Wetlands (*Wetlands of Kolkhetti Lowland* 1997). It was noted however, that this information appeared to be directly taken from a report by Lansdown (1996).

Format of study	
Paper	78%
Electronic text	4%
Electronic database	7%
Personal communication	0%
Web presentation	19%

Part of GIS or GIS output	0%
Map based	0%
Other format	19%
More than one format	7%

Similarly, most information (70%) was stored in paper format, though 19% of information was stored within electronic databases, and 19% on the World Wide Web. A very small percentage was stored as digitised maps or hard copy maps (each at 4%), and for 4% the storage medium was unknown. Several were stored in more than one medium (15%) though this figure is probably an underestimate, since details of storage were often not stated in, for example, World Wide Web documents, which may also be stored on paper or as word-processed documents.

Data storage media	
Paper	70%
Web (electronic)	19%
Other electronic (not web or dbase)	7%
Electronic database	19%
GIS	0%
Hard copy map	4%
Digitised map	0%
Other	4%
Unknown or ambiguous	4%
More than one medium	15%

The majority (56%) of material examined had been published (in one way or another), which is slightly higher than the figure for Africa (only 43% published) (Stevenson & Frazier 1999a), but much lower than Western Europe (78% of material was published) (Stevenson & Frazier 1999b). (It is assumed that publications have greater circulation or dissemination potential than unpublished material.) The fact that non-governmental organisations are responsible for conducting wetland inventory activities in Eastern Europe rather than governmental organisations, may be the reason why only approximately half the wetland inventory material in this region is formally published.

Circulation of study	
Published	56%
Interdepartmental (unpublished)	0%
Internal (unpublished)	11%
Restricted (unpublished)	0%
Unrestricted (unpublished)	26%
Other types	7%
Unknown	4%
More than one type	4%

In Western Europe where GOs produce most of the wetland inventory material (Stevenson & Frazier 1999b), a higher proportion of the material is also published. A substantial amount of NGO inventory material throughout the Africa, Europe, Middle East region often comprised draft reports or unpublished final reports, which had not been published (presumably due to lack of funding). This seemed to be particularly prevalent in Eastern Europe, with many reports remaining unpublished covering wetlands in Belarus, Ukraine, Georgia, Moldova, Russia, Latvia and Lithuania.

2.5 Reliability of data

It is difficult to make judgements on the reliability of the individual data sources examined and included in this review when much of the material did not provide basic information. For instance, basic information such as the date of survey or date ranges of material featuring in a compilation/review, methodologies used, or contact information was frequently omitted. The tendency is to judge material as unreliable if it does not contain such basic information, but this judgement is by no means certain. The variety of classification schemes and definitions of wetlands used (often not defined) further hampers any attempts to judge the reliability of material. However, as material for individual countries is judged collectively, it becomes (subjectively) more clear which information sources are likely to be more reliable.

By examining the methods, the date ranges and inclusion (or exclusion) of particular wetland types it is possible to at least generate best estimates of wetland coverage for any particular country by consolidating the estimates from several sources. For example, one source may provide an estimate of wetlands in a country comprising an estimate of coastal wetlands which appears to be accurate, but an estimate of freshwater wetlands which noticeably excludes (for example) floodplains. The estimate for coastal wetlands would then be consolidated with the estimate of freshwater wetlands provided by another source examined that purports to include floodplain wetlands (providing it was a greater area than the other source).

Section 3.3 provides a more detailed description of how wetland area estimates by type were generated for this review, and provides guidance for interpreting the summary sheets of wetland coverage and extent (Annex 2) and material reviewed. Comments on the age of data, methods used and exclusions in coverage (eg the estimate excludes floodplain wetlands and ephemeral wetlands) are given and these provide an assessment of data reliability.

Several generic difficulties emerged throughout the evaluation process that should be noted when judging the reliability of data. These are summarised below.

- usage of different wetland definitions/classifications and the inclusion or exclusion of some wetland types, eg lakes and open water, in inventories. Certain wetland types are frequently excluded from wetland assessments (see section 3.1 for further details).
- artificial wetlands were also often largely ignored in many national inventories and therefore national inventories are often incomplete in their coverage.
- the date of data collection and inventory productions were often not recorded, and it should be noted that review compilations by their very nature, use different sources of widely differing ages (the dates of which are rarely stated).
- recent changes in political boundaries (a particular issue in Eastern Europe and the former USSR) made older sources difficult to interpret.
- defined boundaries of wetlands were often not provided, making comparisons between different sources difficult, as did the variable treatment of individual wetlands in wetland complexes.

- many sources lacked a summary, making extracting national-level information time-consuming; some of the material (which did provide a summary) contained summary information that did not always match the text of the report.
- the wide variety of languages of national inventories made extraction and review of information difficult and time consuming (and potentially expensive if translations were carried out).
- many potential wetland inventory information sources were unpublished material which proved to be difficult to obtain or access; much of the information that was accessed were also draft reports written up to 5 years ago which have never progressed beyond draft report stage.
- often the areas provided in many potential sources of information were site areas, eg national park areas and not actually wetland areas (these sources were excluded from the analysis, with the exception of Ramsar sites).
- contradiction of information about some sites *between* different references was found to occur. With a little detective work, in most cases it was possible to identify erroneous material, but this was not always possible.
- contradictions within *one individual* source document were also noted to occur. This meant that some detective work was often required to identify and rectify errors, resulting in slow assessment.

This project has identified several cases where source material has quoted wetland area estimates taken from studies that had been comprehensively updated by more recent studies, and therefore their estimates were out of date, and had been supplanted by more recent and accurate data. This creates a misinformation trail that makes it difficult to assess the accuracy of reports that yield conflicting data.

Some less accessible inventories have been missed in this review. Additional material has been identified since the analysis phase was completed and some key sources of material were therefore not incorporated in this preliminary analysis. Further additional sources may be revealed during the consultation phase and after circulation of the completed report. An update of the dataset is recommended after the consultation process has been completed.

3 Extent and distribution of wetlands

3.1 Definition and classification of wetlands

A major consequence of using the rather broad Ramsar definition of wetlands in this review (given in Annex 3 Definitions and Abbreviations) is that the estimates of wetland coverage generated by this project cannot strictly be regarded as estimates of true or actual wetland cover, but are instead estimates of *described* wetland cover. Consequently, the area values given in this review should be viewed as underestimates, and do not represent estimates of the entire wetlands resource, but only those for which coverage estimates already exist in their many disparate forms.

Differing wetland definitions and classification schemes were used in different studies and these definitions are not always stated, making it difficult to assess the degree of completeness of cover (and thereby the estimates of wetland extent). For instance, many inventories include or exclude some wetland types, eg open water bodies, and estuaries.

A definition of the terms ‘marine wetlands’, ‘coastal wetlands’ and ‘inland wetlands’, was almost without exception absent, and yet separate authors used them to mean different things.

Extracting information on even broad wetland categories was found to be difficult. Particularly when some authors use, for example, the term ‘coastal wetlands’ to mean strictly saline and brackish habitats and others use it to mean wetlands in the coastal zone (which often for practical purposes means coastal lowlands and incorporates wetlands which experience no tidal inundation). For instance, Lansdown (1996) provides a value of 39 844 ha of ‘coastal wetlands’ in Moldova, and yet Moldova does not have a coastline, although it is in close proximity to the Black Sea. Similarly the term ‘inland wetlands’ to some authors meant freshwater wetlands, to others it meant all wetlands except those in the coastal plain, to others it meant all wetlands except those wetlands under tidal influence.

It was apparent (though not defined) that many authors utilised a more narrow definition of wetlands than that given by the Ramsar definition. For instance, many authors may argue that wetlands must be vegetated (therefore mudflats and sand flats and open water would be excluded). Others may argue that coral reefs, seagrass beds and subterranean karst are not wetlands, and others may also exclude artificial or created wetlands from their definition of wetlands. Similarly, forested wetlands are often regarded as forests and not wetlands, and are therefore excluded from wetland assessments (and yet may also be excluded from forestry assessments for exactly the opposite reason).

It is therefore not surprising that certain wetland types were commonly excluded from wetland assessments. These include dune slacks, humid sands, wet mesotrophic grasslands, seagrass beds, maerl beds, glacial and alpine wetlands, artificial wetlands (especially reservoirs, fish ponds, rice paddies, dams etc) and, finally, recent additions to the Ramsar list of wetland types, such subterranean karst wetlands.

Wetland definition	
Definition provided	26%
Definition implied	44%
No definition provided or implied	30%
Unknown/ambiguous	0%
Ramsar definition	
Ramsar definition used	59%
Ramsar definition not used	15%
Use of Ramsar definition unknown	26%
Ramsar classification	
Ramsar wetland types used	56%
Other wetland classification used	4%
Wetland classification varies	0%
Unknown	22%
Not applicable	19%

In the Eastern European region several terms were commonly treated differently. These included different treatment of the terms ‘coastal’, ‘marine’ and ‘inland’, and ‘peat’, ‘bog’, ‘mire’ and ‘fen’. Estuaries, open water bodies, tidal flats, riparian systems, artificial waterbodies (eg reservoirs, flooded quarries etc) appeared to be excluded form many wetland inventories.

A definition of wetlands was provided in only 26% of studies; in 44% of cases a definition was implied, but in 30% of cases no definition was either provided or could be surmised. However, 59% of studies used the Ramsar definition of wetlands (though it was unknown for

26% of studies, so the true usage of the Ramsar definition of wetlands may be much higher). The Ramsar classification system for wetland type was used in 56% of studies (compare this with 7% in Western Europe, Stevenson & Frazier 1999b), was unknown for 30% of studies and not applicable for some 19% of studies (these were usually reviews or collations of material).

3.2 Overall extent of wetlands in Eastern Europe

In 89% of studies, only part of the wetland resource was examined, whereas all wetland resources were purportedly included in just 11% of studies. Where only part of the wetland resource was assessed by a study, the basis for selection was mainly influenced by landform type (ie inland, coastal, lowland, upland) and jurisdiction (ie over a province or sub-national region). This is interesting in that this differs from Western Europe where habitat type (eg forested peat, coastal marsh) was the most common basis for selection of wetlands for study. Some 44% were due to ‘other basis’ and these included wetlands of international importance, and ‘shadow’ Ramsar sites).

Extent of coverage	
All wetlands	11%
Part of wetland resource	89%
Ambiguous	0%
Wetland type coverage	
Sources providing area values per wetland type	52%
Sources partially providing area values per wetland type	44%
Sources not providing area values per wetland type	0%
Not known	4%

The fact that 89% of studies examined only part of the wetland resource should be noted when viewing the estimates of wetland coverage in each country in the region, since they are only estimates, rather than verified values.

Basis of selection (if not complete wetland coverage)	
Geography/jurisdiction	30%
Land cover or remotely sensed data	0%
Landform type	19%
Suprahabitat	0%
Habitat type	11%
Floral/faunal groups or species	0%
Climate	4%
Wetland function	0%
Hydrology	0%
Biodiversity value	15%
Cultural value	0%
Artefact of data collection	19%
Other basis	44%
Unknown or ambiguous	0%

More than one basis	48%

A summary of wetland coverage in Eastern Europe is presented in tables 3.1 and 3.2 below. The total area calculated by the EEUR dataset amounted to some 229 217 000 ha, covering 12% of the land surface. As would be expected, more than 96% (220 149 331 ha) of these were inland wetlands, with less than 2% described as marine/coastal wetlands (4 051 818 ha) and a further 0.15% described as artificial wetlands (355 700 ha).

It should be noted that if the data for Russia is removed from the EEUR dataset, a mere 0.6% of the land area is by covered by wetlands (11 580 000 ha). This is an extremely low percentage by comparison with that identified by the datasets for Western Europe and Africa (Stevenson & Frazier 1999a,b). It is also very low when you consider that according to Matthews and Fung (1987) more wetlands are located in temperate than in sub-tropical or tropical regions, and when you consider that Eastern Europe is much less populated than Western Europe. These statements by Matthews and Fung (1987) would suggest that the estimates of wetland coverage resulting from the EEUR dataset are a gross underestimate.

Since the scope and coverage of most inventory material did not state whether total wetland estimates included Ramsar sites, it is not possible to state whether this value includes, partially includes or excludes these sites. It must also be noted that the area values for Ramsar sites given in table 3.2 are site area and not wetland area.

Table 3.1 Wetland coverage in Eastern Europe as identified by the EEUR dataset

Eastern Europe	Estimate of area in hectares (ha)
Marine/coastal wetlands	4 051 818
Inland wetlands	220 149 331
Artificial wetlands	355 700
Area of unspecified types of wetland	4 660 123
Total area of wetlands identified in this study	229 216 972
# of national datasets per region	36
# of national datasets which can be regarded as comprehensive in cover	3

Table 3.2 Wetland coverage in Eastern Europe as a percentage of land cover, and Ramsar site information

Eastern Europe	
# of countries	22
Total land area of Region (ha)	1 944 683 100
Total area of wetlands identified in this study (ha)	229 216 972
Median value of wetland area (ha)	–
% of land area covered by these wetlands	11.79%
Total area of Ramsar sites (ha)	12 646 392
# of Ramsar Sites	128

(Source of Ramsar site Information: Ramsar Database, date of data extraction 17/8/98)

3.3 Wetland extent in Eastern European countries

Best estimates of wetland extent by broad wetland type (‘inland’, ‘marine/coastal’ and ‘artificial’) for the Eastern European countries are given in table 3.4. A description of how best estimates of wetland coverage per country were derived is outlined below.

3.3.1 Derivation of country ‘best estimates’ of wetland coverage

The estimates of wetland coverage cited in the material examined in this review (and included in the Eastern European dataset) were entered into a system of *country coverage files* (in spreadsheet format). An individual wetland coverage file for each country within the Eastern European region, was created to facilitate the generation of best estimates of wetland area coverage per country and to serve as a summary and provide an ‘audit trial’ of material included.

Each file (workbook) consisted of several components (worksheets) broken down by Ramsar wetland type and also by broad wetland category (marine/coastal, inland and artificial) as follows:

1. Sheet one contains area statistics for marine/coastal wetlands broken down by Ramsar wetland type (*types: A, B, C,D, E, F, G, H, I, J, K*).
2. Sheet two contains area statistics for inland wetlands broken down by Ramsar wetland types (*types: L, M, N, O, P,Q, R, Sp, Ss, Tp, Ts, U, Va, Vt, W, Xf, Xp, Y, Zg, Zk*).
3. Sheet three contains area statistics for artificial wetlands broken down by Ramsar wetland types (*types: 1, 2, 3, 4, 5, 6, 7, 8, 9*).
4. Sheet four contains ‘notes and comments’ which provides an indication of the reliability of the data (subjective assessment), and notes about methodology and or original sources of data.
5. Sheet five ‘summary’ contains the *total* values for ‘marine/coastal’, ‘inland’ and ‘artificial’ wetlands (not broken down per Ramsar wetland type) and the ‘notes and comments’ sheet. This sheet is generated automatically from sheets 1–4. Changes made to sheets 1–4 will update in the summary sheet.

The summary sheet (sheet five) for each country can be found in Annex 2. Where possible, approximate estimates per Ramsar wetland type were entered in the appropriate columns (in sheets 1–3; where this was not feasible, approximate values for broad wetland type were entered, and where this was not feasible, a total value was entered. This created a hierarchical system where it was possible to examine the quality of wetland coverage and extent information per country, which was assessed in the Eastern European dataset.

Each file provided wetland estimates, along with brief notes as to scope, and in particular, exclusions in coverage (eg open water bodies), and gave an indication as to the reliability of the data (sheet 4). This provided a convenient means of auditing all the material included in the dataset, and provides an ‘at a glance’ summary of the material examined.

Once all the wetland area values had been entered into a coverage file for each country, along with the appropriate notes on method and reliability, a subjective assessment of all material for each country was made. Best estimates were composed according to broad wetland category (marine/coastal, inland and artificial), and a justification of the rationale entered into sheet 5. Once the coverage files were completed for all the countries within a region, the estimates were compiled into a summary table (given in table 3.4).

It should be noted that several wetland inventories included information on more than one country, and hence these documents feature in many country coverage files. The number of materials (referred to as datasets) examined per country were totalled and also entered into the summary document for each region.

Please note: there are some notes which will appear on summary sheet five which refer to specific Ramsar wetlands or values shown on sheets 1–4 (in the individual country coverage files as described above). In a small number of cases the notes appearing on the summary sheet are not self-explanatory when viewed independently of sheets 1–4. This is regrettable, but unavoidable given the time constraints associated with the production of national overviews.

The summaries of wetland coverage for each Eastern European country deemed to have sufficient material to generate a 'best estimate' of wetland coverage either in total or by category type (inland, marine/coastal, artificial) can be found in Annex 2. Notes on the reliability of the assessment are included with each summary. Countries that were omitted from the 'best estimate' and reliability assessment due to lack of data in the WEUR dataset are given below in table 3.3.

Table 3.3 Countries omitted from the 'Best Estimate' and reliability assessment due to lack of data in the Eastern European (EEUR) dataset

Eastern Europe	
Armenia	Macedonia
Azerbaijan (Republic of)	Serbia and Montenegro
Belarus	Slovak Republic
Bosnia and Herzegovina	Slovenia

3.3.2 'Best estimates' of wetland coverage per country

'Best estimates' of Wetland Coverage per Broad Wetland Category for Countries in the Eastern Europe Region are given in table 3.4.

4 Rate and extent of wetland loss and degradation

The majority of sources examined (81%) did not provide any details of wetland loss and/or degradation. This does not mean that loss values do not exist, simply that the material sought for this review was wetland inventory material, which as it turned out, rarely dealt with these issues in any detail. No specific tasks were performed to identify material that specifically outlined wetland loss (in isolation of inventories/directories). Thus, wetland inventory material within the Eastern European region does not normally include any appreciable data on wetland loss. This may, however, be directly related to the time scale of most wetland inventory activities, which are largely discrete surveys, which have not yet been repeated.

Wetland loss and degradation	
Sources providing information on wetland loss and/or degradation	15%
Sources not providing information on wetland loss and/or degradation	81%
Not known	4%

Table 3.4 Best estimates of wetland coverage per broad wetland category for countries in the Eastern Europe Ramsar region[1]

	BEST ESTIMATES					**COVERAGE INFO**		**RAMSAR INFO**	
EASTERN EUROPE REGION	**Marine/Coastal (ha)**	**Inland (ha)**	**Artificial (ha)**	**Unspecified wetland type (ha)**	**Total (ha)**	# of datasets accessed per country [1, 2]	# of datasets which can be regarded as comprehensive in cover per country	Total area of Ramsar sites	# of Ramsar sites
ALBANIA	20 000	35 000	unknown		**55 000**	2	1?	20 000	1
ARMENIA	none	no data	no data		**no data**	0	0	492 239	2
AZERBAIJAN, REPUBLIC OF[3]	insufficient data	insufficient data	insufficient data		**insufficient data**	1	0	132 500	1
BELARUS	insufficient data	insufficient data	insufficient data		**insufficient data**	1	0	0	0
BOSNIA and HERZEGOVINIA	no data	insufficient data	no data		**insufficient data**	1	0	0	0
BULGARIA	unknown	10 000	220 000		**230 000**	2	0	2 803	5
CROATIA	unknown	unknown	unknown	116 423	**116 423**	2	1?	80 455	4
CZECH REPUBLIC	none	unknown	49 000		**49 000**	1	0	37 891	10
ESTONIA	unknown	unknown	unknown	4 543 700	**4 543 700**	5	0	215 950	10
GEORGIA	37 145	1 079	unknown		**38 224**	2	0	34 223	2
HUNGARY	none	50 000	26 000		**76 000**	2	0	149 841	19
LATVIA	142 600	640 165	3 500		**786 265**	3	1	43 300	3

1. Please consult 3.3.1 for a description of how these estimates were generated.
2. Excluding the Ramsar sites and GLCC databases.
3. Ramsar Site was designated by the former USSR; Azerbaijan has not yet acceded to the Convention on Wetlands.
4. The author Lansdown (1996) refers to these wetlands as 'coastal' and yet they are freshwater wetlands.

	BEST ESTIMATES					COVERAGE INFO		RAMSAR INFO	
EASTERN EUROPE REGION	**Marine/Coastal (ha)**	**Inland (ha)**	**Artificial (ha)**	**Unspecified wetland type (ha)**	**Total (ha)**	**# of datasets accessed per country[1, 2]**	**# of datasets which can be regarded as comprehensive in cover per country**	**Total area of Ramsar sites**	**# of Ramsar sites**
LITHUANIA	unknown	507 080	unknown		507 080	3	1	50 451	5
MACEDONIA	none	no data	no data		no data			18 920	1
MOLDOVA	39 844	unknown	unknown		39 844	2	1	0	0
POLAND	unknown	1 636 927	unknown		1 636 927	1	0	90 455	8
ROMANIA	unknown	269 080	unknown		269 080	1	0	647 000	1
RUSSIAN FEDERATION	578 599	217 000 000	57 200		217 635 799	5	0	10 323 767	35
SERBIA and MONTENEGRO	no data	no data	no data		no data			39 861	4
SLOVAK REPUBLIC	no data	no data	no data		no date			37 086	12
SLOVENIA	no data	no data	no data		no data			650	1
UKRAINE	3 233 630	unknown	unknown		3 233 630	2	0	229 000	4
Total estimated wetland cover	4 051 818	220 149 331	355 700	4 660 123	229 216 972	36	3	12 646 392	128

1. Please consult 3.3.1 for a description of how these estimates were generated.
2. Excluding the Ramsar sites and GLCC databases.
3. Ramsar Site was designated by the former USSR; Azerbaijan has not yet acceded to the Convention on Wetlands.
4. The author Lansdown (1996) refers to these wetlands as ‘coastal’ and yet they are freshwater wetlands.

Of the 15% of material in the Eastern European region which did provide some information, this was almost exclusively descriptive, rather than quantitative. Whilst wetland loss throughout Eastern Europe is thought to be substantial, very little quantification of loss or damage was uncovered in this review. It was therefore not possible to either refute or support other existing reported values. The following statement was published by OECD (1996):

> Some estimates show that the world may have lost 50% of the wetlands that existed since 1900; whilst much of this occurred in the northern countries during the first 50 years of the century, increasing pressure for conversion to alternative land use has been put on tropical and sub-tropical wetlands since the 1950s.

Jones and Hughes (1993) provided an overview of the extent of wetland loss in Europe. The only study allowing broad comparisons for a particular wetland type across the whole of Europe are that of Immirzi et al (1992), which reports loss rates for peatlands in excess of 50% for 11 European countries).

It was noted that a wide diversity of methodologies are used to measure wetland loss, and the lack of co-ordination between studies in different countries or for different wetland types prohibits any overview at regional level.

More recent information on wetland loss may have emerged since the works mentioned above. However, the important thing to note, is that, if the EEUR dataset is representative of the wetland inventory material that exists in Eastern Europe, we can conclude that wetland loss is rarely measured or recorded during wetland inventory activities in the region. Studies that specifically set out to measure wetland loss may have been undertaken, but loss values do not feature in inventory assessments.

Wetland status description	
Overall wetland status description included	44%
Overall wetland status description not included	48%
Unknown	7%

Similarly, of the material examined for Eastern Europe, only 44% included a description of overall wetland status in a country (though these descriptions were of course totally generic in nature). Overall, those that did provide such information often provided detailed individual site information (often the ‘study site’ subject to scientific research), and some studies provided an overview or summary of such information. These latter studies were generally not conventional wetland inventories or directories *per se*, and were frequently academic peer review publications, which are necessarily short in length. Where wetland loss information was provided it must be noted that the rates or amounts identified on a local scale do not necessarily reflect national trends in wetland loss. Overall, it can be said that the information on wetland loss was usually lacking, but where it was included it was highly variable and inconsistent in its detail.

Details of the major threats to wetlands are also lacking from most inventory material in the Eastern European region. Some site based studies do provide very brief descriptions of threats to individual wetlands; usually these studies are ones undertaken to designate or describe wetlands of ‘international importance’ (according to the Convention on Wetlands, Ramsar, 1971). Standard site descriptions are recorded on a Convention-approved form, the ‘Ramsar Information Sheet’ (RIS), and this *pro-forma* includes an information category called ‘Adverse factors’. This subject is recorded in the Ramsar Database according to an ad hoc set of past (but still influential), present and/or potential wetland threats (both in and around the site). These developed based on the data that have been provided, rather than fitting incoming data to a pre-existing structured classification.

Due to this historical legacy, the urgency, extent and character of any threat at any site listed has never been codified in the current (to be supplanted) database. Such information, if it exists, might be found in individual site files that support the database. Oftentimes, the level of detail provided is very low, and example statements include ‘peat cutting is common at the site’ ‘livestock grazing is causing physical damage to the wetland’, ‘water extraction for agricultural purposes is leading to a lowering of the water table’.

5 Wetland benefits and values

Wetland values as defined by the Ramsar Bureau, are ‘the perceived benefits to society, either direct or indirect, that result from wetland functions. These values include human welfare, environmental quality, and wildlife support’ (Ramsar Convention Bureau 1996).

A large proportion of material examined for the review was not a conventional inventory/directory (see section 2.4) and did not contain site by site information. These sources did not usually contain details of wetland values and /or benefits (other than generic statements), since they usually referred to wetlands at a national level (or at least above a local or provincial level) and would therefore not contain detailed management information.

Eastern Europe	**Inclusion of wetland values and benefits information (site based studies only)**
Some level of information	0%
Always	15%
Most of the time	11%
Commonly	7%
Sometimes	0%
Rarely	4%
Never	44%
Unknown	19%

Site based studies (usually wetland inventories *per se*) were treated differently in the evaluation process and were evaluated against Ramsar Information Sheet (RIS) categories, and the frequency (ie never, rarely, sometimes, commonly etc) of the inclusion of the RIS category was recorded. The frequency of inclusion of values and benefits information for *each and every site* described within (site based) studies was assessed. The results showed that 44% ‘never’ contained any values and benefits information; ‘rarely’ 4%; ‘sometimes’ 0%; ‘commonly’ only 7%; ‘most of the time’ 11%; and ‘always’ 15%. In the majority of non-site based studies, a paragraph or two describing values and benefits of wetlands in general was usually all that was provided. None of the material examined included any financial or economic estimates.

In the majority of site based studies (wetland inventories *per se*), values and benefits information amounted to one or two sentences per site. For example ‘the site experiences pressure from artisanal fisheries’, ‘the wetland provides flood buffer and water storage capabilities’, and ‘the area is a tourist destination and the wetland provides healing muds which are used in the many health spas'. In the majority of non-site based studies, a paragraph or two describing values and benefits of wetlands in general was usually all that was provided. None of the material examined included any financial or economic estimates.

6 Land tenure and management structures

A large proportion of material examined for the review was not a conventional inventory /directory (see section 2.4) and did not contain site by site information. These sources did not contain information on land tenure, management authority or jurisdiction, since they usually referred to wetlands at a national level (or at least above a local or provincial level) and would therefore not contain detailed management information.

When material did contain site by site information the material was evaluated against Ramsar Information Sheet (RIS) categories and the frequency (ie never, rarely, sometimes, commonly etc) of the inclusion of the RIS category was recorded. As can be seen below, for some 33% details of land tenure/ownership were 'always included'; for only 7% of the time, details of land tenure/ownership were recorded 'most of the time' and for some 37% of the time details were never recorded.

Some 41% of the material 'never included' jurisdiction information recorded, and only 22% 'always' contained jurisdiction information. Some 41% of the material also 'never included' any management authority information, but some 22% 'always' contained management authority information. In the cases where some information was included, this usually only extended to a sentence such as 'the site falls within the national park' or 'the wildlife department monitor the population of endangered species'.

Eastern Europe	Inclusion of land tenure/ownership information (site based studies only)
Some unknown level	0%
Always included	33%
Most of the time included	7%
Commonly included	0%
Sometimes included	0%
Rarely included	4%
Never included	37%
Unknown	19%

Eastern Europe	Inclusion of jurisdiction information (site based studies only)
Some unknown level	4%
Always included	22%
Most of the time included	7%
Commonly included	4%
Sometimes included	0%
Rarely included	4%
Never included	41%
Unknown	19%

NB The Ramsar information sheet states 'Jurisdiction (territorial eg state/region and functional eg Department Agriculture/Department of Environment)'

On the whole it can be said almost no sources in the Eastern European region contained information on land tenure, management authority or jurisdiction.

Eastern Europe	Inclusion of management authority information (site based studies only)
Some unknown level	7%
Always included	22%
Most of the time included	7%
Commonly included	4%
Sometimes included	0%
Rarely included	0%
Never included	41%
Unknown	19%

NB The Ramsar information sheet states 'Management authority: (name and address of local body directly responsible for managing the wetland)'

7 Extent and adequacy of updating programs

The majority (50%) of information examined in this review were published or dated after 1995, and some 35% were published or dated between 1991 and 1995. Most of the information was judged to not have a temporal scale (generally these studies were reviews and collations), and only 7% had defined temporal scale (ie were discrete 'one-off' surveys, or ongoing surveys) with a further 11% unknown.

Publication Date	
After 1995	50%
Between 1991–1995	35%
Between 1986–1990	4%
Between 1981–1985	0%
Unknown/ambiguous	15%
Temporal scale	
Studies with a temporal scale *	7%
Partly include a temporal scale	0%
No temporal scale (eg review)	78%
Unknown	11%
** Broken down further:*	
Discrete surveys	15%
Surveys updated on an ad-hoc basis	4%
Update purpose to add sites	4%
Update purpose to review status	0%
Update purpose to make corrections	4%
Other update purpose	0%
Unknown purpose	0%
Current /ongoing surveys	7%
Updated on ad-hoc basis	0%
Updated on annual basis	0%
Frequency of update unknown	7%

It could be argued that low resolution comprehensive national field surveys should be undertaken (whether remotely or as part of ground surveys) as a priority to at least identify wetland locations for more detailed study later. However, in terms of resource conservation, repetition of detailed surveys at sites thought to be at risk should also be a priority undertaking. One-off surveys for previously un-surveyed areas are critically important in terms of resource assessment, but few surveys examined in this review were found to be part of a long-term assessment or monitoring program.

None of the inventories identified in the region (with the exception of the Ramsar database) have been updated after any given time interval after the first inventory. Wetland inventories must be regularly reviewed and updated otherwise data are likely to be lost, become out of date and become of historical interest only.

It would be overly critical to state that the updating procedures of wetland inventory in Eastern Europe are grossly inadequate, since 50% of the studies examined were published after 1995. The wetland inventory process in Eastern Europe is still relatively young, and therefore it is not surprising that no wetland inventories were identified that have been updated since first completion.

8 Standardising of inventory approaches

This section outlines the broad types of wetland inventory that have been included in this review, followed by notes on some relevant findings from the analysis of the Eastern European material which have bearing on wetland inventory approaches. Standardisation of inventory approaches must be developed in accordance with the objectives of those organisations carrying out wetland inventory. The ‘who’, ‘how’ and ‘why’ must be examined before any attempts to standardise procedures are made. Finally, generic suggestions for standardisation of wetland inventory approaches are outlined.

8.1 Types of wetland inventory

As stated by Scott (1993) in his review of wetland inventories and their role in the assessment of wetland loss, there are three main types of inventory:

- comprehensive national wetland inventories
- regional or global inventories of specific wetland types
- national or international inventories of wetlands of special conservation importance

This review of wetland inventory material in Eastern Europe included material in each of these categories, which were defined by Scott (1993) as follows:

comprehensive national wetland inventories:

> these constitute an accurate account of the location and extent of all wetland resources: they usually included detailed mapping and may or may not include an evaluation. Such inventories are time consuming and costly, and require a precise wetland classification system. However they provide an ideal basis for a comprehensive assessment of wetland loss over time.

regional or global inventories of specific wetland types:

> such inventories are usually too crude and contain too many gaps in coverage to provide a baseline assessment of wetland loss.

national or international inventories of wetlands of special conservation importance:

these focus on specific sites or systems with high conservation values, rather than wetland types, and on the whole exclude wetland habitat that is too small, fragmented or degraded to merit special attention. The Ramsar Convention provides an agreed set of criteria for the identification of sites of international importance, and these have been, or are being used in the compilation of wetland inventories in most parts of the world. Inventories of this type can be carried out relatively quickly and cheaply, and are of considerable value in focusing conservation effort where it is most required. While far too superficial to be used to measure total wetland loss, they constitute a sound basis for the monitoring of rates of loss of key habitat, especially those in countries which are unable to conduct comprehensive wetland inventories in the foreseeable future.

To this list, a further group could be added

landscape level mapping of land use and land cover:

these focus on the landscape from an anthropogenic perspective, and provide information on land use and land cover. They usually utilise satellite remote sensing technologies in combination with topographic maps, and soil maps. The resolution is frequently low (100 x 100 ha) and does not distinguish between many wetland types (this can be due to limitations in the spectral capabilities of the sensor, or may be due to operator preference). Wetlands are usually lumped into very broad generic categories. These may be categories such as 'open water', 'forested wetlands', and 'agriculturally improved wetlands', or may simply be one very broad category 'wetlands'. In such inventories wetland habitat is quantified in terms of approximate area, and the distribution mapped. There is potential for monitoring total national wetland loss or change if the spatial resolution of the satellite sensor is high, or if rates of loss or change are very high. Assessments of wetland quality do not feature in these landscape maps.

8.2 Wetland inventory approaches in Eastern Europe – results from the analysis of the dataset

8.2.1 Who is conducting wetland inventory and who is funding it?

Non-governmental organisations (NGOs) were responsible for implementing 70% of studies in Eastern Europe and governmental organisations (GOs) were responsible for implementing a much smaller percentage (37%). Compare this with the figures in Western Europe where GOs implement a much greater proportion of wetland inventory activities.

Study implementation	
International NGO	44%
National NGO	26%
Sub-national NGO	0%
Local NGO	0%
International GO	11%
National GO	26%
Sub national GO	0%
Local GO	0%
Private agency/individual	4%
Consultancy agency	0%
Academic institution	7%
Other body	0%
More than one agency or body	22%
Unknown	7%

However, only 15% of studies were funded by NGOs and 66% by GOs (this 66% splits into 44% national GOs and 22% international GOs). In Eastern Europe at least, GOs appear to be funding more wetland inventory activities than NGOs, but appear to be implementing much less than NGOs. Perhaps this is linked to governmental capabilities, especially in newly independent states.

Study Funding	
International NGO	15%
National NGO	0%
Sub-national NGO	0%
Local NGO	0%
International GO	22%
National GO	44%
Sub-national GO	0%
Local GO	0%
Private agency/individual	0%
Consultancy agency	0%
Academic institution	0%
Other body	0%
More than one agency or body	4%
Unknown	22%

8.2.2 Why is wetland inventory being carried out?

One must ask why wetland inventories are being carried out? Considering the wide variety of organisations (NGOs, GOs, academics, consultants etc) undertaking wetland inventories in Eastern Europe, there is likely to be a variety of purposes. This study examined the objectives of wetland inventory activities. The objectives were explicitly stated in only 39% of studies (compare this to 59% in Western Europe – Stevenson & Frazier 1999b), and for more than half (52%) they were not explicitly stated. The most common objectives (including those explicitly stated and surmised) were for baseline inventory purposes (67%), international designation (48%), general biodiversity (41%), and public education (30%), Note that most studies had several objectives.

Statement of objectives	
Objectives explicitly stated	30%
Objectives not explicitly stated	52%
Unknown	19%
Main objectives of study	
General biodiversity	41%
Biodiversity research	4%
Baseline biodiversity	4%
Repeat survey/surveillance	0%
Management tool for biodiversity	0%
Biodiversity monitoring	0%
Wetland products	4%

Geographical	4%
International designation	48%
Baseline inventory	67%
Academic research	7%
Land use planning	15%
Wetland services	4%
Public education	30%
Other research	4%
Other	22%

Baseline studies are likely to include different information fields than studies carried out for international designation purposes. In Eastern Europe there are 128 Ramsar sites distributed through 19 countries (an average of 6.7 sites per country) (Contracting party and Ramsar sites information source: Ramsar Database, 17/8/98, Wetlands International, AEME). It is likely that the international designation of wetlands in Eastern Europe is in the early stages. The data fields required for baseline inventories, and the methods employed are likely to be very different to those required and utilised for international designation.

8.2.3 How are wetland inventory studies conducted?

Some 56% of studies examined for the Eastern European dataset were reviews and collations. Of the studies which were not reviews or collations, some 26% of studies undertook ground surveys, and some 4% utilised remote sensing techniques, which were largely dependant on aerial photography (none of those examined utilised satellite imagery). Of those studies that did conduct ground surveys, 4% of these were total or near comprehensive in their coverage, and 7% undertook ground surveys which were partial in their coverage.

Data collection methodology	
Collation or review	56%
Ground survey	26%
Remote sensing	4%
Questionnaire survey	0%
More than one methodology	15%
Unknown methodology	33%
Extent of ground survey	
Total	4%
Partial	7%
Unknown	15%
Type of remote sensing	
Satellite imagery	0%
Aerial photography	4%
Videography	0%
Radar imagery	0%
Lidar imagery	0%
Map product	0%
Unknown	0%

8.2.4 What definitions and classifications are used?

There are many definitions of wetlands, as others have noted (eg Davies & Claridge 1993). Dugan (1990) stated that over 50 separate wetland definitions were (even then) currently in use. Differing wetland definitions and classification schemes were used in different studies in Eastern Europe, and these definitions were not always stated, making it difficult to assess the degree of completeness of cover (and thereby the estimates of wetland extent).

For example, the term ‘coastal wetlands’ can mean strictly saline and brackish habitats, or to mean wetlands in the coastal zone (which often for practical purposes means coastal lowlands and incorporates wetlands which experience no tidal inundation). Sorensen (1997) provides six different and commonly used definitions for the term ‘coastal area’ which demonstrate the enormous difference between various meanings. Great improvements in the efficiency and accuracy of wetland evaluation could be achieved if common, but imprecise terms were more precisely defined.

A definition of wetlands was provided in only 26% of studies but it was implied in 44% of studies. Some 22% of studies appeared to use the Ramsar definition of wetlands (whether it was stated or implied) (though it was unknown for 26% of studies, so the true value may be much higher). The Ramsar classification system for wetland type was used in 56% of studies (compare this with 7% in Western Europe – Stevenson & Frazier 1999b); it was unknown for 22% of studies and not applicable for some 19% of studies (these were usually reviews or collations of material). This means that the Ramsar definition of wetlands and Ramsar classification has been commonly used in Eastern Europe, and has therefore provided some level of standardisation of approach. This of course is directly due to the fact that many Eastern European countries have recently become contracting parties to the Ramsar Convention, and are in the process of identifying and designating Ramsar sites.

See section 3.1 for further details.

8.3 Generic suggestions for the standardisation of inventory approaches

- Mechanisms to develop indices and scorecards of wetland value/benefits and site quality (status) should be developed to enable easy communication of information to be made to the decision-makers and the public.
- The presentation of data in wetland inventories should become more accessible by inclusion of summaries and the avoidance of poorly organised bulky text descriptions in favour of tabulated results.
- The scope of data coverage in wetland inventory activities should attempt to incorporate the information fields used in Ramsar Information sheets. This would aid management of trans-boundary wetlands and would facilitate regional and international wetland assessments which can be utilised in European (and global) policy and planning initiative.
- Every effort should be made to cover all wetland types, particularly those types that are currently under-represented in wetland inventories. This includes artificial wetlands, dune slacks, wet mesotrophic grasslands, seagrass beds, maerl beds, and glacial and alpine wetlands. An attempt to systematically collect information on current extent of different wetland types in different countries in the region should be carried out as a priority.
- A program should be established to monitor changes in the areal extent of rare and threatened wetland types once a baseline of the original or current extent has been determined.

- Standardised methodologies should be developed, and linked to the objectives of wetland inventory studies, such that for any given objective, standard information fields should be gathered using standard methodologies.
- A standardised (generic) database format (and software) should be developed for storage and extraction of local, national, and international wetland information that can be applied throughout the Eastern European region.
- More effort should be made to integrate wildlife surveys (especially waterfowl) and wetland surveys to avoid duplication of effort and to increase the wider applicability of information.
- Regional and national inventories should be made available in digital form as CD-ROMs or downloadable files from the Internet to enhance the access to the information and encourage greater levels of feedback on changes at the sites.
- A review should be undertaken on the applicability of land use and land cover mapping information for the monitoring of changes in wetland extent in the region.

9 Priority areas for wetland inventory

9.1 Status of national level wetland inventory information in Eastern European countries

Although it was possible to generate estimates of the national wetland resource in all but three Eastern European countries (Azerbaijan, Belarus, Bosnia and Herzegovina), much of the data was noted to be slim in volume – often amounting to no more than a paragraph or two outlining a country's approximate wetland resource (eg Croatia – Muzinic 1994).

The EEUR dataset revealed that in many instances, wetland inventories to date in Eastern Europe have examined wetlands of international importance only (eg Ukraine, Russia, Latvia and Lithuania). Some countries initially completed inventories of internationally important wetlands and then later extended their wetland inventory activities to wetlands of national importance, eg Slovak Republic (Slobodnik & Kadlecik, in development). Other countries have progressed even further, and have conducted comprehensive national wetland inventories encompassing internationally, nationally and locally important wetlands, eg the Czech Republic (Hudec et al 1993) and Estonia (Estonian Fund for Nature 1996).

Of the 22 countries in the Eastern European region examined in this review, only two of these can be said to have quasi-adequate inventory data on wetlands. These are the Czech Republic and Estonia, though it must be noted that even these countries do not have inventory material that cover the entire national wetland resource and all possible wetland types.

Countries which (on the basis of the EEUR dataset) have less detailed national wetland inventory material or material which is less comprehensive in scope and coverage are listed in column two (labelled 'some but inadequate national wetland inventory information') of table 9.1. These are Albania, Belarus, Bulgaria, Croatia, Georgia, Hungary, Latvia, Lithuania, Moldova, Poland, Romania, Russia, Slovak Republic and Ukraine.

There was a noticeable lack of wetland inventory information for several countries listed in column one (labelled 'little or no national wetland inventory information') of table 9.1. These are Armenia, Azerbaijan, Bosnia and Herzegovina, the former Yugoslav Republic of Macedonia, Slovenia, and Serbia and Montenegro. It is possible that wetland inventory activities (in some form or other) occurred in the former USSR (an example would be the

MAR project, Olney 1965 *cited in* Scott & Jones 1995). After the creation of newly independent states such as Armenia and Azerbaijan in the early 1990s, it is likely that much of this information has become inaccessible due to the dissolution and creation of new governmental offices and departments.

This review did not attempt to access information generated prior to the dissolution of the USSR except where it was accessed incidentally. Greater resources than were available in this preliminary review would have been needed in order to adequately identify, locate and evaluate material from the former USSR. Most certainly the services of a translator would have been required, and such a mammoth task would have required specific in-country information and knowledge which were not available to the AEME team.

It should be noted that additional materials for Eastern Europe have been identified since the analysis stage of this review – particularly for Belarus (Belokurov 1998, Dorofeev 1993, Edwards & Prentice 1995), as well as an additional document each for Russia and the Ukraine (Chernichko & Siokhin 1993) – and it is likely that these will reveal new information. Our findings must therefore be viewed as preliminary.

Many specific types of wetlands were frequently ignored in wetland inventory activities in Eastern Europe, for instance, glacial, alpine and tundra wetlands, marine subtidal aquatic beds, and dune slacks. A common exclusion was smaller wetlands (for example <10 ha, and in some cases <100 ha). Artificial wetlands did not feature in many wetland inventories and must therefore be presumed to be a 'gap' in coverage. The notable exception to this is Latvia (Latvian Fund for Nature and Latvian Ornithological Society 1995) where artificial fishponds have been included in much of the wetland inventory work examined in this review.

The majority of wetland area estimates examined by this report were approximations (often based on dated aerial photography, soil and vegetation maps, and limited field studies). The resulting best estimates must therefore be viewed with caution since accurate results cannot be generated from such approximate data.

9.2 Relevance to previous studies

Hughes (1995) produced a review of the status of wetland inventories in Europe (encompassing some countries in both Eastern and Western Europe). She did not provide estimates of wetland area, but did provide a brief description of wetland inventories per country, and noted whether a national wetland inventory program was underway, planned or completed (table 9.2). Scott and Jones (1995) made a comparison between wetland sites within countries identified in the 1965 MAR project and those designated as Ramsar sites in the same countries by July 1993. This demonstrated that there had been significant progress in the wetland inventory of potential internationally important wetlands over a 30-year period. Table 9.3 takes this comparison one step further by the addition of Ramsar site information as of August 1998.

Whilst the EEUR dataset cannot claim to be totally comprehensive in its coverage, it is interesting to note that many of the countries which Hughes (1995) listed as having little wetland inventory material in 1995 (table 9.2) still appear to have little wetland inventory material (table 9.1). Countries that were omitted from the Hughes (1995) review 'due to a lack of available information' include Armenia, Azerbaijan, and Bosnia and Herzegovina. Based on the EEUR dataset these countries still appear to have little wetland inventory information.

The former Yugoslav Republic of Macedonia and Serbia and Montenegro were not included in the Hughes (1995) review; however, no wetland inventory information for these countries was identified in this review. The current status of wetland inventory in these countries is therefore currently unknown. Hughes (1995) also omitted Moldova, Poland, the Slovak Republic and Slovenia from her review 'due to a lack of available information' but these countries now appear to have improved wetland inventory information. Albania, Hungary and Georgia had very little wetland inventory information and this situation does not appear to have changed.

Hughes (1995) also noted that Latvia, Romania, the Russian Federation, Belarus, Estonia and Lithuania have some (sub national) wetland inventory material, but that the coverage of the inventory material available was incomplete in coverage. Each of these countries were similarly identified by the EEUR dataset as having some but inadequate *national* wetland inventory material, with the exception of Estonia (Estonian Fund for Nature 1996) which has been undertaking rigorous and comprehensive wetland inventory activities.

Table 9.1 Status of national wetland inventory information in Eastern European countries based on the EEUR datase. Note: these are preliminary assessments only.

Little or no national wetland inventory information	Some, but inadequate national wetland inventory information	Adequate information available, but requires updating and more detailed surveys
Armenia	Albania	Czech Republic [1]
Azerbaijan	Belarus [2]	Estonia [3]
Bosnia and Herzegovina	Bulgaria [4]	
Macedonia	Croatia [5]	
Serbia	Georgia	
Slovenia [6]	Hungary	
	Latvia [7]	
	Lithuania [8]	
	Moldova	
	Poland	
	Romania	
	Russia [9]	
	Slovak Republic [10]	
	Ukraine [11]	

1. A comprehensive inventory of wetlands of local, national and international importance was published in 1993 by Hudec et al (1993). This material was obtained after the analysis stage of this review was completed; however, this source contains detailed wetland inventory information.
2. Additional wetland inventory material for Belarus has been identified since the analysis stage of this review which contains an overview of rivers, lakes, reservoirs, bogs, forested wetland and seasonally flooded meadows (Edwards & Prentice 1995). It does not constitute a national wetland inventory, but it does contain useful information such as values and benefits, threats, flora and fauna etc. This new information will be incorporated into any future update of the GRoWI-EEUR database.
3. Estonia is currently completing project WETSTONIA, which is undertaking separate inventory fieldwork missions of Estonian lakes, mires, wet forests, bogs, and meadows. A publication detailing the findings from the meadows inventory (Leibak & Lutsar 1996) has been incorporated in this review, however, it is uncertain as to whether information on the other habitat types has yet been published. Efforts to establish the current status of the WETSTONIA project are continuing.
4. A national action plan for the conservation of the most important wetlands in Bulgaria was prepared in 1994 which provided a summary of 7 wetland complexes in Bulgaria (Ministry of Environment 1994). The current status of national wetland inventory activities is unknown, and no other publications have been identified.
5. A limited preliminary national wetland inventory was completed by 1994, covering 30 sites (Muzinic 1994). Only the name, co-ordinates, area, and wetland type appear to have been recorded. The current status of this inventory is uncertain.
6. A national wetland inventory in Slovenia (incorporating a MedWet style database) is planned to commence in 1998/99.
7. An inventory of 7 potential Ramsar sites was completed in 1995 (Latvian Fund for Nature & Latvian Ornithological Society 1995).
8. A preliminary inventory of important wetlands in Lithuania was completed in 1995 covering just 9 potential Ramsar sites (Svazas 1995). A national inventory was initiated in 1997, which aims to inventory a total of 60 sites by end of 1999 (Balciauskas & Svazas 1998).
9. Additional material for Russia has been obtained since the analysis phase of this project, including an English translation of a Russian publication already incorporated (in outline only) in this review (Kamennova & Vinogradov in press).
10. The Slovak Environment Agency began a 10yr national wetland inventory in 1991. Some 2000 sites have been identified for inventory, and approx. 75% have already been inventoried. Inventory results to date are in Slovak (Slobodnik & Kadlecik in development). By completion date, the inventory is expected to be near comprehensive.
11. Additional material on internationally important wetlands in Ukraine has been obtained since the analysis phase of this project, which will be incorporated into any future update of the GRoWI-EEUR database (Chernichko & Siokhin 1993).

Table 9.2 Status of wetland inventories in Eastern Europe described by Hughes (1995)

Omitted due to 'lack of data'	Noted as poor national wetland inventory information	Wetland inventory material exists but incomplete coverage	Some wetland inventory activities in process	Planned wetland inventory activities
Armenia	Albania	Latvia	Latvia	Estonia
Azerbaijan	Hungary	Romania	Belarus	Lithuania
Bosnia and Herzegovina	Georgia	Russian Federation		Russian Federation
Moldova				
Poland				
Slovak Republic				
Slovenia				
Noted as having some national wetland inventory information	**Notes on national wetland inventory (NWI)**		**Reference for NWI (full citation given in Hughes 1995)**	
Bulgaria	NWI completed 1993		Ministry of Environment (1994)	
Ukraine	NWI underway in 1995		–	
Czech Republic	NWI produced 1993		Hudec et al (1993)	
Croatia	preliminary NWI		–	

Table 9.3 Comparison of wetland sites in Eastern Europe listed by the MAR project, and by Scott and Jones (1995) and those designated as Ramsar sites in 1998

Country	# of sites on MAR list published 1965	# of Ramsar sites designated by July 1993	# of Ramsar sites designated by August 1998
Albania	0	Not a Ramsar party	1
Armenia	0	2	2
Azerbaijan*	1	Not a Ramsar party	1
Belarus	0	Not a Ramsar party	Not a Ramsar party
Bulgaria	4	4	5
Croatia	1	4	4
Czech Republic	3	4	10
Estonia	2	Not a Ramsar party	10
Georgia	0	Not a Ramsar party	2
Hungary	6	13	19
Latvia	1	Not a Ramsar party	3
Lithuania	1	Not a Ramsar party	5
Moldova	0	Not a Ramsar party	Not a Ramsar party
Poland	15	5	8
Romania	5	1	1
Russia	4	3	35
Slovak Republic	2	7	12
Slovenia	9	1	1
Ukraine	0	Not a Ramsar party	4
Yugoslavia**/Serbia and Montenegro	4	2	4

(adapted from Scott & Jones 1995)

* Ramsar site was designated by the former USSR: Azerbaijan has not yet acceded to the Ramsar Convention on Wetlands.

** Values for the former Yugoslavia.

Hughes (1995) noted that Bulgaria, Ukraine, the Czech Republic and Croatia all had some national wetland inventory material. With the exception of the Czech Republic, which has detailed national wetland inventory information (Hudec et al 1993), and based on the EEUR dataset, Ukraine and Croatia are still somewhat lacking in national wetland information in 1998 but have initiated national wetland inventory activities. Bulgaria has a national action plan for the conservation of wetlands (Ministry of Environment 1994), but whether a national wetland inventory is underway is currently uncertain.

If we examine the information given by Scott and Jones (1995) (table 9.3), nine countries were not contracting parties to the Ramsar Convention in July 1993 (Albania, Azerbaijan, Belarus, Estonia, Georgia, Latvia, Lithuania, Moldova and Ukraine). By August 1998, only Belarus, Moldova and Azerbaijan still remain non-signatories to the Ramsar Convention. (The former USSR designated one Ramsar site in Azerbaijan but Azerbaijan has not yet acceded to the Convention on Wetlands.)

This means that since 1993 the following countries have become signatories to the Ramsar Convention: Estonia, Georgia, Latvia, Lithuania, and Ukraine. Each of these countries is undertaking wetland inventory activities (at some level), however, Estonia has completed some exceptionally comprehensive and detailed wetland inventories in this 5 year time period, and activities in the region are still continuing (Estonian Fund for Nature 1996, Leibak & Lutsar 1996, Rein & Kuresoo 1998). Estonia should be commended for having made such significant progress in such a short time period, and the approach used could serve as a demonstration model in the Eastern European region. The lessons learned and successes achieved could prove to be extremely pertinent elsewhere in the region.

Four countries have not designated any further Ramsar sites between 1993 and 1998; these are Armenia, Croatia, Romania and Slovenia. Some countries have designated a few additional Ramsar sites since 1993; these are Bulgaria and Poland. But the Czech Republic, Hungary, Russia, and the Slovak Republic have all substantially increased the number of wetland sites designated as internationally important wetlands in the 1993–1998 period.

10 Priority processes

This section provides brief recommendations pertaining to wetlands inventory activities as a whole. It proved beyond the scope of this study to recommend particular field survey methods, or to provide instructions for wetland inventory activities. Taylor et al (1995) covers the relative merits and disadvantages of wetland inventory methods used in southern Africa and these are equally applicable in other regions.

Similarly, it would not be appropriate to enter the debate on traditional field survey techniques versus remote sensing techniques (again these are discussed admirably by Taylor et al (1995) and Grainger (1993) from analogous forestry studies). However, the process of extracting and analysing data from the sources examined in this review, has revealed common problems that could be easily avoided if wetland inventory data were presented in a particular fashion. If certain specific data were routinely recorded for the benefit of the reader (such as date of survey, objectives, and wetland definition and coverage) then extraction of information would be much easier.

10.1 Establishing inventories

10.1.1 Preparatory activities

- A thorough review of previous studies and surveys undertaken should be conducted prior to any wetland inventory activity, to delineate gaps and to benefit from lessons learned or mistakes made. This should also include less obvious sources such as academic material and conference material, as well as conventional wetland inventories.

- Adequate time and resources should be allocated (by funding bodies and implementing agencies) to review, and obtain existing wetland inventory material for any given region or country. As stated by Taylor et al (1995), it requires time and effort to establish the existence of sources of information already available, and often there is repetition of previous survey work because adequate efforts to assess the existing information base have not been undertaken. This project has identified several cases where source material has quoted wetland area estimates taken from studies that had been comprehensively updated by more recent studies, and therefore their estimates were out of date, and had been supplanted by more recent and accurate data.

10.1.2 Background and setting to wetland inventory activities

- Information such as the history, development and rationale of wetland inventories is crucial for understanding the context of these studies and should be described briefly within reports. Information detailing contact persons and addresses is very helpful to successive workers, as are plans for future activities. If the surveys are part of a longer-term study, this should also be stated.

10.1.3 Objectives

- The objectives of wetland inventories should be identified prior to the commencement of wetland inventory activities (particularly those involving fieldwork). The objectives of wetland inventory activities should play a key role in choice of the most suitable wetland inventory methodology to be used in any given particular inventory program.
- Wetland inventory activities should aim to make provision for regular updating of wetland information, and where appropriate should make provision for monitoring changes in extent, distribution and loss of wetlands.
- The objectives should be clearly stated in wetland inventory reporting and published material.
- Those coordinating wetland inventory activities should specifically aim to widely disseminate wetland inventory material, and should aim to permit ready access to wetland inventory information. This objective should feature in all future wetland inventory activities.

10.2 Updating or extending inventories

10.2.1 Wetland coverage

- Certain wetland types were commonly excluded from wetland assessments and these included artificial wetlands (eg fish ponds, rice paddy, reservoirs and dams) and natural wetlands including dune slacks, humid sands, dambos, wet mesotrophic grasslands, seagrass beds, maerl beds, coral reefs, glacial and alpine wetlands. More attention should be paid to these and similarly overlooked wetland types in future inventory studies.

10.2.2 Wetland definitions and classification of wetlands

- Clear distinction should be made between the description of ‘marine wetlands’ and ‘coastal wetlands’, and ‘inland wetlands’. Extracting information on even broad wetland categories is difficult when different definitions of habitats are used. Some authors use, for example, the term ‘coastal wetlands’ to mean strictly saline and brackish habitats and others use it to mean wetlands in the coastal zone (which often for practical purposes mean coastal lowlands and incorporates wetlands which experience no tidal inundation).

- A definition of wetlands should be always be given, and it should be expressly stated whether habitats such as floodplains, and open water bodies have been included in the definition and whether they have been included in a wetland survey.
- Where wetland classification systems are used, these should be stated and adequately referenced.

10.3 Inventory content

10.3.1 Minimum information fields

- Wetland area estimates and identification of whether wetland area estimates are minimal, maximal or average values (stating number of years and which years the average value is based on).
- The geographical coordinates and general location of wetlands should always be included, so that discrepancies involving the names of wetlands can be identified by location. (For countries that are newly independent, it is very difficult identifying wetlands that have been renamed, and adequate geo-referencing may reduce this difficulty.)

10.3.2 Recommended information fields

- Objectives of study.
- Dates of field work (including season) and collation should always be included, as well as the known dates of any compiled information.
- Description of methodologies used in fieldwork.
- Resolution capabilities of remotely sensed data.
- Definition of wetland used.
- Classification scheme used (eg Ramsar, Cowardin, Corine etc).
- Inclusions/exclusions in coverage (eg excluding wetlands of less than 100 ha, or excluding open water bodies etc).
- A *summary* of the coverage and characteristics of the wetland resource including tabulations where possible.
- Contact points for data custodians or publishers and their institutional details.
- Contact details of persons undertaking fieldwork should always be provided in fieldwork.
- Full referencing of primary source material should always be provided in reviews/collations.
- Ramsar Information Sheet data fields.

10.4 Wetland values and benefits

- Information on wetland values and benefits should be included in wetland inventories. As a minimum this should constitute a textual description of benefits, but preferably should indicate the economic values for wetland goods and services.
- A structure to aid the assessment of wetland benefits and values using simple means and local knowledge of wetland sites should be developed for use in conjunction with wetland inventories. This could take the form of a key or questionnaire which could be spilt into sections under the headings of fisheries, water supply, tourism, education, hydrological

functions etc, and the assessor answer general questions under the appropriate headings. Or it could take the form of a table that should be completed, with sections containing questions such as ‘approximately how many artisanal fishermen use this site? Is this seasonal? Approximately what is their daily/weekly catch?’ Or this could take the form of a matrix, which the assessor simply adds tick marks where a particular good or service is important. More effort should be put into developing simple ways of calculating the approximate total economic value of a wetland site in a standardised manner.

- The findings of wetland inventories that complete preliminary assessments of the values and benefits of a particular wetland site should be widely disseminated in order to demonstrate the values and benefits to policy makers and management authorities.

10.5 Temporal scale/updating programs

- It could be argued that low resolution comprehensive national surveys should be undertaken as a priority to at least identify wetland locations for more detailed study later. However, in terms of resource conservation, repetition of detailed surveys at sites thought to be at risk should also be a priority undertaking.
- Wetland inventories must be regularly reviewed and updated, otherwise data are likely to be lost, become out of date and become of historical interest only.

10.6 Presentation of data

- A summary of the coverage and characteristics of the wetland resource should preferably be included in all wetland inventory reference material. It is exceedingly difficult to construct a useful overview of an inventory reference by extracting values and statistics from reams of text entries.
- Local naming conventions of wetlands or locations are often ignored, and authors may use their own ‘version’ of a local name for a particular wetland. There are obviously difficulties in translation, but more efforts should be made to ensure that the local and English (and French, or Spanish as appropriate) version names are included in inventory material if it is intended for use beyond the local area. A guide to the pronunciation of local names may also be useful (particularly where these names have not previously been recorded, and are perhaps only known by local names) although this may not be practicable for directory type inventories.
- Key quantitative wetland inventory information should preferably not be presented in block text format (where data such as coverage and loss estimates lay hidden in sentences, perhaps with imprecise wording leading to an ambiguous interpretation). This would aid the input of existing and future inventory information into database format.
- Maps of habitats and atlases should also present summary area and type by area information. Many maps examined did not contain a scale and/or other fundamental spatial reference information such as geographic coordinates. It is very difficult to manually extract useful inventory or management information out of most of the maps examined for potential inclusion in the Eastern European dataset.

10.7 Handling and storage of wetland inventory information

- Every effort should be made to store both the paper and electronic versions of wetland inventory information with both those coordinating or conducting wetland inventory, and also with international organisations such as the Ramsar Bureau and Wetlands International or a central clearing house (if one is developed).

- Electronic forms should preferably be stored in some format which is readily translatable into either word processing packages or commonly used databases.
- A standardised (generic) database format (and software) should be developed for storage and extraction of local, national, and international wetland information that can be applied throughout the Eastern European region.

10.8 Availability and dissemination of inventories

- Much material is currently available in draft format, remains unpublished or has a limited distribution. Considerably more effort should be devoted to ensuring that existing draft reports are finalised, and resources permitting, published, preferably with some or all of the information made available on the World Wide Web.
- Those undertaking to produce national bibliographic databases, should also be aware that the usefulness of such information is severely limited if there is no provision for supplying the references to those who need them. Funding should be made available to ensure that national bibliographic databases don't simply supply a list of references, but can also provide copies of the material upon request. The existence of such databases should also be more widely advertised.
- More emphasis should be directed toward publishing electronic format material (eg World Wide Web presentations) as well as any paper versions of reports.
- A central clearinghouse or structured information retrieval system for wetland inventory material should be put in place. It should be noted that identifying and obtaining wetland inventory material for a particular country may be largely dependent on a network of contacts and may chiefly rely on key individuals and/or organisations to supply or provide access to data. It is likely that these persons and organisations receive repeated requests for information and a positive result often depends on the goodwill and resources of these key individuals and organisations. The current situation is that a person or agency seeking information must first identify the ‘key players’, which in itself is often a time consuming process. The retrieval of information can occasionally be restricted due to deliberate actions on the part of some individuals who see a request for information as an opportunity to offer their services for substantial fee rates, and who it appears deliberately withhold information to increase their bargaining power.

11 Specific recommendations

The reader should also consult sections 8 and 10 for more detailed recommendations

- Every effort should be made to complete existing preliminary national wetland inventories. Based on the EEUR dataset these include Bulgaria, Croatia, Lithuania, Latvia and the Russian Federation.
- Every effort should be made to establish national wetland policies and establish national wetland inventory programs as a priority.
- The approach used by Estonia for wetland inventory activities could serve as a demonstration model in the Eastern European region. The lessons learned and successes achieved could prove to be extremely pertinent elsewhere in the region.

- The current trend to produce wetland inventory material closely following the format given in the Ramsar Information Sheets (RIS) should continue. This should serve to aid management of trans-boundary wetlands and should facilitate regional and international wetland assessments that can be utilised in European (and global) policy and planning initiatives.
- An intensive review of information generated prior to the dissolution of the USSR could potentially fill some information gaps that presently appear to exist in former USSR countries. A thorough review of such material should be undertaken prior to commencing comprehensive surveys in these newly independent states. This would serve to ascertain where work has already been completed and would provide potentially useful baseline information with which any new material can be compared.
- Wetland inventories should be undertaken (whether as part of a national wetland inventory program or not) in those countries which currently have little wetland inventory information. Based on the EEUR dataset this includes Armenia, Azerbaijan, Bosnia and Herzegovina, the former Yugoslav Republic of Macedonia, Serbia and Montenegro, and Slovenia (although it is known that Slovenia already has plans to commence national wetland inventory activities in 1998/99).
- There should be greater dissemination of existing wetland inventory information. Existing draft reports that have been produced in recent years with the assistance of NGOs should be published as soon as possible. Much useful and pertinent draft material has been uncovered which has never reached external audiences.
- Greater use of the World Wide Web as a publishing medium should be encouraged. This may be of particular use where finances are unavailable to produce paper publications of reports which have never progressed beyond the draft stage.
- Information about the objectives, wetland definition, wetland classification, wetland coverage (particularly inclusions and exclusions of particular wetland types), survey or compilation dates, and data custodians should be included in wetland inventories as a matter of course.

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Our sincerest apologies to any person or institute we may have inadvertently omitted from this list.

Annex 2 Best estimates of wetland coverage

(see section 3.3 for a list of countries omitted from this section)

Country name (& Code) ALBANIA ALB		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Ramsar database	none	20,000	0	0	20,000	date of extraction 14 August 1998; despite some inland and man-made wetland types, the site is completely coastal/marine
2 IUCN 1993	111	?	?	?	0	In the report it states" the wetlands of Albania are poorly known" . 4 important lakes are named, and it is noted that there is 400km of coastline, which includes "extensive marshy shores"
3 Britton & Crivelli 1993	505	0	35,000	0	35,000	Coastal lagoons, non tidal salt marsh, freshwater marshes and forested wetlands are also noted as being present, but no area values are available.
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		20,000	35,000	?	55,000	

Notes/comments on best estimate

The available information is very limited and so the best estimate must be regarded as approximate

Date of best estimate 26-Aug-98

Country name (& Code) BULGARIA BGR		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Ramsar database	none	1,804	999	0	2,803	Date of extraction 14 August 1998; limited man-made area included with inland
2 IUCN 1993	372	0	10,000	220,000	230,000	In the report it states that " Bulgaria has few natural wetlands"
3 Ministry of Environment 1994	123	0	0	0	11,000	Covers natural wetlands only
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		?	10,000	220,000	230,000	

Notes/comments on best estimate

Estimate on coastal cannot be used from Ramsar, since Ramsar does not cover wetland areas exclusively.

Date of best estimate 26-Aug-98

Country name (& Code) CROATIA HRV		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	**Reference code**					
1 Ramsar database	none	11,500	64,901	4,054	80,455	Date of extraction 14 August 1998; all man-made type areas except "1" have been included under inland, since the sites where they occur are largely inland, and areas could not be split.
2 IUCN 1993	111	?	45,000	0	45,000	In the report it states that " The Sava River valley and Kopacki Rit complex contains approx 45,000 ha of alluvail forest which is regularly flooded." No other estimates of area are provided.
3 Muzinic 1994	121	0	?	?	116,423	Estimates result from a preliminary national inventory. It is believed that there are more wetlands which have not yet been included. However site by site information is provided, (in Croatian) in the inventory
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		?	?	?	116,423	

Notes/comments on best estimate

No best estimate could be made for coastal, inland and man-made. The Ramsar database does not cover the entire country at all, and does not list wetland area exclusively. The IUCN reference only covers 2 areas. The Muzinic reference does not specify areas according to coastal, inland or man-made.

Date of best estimate 26-Aug-98

	Country name (& Code)						
	CZECH REPUBLIC		**Area (ha) Wetland**				
	CZE		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	0	30,028	7,863	37,891	Date of extraction 14 August 1998; inland and man-made areas are estimates
2	IUCN 1993	111	0	300	49,000	49,300	In the report it states that " Natural lakes are rare," but that there "are 160m small glacial lakes in the high Tatra.The existence of lowland floodplains (inc riverine forests,wet meadows, & oxbows) are mentioned but not described or quantified
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			none	?	49,000	49000	

Notes/comments on best estimate

The inland area for Ramsar cannot be used, since it does not cover wetlands exclusively.

For the total wetland area, the figure is a large underestimation of the real situation, but this is the only conclusion that is possible from these data.

Date of best estimate 26-Aug-98

	Country name (& Code) ESTONIA EST		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	82,330	133,620	-	215,950	Date of data extraction August 14th 1998
2	Estonian Fund for Nature 1996	105	46,989	121,457	0	168,446	28 sites of international importance have been listed in this inventory. Only 12 of them are described (as 12 proposed Ramsar sites) Values do NOT including Matsalu Bay,hence why value appears low..
3	Kuresoo 1998	103	?	?	?	646,851	10 sites (the existing Ramsar sites) are described (in Estonian), with English summary. However, Matsalu Bay is listed as 476400 ha, whereas all other sources list it as 48640ha, hence why estimate appears high.
4	IUCN 1993	111	0	1,752,200	?	1,752,200	Inland wetlands includes 992,200 peatlands: 260,000 wet meadows: 500,000 wet forests.
5	IWRB Natnl. Reports 93-95	504	0	0	0	4,521,500	Only a total value for " Estonian mires" (including fens & bogs) is provided. Estimate should be reliable.
6	Leibak 1996	117	0	22,200	0	22,200	Estimate is comprised of 5100 ha of coastal wet meadows, and 17100ha of floodplain meadows. Comprehensive assessment.
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			?	?	?	4,543,700	

Notes/comments on best estimate

Note that there is discrepancy between estimates for nationally & internationally important sites (ref 1-3).These are not used for the best estimates.
The total best estimate is derived from refs 5+6.It is not certain whether reference 5 includes wet forests, though it is likely that it does since the value given is much higher than that of IUCN (which apparently does include wet forests)

Date of best estimate 29-Aug-98

	Country name (& Code) GEORGIA GEO		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	33,710	513	-	34,223	Date of data extraction 14th August 1998
2	Lansdown 1996	107	37,145	0	0	37,145	number of sites are not given, but all sites are within the Kolkheti lowlands complex. Inventory covers only small proportion of wetlands in Georgia, 'cos only covers wetlands in Black Sea coastal region
3	State of the Envt report www 1997?	112	36,301	1,079	0	37,379	Inventory is of the Black Sea lowlands. Value for marine encompasses wetland complexes & includes many of the inland types also. Value for inland is strictly inland only. Only the total value can be considered reliable.
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			37,145	1,079	?	38,224	

Notes/comments on best estimate

No other data was identified in time for the preparation of this preliminary report. No information on manmade wetlands was uncovered.
Data from the Lansdown and the SoE reports have been combined to derive a best estimate

Date of best estimate 1-Sep-98

Country name
(& Code)
HUNGARY

HUN

	Reference author	Reference code	MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
			Area (ha) Wetland				
1	Ramsar database	none	-	125,322	24,519	149,841	Date of data extraction August 14th 1998
2	IUCN 1993	111	0	50,000	26,000	76,000	Values for inland are riverine forest on the Danube &Tisza rivers. Also mentioned in the publication are the existence of soda lakes, mires, & moorland associations,but these are not described.
3	State of the Envt report www 1997?	114	0	13,822	8,354	22,176	Value for inland is described as area of 'reeds' in report. Value for manmade is fish pond area. No other data provided in the report.
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			none	50,000	26,000	76,000	

Notes/comments on best estimate

The SoE report seems to be a severe underestimate appears to only cover 'reeds' and manmade wetlands, and therefore the IUCN data has been used, which is also likely to be an underestimate

Date of best estimate 1-Sep-98

Country name (& Code) LATVIA LVA		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Ramsar Database	None	19,300	24,000	-	43,300	Date of extraction August 14th 1998
2 State of Envt. www report	109	0	640,000	0	640,000	Value given is for inland bogs, it is not stated whether these are forested or unforested. www page is a based on a publication which we have not been able to obtain or ascertain the reference details.
3 Latvian Fund Nature et al 1995	110	142,600	93,150	3,500	239,250	Grand total = estimate of shadow and Ramsar sites only (7 sites) . Many of the wetlands are complexes of various wetland types, therefore the totals for each category (marine,inland, manmade) are only approx values.
4 Latvijas Mitraji un Ramsares Konvencija 1998	108	?	?	?	264,000	Estimate is for 12 sites (includes 3 Ramsar sites and 9 shadow Ramsar sites). Wetland types unknown. (language =Latvian)
5 IUCN 1993	111	0	640,165	0	640,165	Value for inland is for mires only.
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		142,600	640,165	3,500	786,265	

Notes/comments on best estimate

The SoE report & the IUCN report are in close agreement for inland wetlands. The higher value provided by IUCN has been used for the inland best estimate. No other data for coastal & manmade wetlands have been identified other than the Latvian Fund for Nature & so this has been used for the coastal & manmade best estimates, although the values must be regarded as approximate.

Date of best estimate 1-Sep-98

	Country name (& Code)		Area (ha) Wetland				
	LITHUANIA LTU		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	Reference code					
1	Ramsar Database	none	23,950	26,501	-	50,451	Date of data extraction August 14th 1998
2	Balciauskas & Svazas 1998	102	?	?	?	120,000	The types of wetlands are not described, but the total value given here is the total area of potential Ramsar sites (thought to include existing Ramsar sites)
3	Svazas 1995	104	14,000	19,362	0	33,362	9 internationallly important sites are listed. Most of these are wetland complexes, however, they have been broadly ascribed to the Marine/coastal and inland types.
4	Svazas 1998	106	?	?	?	0	Source is in Lithuanian and area figures did not seem to be included
5	IUCN 1993	111	0	507,080	0	507,080	Value for type O inland is for lakes (this may include lakes smaller than 8 ha, though not known). Value for type Ts inland is flood meadows and type U is peatlands (not stated whether forested or unforested)
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			?	507,080	?	507080	

Notes/comments on best estimate

The only estimate that can be regarded as comprehensive in its cover is the IUCN reference, the others cover either nationally or internationally important wetlands. Therefore the IUCN reference has been used for the best estimate

Date of best estimate 1-Sep-98

Country name (& Code) MOLDOVA MDA		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 IUCN 1993	111	?	?	?	?	No values were provided and it is stated that "there appear to be no internationally important wetlands in Moldova"
2 Lansdown 1996	107	39,844	0	0	39,844	Total value given covers 11 sites, 2 of international importance (together covering 14764 ha). Inventory covers most of wetlands in Moldova except high altitude lakes.
3 0	0	0	0	0	0	0
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		39,844	?	?	39,844	

Notes/comments on best estimate

The Lansdown inventory claims to cover most of wetlands in Moldova except high altitude lakes, and is the only data which has been identified to date for MDA

Date of best estimate 1-Sep-98

Country name (& Code) POLAND POL		Area (ha) Wetland MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	**Reference code**					
1 Ramsar database	none	18,247	67,973	4,235	90,455	Date of data extraction Augsut 14th 1998
2 IUCN 1993	111	0	1,636,927	0	1,636,927	Value given in type U inland is peatlands (unknown whether forested or unforested) Also listed 18000km of rivers, 509km of coastline (mostly sandy). it is mentioned that fishponds are very common, & that the largest of these (a complex) covers 6521 ha
3 0	0	0	0	0	0	0
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		?	1,636,927	?	1,636,927	

Notes/comments on best estimate

No other comprehensive estimate of wetlands in Poland was identified, other than the IUCN report and therefore this has been used for the best estimate. This value is an underestimate since it omits coastal wetlands, and manmade wetlands.

Date of best estimate 1-Sep-98

Country name (& Code) ROMANIA ROM		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Ramsar database	none	323,500	323,500	-	647,000	Date of data extraction August 14th 1998
2 IUCN 1993	111	0	269,080	0	269,080	Value for type O inland is for lakes (unknown whether this includes lakes under 8 ha) Value for type U inland is described as 'mires' in the publication, ie not know whether forested or unforested.
3 0	0	0	0	0	0	0
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		?	269,080	?	269,080	

Notes/comments on best estimate

The IUCN reference is the only one which covers most wetland types, though it does not appear to include coastal wetlands.
The Ramsar site information cannot be used as a wetland estimate since this is the total area of the sites, not the wetlands

Date of best estimate 1-Sep-98

Best estimates (ha)		3,233,630	?	?	>3233630	

Notes/comments on best estimate

This best estimate is an underestimate since it incorporates only wetlands of international importance

Date of best estimate 1-Sep-98

Annex 3 Definitions and Abbreviations

Ramsar Region	The Ramsar Bureau has adopted a system whereby countries are assigned to one of the following administrative and reporting regions: Africa, Asia, Eastern Europe, Neotropics, North America, Oceania, and Western Europe.
Regional Scale	A scale which encompasses all, or the vast majority of countries within one Ramsar region.
Supra-regional Scale	A scale which is greater than the Regional scale which normally encompasses several countries within any *two or more* Ramsar regions but not covering each and every country within those Ramsar regions.
Sub-regional Scale	A scale which is greater than the national scale which normally encompasses several countries within any *one* Ramsar region but not covering each and every country within that Ramsar region
Wetland Inventory Assessment Sheet	This consists of a series of sheets designed to evaluate and summarise wetland inventory material. These are completed for each and every inventory source which contains useful coverage and attribute data. The details from these sheets are then entered into the GRoWI database. Wetland Inventory Assessment Sheets are not completed for sources which are deemed to be of little use for inventory purposes.
Wetland	According to the Ramsar Convention, wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres. In addition, the Ramsar Convention (Article 2.1) provides that wetlands: 'may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands'.
Wetland Inventory	For the purposes of this project the definition of 'wetland inventory material' is necessarily broad, and encompasses standard wetland inventories carried out specifically for this purpose, but also includes material, which does not constitute a wetland inventory *per se* (eg Hughes et al 1994, A Preliminary Inventory of Tunisian Wetlands). Relevant NGO material, GO material, conference proceedings, workshop material and academic/research material were also considered as wetland inventory material.

eriss	Environmental Research Institute of the Supervising Scientist
GO	Governmental organisation
NGO	Non-governmental organisation
WI-A	Wetlands International–Americas
WI-AEME	Wetlands International–Africa, Europe, Middle East
WI-AP	Wetlands International–Asia Pacific
WIAS	see *Wetland Inventory Assessment Sheet*
GRoWI	Global Review of Wetland Resources and Priorities for Wetland Inventory

Review of wetland inventory information in Western Europe

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Contents

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A large and helpful network of old and new contacts provided us with references, contacts and tips. Please see the list of persons and institutions contacted which are listed in Annex 1. Finally, we'd like to thank Mike Smart who, while at the Ramsar Bureau, was always asking the question 'Just how much wetland is there in the world?'

1 Introduction

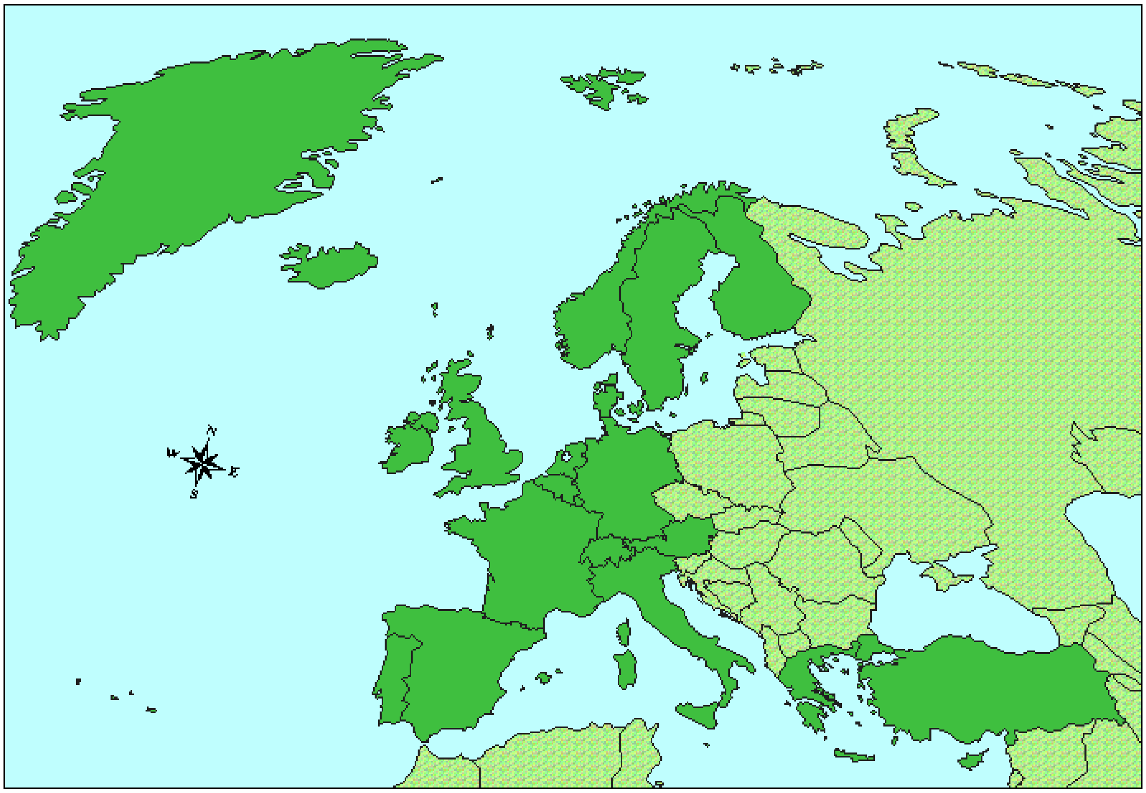
The Western European countries covered by this review are listed below in table 1.1. These countries constitute the Ramsar Region of Western Europe which encompasses some twenty-five countries. This includes the Atlantic Ocean coast countries of Portugal, Spain, France, Ireland and Iceland; the North Sea countries of the United Kingdom, Belgium, the Netherlands and Germany; the Scandinavian countries of Norway, Denmark (including Greenland), Sweden and Finland in the north. It also includes the land locked countries of Andorra, Austria, Switzerland, Liechtenstein, and Luxembourg, and the Mediterranean countries of Italy, Malta and Monaco (also Spain and France) in the south. It encompasses San Marino on the Western coast of the Adriatic, (but not the countries on the Eastern Adriatic coast), and the countries of Greece, Turkey and Cyprus in the south east.

Table 1.1 Countries included in the Ramsar region of Western Europe

Countries included in Western Europe	
Andorra	Luxembourg
Austria	Malta
Belgium	Monaco
Cyprus	Netherlands
Denmark	Norway
Finland	Portugal
France	San Marino
Germany	Spain
Greece	Sweden
Iceland	Switzerland
Ireland	Turkey
Italy	United Kingdom
Liechtenstein	

This review was based on national datasets (including the possibility that a composite national dataset could be amalgamated by equivalent, eg provincial, data subsets). From the beginning, the assumption was made that significant (national) information on wetland extent, health, attributes and values might be found in many other information sources besides conventional wetland inventories or directories. It is believed that this constitutes a divergence from previous studies. While this broadened the scope and potential of the material examined, it also meant that all studies were effectively judged as if they were undertaken with wetland inventory objectives in mind. Often this was, of course, not the case.

Furthermore the authors acknowledge the following deficiencies in this study. The dataset is incomplete, for some countries this is more of a concern than for others. The compressed time frame and limited resourcing for a project of this nature probably promoted certain biases (for example, over-reliance on English language studies, and on the more-familiar elements of contact networks), and was likely heavily influenced by the lag time between requests for study material, and its ultimate receipt. Finally, due to time and resource constraints, spatial information datasets have not been adequately reviewed; this constitutes a large gap in this preliminary study.



Boundaries are not authoritative

Figure 1.1 Map of the Western Europe region

2 Information sources

2.1 Search strategy

This review can simply be described as an inventory of wetland inventories based on national datasets (including composite national datasets that were amalgamated from equivalent, eg 'provincial', data subsets).

Potential sources of wetland inventory data were identified through communications with an extensive network of contacts (see Annex 1), and using the World Wide Web, external (eg Wageningen Agriculture University databases) and in-house libraries, Ramsar National Reports, and IWRB National Reports. Search terms included combinations of the more obvious terms such as:

> *wetland, wetlands, inventory, extent, status, distribution, classification, directory, overview, review*

and habitat names including the following:

> *grasslands, peat, peatland, bog, marshes, swamp, lakes, water, reservoirs, pond*

and less obvious terms such as

> *survey, area, intertidal, subtidal, riparian, aquatic, coastal, evaluation, mapping, census, state, waterfowl, waterbirds*

also non-English search terms included

Les zones humid, Le zone umide, zones humides d'importance, Flussordnungszahlen, Le Littoral, los Humedales, resources cotieres

Where the above terms did not prove successful for any individual country, a search by country name was conducted followed by a lengthy examination of the resulting ‘hits’.

In addition, the reference lists of material obtained were scanned for possible wetland inventory sources. In many cases this proved to be more successful in identifying potential information sources than database or web searching, particularly for unpublished sources.

2.2 Evaluation of the Western Europe dataset

The methodology used to identify and evaluate material for the Western European (WEUR) dataset follows.

2.2.1 Evaluation of inventory material for inclusion in the WEUR dataset

Many potential sources were obtained, and their suitability for inclusion in the database was assessed. The decision whether to include or exclude certain sources depended on several factors. Poor quality material was not usually included except where no alternative data for a country could be obtained. Sub-national data were excluded except where no national information existed. In cases where material was encountered which contained no area data but did contain other useful information, it was considered if no other information for that country was identified.

2.2.2 Meta-data recording

Each assessed information source was evaluated using a *Wetland Inventory Assessment Sheet* (WIAS), designed to permit rapid assessment and compilation of information about each identified inventory, and to compile summary information about the wetland resource contained in each inventory. A set of guidelines for the completion of the sheet was also developed to facilitate consistent handling and coding of relevant information. Derivation of wetland coverage estimates and other wetland parameters are discussed in later sections.

A database was created to include information about each information source that was reviewed and recorded on a WIAS datasheet. Another database was also created to serve as a data dictionary of the codes (and their descriptions) which was used to represent various categories of information in the primary database.

Computer programs were written to analyse the majority of coded fields in the database. The analyses report on the presence or absence of codes or logical values (by use of a filtering system), and produced printed outputs. These outputs provide the meta-data breakdowns given in this report.

2.3 Materials sourced

Some 27 wetland inventory sources were included in the Western European dataset. The number of inventories examined per country is given in table 2.1 and graphically represented in figure 2.1.

A full reference list of materials included in the preliminary assessment is given in Annex 2. The materials examined included both published (including world wide web articles, journal articles and books) and unpublished material, academic material (including peer reviewed material, MSc and PhD theses), governmental and non-governmental material, draft reports, newsletter articles, conference proceedings and consultancy reports (see section 2.4 for further details).

As such, conventional wetland inventories and directories were examined, also natural resource inventories or habitat surveys (which either directly or indirectly included wetlands), and also sources which contained wetland extent information merely as a by-product of some other activity (eg waterfowl counts).

Table 2.1 Numbers of material sourced per country in the Western European region

Country name	No. of materials sourced
Andorra	0
Austria	3
Belgium	1
Cyprus	0
Denmark	5
Finland	5
France	5
Germany	5
Greece	5
Iceland	2
Ireland	4
Italy	7
Liechtenstein	1
Luxembourg	1
Malta	1
Monaco	1
Netherlands	7
Norway	4
Portugal	2
San Marino	0
Spain	2
Sweden	5
Switzerland	1
Turkey	2
United Kingdom	13

Since a degree of selection occurred in choice of material included in the Western Europe (WEUR) dataset, it cannot be stated that ‘x’ countries have more wetland inventory material than ‘y’ countries. In some cases, several sources of material were required in order to make a best estimate of wetland coverage for a specific country, whereas, for other countries, one source alone was comprehensive and detailed enough to provide a best estimate of wetland coverage. An example of the former would be the United Kingdom, and an example of the latter would be Greece. Therefore, it must be noted that the graph above cannot be taken as representative of all the material available per country, simply the material which was included in the WEUR dataset.

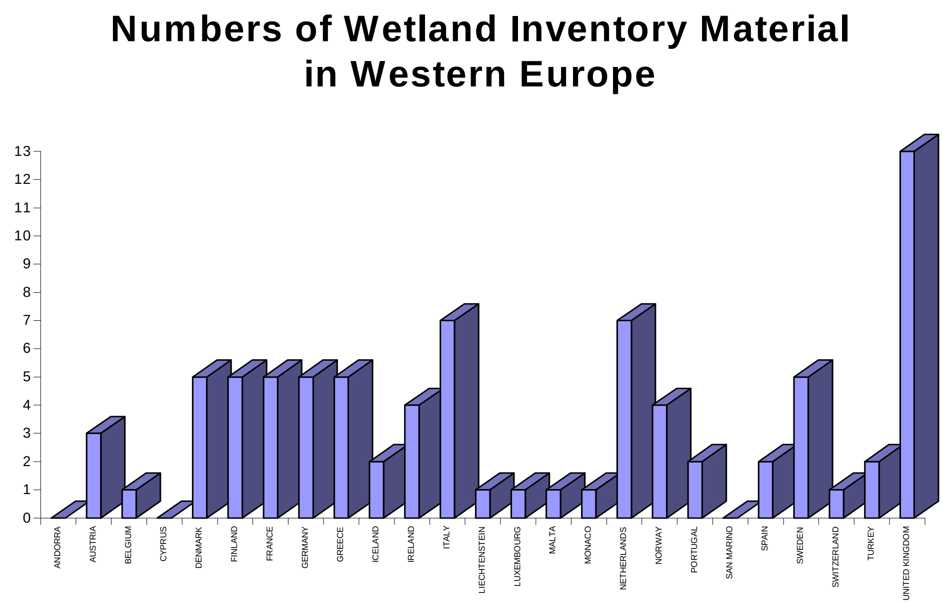


Figure 2.1 Numbers of wetland inventory material in Western European countries

2.4 Summary of information sources reviewed

The majority of materials examined (59%) for Western Europe was national level material, but sub-national level material also featured strongly (19%). The inclusion of sub-national level material indicates that there was insufficient national level material for some countries to derive best estimates, (compare this to 0% sub-national material in the Africa and Eastern European regions). Some 44% of sources examined were either inventories or directories, or their equivalent, (a value higher than that for Africa, but lower than that for Eastern Europe).

Scale of inventory of material	
Global scale	4%
Supra-regional scale	11%
Regional scale	0%
Sub-regional scale	7%
National scale	59%
Single country studies	74%
National scale references including more than one country	4%
Sub-national scale	19%
National and other scale combination	0%

Government publications comprised 41% of material examined in the region, and NGO material comprised some 18% of material examined (comprising 11% reports and 7% formal publications). This differs from the material examined for Africa and Eastern Europe where non-governmental material formed a greater proportion of the material than governmental material. It is encouraging that governments in Western Europe seem to be playing a very active role in wetland inventory activities, and this may be linked to the fact that nearly all the countries (22 out of 25 countries) in Western Europe are signatories to the Ramsar Convention (Source of Ramsar site Information: Ramsar Database, date of data extraction 17/8/98).

Type of source material	
Peer review journals	4%
Peer review books	4%
Chapters in books	4%
Conference or keynote presentation	0%
Article in conference proceedings	7%
Internal government reports	0%
Government formal publications	41%
Other government material	0%
NGO reports	11%
NGO formal publications	7%
Consultancy reports	4%
Newsletter articles	0%
Practitioner periodical article	0%
Database manual	0%
Electronic database	7%
World Wide Web article	7%
Thesis	0%
Other	4%
Unknown	7%

Some 44% of wetland inventory sources assessed in Western Europe were conventional wetland directories or inventories, (or equivalent), and 55% were some other kind of study. This means that the majority of information is not immediately apparent as a source of wetland inventory information; often these sources contain wetland inventory information as a by-product of other activities, such as bird surveys, or land use cover appraisals. Commonly, such studies contained scant or approximate wetland information, but for many countries no other wetland inventory information sources were identified.

Source is a directory/inventory or equivalent?	
Yes	44%
No	56%

The majority of studies were in English (81%), with the remaining sources in a variety of languages including Finnish, French, Italian, German and Spanish.

Language of study	**0%**
English	81%
Other	19%

Nearly all the material were in paper format (85%), although some 7% were in electronic database format and 7% of the material was available on the World Wide Web. Similarly, most information (74%) was stored in paper format, though 19% of information were stored within electronic databases.

Format of study	
Paper	85%
Electronic text	0%
Electronic database	7%
Personal communication	0%
Web presentation	7%
Part of GIS or GIS output	0%
Map based	0%
Other format	0%
More than one format	0%
Data storage media	
Paper	74%
Web (electronic)	7%
Other electronic (not web or database)	7%
Electronic database	19%
GIS	4%
Hard copy map	4%
Digitised map	4%
Other	4%
More than one medium	19%
Unknown or ambiguous	4%

The majority (78%) of material examined were published (in one form or another), which is much higher than the figure for Africa (only 43% published), and Eastern Europe (only 56% published) (Stevenson & Frazier 1999a,b). This must have repercussions for the circulation and dissemination of wetland inventory material in that published material is more likely to be held in public libraries and be listed in literature databases and therefore more readily accessible than unpublished material.

Circulation of study	
Published	78%
Interdepartmental (unpublished)	0%
Internal (unpublished)	7%
Restricted (unpublished)	0%
Unrestricted (unpublished)	7%
Other types	4%
More than one type	4%
Unknown	7%

Certainly the authors have noted that a substantial amount of NGO inventory material often comprised of draft reports and unpublished final reports (which, it was often found, had not been published due to lack of funding or proper publication budget). It is however, very likely that much unpublished *governmental* material exists, but in general, this is much harder to identify and obtain than non-governmental unpublished material. This may be the reason why *unpublished* governmental material did not feature very strongly in this review.

2.5 Reliability of data

It is difficult to make judgements on the reliability of the individual data sources examined and included in this review when much of the material did not provide basic information. For instance, basic information such as the date of survey or date ranges of material featuring in a compilation/review, methodologies used, or contact information was frequently omitted. The tendency is to judge material as unreliable if it does not contain such basic information, but this judgement is by no means certain. The variety of classification schemes and definitions of wetlands used (often not defined) serves to further hamper any attempts to judge the reliability of material. However, as material for individual countries is judged collectively, it becomes (subjectively) more clear which information sources are likely to be more reliable.

By examining the methods, the date ranges and inclusion (or exclusion) of particular wetland types it is possible to at least generate best estimates of wetland coverage for any particular country, by consolidating the estimates from several sources. For example, one source may provide an estimate of wetlands in a country comprising an estimate of coastal wetlands which appears to be accurate, but an estimate of freshwater wetlands which noticeably excludes (for example) floodplains. The estimate for coastal wetlands would then be consolidated with the estimate of freshwater wetlands provided by another source that purports to include floodplain wetlands (providing it was a greater area than the other source).

Section 3.3 provides a more detailed description of how wetland area estimates by type were generated for this review, and provides guidance for interpreting the summary sheets of wetland coverage and extent (given in Annex 2), and material reviewed. Comments on the age of data, methods used, and exclusions in coverage (eg the estimate excludes floodplain wetlands and ephemeral wetlands) are given, and these provide an assessment of data reliability.

Several generic difficulties emerged throughout the evaluation process that should be noted when judging the reliability of data. These are summarised below.

- usage of different wetland definitions/classifications and the inclusion or exclusion of some wetland types, eg lakes and open water, in inventories. See section 3.1 for a further discussion of wetland definition and classification issues;
- artificial wetlands were also often largely ignored in many national inventories and therefore national inventories are often incomplete in their coverage;
- the date of data collection and inventory productions were often not recorded, and it should be noted that review compilations, by their very nature, use different sources of widely differing ages (the dates of which are rarely stated);
- defined boundaries of wetlands were often not provided, making comparisons between different sources difficult, as did the variable treatment of individual wetlands in wetland complexes;

- many sources lacked a summary, making extracting national-level information time-consuming; some of the material which did provide a summary contained summary information that did not always match the text of the report;
- the wide variety of languages of national inventories made extraction and review of information difficult, and time consuming (and potentially expensive if translations were carried out);
- many potential wetland inventory information sources were unpublished material which proved to be difficult to obtain or access; much of the information which was accessed were also draft reports written up to 5 years ago which have never progressed beyond draft report stage;
- often the areas provided in many potential sources of information were site areas, eg national park areas and not actually wetland areas, (these sources were excluded from the analysis, with the exception of Ramsar sites);
- contradiction of information about some sites *between* different references was found to occur. With a little detective work, in most cases it was possible to identify erroneous material, but this was not always possible;
- contradictions within *one individual* source document were also noted to occur. This meant that some detective work was often required to identify errors and rectify errors, resulting in slow assessment.

This project has identified several cases where source material has quoted wetland area estimates taken from studies that had been comprehensively updated by more recent studies, and therefore their estimates were out of date, and had been supplanted by more recent and accurate data. This creates a misinformation trail, which makes it difficult to assess the accuracy of reports that yield conflicting data.

Some less accessible inventories have been missed in this review. Additional material has been identified since the analysis phase was completed and some key sources of material were therefore not incorporated in this preliminary analysis. Further additional sources may be revealed during the consultation phase and after circulation of the completed report. An update of the dataset is recommended after the consultation process has been completed.

3 Extent and distribution of wetlands

3.1 Definition and classification of wetlands

A major consequence of using the rather broad Ramsar definition (Annex 3) of wetlands in this review, is that the estimates of wetland coverage generated by this project cannot strictly be regarded as estimates of true or actual wetland cover, but are instead estimates of *described* wetland cover. Consequently the area values given in this review should be viewed as underestimates, and do not represent estimates of the entire wetlands resource, but only those for which coverage estimates already exist in their many disparate forms.

Differing wetland definitions and classification schemes were used in different studies and these definitions are not always stated, making it difficult to assess the degree of completeness of cover (and thereby the estimates of wetland extent). For instance, many inventories include or exclude some wetland types, eg open water bodies, and estuaries.

A definition of the terms ‘marine wetlands’, ‘coastal wetlands’ and ‘inland wetlands’ was almost without exception absent, and yet separate authors used them to mean different things. Extracting information on even broad wetland categories was found to be difficult. Particularly when some authors use, for example, the term ‘coastal wetlands’ to mean strictly saline and brackish habitats and others use it to mean wetlands in the coastal zone (which often for practical purposes means coastal lowlands and incorporates wetlands which experience no tidal inundation). Similarly the term ‘inland wetlands’ to some authors meant freshwater wetlands, to others it meant all wetlands except those in the coastal plain, to others it meant all wetlands except those wetlands under tidal influence.

It was apparent (though not defined) that many authors utilised a more narrow definition of wetlands than that given by the Ramsar definition. For instance, many authors may argue that wetlands must be vegetated, (therefore mudflats and sand flats and open water would be excluded). Others may argue that coral reefs, seagrass beds and subterranean karst are not wetlands, and others may also exclude artificial or created wetlands from their definition of wetlands. Similarly, forested wetlands are often regarded as forests and not wetlands, and are therefore excluded from wetland assessments (and yet may also be excluded from forestry assessments for exactly the opposite reason).

It is therefore not surprising that certain wetland types were commonly excluded from wetland assessments. These include dune slacks, humid sands, wet mesotrophic grasslands, seagrass beds, maerl beds, glacial and alpine wetlands, artificial wetlands (especially reservoirs, fish ponds, rice paddies, dams etc) and finally recent additions to the Ramsar list of wetland types such subterranean karst wetlands.

In the Western European region several terms were commonly treated differently. These included different treatment of the terms ‘coastal’, ‘marine’ and ‘inland’, and ‘peat’, ‘bog’, ‘mire’ and ‘fen’. Estuaries, open water bodies, tidal flats, riparian systems, artificial waterbodies (eg reservoirs, flooded quarries etc) also appeared to be frequently ignored, perhaps resulting from a view that these do not constitute wetlands.

A definition of wetlands was provided in only 30% of studies, and only 22% of studies used the Ramsar definition of wetlands. It was not possible to identify which definition was used for some 33% of studies, so the true value of Ramsar definition usage may be much higher. The Ramsar classification system for wetland type was used in only 7% of studies, was unknown for 30% of studies and not applicable for some 41% of studies (these were usually reviews or collations of material). It is likely that the definition of wetlands and classification of wetland types given by Ramsar are more globally applicable, and less suited to an individual country’s management requirements; hence the low usage of the Ramsar terms.

Wetland definition	
Definition provided	30%
Definition implied	15%
No definition provided or implied	52%
Unknown/ambiguous	4%
Ramsar definition	
Ramsar definition used	22%
Ramsar definition not used	44%
Use of Ramsar definition unknown	33%

Ramsar classification	
Ramsar wetland types used	7%
Other wetland classification used	22%
Wetland classification varies	0%
Unknown	30%
Not applicable	41%

3.2 Overall extent of wetlands in Western Europe

The analysis showed that in 81% of studies, only *part* of the wetland resource was examined, whereas *all* wetland resources were purportedly included in just 19% of studies. Where only part of the wetland resource was assessed by a study, the basis for selection was mainly (44%) influenced by habitat type (eg forested peat, coastal marsh) and jurisdiction (ie over a province or sub-national region). These features may be due to the prevalence of a sectoral management approach within governments, such that forested wetlands may be managed and inventoried by the forestry department, coastal wetlands by the fisheries department and inland wetlands and artificial wetlands by water quality authorities. This is also directly due to the fact that only 56% of the studies analysed were conventional directories or inventories. The remaining percentage consisted of material that reviewed wetlands in a region or country, and estimates of wetland area were based on approximations.

Extent of coverage	
All wetlands	19%
Part of wetland resource	81%
Ambiguous	0%
Wetland type coverage	
Sources providing area values per wetland type	56%
Sources partially providing area values per wetland type	30%
Sources not providing area values per wetland type	11%
Not known	4%
Basis of selection (if not complete wetland coverage)	
Geography / jurisdiction	41%
Land cover or remotely sensed data	0%
Landform type	4%
Supra-habitat	11%
Habitat type	44%
Floral / faunal groups or species	4%
Climate	4%
Wetland function	0%
Hydrology	0%
Biodiversity value	4%
Cultural value	0%
Artefact of data collection	4%
Other basis	15%
Unknown or ambiguous	4%
More than one basis	44%

A summary of wetland coverage in Western Europe as a region is presented in tables 3.1 and 3.2. The total area calculated from the WEUR dataset amounted to some 28 822 000 ha, covering 4% of the land surface. A large percentage (62%) of the wetlands included in this estimate were not specified as either ‘marine/coastal’, ‘inland’ or ‘artificial’ wetlands. This is a staggering value, amounting to some 17 951 000 ha of wetlands. It would be premature to state that these wetlands are truly undescribed, but within the scope and time constraints dictated by this review project, it was not possible to uncover basic information about these ‘unspecified’ types of wetland in the Western European dataset. More information has been uncovered since the analysis phase of this project; however, this newly acquired data is not expected to significantly alter the proportion of unspecified wetlands.

Table 3.1 Wetland coverage in Western Europe as identified from the WEUR dataset

Western Europe	Estimate of area in hectares (ha)
Marine/coastal wetlands	3 571 362
Inland wetlands	7 248 283
Manmade wetlands	51 274
Area of unspecified types of wetland	17 951 060
Total area of wetands identified in this study	28 821 979
# of national datasets per region	42
# of national datasets which can be regarded as comprehensive in cover	8

Table 3.2 Wetland coverage in Western Europe as a percentage of land cover, and Ramsar site information

Western Europe	
# of Countries	26
Total land area of region (ha)	673 304 000
Total area of wetlands identified in this study (ha)	28 821 979
(median value of wetland area – ha)	–
% of land area covered by these wetlands	4.28%
Total area of Ramsar sites (ha)	5 682 196
# of Ramsar sites	469

(Source of Ramsar site information: Ramsar Database, date of data extraction 17/8/98)

The WEUR review showed that more than 25% (7 248 283 ha) of specified wetlands were inland wetlands, with less than 12% of specified wetlands described as marine/coastal wetlands (3 571 362 ha) and a further 0.2 % described as artificial wetlands (51 274 ha).

Since the scope and coverage of most inventory material did not state whether total wetland estimates included Ramsar sites, it is not possible to state whether this value includes, partially includes or excludes these sites. It must also be noted that the areas of Ramsar sites listed in table 3.2 are site areas and not wetland areas *per se.*

3.3 Wetland extent in Western European countries

Best estimates of wetland extent by broad wetland type (‘inland’, ‘marine/coastal’ and ‘artificial’) for the Western European countries are given in table 3.4. A description of how best estimates of wetland coverage per country were derived is outlined below.

3.3.1 Derivation of country 'best estimates' of wetland coverage

The estimates of wetland coverage cited in the material examined in this review (and included in the Western European dataset) were entered into a system of *country coverage files* (in spreadsheet format). An individual wetland coverage file for each country within the Western European region, was created to facilitate the generation of best estimates of wetland area coverage per country and to serve as a summary and provide an 'audit trial' of material included.

Each file (workbook) consisted of several components (worksheets) broken down by Ramsar wetland type and also by broad wetland category (marine/coastal, inland and artificial) as follows:

1. Sheet one contains area statistics for marine/coastal wetlands broken down by Ramsar wetland type (*types: A, B, C, D, E, F, G, H, I, J, K).*
2. Sheet two contains area statistics for inland wetlands broken down by Ramsar wetland types (*types: L, M, N, O, P,Q, R, Sp, Ss, Tp, Ts, U, Va, Vt, W, Xf, Xp, Y, Zg, Zk)*.
3. Sheet three contains area statistics for artificial wetlands broken down by Ramsar wetland types (*types: 1, 2, 3, 4, 5, 6, 7, 8, 9,)*.
4. Sheet four contains 'notes and comments' which provides an indication of the reliability of the data (subjective assessment), and notes about methodology and or original sources of data.
5. Sheet five 'summary' contains the *total* values for 'marine/coastal', 'inland' and 'artificial' wetlands (not broken down per Ramsar wetland type) and the 'notes and comments' sheet. This sheet is generated automatically from sheets 1–4. Changes made to sheets 1–4 will update in the summary sheet.

The summary sheet (sheet five) for each country can be found in Annex 2. Where possible, approximate estimates per Ramsar wetland type were entered in the appropriate columns (in sheets 1–3; where this was not feasible, approximate values for broad wetland type were entered, and where this was not feasible, a total value was entered. This created a hierarchical system where it was possible to examine the quality of wetland coverage and extent information per country, which was assessed in the Western European dataset.

Each file provided wetland estimates, along with brief notes as to scope, and in particular, exclusions in coverage (eg open water bodies), and gave an indication as to the reliability of the data (sheet 4). This provided a convenient means of auditing all the material included in the dataset, and provides an 'at a glance' summary of the material examined.

Once all the wetland area values had been entered into a coverage file for each country, along with the appropriate notes on method and reliability, a subjective assessment of the all material for each country was made. Best estimates were composed according to broad wetland category (marine/coastal, inland and artificial), and a justification of the rationale entered into sheet 5. Once the coverage files were completed for all the countries within a region, the estimates were compiled into a summary table (table 3.4).

It should be noted that several wetland inventories included information on more than one country, and hence these documents feature in many country coverage files. The number of materials (referred to as datasets) examined per country were totalled and also entered into the summary document for each region.

Some notes which will appear on summary sheet five, which refer to specific Ramsar wetlands or values shown on sheets 1–4 (in the individual country coverage files as described above). In a small number of cases the notes appearing on the summary sheet are not self-explanatory when viewed independently of sheets 1–4. This is regrettable, but unavoidable given the time constraints associated with the production of national overviews.

The summaries of wetland coverage for each Western European country deemed to have sufficient material to generate a 'best estimate' of wetland coverage either in total or by category type (inland, marine/coastal, artificial) can be found in Annex 2. Notes on the reliability of the assessment are included with each summary. Countries that were omitted from the 'best estimate' and reliability assessment due to lack of data in the WEUR dataset are given below in table 3.3.

Table 3.3 Countries omitted from the 'best estimate' and reliability assessment due to lack of data in the WEUR Dataset

Western Europe	
Andorra	Luxembourg
Belgium	Malta
Cyprus	Monaco
Iceland	San Marino
Ireland*	Switzerland
Liechtenstein	

*Data was available for certain wetland types, but there was insufficient data to create a best estimate of national wetland area.

3.3.2 'Best estimates' of wetland coverage per country

'Best estimates' of wetland coverage per broad wetland category for countries in the Western Europe region are given in table 3.4.

Table 3.4 Best estimates of wetland coverage per broad wetland category for countries in the Western Europe region[1]

WESTERN EUROPE REGION	BEST ESTIMATES					COVERAGE INFO		RAMSAR INFO	
	Marine/Coastal (ha)	**Inland (ha)**	**Artificial (ha)**	**Unspecified Wetland Type (ha)**	**Total (ha)**	# of datasets accessed per country [2]	# of datasets which can be regarded as comprehensive in cover per country	Total area of Ramsar sites	# of Ramsar sites
ANDORRA	No data	No data	No data		**No data**			0	0
AUSTRIA	none	265 622	435		**266 057**	1	1 ?	102 772	9
BELGIUM	No data	No data	No data		**No data**			7 935	6
CYPRUS	No data	No data	No data		**No data**			0	0
DENMARK [3]	885 142	1 399 830	unknown		**2 284 972**	2	0	2 283 013	38
FINLAND	50 143	3 352 200	unknown		**3 402 343**	3	0	101 343	11
FRANCE	381 280	800 627	3 600		**1 185 507**	2	1?	579 085	15
GERMANY	680 881	427 424	unknown	158 897	**1 267 202**	3	1?	672 852	31
GREECE	105 987	65 733	35 824		**207 544**	4	2	163 501	10
ICELAND	No data	No data	No data		**No data**			58 970	3
IRELAND	Insufficient data	Insufficient data	Insufficient data		**Insufficient data**			66 994	45
ITALY	Insufficient data	Insufficient data	Insufficient data	450 563	**450 563**	4	2	56 950	46
LIECHTENSTEIN	No data	No data	No data		**No data**			101	1
LUXEMBOURG	No data	No data	No data		**No data**			313	1
MALTA	No data	No data	No data		**No data**			16	2
MONACO	No data	No data	No data		**No data**			10	1

Table 3.4 continued

WESTERN EUROPE REGION		BEST ESTIMATES				COVERAGE INFO		RAMSAR INFO	
	Marine/Coastal (ha)	Inland (ha)	Artificial (ha)	Unspecified Wetland Type (ha)	Total (ha)	# of datasets accessed per country[1]	# of datasets which can be regarded as comprehensive in cover per country	Total area of Ramsar sites	# of Ramsar sites
NETHERLANDS	404 335	391 134	Insufficient data		**795 469**	4	1?	324 918	18
NORWAY	Insufficient data	Insufficient data	Insufficient data	3 301 600	**3 301 600**	2	1	70 150	23
PORTUGAL	79 500	unknown	unknown		**79 500**	1	1	65 813	10
SAN MARINO	No data	No data	No data		**No data**			0	0
SPAIN	129 596	27 000	9 112		**165 708**	1	1	158 216	38
SWEDEN	Insufficient data	Insufficient data	Insufficient data	12 800 000	**12 800 000**	4	1	382 750	30
SWITZERLAND	No data	No data	No data		**No data**			7 049	8
TURKEY	unknown	unknown	unknown	1 240 000	**1 240 000**	1	0	159 300	9
UNITED KINGDOM	854 498	518 713	2 303		**1 375 514**	10	0	420 145	114
Total estimated wetland cover	**3 571 362**	**7 248 283**	**51 274**	**17 951 060**	**28 821 979**	**42**	**8**	5 682 196	469

1. Please consult section 3.3.1 for a description of how these estimates were generated.
2. Excluding the Ramsar sites and GLCC databases.
3. Includes sites in Greenland.

4 Rate and extent of wetland loss and degradation

The majority of sources examined (59%) did not provide any details of wetland loss and/or degradation. This does not mean that loss values do not exist, simply that the material sought for this review was wetland inventory material, which as it turned out, rarely dealt with these issues in any detail. No specific tasks were performed to identify material that specifically outlined wetland loss (in isolation of inventories/directories). Thus, wetland inventory material within the Western European region does not normally include any appreciable data on wetland loss. This may, however, be directly related to the time scale of most wetland inventory activities, which are largely discrete surveys, which have not yet been repeated.

Of the 37% of material in the Western European region which did provide some information, this was almost exclusively descriptive, rather than quantitative. Whilst wetland loss throughout Western Europe is thought to be substantial, very little quantification of loss or damage was uncovered in this review. It was therefore not possible to either refute or support other existing reported values. The following statement was published by OECD (1996):

> Some estimates show that the world may have lost 50% of the wetlands that existed since 1900; whilst much of this occurred in the northern countries during the first 50 years of the century, increasing pressure for conversion to alternative land use has been put on tropical and sub-tropical wetlands since the 1950s.

Wetland loss and degradation	
Sources providing information on wetland loss and/or degradation	37%
Sources not providing information on wetland loss and/or degradation	59%
Not known	4%

Jones and Hughes (1993) provided an overview of the extent of wetland loss in Europe. Overall wetland losses exceeding 50% of original area have been reported by the Netherlands, Germany, Spain, Greece, Italy, France and parts of Portugal (Jones & Hughes 1993, Commission of the European Communities 1995). In the United Kingdom, loss rates of 23% of estuaries and 50% of saltmarshes since Roman times (Davidson et al 1991), and 40% of wet grasslands (RSPB 1993) have been reported. The only study allowing broad comparisons for a particular wetland type across the whole of Europe is that of Immirzi et al (1992), which reports loss rates for peatlands in excess of 50% for 11 European countries.

It was noted that a wide diversity of methodologies are used to measure wetland loss, and the lack of co-ordination between studies in different countries or for different wetland types prohibits any overview at regional level.

More recent information on wetland loss may have emerged since the works mentioned above. However, it is important to note that, if the WEUR dataset is representative of the wetland inventory material that exists in Western Europe, then we can conclude that wetland loss is rarely measured or recorded during wetland inventory activities in the region. Studies that specifically set out to measure wetland loss may have been undertaken, but loss values do not feature in inventory assessments.

Similarly, of the material examined for Western Europe, only 33% of material included a description of overall wetland status in a country (though these descriptions were of course totally generic in nature). Overall those that did provide such information often provided detailed individual site information (often the ‘study site’ subject to scientific research), and some studies provided an overview or summary of such information. These latter studies were generally not conventional wetland inventories or directories *per se*, and were frequently academic peer review publications, which are necessarily short in length. Where wetland loss information was provided it must be noted that the rates or amounts identified on a local scale do not necessarily reflect national trends in wetland loss. Overall it can be said that the information on wetland loss was usually lacking, but where it was included it was highly variable and inconsistent in its detail.

Wetland status description	
Overall wetland status description included	33%
Overall wetland status description not included	59%
Unknown	7%

Details of the major threats to wetlands are also lacking from most inventory material in the Western European region. Some site based studies do provide very brief descriptions of threats to individual wetlands; usually these studies are ones undertaken to designate or describe wetlands of 'international importance' (according to the Convention on Wetlands, Ramsar, 1971). Standard site descriptions are recorded on a Convention-approved form, the 'Ramsar Information Sheet' (RIS), and this *pro-forma* includes an information category called 'Adverse factors'. This subject is recorded in the Ramsar Database according to an *ad hoc* set of past (but still influential), present and/or potential wetland threats (both in and around the site). These developed based on the data that have been provided, rather than fitting incoming data to a pre-existing structured classification.

Due to this historical legacy, the urgency, extent and character of any threat at any site listed has never been codified in the current (to be supplanted) database. Such information, if it exists, might be found in individual site files that support the database. Oftentimes, the level of detail provided is very low, and example statements include 'peat cutting is common at the site' 'livestock grazing is causing physical damage to the wetland', 'water extraction for agricultural purposes is leading to a lowering of the water table'.

5 Wetland benefits and values

Wetland values as defined by the Ramsar Bureau, are 'the perceived benefits to society, either direct or indirect, that result from wetland functions. These values include human welfare, environmental quality, and wildlife support' (Ramsar Convention Bureau 1996).

A large proportion of material examined for the review was not a conventional inventory/directory (see section 2.4) and did not contain site by site information. These sources did not usually contain details of wetland values and/or benefits (other than generic statements), since they usually referred to wetlands at a national level (or at least above a local or provincial level) and would therefore not contain detailed management information. However, the inclusion of generic statements in studies which were not 'site-based' inventories (ie general overviews) was recorded, and the analysis showed that 11% of 'non-site based' studies contained 'some level' of wetland values and benefits information.

Western Europe	Inclusion of wetland values and benefits information (site based studies only)
Some level of information	11%
Always	4%
Most of the time	4%
Commonly	4%
Sometimes	0%
Rarely	4%
Never	70%
Unknown	4%

Site-based studies (usually wetland inventories *per se*) were treated differently in the evaluation process and were evaluated against Ramsar Information Sheet (RIS) categories, and the frequency (ie never, rarely, sometimes, commonly etc) of the inclusion of the RIS category was recorded. The frequency of inclusion of values and benefits information for *each and every site* described within (site based) studies were assessed. The results showed that 70% 'never' contained any values and benefits information; 'rarely' 4%; 'sometimes' 0%; 'commonly' only 4%; 'most of the time' 4%; and 'always' 4%. In the majority of non-site based studies, a paragraph or two describing values and benefits of wetlands in general was usually all that was provided. None of the material examined included any financial or economic estimates.

In the majority of site based studies (wetland inventories *per se*), values and benefits information amounted to one or two sentences per site. For example 'the site experiences pressure from artisanal fisheries', 'the wetland provides flood buffer and water storage capabilities', and 'the area is a tourist destination and the wetland provides healing muds which are used in the many health spas'. In the majority of non-site based studies, a paragraph or two describing values and benefits of wetlands in general was usually all that was provided. None of the material examined included any financial or economic estimates.

This study did not therefore reveal any new information on wetland values and benefits in Western Europe. It was therefore not possible to either refute or support any values reported elsewhere. A general (non-site specific) overview of the functions and values of Mediterranean wetlands is given by Skinner and Zalewski (1995) (though monetary values are not included).

6 Land tenure and management structures

A large proportion of material examined for the review was not a conventional inventory/directory (see section 2.4) and did not contain site by site information. These sources did not contain information on land tenure, management authority or jurisdiction, since they usually referred to wetlands at a national level (or at least above a local or provincial level) and would therefore not contain detailed management information.

When material did contain site by site information the material was evaluated against Ramsar Information Sheet (RIS) categories and the frequency (ie never, rarely, sometimes, commonly etc) of the inclusion of the RIS category was recorded. As can be seen below, for only 7% of the time, details of land tenure/ownership were recorded 'most of the time' and for some 93% of the time details were never recorded.

Western Europe	Inclusion of land tenure / ownership information (site based studies only)
Some unknown level	0%
Always included	0%
Most of the time included	7%
Commonly included	0%
Sometimes included	0%
Rarely included	0%
Never included	93%
Unknown	0%

Some 85% of the material 'never included' jurisdiction information recorded, and some 81% of the material also 'never included' any management authority information recorded. The cases where some information was included, this usually only extended to a sentence such as 'the site falls within the national park' or 'the wildlife department monitor the population of endangered species'.

Western Europe	Inclusion of jurisdiction information (site based studies only)
Some unknown level	11%
Always included	0%
Most of the time included	4%
Commonly included	0%
Sometimes included	0%
Rarely included	0%
Never included	85%
Unknown	0%

NB The Ramsar information sheet states "Jurisdiction (territorial eg state/region and functional eg Department Agriculture /Department of Environment)"

On the whole it can be said almost no sources in the Western European region contained information on land tenure, management authority or jurisdiction.

Western Europe	Inclusion of management authority information (site based studies only)
Some unknown level	11%
Always included	0%
Most of the time included	7%
Commonly included	0%
Sometimes included	0%
Rarely included	0%
Never included	81%
Unknown	0%

NB The Ramsar information sheet states 'Management authority: (name and address of local body directly responsible for managing the wetland)'

7 Extent and adequacy of updating programs

The majority (48%) of information examined in this review were published or dated between 1991 and 1995, and some 37% were published or dated after 1995. Most of the information were judged to not have a temporal scale (generally these studies were either mapping studies or reviews and collations), and only 22% had defined temporal scale (ie were discrete 'one-off' surveys, or ongoing surveys) with a further 19% unknown.

Publication date	
After 1995	37%
Between 1991-1995	48%
Between 1986-1990	7%
Between 1981-1985	4%
Unknown / ambiguous	4%
Temporal scale	
Studies with a temporal scale *	22%
Partly include a temporal scale	0%
No temporal scale (eg review)	59%
Unknown	19%
** Broken down further:*	
Discrete surveys	22%
Surveys updated on an ad-hoc basis	4%
Update purpose to add sites	4%
Update purpose to review status	0%
Update purpose to make corrections	4%
Other update purpose	0%
Unknown purpose	0%
Current /ongoing surveys	11%
Updated on ad-hoc basis	0%
Updated on annual basis	4%
Frequency of update unknown	7%

Only 37% of studies undertook ground surveys and only 15% utilised remote sensing of some type, and some 30% utilised more than one methodology (see section 8.2.3 for further details). The vast majority of studies were reviews or collations of existing material. Repetitions of the review or collation process are only useful if the information they are reviewing or compiling is up to date and/or is based on 'real' data. If no progress has been made in obtaining updated or new field data over any given period (eg 10–15 years), then the review process is meaningless (except to highlight a lack of progress!). At present there appears to be many reviews and overviews available in Western Europe, but these are based on scant and often dated field data.

It could be argued that low resolution comprehensive national field surveys should be undertaken (whether remotely or as part of ground surveys) as a priority to at least identify wetland locations for more detailed study later. However, in terms of resource conservation, repetition of detailed surveys at sites thought to be at risk should also be a priority undertaking. One-off surveys for previously unsurveyed areas are critically important in terms of resource assessment, but few surveys examined in this review were found to be part of a long-term assessment or monitoring program. Most inventories (with the exception of the Ramsar database) have not been updated after any given time interval after the first inventory. Wetland inventories must be regularly reviewed and updated otherwise data is likely to be lost, become out of date and become of historical interest only.

Some countries (eg Sweden) have a national wetland inventory program that has been underway for 10 years or more (Lofroth 1994, Swedish EPA 1998) (Torsten Larsson pers comm). However, most of these national wetland inventory programs begin with an inventory of internationally important sites, later followed by nationally important sites, later followed by wetlands of more than 100ha in size, later followed by wetlands of between 10–100 ha. This is a logical progression, especially when funding and resources are limited. Unfortunately, even some of the most organised, long standing and well documented wetland inventory programs have not yet undertaken any updating programs since baseline data gathering is not yet complete. The cynical view is that by the time these programs are completed, the findings will have little relevance at the time of completion, or the relevant authorities will be presented with data now considered to be inappropriate or insufficient for management purposes.

The authors conclude that the updating procedures of wetland inventory in Western Europe are grossly inadequate, and that few wetland inventories have been updated since first completion.

8 Standardising of inventory approaches

This section outlines the broad types of wetland inventory that have been included in this review (see section 8.1), followed by notes on some relevant findings from the analysis of the Western European material which have bearing on wetland inventory approaches (see section 8.2). Standardisation of inventory approaches must be developed in accordance with the objectives of those organisations carrying out wetland inventory. The ‘who’, ‘how’ and ‘why’ must be examined before any attempts to standardise procedures are made. Finally, generic suggestions for the standardisation of wetland inventory approaches are outlined in section 8.3

8.1 Types of wetland inventory

As stated by Scott (1993) in his review of wetland inventories and their role in the assessment of wetland loss, there are three main types of inventory:

- comprehensive national wetland inventories
- regional or global inventories of specific wetland types
- national or international inventories of wetlands of special conservation importance

This review of wetland inventory material in Western Europe included material in each of these categories, which were defined by Scott (1993) as follows:

comprehensive national wetland inventories:

> these constitute an accurate account of the location and extent of all wetland resources: they usually included detailed mapping and may or may not include an evaluation. Such inventories are time consuming and costly, and require a precise wetland classification system. However they provide and ideal basis for a comprehensive assessment of wetland loss over time.

regional or global inventories of specific wetland types:

such inventories are usually too crude and contain too many gaps in coverage to provide a baseline assessment of wetland loss.

national or international inventories of wetlands of special conservation importance:

these focus on specific sites or systems with high conservation values, rather than wetland types, and on the whole exclude wetland habitat that is too small, fragmented or degraded to merit special attention. The Ramsar Convention provides an agreed set of criteria for the identification of sites of international importance, and these have been, or are being used in the compilation of wetland inventories in most parts of the world. Inventories of this type can be carried out relatively quickly and cheaply, and are of considerable value in focusing conservation effort where it is most required. While far too superficial to be used to measure total wetland loss, they constitute a sound basis for the monitoring of rates of loss of key habitat, especially those in countries which are unable to conduct comprehensive wetland inventories in the foreseeable future.

To this list, a further group could be added

landscape level mapping of land use and land cover:

these focus on the landscape from an anthropogenic perspective, and provide information on land use and land cover. They usually utilise satellite remote sensing technologies in combination with topographic maps and soil maps. The resolution is frequently low (100 x 100 ha) and does not distinguish between many wetland types, (this can be due to limitations in the spectral capabilities of the sensor, or may be due to operator preference). Wetlands are usually lumped into very broad generic categories. These may be categories such as ‘open water’, ‘forested wetlands’, and ‘agriculturally improved wetlands’, or may simply be one very broad category ‘wetlands’. In such inventories wetland habitat is quantified in terms of approximate area, and the distribution mapped. There is potential for monitoring total national wetland loss or change if the spatial resolution of the satellite sensor is high, or if rates of loss or change are very high. Assessments of wetland quality do not feature in these landscape maps.

8.2 Wetland inventory approaches in Western Europe – results from the analysis of the dataset

8.2.1 Who is conducting wetland inventory and who is funding it?

Governmental organisations (GOs) were responsible for implementing 60% of studies in Western Europe and non-governmental organisations (NGOs) were responsible for implementing a much smaller percentage (30%). Compare this with the figures in Africa and Eastern Europe where NGOs implement a much greater proportion of wetland inventory activities (Stevenson & Frazier 1999a,b). Similarly, 45% of studies were funded by GOs, and 19% by NGOs. In Western Europe at least, GOs appear to conducting, implementing, and funding more wetland inventory activities than NGOs.

Study implementation	
International NGO	15%
National NGO	15%
Sub-National NGO	0%
Local NGO	0%
International GO	4%
National GO	56%
Sub-National GO	0%
Local GO	0%

Private agency/individual	4%
Consultancy agency	0%
Academic institution	4%
Other body	0%
Unknown	11%
More than one agency or body	7%
Study funding	
International NGO	15%
National NGO	4%
Sub National NGO	0%
Local NGO	0%
International GO	4%
National GO	41%
Sub-National GO	0%
Local GO	0%
Private agency/individual	0%
Consultancy agency	0%
Academic institution	4%
Other body	7%
More than one agency or body	4%
Unknown	30%

8.2.2 Why is wetland inventory being carried out?

Considering the wide variety of organisations (NGOs, GOs, academics, consultants etc) undertaking wetland inventories in Western Europe, there is likely to be a variety of purposes for inventory to be conducted. This study examined the objectives of wetland inventory activities. The objectives were explicitly stated in only 59% of studies. The most common objectives (including those explicitly stated and surmised) were for baseline inventory purposes (67%), land use planning (33%), public education (19%), and international site designation (15%). Note that most studies had several objectives.

Statement of objectives	
Objectives explicitly stated	59%
Objectives not explicitly stated	33%
Unknown	7%

Main objectives of study	
General biodiversity	26%
Biodiversity research	0%
Baseline biodiversity	0%
Repeat survey/surveillance	0%
Management tool for biodiversity	0%
Biodiversity monitoring	0%

Wetland products	0%
Geographical	0%
International designation	15%
Baseline inventory	67%
Academic research	7%
Land use planning	33%
Wetland services	7%
Public education	19%
Other research	4%
Other	48%

Baseline studies are likely to include different information fields than studies carried out for international designation purposes. In Western Europe there are already 469 designated Ramsar sites distributed through 25 countries (Source of Ramsar site Information: Ramsar Database, date of data extraction 17/8/98) producing an average of 21.3 Ramsar sites per country (if the United Kingdom, which has 114 Ramsar sites, is removed from this calculation, the average remains high at 14.2 sites per country). This is much higher than either Africa or Eastern Europe (Stevenson & Frazier 1999a,b). Perhaps Western European governments are now shifting focus to the management of all their wetland resources, rather than concentrating on international designation. The data fields required for baseline inventories, and the methods employed are likely to be very different to those required and utilised for international designation.

8.2.3 How are wetland inventory studies conducted?

Some 56% of studies examined for the Western European dataset were either mapping studies or reviews and collations). Of the studies which were not reviews or collations, 37% undertook ground surveys, and 15% utilised remote sensing techniques, which were largely dependant on aerial photography (somewhat surprisingly, none of those examined utilised satellite imagery). Of those studies that did conduct ground surveys, 11% of these were total or near comprehensive in their coverage, and 22% undertook ground surveys which were partial in their coverage.

Data collection methodology	
Collation or review	56%
Ground survey	37%
Remote sensing	15%
Questionnaire survey	0%
More than one methodology	30%
Unknown methodology	30%
Extent of ground survey	
Total	11%
Partial	22%
Unknown	4%
Type of remote sensing	
Satellite imagery	0%
Aerial photography	11%
Videography	0%

Radar imagery	0%
Lidar imagery	0%
Map product	4%
Unknown	4%

8.2.4 What definitions and classifications are used?

There are many definitions of wetlands and as others have noted (eg Davies & Claridge 1993). Dugan (1990) stated that over 50 separate wetland definitions were (even then) currently in use. Differing wetland definitions and classification schemes were used in different studies in Western Europe, and these definitions were not always stated, making it difficult to assess the degree of completeness of cover (and thereby the estimates of wetland extent).

For example, the term 'coastal wetlands' can mean strictly saline and brackish habitats, or to mean wetlands in the coastal zone (which often for practical purposes means coastal lowlands and incorporates wetlands which experience no tidal inundation). Sorensen (1997) provides six different and commonly used definitions for the term 'coastal area' which demonstrate the enormous difference between various meanings. Great improvements in the efficiency and accuracy of wetland evaluation could be achieved if common but imprecise terms were more precisely defined.

A definition of wetlands was provided in only 30% of studies, and only 22% of studies used the Ramsar definition of wetlands (though it was unknown for 33% of studies, so the true value may be much higher). The Ramsar classification system for wetland type was used in only 7% of studies, was unknown for 30% of studies and not applicable for some 41% of studies (these were usually reviews or collations of material). It is likely that the definition of wetlands and classification of wetland types given by Ramsar are more globally applicable, and less suited to an individual country's management requirements; hence the low usage of the Ramsar terms.

See section 3.1 for further details.

8.3 Generic suggestions for the standardisation of inventory approaches

- Mechanisms to develop indices and scorecards of wetland value/benefits and site quality (status) should be developed to enable easy communication of information to be made to the decision-makers and the public.
- The presentation of data in wetland inventories should become more accessible by inclusion of summaries and the avoidance of poorly organised, bulky text descriptions in favour of tabulated results.
- The scope of data coverage in wetland inventory activities should attempt to incorporate the information fields used in Ramsar Information sheets. This would aid management of trans-boundary wetlands and would facilitate regional and international wetland assessments, which can be utilised in European (and global) policy and planning initiatives.
- Every effort should be made to cover all wetland types, particularly those types which are currently under-represented in wetland inventories. This includes artificial wetlands, dune slacks, wet mesotrophic grasslands, seagrass beds, maerl beds, and glacial and alpine wetlands. An attempt to systematically collect information on current extent of different wetland types in different countries in the region should be carried out as a priority.

- A program should be established to monitor changes in the areal extent of rare and threatened wetland types once a baseline of the original or current extent has been determined.
- Standardised methodologies should be developed, and linked to the objectives of wetland inventory studies, such that for any given objective, standard information fields should be gathered using standard methodologies.
- A standardised (generic) database format (and software) should be developed for storage and extraction of local, national, and international wetland information which can be applied throughout the Western European region.
- More effort should be made to integrate wildlife surveys (especially waterfowl) and wetland surveys to avoid duplication of effort and to increase the wider applicability of information.
- Regional and national inventories should be made available in digital form as CD-ROMs or down-loadable files from the Internet to enhance the access to the information and encourage greater levels of feedback on changes at the sites.
- A review should be undertaken on the applicability of land use and land cover mapping information for the monitoring of changes in wetland extent in the region.

9 Priority areas for wetland inventory

9.1 Status of national level wetland inventory information in Western European countries

Although it was possible to generate estimates of the national wetland resource in all but a few Western European countries, much of the data were noted to be of poor quality, and likely to be currently out of date. The majority of values examined by this report were approximations (often based on dated material and limited field studies). The resulting best estimates must therefore be viewed with caution since accurate results cannot be generated from inaccurate data.

Of the 25 countries in the Western European region examined in this review, only four of these can be said to have quasi-adequate inventory data on wetlands. These are Greece, the United Kingdom, France and Turkey, though it must be noted that even these countries do not have inventory material which covers the entire national wetland resource, and all possible wetland types.

Countries which (on the basis of the WEUR dataset) have less detailed national wetland inventory material, or material which is less comprehensive in scope and coverage, are listed in column two (labelled ‘some but inadequate national wetland inventory information’) of table 9.1. These are Austria, Denmark, Finland, Germany, Italy, Norway, Portugal, Spain, Sweden and Switzerland.

There was a noticeable lack of wetland inventory information for several countries listed in column one (labelled ‘little or no national wetland inventory information’) of table 9.1. These are Andorra, Belgium, Cyprus, Iceland, Ireland, Liechtenstein, Luxembourg, Malta, Monaco, the Netherlands and San Marino.

It should be noted that additional material for Western Europe has been identified since the analysis stage of this review, and it is likely that these will reveal new information. Our findings must therefore be viewed as preliminary.

Many specific types of wetlands are frequently ignored in wetland inventory activities. Common exclusions were seagrass beds, subtidal reefs, maerl beds, tidal flats, dune slacks, and wet grasslands. Wetlands of less than 10 ha (and in some cases 100 ha) in size were also excluded in many inventories. By comparison, the United Kingdom has (disparate) wetland inventory material, which in some cases is very detailed (down to tenths of hectares), particularly its estimates of wet dune slacks and lowland wet grasslands (Dargie 1993a,b, 1995). Artificial wetlands are also frequently ignored in wetland inventories, except in a few cases where they are of importance to waterbirds. These gaps should receive attention in future wetlands inventory activities in Western Europe.

It should be noted that at the time of this review, the Ramsar Bureau was collating National Reports from Contracting Parties in preparation for COP7, Costa Rica, May 1999. This review examined previous national reports, but the information gathered in these forthcoming reports should be reviewed in any future update of the WEUR dataset.

Table 9.1 Status of national wetland inventory information in European Countries based on the WEUR dataset

Little or no national wetland inventory information	Some, but inadequate national wetland inventory information	Adequate information available, but requires updating and more detailed surveys
Andorra	Austria [1]	Greece
Belgium [2]	Denmark [3]	United Kingdom
Cyprus	Finland [4]	France [5]
Iceland	Germany [6]	Turkey
Ireland	Italy [7]	
Liechtenstein	Portugal	
Luxembourg	Spain	
Malta	Sweden [8]	
Monaco	Switzerland [9]	
The Netherlands [10]	Norway [11]	
San Marino		

Note: these are preliminary assessments only

1. Austria completed a wetland inventory in 1996 which aimed 'to give a preliminary overview of Austrian wetlands whose importance goes beyond the regional level' (Federal Environment Agency 1997). A copy of the report has been requested but has not yet been obtained; at present it is assumed that the inventory is still preliminary.
2. IWRB (1995) national reports state that information on major wetlands only is available as part of other related activities such as the National Biological Evaluation Map. No other recent information has been identified.
3. IWRB (1995) states that 'detailed national wetland inventory information is available' for Denmark and yet states that there are 'no comprehensive sources of wetland inventory information in general' and that 'figures exist on a regional level but have never been summarised'.
4. IWRB (1995) states that 'detailed national wetland inventory information is available' in Haapanen & Rassi (1982), however, this article covers national and internationally important wetlands only (totalling 91,300ha), and focuses largely on peatlands and lakes.
5. A considerable amount of additional data have been obtained or come to light since the conduct of the analysis stage of this project. Some of these data suggest that France has substantial wetland inventory material. Therefore France has been provisionally listed in this table as having 'adequate information but requires updating and more detailed surveys', even though this material has not been analysed as part of the preliminary GRoWI-WEUR dataset.
6. IWRB (1995) states that "a preliminary inventory of major wetlands only' has been completed. No recent additional information has been identified by this report.
7. Italy has completed an inventory of wetlands of national and international importance (De Maria 1992). A report by WWF-Italie states that 'a complete list of all the Italian wetland areas does not yet exist' (Bardi & Fraticelli 1996). No recent additional information has been identified by this review.
8. Sweden is finalising a national wetland inventory, which covers wetlands over 50 ha in some counties, and over 10 in other counties (and including wetlands of less than 10 ha in a few counties).
9. Switzerland was noted by Hughes (1995) as having some wetland inventory information, but as yet this has not been identified, nor included in this preliminary analysis. IWRB (1995) states that 'detailed national wetland inventory information is available' from several different national wetland habitat inventories, but that the data has yet to be extracted from these sources to generate a national overview.
10. The most recent and comprehensive source of information is Eekhout & Van den Tempel (1998) which lists and briefly describes wetlands of importance to birds, but does not provide estimates of wetland area.
11. Norway has completed a national wetlands inventory, however, detailed outputs or reports pertaining to wetland status and extent have been requested but have not yet been obtained.

9.2 Relevance to previous studies

In 1995, Hughes (1995) produced a review of the status of wetland inventories in Europe (encompassing some countries in both Eastern and Western Europe). Hughes (1995) did not provide estimates of wetland area, but did provide a brief description of wetland inventories per country, and noted whether a national wetland inventory program was underway, planned or completed (table 9.3).

Table 9.2 Comparison of wetland sites in Europe listed by the MAR Project, and by Scott and Jones (1995) and those designated as Ramsar sites in 1998

Country	# of sites on MAR list published 1965	# of Ramsar sites designated by July 1993	# of Ramsar Sites designated by August 1998
Andorra	0	Not a Ramsar party	Not a Ramsar party
Austria	3	7	9
Belgium	2	6	6
Denmark	4	3	38
Finland	3	11	11
France	21	8	15
Germany	16	31	31
Greece	7	11 [1]	10
Iceland	0	2	3
Italy	7	46	46
Liechtenstein	0	1	1
Luxembourg	0	Not a Ramsar party	1
Malta	0	1	2
Monaco	0	Not a Ramsar party	1
Netherlands	10	21 [2]	18
Norway	7	14	23
Portugal	4	2	10
Spain	10	26	38
Sweden	17	30	30
Turkey	8	Not a Ramsar party	9
United Kingdom	20	62	114

(adapted from Scott and Jones 1995)

1. The former Lake Vistonis and Lake Mitrikou sites were combined into the ‘Lake Vistonis, Porto Lagos, Lake Ismaris & adjoining lagoons’ site, leaving Greece with 10 instead of 11 sites in total.
2. This figure includes the six Netherlands dependant territory sites in the Caribbean. Three additional sites were designated in 1995, taking the total to 18 as shown by the 1998 data (excluding the dependant territories).

Scott and Jones (1995) made a comparison between wetland sites within countries identified in the 1965 MAR project and those designated as Ramsar sites in the same countries by July 1993. This demonstrated that there had been significant progress in the wetland inventory of potential internationally important wetlands over a 30-year period. Table 9.2 takes this comparison one step further by the addition of Ramsar site information as of August 1998.

Whilst the WEUR dataset cannot claim to be totally comprehensive in its coverage, it is interesting to note that many of the countries which Hughes (1995) noted to have little wetland inventory material in 1995 (table 9.3) still appear to have little wetland inventory material. These countries include Andorra, Liechtenstein, Luxembourg; Malta, Cyprus, Iceland, Ireland, and Belgium. She also described Austria, Germany, and the Netherlands as having poor wetland inventory information (with the exception of Ramsar sites and some sites of importance to waterfowl), which now appear by the GRoWI-WEUR assessment to have improved their wetland inventory information.

If we examine the information given by Scott and Jones (1995) (table 9.2) in 1993, four countries were not contracting parties to the Ramsar Convention (Andorra, Luxembourg, Liechtenstein and Turkey) in 1998; only Andorra still remains to become a signatory to the Ramsar Convention. Six countries have not designated any further Ramsar sites; these are Belgium, Finland, Germany, Italy, Liechtenstein and Sweden. However, Austria, Iceland and Malta have added one or two more sites, and Denmark, the United Kingdom, Norway, Portugal, and Spain have substantially increased the number of wetland sites designated as internationally important wetlands.

It is difficult to comment on which occurs first – a national wetland inventory that serves to identify internationally important wetlands, or the designation of internationally important wetlands which stimulates national wetland inventory activity. Whichever it is, the countries which have substantially added to their list of Ramsar sites in the five year period since 1993, were also those noted by Hughes (1995) to be undertaking national wetland inventory activities at that time. These include Denmark, Spain, the United Kingdom, and Portugal, which are listed in column two of table 9.1 (labelled ‘some, but inadequate national wetland inventory information’).

With the exception of Italy and Sweden, countries that have not added any new Ramsar sites to their lists between 1993 and 1998, and those that have added only one or two more sites since 1993 were noted by Hughes (1995) to be generally lacking in wetland inventory information. The WEUR dataset includes very little wetland inventory information on these very same countries, which are listed in column one of table 9.1 (labelled ‘little or no national wetland inventory information’). It is disappointing to note that little progress seems to have been made in these countries since 1993, although it is possible that the inevitable time lag which occurs between inventory activities and the publication and dissemination of results is responsible for this apparent lack of progress.

Although Sweden and Italy have not added any new Ramsar sites since 1993, this may be due to the fact that they already have a substantial number of sites (30 and 46 respectively). It may also be possible that having already completed preliminary national wetland inventories, less attention is currently being given to wetland inventory. However, in 1993 the United Kingdom had 62 designated Ramsar sites, and five years later this has increased to 114 sites. In 1995, the United Kingdom was described by Hughes (1995) as having incomplete wetland inventory information (Table 9.3), but the situation has improved somewhat over the last few years with the publication of various documents which detail specific wetland types such as estuaries, lowland raised bog and dunes.

France, Spain, Italy, Greece and Turkey were all identified by Hughes (1995) as having produced national wetland inventory information, and these countries were identified as having adequate national wetland inventory information in this review. However, some key references for France were not obtained within the time frame needed to conduct the preliminary analysis of data. Likewise, Norway and Sweden were identified by Hughes (1995) as having national wetland inventories (table 9.3), but despite this, and despite contact with the relevant authorities, it has not been possible to obtain enough detailed national information or information covering specific wetland types and approximate areas of coverage.

Table 9.3 Status of wetland inventories in Western Europe described by Hughes (1995)

Omitted due to 'lack of data'	Noted as poor wetland inventory information	Wetland inventory material exists but incomplete coverage
Andorra	Cyprus	Germany
Austria	Iceland	Denmark
Liechtenstein	Ireland	United Kingdom
Luxembourg	Germany	Switzerland
Malta	Netherlands	
	Belgium	
Noted as having some national wetland inventory information	**Notes on national wetland inventory (NWI)**	**Reference for NWI (full citation given in Hughes 1995)**
Norway	NWI underway	–
Sweden	NWI underway	–
Finland	National wetland conservation program but no NWI	–
France	2 different NWI produced 1991-1992	Secretariat de la Faune et de la Flore (1992), Lierdeman & Mermet (1994)
Spain	NWI produced 1992	Ministerio de Obras Publicas y Transportes (1991)
Portugal	Preliminary NWI	Farinha & Trindade (1994)
Italy	NWI produced 1992	De Maria (1992)
Greece	NWI produced 1993	Zalidis (1993), Zalidis & Mantzavelas (1994)
Turkey	preliminary NWI completed 1989 & updated 1993	TÇV (1993)

(compiled from textual information in Hughes 1995)

10 Priority processes

This section provides brief recommendations pertaining to wetlands inventory activities as a whole. It proved beyond the scope of this study to recommend particular field survey methods, or to provide instructions for wetland inventory activities. Taylor et al (1995) covers the relative merits and disadvantages of wetland inventory methods used in southern Africa and these are equally applicable in other regions.

Similarly, it would not be appropriate to enter the debate on traditional field survey techniques versus remote sensing techniques (again these are discussed admirably by Taylor et al 1995, and Grainger 1993, from analogous forestry studies). However, the process of extracting and analysing data from the sources examined in this review has revealed common problems which could be easily avoided if wetland inventory data were presented in a particular fashion, and if certain specific data were routinely recorded for the benefit of the reader (such as date of survey, objectives, and wetland definition and coverage).

10.1 Establishing inventories

10.1.1 Preparatory activities

- A thorough review of previous studies and surveys undertaken should be conducted prior to any wetland inventory activity, to delineate gaps and to benefit from lessons learned or mistakes made. This should also include less obvious sources such as academic material and conference material, as well as conventional wetland inventories.

- Adequate time and resources should be allocated (by funding bodies and implementing agencies) to review and obtain existing wetland inventory material for any given region or country. As stated by Taylor et al (1995), it requires time and effort to establish the existence of sources of information already available, and often there is repetition of previous survey work because adequate efforts to assess the existing information base have not been undertaken. This project has identified several cases where source material has quoted wetland area estimates taken from studies which had been comprehensively updated by more recent studies, and therefore their estimates were out of date, and had been supplanted by more recent and accurate data.

10.1.2 Background and setting to wetland inventory activities

- Information such as the history, development, and rationale of wetland inventories are crucial elements for understanding the context of these studies, and this information should be described briefly within reports. Information detailing contact persons and addresses is very helpful to successive workers, as are plans for future activities. If the surveys are part of a longer-term study, this should also be stated.

10.1.3 Objectives

- The objectives of wetland inventories should be identified prior to the commencement of wetland inventory activities (particularly those involving field work). The objectives of wetland inventory activities should play a key role in choice of the most suitable wetland inventory methodology to be used in any given particular inventory program.
- Wetland inventory activities should aim to make provision for regular updating of wetland information, and where appropriate should make provision for monitoring changes in extent, distribution and loss of wetlands.
- The objectives should be clearly stated in wetland inventory reporting and published material.
- Those coordinating wetland inventory activities should specifically aim to widely disseminate wetland inventory material, and should aim to permit ready access to wetland inventory information. This objective should feature in all future wetland inventory activities.

10.2 Updating or extending inventories

10.2.1 Wetland coverage

- Certain wetland types were commonly excluded from wetland assessments and these included artificial wetlands (eg fish ponds, rice paddy, reservoirs, and dams) and natural wetlands including dune slacks, humid sands, dambos, wet mesotrophic grasslands, seagrass beds, maerl beds, coral reefs, glacial and alpine wetlands. More attention should be paid to these and similarly overlooked wetland types in future inventory studies.

10.2.2 Wetland definitions and classification of wetlands

- Clear distinction should be made between the description of ‘marine wetlands’ and ‘coastal wetlands’, and ‘inland wetlands’. Extracting information on even broad wetland categories is difficult when different definitions of habitats are used. Some authors use, for example, the term ‘coastal wetlands’ to mean strictly saline and brackish habitats and others use it to mean wetlands in the coastal zone (which often for practical purposes means coastal lowlands and incorporates wetlands which experience no tidal inundation).

- A definition of wetlands should be always be given, and it should be expressly stated whether habitats such as floodplains and open water bodies have been included in the definition, and whether they have been included in a wetland survey.
- Where wetland classification systems are used, these should be stated and adequately referenced.

10.3 Inventory content

10.3.1 Minimum information fields

- Wetland area estimates, and identification of whether wetland area estimates are minimal, maximal, or average values (stating number of years and which years the average value is based on).
- The geographical coordinates and general location of wetlands should always be included, so that discrepancies involving the names of wetlands can be identified by location. (For countries which are newly-independent, it is very difficult identifying wetlands which have been renamed, and adequate geo-referencing may reduce this difficulty.)

10.3.2 Recommended information fields

- Objectives of study
- Dates of field work (including season) and collation should always be included, as well as the known dates of any compiled information.
- Description of methodologies used in field work.
- Resolution capabilities of remotely sensed data.
- Definition of wetland used.
- Classification scheme used (eg Ramsar, Cowardin, Corine etc).
- Inclusions/exclusions in coverage (eg excluding wetlands of less than 100 ha, or excluding open water bodies etc).
- A *summary* of the coverage and characteristics of the wetland resource including tabulations where possible.
- Contact points for data custodians or publishers and their institutional details.
- Contact details of persons undertaking field work should always be provided.
- Full referencing of primary source material should always be provided in reviews/collations.
- Ramsar Information Sheet data fields.

10.4 Wetland values and benefits

- Information on wetland values and benefits should be included in wetland inventories. As a minimum this should constitute a textual description of benefits, but preferably should indicate the economic values of wetland goods and services.

- A structure to aid the assessment of wetland benefits and values using simple means and local knowledge of wetland sites should be developed for use in conjunction with wetland inventories. This could take the form of a key or questionnaire which could be spilt into sections under the headings of fisheries, water supply, tourism, education, hydrological functions etc, and the assessor answer general questions under the appropriate headings. Alternatively, it could take the form of a table that should be completed, with sections containing questions such as 'approximately how many artisanal fishermen use this site? Is this seasonal? Approximately what is their daily/weekly catch?' Alternatively, this could take the form of a matrix, in which the assessor simply adds tick marks where a particular good or service is important. More effort should be put into developing simple ways of calculating the approximate total economic value of a wetland site in a standardised manner.
- The findings of wetland inventories that complete preliminary assessments of the values and benefits of a particular wetland site should be widely disseminated in order to demonstrate the values and benefits to policy makers and management authorities.

10.5 Temporal scale/updating programs

- It could be argued that low resolution, comprehensive national surveys should be undertaken as a priority to at least identify wetland locations for more detailed study later. However, in terms of resource conservation, repetition of detailed surveys at sites thought to be at risk should also be a priority undertaking.
- Wetland inventories must be regularly reviewed and updated, otherwise data are likely to be lost, become out of date and become of historical interest only.

10.6 Presentation of data

- A summary of the coverage and characteristics of the wetland resource, should preferably be included in all wetland inventory reference material. It is exceedingly difficult to construct a useful overview of an inventory reference by extracting values and statistics from reams of text entries.
- Local naming conventions of wetlands or locations are often ignored, and authors may use their own 'version' of a local name for a particular wetland. There are obviously difficulties in translation, but more efforts should be made to ensure that the local and English (and French, or Spanish as appropriate) version names are included in inventory material if it is intended for use beyond the local area. A guide to the pronunciation of local names may also be useful (particularly where these names have not previously been recorded, and are perhaps only known by local names), although this may not be practicable for directory type inventories.
- Key quantitative wetland inventory information should preferably not be presented in block text format (where data such as coverage and loss estimates lay hidden in sentences, perhaps with imprecise wording leading to an ambiguous interpretation). This would aid the input of existing and future inventory information into database format.
- Maps of habitats (eg Wadden Sea islands and mainland coastal areas, Dijkema & Wolff 1982) and atlases (eg colour atlas of the Rhine, Commission Internationale pour la Protection du Rhin 1998) should also present summary area and type by area information. Many maps examined did not contain a scale and/or other fundamental spatial reference information such as geographic co-ordinates. It is very difficult to manually extract useful

inventory or management information from the majority of the maps examined for potential inclusion in the Western European dataset.

10.7 Handling and storage of wetland inventory information

- Every effort should be made to store both the paper and electronic versions of wetland inventory information with those coordinating or conducting wetland inventory, and also with international organisations such as the Ramsar Bureau and Wetlands International or a central clearing house (if one is developed).
- Electronic forms should preferably be stored in some format that is readily translatable into either word processing packages or commonly used databases.
- A standardised (generic) database format (and software) should be developed for storage and extraction of local, national, and international wetland information that can be applied throughout the Western European region.

10.8 Availability and dissemination of inventories

- Much material is currently available in draft format, remains unpublished or has a limited distribution. Considerably more effort should be devoted to ensuring that existing draft reports are finalised and, resources permitting, published, preferably with some or all of the information made available on the World Wide Web.
- Those undertaking to produce national bibliographic databases should also be aware that the usefulness of such information is severely limited if there is no provision for supplying the references to those who need them. Funding should be made available to ensure that national bibliographic databases don't simply supply a list of references, but can also provide copies of the material upon request. The existence of such databases should also be more widely advertised.
- More emphasis should be directed toward publishing electronic format material (eg World Wide Web presentations) in addition to any paper versions of reports.
- A central clearinghouse or structured information retrieval system for wetland inventory material should be established. It should be noted that identifying and obtaining wetland inventory material for a particular country may be largely dependent on a network of contacts and may chiefly rely on key individuals and/or organisations to supply or provide access to data. It is likely that these persons and organisations receive repeated requests for information and a positive result often depends on the goodwill and resources of these key individuals and organisations. The current situation is that a person or agency seeking information must first identify the 'key players', which in itself is often a time consuming process. The retrieval of information can occasionally be restricted due to deliberate actions on the part of some individuals who see a request for information as an opportunity to offer their services for substantial fee rates, and who it appears deliberately withhold information to increase their bargaining power.

11 Specific recommendations

The reader should also consult sections 8 and 10 for more detailed recommendations.

- Every effort should be made to complete existing preliminary national wetland inventories. Based on the WEUR dataset this includes the following countries: Austria, Belgium, Portugal, Finland, Germany, and Italy. Every effort should be made to consolidate information, ie where regional level information exists but has not yet been brought together at the national level (eg Denmark) and where different wetland habitat level information exists but has not yet been brought together at the national level (eg Switzerland).

- Wetland inventories should be undertaken (whether as part of a national wetland inventory program or not) in those countries which, based on the WEUR dataset, currently have little national wetland inventory information. These include Andorra, Austria, Cyprus, Iceland, Ireland, Liechtenstein, Luxembourg, Malta, Monaco, the Netherlands and San Marino.
- Existing national wetland inventories should updated and, where necessary, the coverage extended to include all wetlands, not just those which are of national or international importance, or those above a particular size. For example, where wetlands less than 50 ha or 100 ha are currently excluded in wetland inventories, these should now be included.
- Every effort should be made to incorporate all wetland types into wetland inventories, particularly those types which are currently under-represented. This includes artificial wetlands, dune slacks, wet mesotrophic grasslands, seagrass beds, maerl beds, and glacial and alpine wetlands.
- The presentation of data should become more accessible by inclusion of summaries and the avoidance of poorly organised, bulky text descriptions in favour of tabulated results.
- The scope of data coverage in wetland inventory activities should attempt to incorporate the information fields used in Ramsar Information. This would aid management of trans-boundary wetlands and would facilitate regional and international wetland assessments that can be utilised in European (and global) policy and planning initiatives.
- Wetland inventories which are not part of an ongoing national wetland inventory program should also be captured or updated to ensure that data does not become static or out of date.
- Studies should aim to incorporate summaries in languages such as English or French and Spanish (as appropriate).

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Our sincerest apologies to any person or institute we may have inadvertently omitted from this list.

Annex 2 Best estimates of wetland coverage

(see section 3.3 for a list of countries omitted from this section)

Country name (& Code) AUSTRIA AUT		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Ramsar database	none	0	102,337	435	102,772	Date of data extraction August 14 1998; although many sites have a small man-made part, they are usually classified as totally inland
2 Fed. Envt. Agency www 96/97	206	0	0	0	266,057	Value is for total area of wetlands, (357 sites). No further information given.
3 0	0	0	0	0	0	0
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		0	265,622	435	266,057	

Notes/comments on best estimate

The best estimate for inland is total wetland area minus total known man-made area.

No other information for Austria was identified in this first preliminary survey of wetland inventory material

Date of best estimate 26-Aug-98

Country name (& Code) DENMARK DNK		*Area (ha) Wetland*				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	**Reference code**					
1 Ramsar database	none	883,183	1,399,830	0	2,283,013	Date of data extraction 14 August 1998; area for man-made types is very limited, and included in inland area (could not be separated).
2 Schultink & Van Vliet 1997	211	885,142	64,399	0	949,541	Figures are for "important wetlands". No further description was given. No wetland types are identified. Figures based on a 1991 report.
3 de Vlas	210	8,050	0	0	8,050	Value is for salt marsh only
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		885,142	1,399,830	?	2,284,972	

Notes/comments on best estimate

For marine/coastal, the best estimate is probabaly an underestimate since the values identified so far are for important marine wetlands only.

For inland, the only value that can be extracted from these data is clearly a large underestimation, but is the only area estimate we have identified in this first prelimina estimate of wetland inventory material in Denmark

Date of best estimate 26-Aug-98

	Country name (& Code) FINLAND FIN		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	50,143	51,200	0	101,343	Date of data extraction August 14th 1998
2	Schultink & Van Vliet 1997	211	0	3,352,200	0	3,352,200	Values are for "important wetlands". No further description was given. Figures based on a 1991 report.
3	National Peatland Preservation Programme 1981	212	0	448,537	0	448,537	Value is for peatlands only.
4	IWRB Natnl. Reports 93-95	504	0	3,270,000	0	3,270,000	Value is for lakes only. Estimate should be reliable.
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			50,143?	3,352,200	?	3,352,200	

Notes/comments on best estimate

It is not known whether the wetland area estimate provided by Schultink & van Vliet encompasses water bodies (eg lakes) if not, then it would seem appropriate to add this figure to the area for lakes provided by IWRB National Reports. However, since it is uncertain, it has been assumed that these values overlap and only the Schultink & van Vliet values have been used for the best estimate for inland wetlands, (though this is likely to be an underestinmate since it covers only 'important wetlands'). The value for marine wetlands provided by the Ramsar database has been used for the best estimate of marine wetlands since it is the only information identified to date for marine wetlands,though it must be noted that this is 'site area, and not necessarily wetland area.

Date of best estimate 27-Aug-98

Country name (& Code)
FRANCE
FRA

	Reference author	**Reference code**	MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
			Area (ha) Wetland				
1	Ramsar database	none	241,550	337,535	?	579,085	Date of data extraction August 14th 1998
2	Schultink & Van Vliet 1997	211	381,280	800,627	0	1,181,907	Figures are for "important wetlands". No further description was given. Figures based on a 1991 report.
3	Britton & Crivelli 1993	505	70,100	66,300	3,600	140,000	Values are likely to be reliable
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			381,280	800,627	3,600	1,185,507	

Notes/comments on best estimate

The value for marine wetlands provided by Schultink & Van Vliet has been used for the best estimate. Note that the value for marine wetlands from the Ramsar database is a value for Ramsar site area, not wetland area, and therefore cannot be used for a best estimate.

The value for inland wetland area given by Schultink & Van Vliet has been used for the best estimate since it is the most recent data. The discrepancy between this value and that provided by Britton & Crivelli probably results from differences in wetland definition

No data for manmade wetlands was identified except for Britton & Crivelli and therefore their estimate has been used.

Date of best estimate 21-Aug-98

	Country name (& Code) GERMANY DEU		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	558,505	107,017	7,330	672,852	Date of extraction 14 August 1998
2	Schultink & Van Vliet 1997	211	680,881	427,424	0	1,108,305	Figures are for "important wetlands". No further description was given. Figures based on a 1991 report.
3	de Vlas 1990	210	18,940	0	0	18,940	Value is for salt marsh only
4	IWRB Natnl. Reports 93-95	504	0	0	0	1,267,202	Total value given comprises 2.2% of land area (approx 785,202) of inland waters (presumably manmade as well as natural) and 482,000 ha of peatlands.
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			680,881	427,424	?	1,267,202	

Notes/comments on best estimate

Figures estimated are an underestimation, since only "important wetlands" are included by Schultink & Van Vliet.
The Ramsar database area cannot be used, since Ramsar also includes non-wetland area, and does not cover the entire country.
The total area figure is from IWRB national reports, therefore not the sum of inland and coastal estimates
Therefore some 158897 ha are included in the best estimate total,but not in the wetland type estimates

Date of best estimate 26-Aug-98

Country name (& Code) GREECE GRC		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	**Reference code**					
1 Ramsar Database	none	131,039	24,765	7,697	163,501	Date of data extraction August 14th 1998
2 Zalidis & Mant-zavelas 1994a	218	105,687	52,093	31,408	189,188	These figures were generated by examining every site record within the inventory & summing the area of each site having a particular dominant wetland type. So values are areas of wetland with a dominant wetland type, not areas per se.
3 Zalidis & Mant-zavelas 1994b	218	101,061	65,733	35,824	202,618	The inventory used a simplified definition of Ramsar types. which resulted in the following summary of types: deltas-68030; marshes-5832.6; lakes-59767.3; lagoons-28766; springs 133.1; estuaries-4264.6; reservoirs-35823.5 ha River length-4268km
4 IWRB Natnl. Reports 93-95	504	0	0	0	202,618	Value quoted is from Zalidis and Mantzavelas 1994.
5 Britton & Crivelli 1993	505	29,200	179,100	12,500	220,800	Estimates likely to be reasonably reliable, though the source of data is not stated
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		105,987	65,733	35,824	207,544	

Notes/comments on best estimate

Zalidis & Mantzavelas 1994 is the most recent and comprehensive study of Greek wetlands identified and so these values are used for all best estimates
This is despite the fact that the value for inland given by Britton and Crivelli is much higher. It is likely that differences in the definition of marine/coastal & inland wetlands have led to the lower value for marine wetlands and the higher value for inland suggested by Britton & Crivelli

Date of best estimate 21-Aug-98

Country name (& Code) REPUBLIC OF IRELAND IRE		*Area (ha) Wetland*				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	**Reference code**					
1 Ramsar database	none	33,299	33,695	?	66,994	Date of data extraction August 14th 1998
2 Foss (in O'Leary & Gormley 1998)	208	0	220,902	0	220,902	Value is for Republic of Ireland only, for 'Intact raised bogs'-23628 ha: 'intact blanket bogs' 143248 ha : fens 54026 ha. note figures are for intact peatlands, not comprehensive
3 0	0	0	0	0	0	0
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)						

Notes/comments on best estimate

There is insufficient data to make best estimates of wetland coverage. No other data was identified in this first survey of wetlands in the Republic of Ireland.

Date of best estimate 28-Aug-98

Country name (& Code) ITALY ITA		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Ramsar database	none	44,934	7,616	4,400	56,950	Date of data extraction August 14th 1998
2 Schultink & Van Vliet 1997	211	165,070	107,742	?	272,812	Figures are for "important wetlands". No further description was given. Figures based on a 1991 report.
3 Britton & Crivelli 1993	505	11,500	4,900	?	16,400	Estimates likely to be reasonably reliable
4 WWF- Italie	221	?	?	?	450,563	Includes 244 sites. Estimates based on Min of Environment wetland inventory plus additonal recent information. Estimate should be reliable. estimates per wetland type not available.
5 De Maria 1992	223	?	?	?	176,278	104 sites of national and international importance are listed and categorised as natural or artificial. Document in italian and therefore not possible to extract further details at this stage
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		?	?	?	450,563	

Notes/comments on best estimate

From the data available it is not possible to identify wetland area per type, though it would appear that the total value is likely to be the most accurate.

Date of best estimate 29th August 1998

	Country name (& Code) NETHERLANDS NLD		***Area (ha) Wetland***				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	302,971	21,947	0	324,918	Date of data extraction 14th August 1998
2	Eekout & van den Tempel 1997	tba	?	?	?	?	This annual publication provides a variety of useful information, but no estimates of coverage are included.
3	Schultink & Van Vliet 1997	211	404,335	391,134	0	795,469	Figures are for "important wetlands". No further description was given. Figures based on a 1991 report.
4	de Vlas 1990	210	8,240	0	0	8,240	Total value is for saltmarsh only
5	Bakker et al 1993	207	7,300	0	0	7,300	Total value is for saltmarsh only
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			404,335	391,134	?	795,469	

Notes/comments on best estimate

The estimates of Schultink & Van Vliet 1997are used for the best estimates, however this covers important wetlands only and therefore must be an underestimate Though there is detailed information about salt marshes, sources which assess area of other specific wetland types were not identified in this preliminary assessment. It is possible that the area given for inland by Schultink & Van Vliet 1997 incorporates the many manmade wetlands in the Netherlands, though this was not stated. The best estimate is likely to be very approximate

Date of best estimate 29-Aug-98

	Country name (& Code) NORWAY NOR		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	59,796	10,354	?	70,150	Date of data extraction August 14th 1998
2	Norwegian Mapping Authority 1995	205	0	3,301,600?	0	3,301,600	Total value is derived as follows: 'freshwater'-1,747,900 ha (which presumably means open water bodies and rivers) and 'bogs and marshes'- 1,553,700 ha, (which presumably means inland bogs and marshes, though this may also include coastal areas).
3	IWRB Natnl. Reports 93-95	504	0	0	0	2,030,000	Total value is for "mires and other wetlands". Estimate should be reliable.
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			?	?	?	3,301,600	

Notes/comments on best estimate

The estimates of the Norwegian Mapping Authority are used for the best estimates, and is comprehenisive in its cover (NMA pers comm). However, it is unclear about the wetland coverage per type. The area given for bogs and marshes incorporates coastal wetlands, but it is not known how much of the value is coastal.

Date of best estimate 28-Aug-98

Country name (& Code) PORTUGAL POR		Area (ha) Wetland				
		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Ramsar database	none	64,249	1,340	224	65,813	Date of data extraction : August 14th 1998
2 Britton & Crivelli 1993	505	79,500	0	0	79,500	non tidal saltmarsh, freshwater lakes & marshes, reservoirs, salt pans, & forested wetlands are also noted as present, but no values are provided.
3 0	0	0	0	0	0	0
4 0	0	0	0	0	0	0
5 0	0	0	0	0	0	0
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		79,500	0	0	79,500	

Notes/comments on best estimate

No other estimates were identified and therefore Britton & Crivelli 1993 estimates were used for best estimate

Date of best estimate 22-Jul-98

	Country name (& Code) SPAIN ESP		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	129,596	19,508	9,112	158,216	Date of data extraction : August 14th 1998
2	Britton & Crivelli 1993	505	20,400	27,000	0	47,400	Values are likely to be reliable
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			129,596 ?	27,000	9,112 ?	165,708	

Notes/comments on best estimate

No other estimates of wetland cover were identified & therefore Britton & Crivelli 1993 values were used for best estimates for inland & manmade wetlands The value for marine Ramsar wetlands was used instead of Britton & Crivellii since it was clearly much higher (despite only being internationally important wetlands)

Date of best estimate 21-Aug-98

Country name (& Code)		Area (ha) Wetland				
SWEDEN						
SWE		MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
Reference author	Reference code					
1 Ramsar database	none	49,120	332,850	780	382,750	Date of data extraction August 14th 1998
2 Schultink & Van Vliet 1997	211	0	0	0	9,500,000	Figures given were 'wet forest'- 5m ha: 'open mires' 3.6 m ha: 'other' approx 0.9m ha.
3 IWRB Natnl. Reports 93-95	504	0	?	0	12,800,000	Total value is derived from '3.6m ha mire's + '5m ha of wet forests',' 3.9m ha of lakes/watercourses', and '0.3 m ha of other wetlands'. Estimates should be reliable.
4 National Wetland Inventory (VMI)	217	0	0	0	9,300,000	Estimate includes wetlands over 10 ha only, and in some counties over 50 ha only. Torsten larsson (SEPA) pers comm estimates.
5 Lofroth 1991	220	?	approx 8,600,000	?	9,300,000	Estimate includes 3.6m ha of open mires & 5 m ha of wet forests.
6 0	0	0	0	0	0	0
7 0	0	0	0	0	0	0
8 0	0	0	0	0	0	0
9 0	0	0	0	0	0	0
10 0	0	0	0	0	0	0
Best estimates (ha)		?	?	?	12,800,000	

Notes/comments on best estimate

The estimates of the National Wetland Inventory are not used even though they are recent since they cover wetlands of over 10 ha and 50 ha only.
The estimates of the IWRB National Reports 1995 are used since the estimate seems to include all wetlands. It is unclear about the wetland coverage per type.

Date of best estimate 29 Aug 1998

	Country name (& Code) TURKEY TUR		Area (ha) Wetland				
			MARINE/COASTAL	INLAND	MANMADE	TOTAL	NOTES
	Reference author	**Reference code**					
1	Ramsar database	none	66,300	93,000	0	159,300	Date of data extraction : August 14th 1998
2	Magnin & Yarar 1997	222	?	?	?	1,240,000	This source examines wetlands which are important bird areas in Turkey, & states " we are relatively confident that the current inventory included most of the important wetlands in Turkey"
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
Best estimates (ha)			?	?	?	1,240,000	

Notes/comments on best estimate

No other estimates were available for the preparation of the preliminary report, and therefore thes estimate of Magnin & Yarar has been used.

Date of best estimate 29-Aug-98

10	Lindsay & Immirzi 1996	219	0	3,836	0	3,836	Value is for lowland raised bog in England, Scotland and Wales only (not Northern Ireland)
Best estimates (ha)			854,498	518,713	2,303	1,375,514	

Notes/comments on best estimate

The best estimate for marine has been calculated from summing the values from refs 3,4, & 6-9. In the UK coastal inventory is well covered by this material.
The best estimate for inland has been calculated from Schultink & Van Vliet, which may be an underestimate, but is more comprehensive than a total value which can be calculated by summing the inland areas from reference 5 and 10.
The only information which has been identified for manmade wetlands is that covered by Ramsar sites: note this area is site area, not necessarily wetland area.

Date of best estimate 21-Aug-98

Annex 3 Definitions and abbreviations

Ramsar Region The Ramsar Bureau has adopted a system whereby countries are assigned to one of the following administrative and reporting regions: Africa, Asia, Eastern Europe, Neotropics, North America, Oceania, and Western Europe.

Regional Scale A scale which encompasses all, or the vast majority of countries within one Ramsar region.

Supra-regional Scale A scale which is greater than the Regional scale which normally encompasses several countries within any *two or more* Ramsar regions but not covering each and every country within those Ramsar regions.

Sub-regional Scale A scale which is greater than the national scale which normally encompasses several countries within any *one* Ramsar region but not covering each and every country within that Ramsar region

Wetland Inventory Assessment Sheet

This consists of a series of sheets designed to evaluate and summarise wetland inventory material. These are completed for each and every inventory source which contains useful coverage and attribute data. The details from these sheets are then entered into the GRoWI database. Wetland Inventory Assessment Sheets are not completed for sources which are deemed to be of little use for inventory purposes.

Wetland According to the Ramsar Convention, wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres. In addition, the Ramsar Convention (Article 2.1) provides that wetlands: 'may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands'.

Wetland Inventory For the purposes of this project the definition of 'wetland inventory material' is necessarily broad, and encompasses standard wetland inventories carried out specifically for this purpose, but also includes material, which does not constitute a wetland inventory *per se* (eg Hughes et al 1994, A Preliminary Inventory of Tunisian Wetlands). Relevant NGO material, GO material, conference proceedings, workshop material and academic/research material were also considered as wetland inventory material.

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GO Governmental organisation

NGO Non-governmental organisation

WI-A	Wetlands International–Americas
WI-AEME	Wetlands International–Africa, Europe, Middle East
WI-AP	Wetlands International–Asia Pacific
WIAS	see *Wetland Inventory Assessment Sheet*
GRoWI	Global Review of Wetland Resources and Priorities for Wetland Inventory

Review of wetland inventory information in the Neotropics

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Contents

Acknowledgments

We would like to thank the many people throughout the region who provided valuable information, commented on the design and analysis, and reviewed the material presented in this report. Ramsar focal points in many of the countries helped secure data which were otherwise unattainable. The authors recognise that additional information may be published but was not available during the course of this study. Therefore, this report is a first attempt to compile and analyse information and is the basis for a 'living document'.

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1 Introduction

The Neotropical region is divided into three subregions: Central America, South America and the Caribbean. It is bounded by 35 degrees and 95 degrees west longitude, and 55 degrees south latitude to 20 degrees north latitude. In addition to the mainland areas of Central and South America, the Neotropics also encompasses all the Caribbean islands, Galapagos and other outlying islands in the Pacific and Atlantic. Figure 1 is a distribution map of the wetlands of the Neotropical region.

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Figure 1 Distribution of wetlands in the Neotropical region (from *Los Humedales de America del Sur*)

This report provides an analysis of inventory information available on wetlands of the Neotropical region. The information presented in this report compliments material collected by Wetlands International for each of the geographical regions of the world. Recommendations based on the analyses are presented in the final section of this report.

2 Information sources

2.1 Methods used to obtain wetland inventory information

A variety of sources were consulted to determine the most up-to-date and reliable information on the extent, value and status of the region's wetlands. Despite early advances of Scott and Carbonell (1986) to inventory internationally important wetlands of the region, there is little new information available, although current efforts are now underway in several countries to change this. As a result, it was necessary to consult other natural resource inventories and non-inventory data sources to determine the extent of new information available.

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Wetland studies at the regional (supra-national), national and sub-national levels were gathered from:

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- information stored at Wetlands International's offices in Canada, Mexico and Buenos Aires
- library and Internet searches
- direct contact with national Ramsar representatives in every Ramsar affiliated country by way of a questionnaire
- a visit to Washington, DC to access reference collections at United States Fish and Wildlife Agency (USFWS), World Bank, World Wildlife Fund for Nature (WWF) and Conservation International.

Efforts focused on securing national level material but significant studies were obtained at sub-national and supra-national levels. In many cases, these inventories were completed for specific states or provinces within a given country.

2.2 Summary of information reviewed

Although a great deal of information on wetlands exists for the region, much of the information is anecdotal and therefore hard to quantify. Several good regional reports were recently completed on wetlands and freshwater ecosystems but lack detailed information which would allow for establishing baseline information for future analyses.

Specific information was obtained from wetland inventory reports, natural resource inventories that include indirect or direct references to wetlands, resource monitoring studies, land use studies, conservation planning documents, wetland education materials, and supporting information obtained from the Internet (eg Ramsar national reports).

Table 1 summarises the titles of 19 documents used in this report to assess the status of wetland inventories in the Neotropical region. This information was compared with documentation provided by each of the Ramsar focal points in the national reports submitted in preparation for the Ramsar Conference of Parties (CoP7) in Costa Rica, May 1999. Several countries are in the initial process of assessing their wetland resources but this information was not available for this report. Table 2 briefly summarises the data attributes.

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Table 1 Wetland inventory documents used in the analysis of wetlands of the Neotropical Region

Report Title	Countries
1 Estadisticas Sobre el Recurso Agua en Colombia (1992)	co
2 Inventario de los Humedales de Costa Rica (1998)	cr

3 Los Humedales de la Argentina: Clasificacion, Situación Actual, Conservacion y Legislacion (1998)	ar
4 Estrategia Nacional para la Conservacion de Humedales en Peru (1996)	pr

Table 1 continued

5 An Inventory of Brazilian Wetlands (1994)	br
6 Diagnóstico y Zonificacion Preliminar de los Manglares del Pacifico Colombiano (1997)	co
7 Diagnóstico y Zonificacion Preliminar de los Manglares del Caribe Colombiano (1997)	co
8 Plano de Conservacao de Bacia do Alto Paraguai (Upper Paraguay River Basin Conservation Plan) (1997)	br
9 UK Dependent Territories Ramsar Study: Stage 1 (1992)	fk
10 Los Humedales de A. Sur: Un Agenda Para La Conservacion de Los Humedales y Politicas de Desarrollo (1997)	co,ve,ar,bo,br,cl,ec,gy,py,pr,sr,uy,fg
11 Freshwater Biodiversity of Latin America and the Caribbean: A Conservation Assessment (1999)	ar,bl,bo,br,cl,co,cr,ec,gt,gy,hn,me,ni,pc,pr,py,sr,sv,uy,ve
12 Memorias II Taller Regional de Humedales (1992)	ar,bo, br, cl,co,ec,pr,py,uy
13 Uso Sostenible de Humedales en America del Sur (1997)	br,co,cr,ec,pr,uy,ve
14 Atlas of Nearctic Shorebirds on the Coast of South America (1989)	ar,br,cl,co,ec,fg,gy,pr,py,sr,ve,uy
15 Critical Natural Habitats in Latin America and the Caribbean (Volume 1: Southern Cone) (1997)	ar, cl,py,uy
16 Wetland Conservation in Central America (1993)	cr,gt,hn,ni,pa,sv
17 Hidrovia: An Initial Environmental Examination of the Paraguay – Parana Waterway (1993)	ar,br,py,uy
18 EL Ecosistema de Manglar en America Latina y la Cuenca del Caribe: Su Manejo y Conservación (1994)	co,cr,cu,do,ec,gt,hn,me,ni,pa,pr,sv,ve
19 Directory of Neotropical Wetlands (1986)	all Neotropical countries

Refer to appendix 4 for key to countries

Table 2 Attributes of the wetland inventory documentation

Attribute	Analysis (n = 23)
Inventory type:	3 national (Argentina, Brazil, Costa Rica), 3 sub-national (Colombia, Argentina), 2 site (critical habitats) and thematic (migratory waterbird habitat) specific regional inventories
Publication date:	all but one published after 1990
Coverage:	the Neotropical Wetland Directory provides a baseline on wetlands in each Neotropical country: country specific information is available for Argentina, Brazil and Costa Rica, mangrove inventories have been carried out for the region, and site specific information is available for most other countries (albeit primarily qualitative rather than quantitative)
Language:	majority of material in Spanish
Publication format:	19 hard copy papers
Availability of information:	All materials from published sources
Data storage:	19 paper (some accompanied by digitally stored information)
Implementation agencies:	58% international NGO, 32% national NGO, 32% government agency, sub-national government agency 5%
Funding sponsor:	26% from international NGOs, 21% from national governments, 11% from private sources (Foundations), remaining from other (42%) which is comprised primarily of resources directed to governments from bilateral and multilateral organisations (World Bank, OMIT, USAID, CIDA)

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3 Extent and adequacy of wetland inventory information

3.1 Objectives

The objectives of each inventory document varied. Three distinct inventory types were identified: ‘site inventories’, ‘wetland type inventories’ and ‘other inventories’.

3.1.1 Site inventories

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In general, these reports provide information on discrete wetland, including maps, for a region or a country. The Neotropical Wetland Directory (Scott & Carbonell 1986) provides baseline data on discrete sites throughout the region based on biodiversity characteristics. This is very much in keeping with the early focus of Ramsar on wetlands of international importance especially as waterbird habitat. Sites listed in this report are generally well known to the conservation community but under-represent the true extent of wetlands in the region. Additional national inventories in Argentina (Canevari et al 1998), Brazil (Diegues 1994), and Costa Rica (Cordoba et al 1998) focus on wetlands as ecosystems of biological and social importance and therefore tend to be more inclusive. In addition, because of their national perspective and increased access to GIS information, these studies are more thorough.

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3.1.2 Wetland type inventories

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The objective of these inventories is to simply inventory specific wetland habitats. These are almost exclusively wetlands of significant importance to the national and local economies of the region. In this study, they represent studies of mangrove (Suman 1994, Sanchez-Paez & Alvarez-Leon 1997a, b, Spalding et al 1997), coral (Bryant et al 1997), and peatland ecosystems (Lappalainen 1996).

3.1.3 Other inventories

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A large amount of inventory information is a sub-set of larger inventories, assessments, planning and strategy development efforts. ‘Water’ and ‘freshwater ecosystems’ are two categories under which wetland inventories have been completed. The evaluation of freshwater ecosystems by Olson et al (1997) is an example of this. A report on Colombia’s water resources (Ramirez 1992) includes wetlands and provides general information on their extent and status. Several other documents focus on wetland conservation strategies and provide an overview of wetland site information as the basis for defining conservation action (Davidson & Gauthier 1993), (Canevari et al 1997). Some documents include an inventory/overview of wetlands as part of a greater land use planning effort (PNMA 1997) while still others incorporate wetland inventories as part of an environmental impact assessment (Bucher et al 1993).

3.2 Wetland Definitions and Classifications

3.2.1 Wetland Definition

Significant variation in wetland definitions exist. Although it was expected that the Ramsar definition would serve as the basis for defining wetlands, only 9 of the 19 reports used this definition as the basis for identifying and delineating wetlands. Another 7 inferred to wetlands and a further 3 did not provide a definition of wetlands.
The Ramsar definition most widely used is:

> areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres (Ramsar Convention Bureau 1997).

This was true for most inventory work. Definitions for broader habitat and natural resource inventories referred to wetlands and in the specific case of wetland type inventories (eg mangroves), wetlands were explicitly defined by their species composition. No national inventories including the recently published Costa Rican Wetland Inventory, explicitly addressed the issue of coral 'wetland' habitat or eel grass beds.

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3.2.2 Wetland Classification

Only 3 of the reports analysed, employed the Ramsar wetland classification system (Appendix 1). Even the most recently published directory on wetlands of Costa Rica relied on Dugan's (1990) wetland classification system.. Given its availability in Spanish, it is not surprising that this has been adopted as a standard in Costa Rica (Appendix 2). The latter classification system identifies 3 major categories, each with a combined 12 sub-categories, and a further 39 categories within the sub-categories.

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3.3 Geographic scale

The analysed reports can easily be divided into geographic categories.

- Global (4 reviewed, 2 included as part of analysis)
- Supra-national or regional (10)
- National (5)
- Sub-national (4)

Although Bird and Schwartz's (1985) *The World's Coastline* was reviewed, it lacked specific information and data necessary to warrant its inclusion. Global data on reefs (Bryant et al 1997) and additional wetland material found on various web sites was reviewed. The majority of sites lacked sufficient detail to be included as a reference source for this study. Additional materials were reviewed by Wetlands International and will be added to compliment this regional analysis.

A majority of reports analysed presented information on a regional or supra-national basis. Often information was provided on a country by country basis under the auspices of a regional framework. Two reports provide classify and assess wetlands from an ecosystem perspective (Canevari et al 1997, Olson et al 1997).

National inventories provide the most detailed work to date and include information for Argentina, Brazil and Costa Rica. These publications will serve as excellent sources of information for monitoring future changes to wetlands in the region. Sub-national reports for Colombia provide excellent information on the extent of mangroves.

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3.4 Inventory methods

A common approach to inventorying wetlands is lacking. Methodologies vary depending on the objectives of each study.

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3.4.1 Important site inventories

The Neotropical Wetland Inventory (Scott and Carbonell 1986) used national coordinators to secure basic information on internationally important wetlands using the Ramsar definition of wetlands. This information was further massaged, augmented and presented as a unified work on wetlands of the Neotropical Region.

Subsequent inventories in Argentina (Canevari et al 1998), Brazil (Diegues 1994) and Costa Rica (Cordoba et al 1998) applied varying approaches. The Brazilian inventory is essentially based on secondary data from the Neotropical Wetland Inventory. Using multi-disciplinary teams, additional information was gathered from maps (including interpretation of remote sensing information), site visits, and newly referenced materials. This information was compiled and published. The Costa Rican inventory mirrored the approach used by Scott and Carbonell (1986) and further augmented it by incorporating a GIS element to record mapping information. The Wetlands of Argentina (Canevari et al 1998) used information gathered as a result of the South American Wetland Assessment (Canevari et al 1997). This approach is significantly different from the other inventories as it attempts to take the information from Scott and Carbonell (1986) and others, and determine priority areas and issues to guide future wetland conservation activities.

Hepburn et al (1992) surveyed the Malvinas\Falkland Islands as part of an independent study supported by the UK government. This survey used maps and aerial reconnaissance to inventory wetlands.

3.4.2 Wetland type inventories

Essentially, inventories of mangrove and migratory wildlife habitat are the essence of these studies. They are generally focused and quite detailed in their acquisition of data. For mangrove habitat, extensive surveys using state-of-the-art equipment along with sampling to ‘ground truth’ the results were applied in Colombia. For critical wildlife habitats, inventories were carried out by on-site managers and land owners using locally available information. Information on peatlands, coral reefs, swamp forests, was compiled from secondary sources and from on-going global efforts to determine the status of these ecologically important wetland types.

3.4.3 Other inventories

A variety of other methods were used to compile information on wetlands. The majority compiled information already available or brought together state of the knowledge through workshops, interviews and questionnaires. In several cases this information was part of a larger ecosystem assessment (freshwater or specific wetland like the Pantanal).

3.5 Extent and adequacy according to inventory types

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3.5.1 Overview

The Neotropical region is comprised of three distinct sub-regions: South America, Central America and the Caribbean. Inventories for Central and South America have been produced and maps of each sub-region are available. Site based information for inventoried wetlands is also published for these two sub-regions. An inventory of Caribbean wetlands has not been attempted except as part of the Neotropical Wetland Directory (Scott & Carbonell 1986). Table 3 summarises information that is available by country. Supra-national or regional inventories were included and have been recorded against each country. The table further breaks down information on wetland inventories (Canevari et al 1997, Olson et al 1997) using ecoregions to define units.

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Although published wetland inventories exist, few provide sufficient information on the total extent of all wetlands by country or ecoregion. Information does exist on certain wetland types such as mangroves and in some places, wetlands of importance to migratory birds such as shorebirds (Morrison & Ross 1989) and waterfowl (Blanco & Canevari 1998).

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Table 3 Summary of wetland inventory information and geographic extent of data

Country	# Records	Important wetlands by country	Important wetlands by ecoregion	Wetland type by country	Wetland type by ecoregion	Other

Argentina	8	2	1	1	1	3
Bolivia	5	1	1	0	1	2
Brazil	10	2	1	1	1	5
Chile	5	1	1	1	1	1
Colombia	10	1	1	4	1	3
Ecuador	7	1	1	2	1	2
Guyana	4	1	1	1	1	0
French Guyana	4	1	1	1	1	0
Islas Malvinas	3	2	0	0	1	0
Paraguay	6	1	1	1	1	2
Peru	8	1	1	2	1	3
Suriname	4	1	1	1	1	0
Trinidad & Tobago	3	1	0	1	1	0
Uruguay	8	1	1	1	1	4
Venezuela	6	1	1	2	1	1
Belize	2	1	0	0	1	0
Costa Rica	6	3	0	1	1	1
El Salvador	4	2	0	1	1	0
Guatemala	3	2	0	0	1	0
Honduras	4	2	0	1	1	0
Nicaragua	4	2	0	1	1	0
Panama	4	2	0	1	1	0
Anguilla	2	1	0	0	1	0
Antigua & Barbuda	2	1	0	0	1	0
French Antilles	2	1	0	0	1	0
Dutch Antilles	2	1	0	0	1	0
Bahamas	2	1	0	0	1	0
Barbados	2	1	0	0	1	0
Bermuda	2	1	0	0	1	0
Cuba	3	1	0	1	1	0
Dominica	3	1	0	1	1	0
Granada	2	1	0	0	1	0
Haiti	2	1	0	0	1	0
Cayman Islands	2	1	0	0	1	0
Turks and Caicos Islands	2	1	0	0	1	0
Virgin Islands	2	1	0	0	1	0
Virgin Islands	2	1	0	0	1	0
Jamaica	2	1	0	0	1	0
Montserrat	2	1	0	0	1	0
Puerto Rico	2	1	0	0	1	0

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Dominican Republic	2	1	0	0	1	0
San Christobal and Nevis	2	1	0	0	1	0
Saint Vincent	2	1	0	0	1	0
Saint Lucia	2	1	0	0	1	0
Total	**164**	**54**	**13**	**26**	**44**	**27**

Inventory information on wetlands of international importance is available for every country in the region as a result of work completed by Scott and Carbonell (1986). As stated earlier, this information focuses on 'internationally important' wetlands and is therefore incomplete for many areas. The Conservation of Central American Wetlands (Davidson & Gauthier 1993) report provides detailed information on sites which correspond with published maps. Because these assessments were based on compilation of existing information, new and relevant information on wetland extent is lacking. Olson et al's (1997) assessment of Latin American and Caribbean freshwater ecosystems provides a useful overview from an ecoregional perspective but lacks detailed site information.

The South American Wetland Assessment (Canevari et al 1997) also approaches wetlands from an ecoregional perspective but is inclusive of all wetlands whereas Olson et al (1998) focuses on freshwater ecosystems.

Table 3 indicates significant coverage for Central and South America. However, only three countries have completed extensive national wetland inventories. The recently published Costa Rican inventory most accurately reflects the true extent of wetlands although it has not included coral reefs (except for Isla Cocos), riverine wetlands, man-made wetlands or shallow coastal waters.

As with the other regional reports, comprehensive inventories are lacking in the Neotropical Region. Despite producing maps of the wetlands for Central America and South America, most inventory reports do not provide detailed statistics on coverage by wetlands and wetland types. Deciding on the true boundaries of wetlands may in part, explain why this has not been undertaken. Fluctuating water levels as a result of seasonal precipitation can shrink or expand wetland areas by as much as 10 fold in some regions. The Llanos of Venezuela and the vast flooded forests of the Amazon basin are prime examples.

3.5.2 Important wetland site inventory

This category was divided into important sites and ecoregions to demonstrate that new information is being compiled using ecoregions as opposed to traditional political borders (Table 3). The advantage to this approach is that it recognises wetlands as a function of a greater hydrological system which may in some cases include as many as 7 or more countries (eg Amazon basin).

Despite this though, assessing important sites was the most common form of inventory. At least 54 country reports were reviewed as part of this analysis. The Neotropical Wetland Directory provides 43 of these and continues to be the main source of information for Caribbean countries where little if any updated information has been produced (or was accessible during this study).

Table 4 lists the number of important sites per country along with corresponding data on areas.

Table 4 Important wetland sites in the Neotropical Region

Country	Neotropical Wetland Directory 1986		National Inventories 1990+		Ramsar Sites 1999	
	Sites	Area (ha)	Sites	Area (ha)	Sites	Area (ha)
Argentina	60	5 942 278	69	-	6	420 039
Bolivia	31	2 419 100			2	805 240
Brazil	42	68 079 473	84	111 707 200	5	2 680 911
Chile	50	9 243 963			7	100 174
Colombia	40	1 943 000			1	400 000
Ecuador	22	992 530			3	94 750
Guyana	15	63 800				
French Guyana	4	337 700				
Islas Malvinas	9	44 300				
Paraguay	7	5 718 732			4	775 000
Peru	48	22 397 727			7	293 059
Suriname	14	1 325 000			1	12 000
Trinidad and Tobago	9	21 280			1	6 234
Uruguay	12	773 500			1	435 000
Venezuela	30	285 508 555			5	263 636
Belize	19	56 406			2	-
Costa Rica	12	81 755	359	350 000	7	245 301
El Salvador	8	81 100			1	-
Guatemala	24	224 487			3	83 049
Honduras	6	649 000			3	102 575
Nicaragua	17	6 127 491			1	43 750
Panama	22	646 012			3	110 989
Anguilla	10	321				
Antigua and Barbuda	6	4 901				
French Antilles	14	12 525				
Dutch Antilles	11	5 329				
Bahamas	21	383 606			1	32 600
Barbados	3	52				
Bermuda	9	76				
Cuba	17	1 746 500				
Dominica	4	90				
Grenada	7	170				
Haiti	11	52 900				
Cayman Islands	15	7 310				
Turks and Caicos Islands	110	26 669			1	54 400
Virgin Islands (Br)	4	614				
Virgin Islands (US)	15	978				

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Table 4 continued

Country	Neotropical Wetland Directory 1986		National Inventories 1990+		Ramsar Sites 1999	
	Sites	Area (ha)	Sites	Area (ha)	Sites	Area (ha)
Jamaica	15	13 609			1	5 700
Montserrat	2	20				
Puerto Rico	15	25 865				
Dominican Republic	15	36 221				
San Christobal & Nevis	4	352				
Saint Vincent	3	1 000				
Saint Lucia	3	316				

3.5.3 Wetland type inventory

For the purposes of this report 'wetland type' information can be categorised under the following headings:

- mangrove
- peatlands
- coral reefs
- eel grass beds
- freshwater ecosystems
- lakes and rivers
- human made wetlands (reservoirs, rice ponds, aquaculture ponds, salt pans)

Except for mangroves, inventories of wetland types are found in unpublished documents or are unavailable. Unpublished reports for Central America summarise the extent of mangroves in each of the Central American countries. This information is presented in Davidson and Gauthier's (1993) report on Wetland Conservation in Central America. National reports from Colombia (PNMA 1997) and regional summaries (Suman 1994) for Latin America and the Caribbean provide information on Central and South American and the Caribbean (Cuba and Dominican Republic) mangroves.

Olson et al's (1998) report on freshwater ecosystems identifies 117 ecoregions and assesses their conservation status. However, delineation of these ecoregions is broad and in many instances, includes some terrestrial habitat, and is therefore of little use in defining the true limits of wetlands of the region. An example of this is the Altiplano freshwater ecoregion unit which covers a large expanse of montane habitat within which common types of wetlands are found. However, these wetlands may only represent 1–5% of the total land area within that particular ecoregion.

Peatland information is gleaned from a global report published by the International Peat Society and edited by Lappalainen (1996). This information is largely based on general reports and is limited in its treatment of Neotropical peatlands.

Coral reefs surveys were carried out by Spalding et al (1997) but are global in scope and lacking in specific detail. Information on eel grass beds was not available. Nor was information on the extent of human made wetlands such as reservoirs.

3.5.4 Other inventories

A range of other inventories was included. Their use in delineating wetlands is also variable. Several natural resource surveys provide specific information on wetland areas including mangroves, coral reefs, human-made water bodies and aquaculture ponds. In general though, wetlands are not considered a priority habitat type and are often included in broader categories such as forest, grasslands, lakes and rivers. This is changing and more wetland specific projects are being proposed as the profile of wetlands increases in the region.
This report did not consider all national environmental action plans (NEAPs) for each of the 43 countries included in this report. Only that information readily available or within Wetlands International's archives was considered. In general, these reports are lacking in wetland specific information.

3.6 Extent and adequacy of updating activities

Monitoring the status of wetlands requires access to accurate relevant information measured over a time period. General data of this type does not exist for wetlands in the Neotropics. Specific data on wetland types, especially mangroves do exist and have been adequately mapped in some countries at various points in time. Much of the mapping data for mangroves for example can be found in information gathered as part of the Tropical Forest Action Plans (TFAP).

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Without an adequate data set on general wetlands, including mapping information, it is difficult and pointless updating existing data bases. A few countries like Costa Rica have invested resources to develop a useful data set which will enable the monitoring of wetlands in the future.
In the national reports (as of February 1999) to the Ramsar Conference of Parties 7 (CoP7) and through contact with representatives from various Neotropical countries, the following activities are being contemplated to either establish a database on wetlands or update activities already initiated:

Argentina	–	completed national inventory which will be refined
Colombia	–	completed detailed inventory of mangroves which will serve as a base for future comparison
Costa Rica	–	completing a national inventory of wetlands and work continues to augment missing data
Ecuador	–	undertaking a national wetland inventory
Paraguay	–	completed preliminary inventory
Peru	–	prepared wetland action plan which contemplates a national inventory

3.6.1 Important site inventories

The Neotropical Wetland Directory (Scott & Carbonell 1986) provides important site inventories for 43 countries. To date, only Argentina, Brazil and Costa Rica have updated this information. Both updates provide greater detail on wetlands and will serve as useful standards for future monitoring. All three require additional work to delineate extent of current wetland boundaries and establish benchmarks for future comparison.

3.6.2 Wetland type inventories

Only mangroves appear to have been inventoried with some frequency. Spalding et al (1997) questions past techniques to survey mangroves and suggests that earlier data may not be useful for long-term comparisons. Baseline data do exist as a result of the TFAP and more recent surveys in Colombia and elsewhere. Whether the data collected are comparable over time is beyond the scope of this report. Information collected by various groups in Colombia may lend some credibility to Spalding et al's statements (1997) (Table 5). However, variability over 15 years is less than 13% and INDERENA's (government agency responsible for mangrove forests) figures over 12 years vary less than 4%.

Table 5 Change in area of mangrove habitat along the Pacific Coast of Colombia

Organisation	Year	Area
FAO	1981	287 000
INDERENA	1984	284 300
Winagrad	1987	286 700
Yanine-Diaz	1991	322 200
INDERENA	1991	283 700
OIMT(INDERENA)	1996	292 724

3.6.3 Other inventories

Again, the TFAP provides a useful database on mangroves for future comparison. Detailed maps of all forest resources were mapped as part of the TFAP process. Other natural resource inventories may also provide data for temporal comparisons. However, the majority are descriptive in nature and do not provide detailed mapping data with easily accessible referenced information. That is, some wetlands are described but the actual delineation of wetland area is not provided. In other cases, the reverse is found – maps are produced with no information on wetland status.

4 Use of inventory information to assess the status of wetlands

4.1 Extent and distribution

Information on the overall extent of Neotropical wetlands is lacking. There are only three national inventories which have been completed since Scott and Carbonell (1986) published the Neotropical Wetland Directory. However, the distribution of wetlands is much better documented in maps with a scale ranging from 1:1 000 000 (Central America) to 1:4 000 000 (South America) – both for wetland and freshwater ecoregions. These maps portray the overall distribution of major wetlands like the Llanos and the Pantanal. However, they are not detailed enough to measure the vast number of small (< 1km) wetlands located in the Pampas or Altiplano region.

4.1.1 Important wetland sites

The Ramsar definition forms the basis for wetland site inventories in the Neotropics. This definition is however, open to interpretation particularly when delineating wetland boundaries and can lead to variation in coverage – this is particularly true for flooded forests, coastal areas and temporal wetlands. Most inventories have focused on wetlands of national or international importance. Many wetlands do not meet this criteria and therefore inventories tend to underestimate their actual extent.

Table 6 illustrates this situation. Only national inventories provided a reasonable estimate of the distribution and extent of wetlands. However, caution should be exercised when extrapolating the extent of wetlands using inventory information gathered from sites of national or international importance.

The most accurate information to date is contained in the Costa Rican wetland inventory. It uses the Ramsar definition and has nation wide coverage. Unfortunately, it does not include most marine wetlands. However, this database is still under development and will likely include this data shortly. Preliminary inventories in Paraguay and Ecuador are underway but information on these activities was not available.

Table 6 Area and number of wetlands inventoried in the Neotropical Region

Country	**Neotropical Wetland Directory 1986**		**National Inventories 1990+**		**Ramsar Sites 1999**	
	Sites	Area (ha)	Sites	Area (ha)	Sites	Area (ha)
Argentina	60	5 942 278	69	-	6	420 039
Bolivia	31	2 419 100			2	805 240
Brazil	42	68 079 473	84	111 707 200	5	2680 911
Chile	50	9 243 963			7	100 174
Colombia	40	1 943 000			1	400 000
Ecuador	22	992 530			3	94 750
Guyana	15	63 800				
French Guyana	4	337 700				
Islas Malvinas	9	44 300				
Paraguay	7	5 718 732			4	775 000
Peru	48	22 397 727			7	293 059
Suriname	14	1 325 000			1	12 000
Trinidad and Tobago	9	21 280			1	6 234
Uruguay	12	773 500			1	435 000
Venezuela	30	285 508 555			5	263 636
Belize	19	56 406			2	-
Costa Rica	12	81 755	359	350 000	7	245 301
El Salvador	8	81 100			1	-
Guatemala	24	224 487			3	83 049
Honduras	6	649 000			3	102 575
Nicaragua	17	6 127 491			1	43 750
Panama	22	646 012			3	110 989
Anguilla	10	321				
Antigua and Barbuda	6	4 901				
French Antilles	14	12 525				
Dutch Antilles	11	5 329				
Bahamas	21	383 606			1	32 600
Barbados	3	52				
Bermuda	9	76				
Cuba	17	1 746 500				
Dominica	4	90				
Grenada	7	170				

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Table 6 continued

Country	Neotropical Wetland Directory 1986		National Inventories 1990+		Ramsar Sites 1999	
	Sites	Area (ha)	Sites	Area (ha)	Sites	Area (ha)
Haiti	11	52 900				
Cayman Islands	15	7 310				
Turks and Caicos Islands	110	26 669			1	54 400
Virgin Islands (Br)	4	614				
Virgin Islands (U.S.)	15	978				
Jamaica	15	13 609			1	5 700
Montserrat	2	20				
Puerto Rico	15	25 865				
Dominican Republic	15	36 221				
San Christobal & Nevis	4	352				
Saint Vincent	3	1 000				
Saint Lucia	3	316				

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4.1.2 Wetland type specific

Inventories have been completed for a variety of wetland habitats or ‘types’. A particular focus on mangroves has resulted in the compilation of extensive datasets for most tropical countries. FAO supported the TFAP throughout Latin America and resulted in fairly detailed maps of mangrove forests, particularly for the Central American region (Davidson and Gauthier 1993). Additional inventories have been completed or underway for coral reefs, flooded forests, eel grass beds and peatlands.

4.1.2.1 Mangroves

Regional (Suman 1994) and global (Spalding et al 1997) mapping projects provide an overview of the current extent and distribution of these habitat types. Table 7 provides a compilation of recent information on mangrove extent in the Neotropics. In Latin America and the Caribbean, WWF (Olson et al 1997) has compiled a detailed map of the region’s mangroves at a scale of 1:4 000 000 which was used to determine priority areas for conservation. Although lacking data on areas, this exercise does provide detailed information on the distribution and conservation status of mangroves and proposes broad strategies for their future conservation.

Data for estimating mangrove extent varies widely. Estimates for Nicaragua vary from 60 000 ha in 1983 (IUCN in Davidson & Gauthier 1993), 155 000 ha in 1993 (Garcia in Suman 1994) and 94 300 in1998 (data from WCMC Web site). This trend indicates a decline in mangrove since 1993 but may actually be a result of poor coverage given the mangroves of the Caribbean coast are difficult to delineate. Additional data for Colombia (Table 7) also supports varying methods of estimating mangrove area.

Estimates for Caribbean countries are lacking as are data for Guyana where significant mangrove forest dominate coastal wetlands. It is possible that this data has been obtained as part of FAOs TFAP.

Table 7 Area of mangrove forest in the Neotropical Region

Country	Area of Mangrove (ha)	Reference
Cuba	532 400	Menendez et al, in Suman 1994 (ed)
Dominican Republic	41 000	Alvarez in Suman 1994 (ed)
Puerto Rica	9 300	Martinez in Suman 1994 (ed)
Belize	n/a	no reliable data available
Costa Rica	41 000	Pizarro in Suman 1994 (ed)
El Salvador	26 800	Funes in Suman 1994 (ed)
Guatemala	16 000	Aragon de Rendon in Suman 1994 (ed)
Honduras	145 000	Oyuela in Suman 1994 (ed)
Nicaragua	155 000	Garcia in Suman 1994 (ed), based on 1983 soil maps
Panama	170 800	Osorio in Suman 1994 (ed)
Brazil	2 500 000	Diegues 1994
Colombia	379 034	Sanchez and Alvarez 1997
Ecuador	162 000	Bodero in Suman 1994 (ed)
Guyana	–	no reliable data available
French Guyana	–	no reliable data available
Peru	4 541	Castillo in Granizo 1997 (ed)
Suriname	–	no reliable data available
Venezuela	260 000	Rodriguez in Suman 1994 (ed)

4.1.2.2 Peatlands

Regionally or nationally focused data on the extent and distribution of peatlands was sparse. Lappalainen's (1996) effort to compile information on the Neotropics includes a summary of peatlands for most Latin American and Caribbean countries. The only other source of data for peatlands was found in Davidson and Gauthier's (1993) report on Central America which summarised data from Maltby (1986). This chart summarised extent of peatlands in Central America but did not represent data secured through an inventory process. In the national peatland inventories of Argentina, Brazil and Costa Rica, peatlands are seldom identified, although Diegues (1994) does refer to 'peatsoils' as one of the wetland types. Table 8 provides an overview of data on peatlands for the Neotropical region.

Table 8 Peatland area in the Neotropical region

Country	Area of Peatland (ha) Maltby 1986	Area of peatland (ha) Lappalainen 1997
Caribbean		270 000
Cuba		657 900
Haiti		47 500
Jamaica		12 300

Puerto Rica		10 000
Belize	n/a	*68 000
Costa Rica	37 000	37 000
El Salvador	9 000	9 000
Guatemala	n/a	n/a
Honduras	453 000	453 000
Nicaragua	371 000	371 000
Panama	787 000	5 000
Argentina		50 000
Bolivia		900
Brazil		3 500 000
Chile		1 047 000
Colombia		339 000
Ecuador		n/a
Guyana		814 000
French Guiana		162 000
Peru		10 000
Suriname		113 000
Trinidad and Tobago		1 000
Uruguay		3 000
Venezuela		1 000 000
Total area (ha)	1 657 000	8 980 600

4.1.2.3 Freshwater swamp forest

Information on the extent of freshwater swamp forests at both a national and regional level is not readily available in wetland inventories although it would be possible from existing data to compile this information for tropical countries – particularly those involved in the Tropical Forestry Action Plan which attempted to map the forests of the region. Data from WCMC's web site does provide information on Tropical Swamp Forests for Brazil, Ecuador, French Guiana, Guyana, Suriname, Venezuela, Trinidad and Tobago, Cuba, Guadeloupe, Jamaica, Belize, Guatemala, Nicaragua and other swamp forests for Argentina and Paraguay (this information is readily available at http://www.wcmc.org.uk and is not included in the analysis of inventories because of overlap with a broader global analysis of databases of this nature (Spiers 1999)).

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4.1.2.4 Coral reefs

Coral reefs are found along all coastal areas of Caribbean, Central America and along the Pacific coast to southern Colombia and Atlantic coast to southern Brazil. A publication on the 'Status of coral reefs classified by potential threat from human activities' (Bryant et al 1997) provides a global and regional breakdown of the conservation status of coral reefs, including the Neotropical Region. 2 310 000 ha of reefs were identified in this report [2 000 000 from the Caribbean (15 000 in the Lesser Antilles) and 310 000 along the Atlantic coast). However, the report does not provide detailed information on past or current extent of coral reef systems. Inventories of coral reefs were not obtained although it is believed that information is provided on global databases such as those managed by UNEP–IUCN. The Caribbean and Belize are two areas of the Neotropics where considerable information should be available.

4.1.2.5 Human made wetlands and other areas

The area of aquaculture ponds, reservoirs and other human made wetlands is lacking. Several analyses of dammed water bodies include a measurement of the total surface area. This area vastly over estimates wetland area since many, if not all, are shallow enough for inclusion as wetlands under the Ramsar definition. Partial estimates of major human made reservoirs are included in the inventory of Brazilian wetlands and additional reports from Colombia and Peru also include some data.

Aquaculture and salt ponds, and other types of human made wetlands are not accounted for in this report. An inventory of shrimp farms in the Neotropics must be available but at the time of this report, no data had been acquired.

The extent of Colombia's largest 'cienegas', 'lagunas' and reservoirs is published in Ramirez 1992. However, it focuses on the largest and most important and therefore has limited utility.

Although not included in the analysed data, Toresani et al (1994) published a report identifying 1429 bodies of standing water in the pampas region (Buenos Aires province) of Argentina. Unfortunately, the extent of these bodies of water was not recorded.

4.2 Wetland benefits and values

Qualitative information is provided in all of the wetland inventories and assessments and could be divided into: direct benefits, functional values, cultural attributes, and intrinsic values. Specific quantitative data exists for individual sites but does not exist for wetlands as a whole, at either the individual, state, national or regional level. Information on the monetary benefits of mangroves is the most widely published (eg fisheries, fuel or construction wood and/or salt production). Information is also available on shrimp production but this data needs to be analysed carefully because in many cases, the net 'benefit' is a negative figure when considering damage to mangrove ecosystems.

Data on benefits accrued from activities in wetland areas like ecotourism, wildlife use (hunting, fishing, and live capture), and forage harvesting, are sporadically documented. Data on the benefits of important wetland functions like flood water abatement, erosion control, filtration and or aquifer recharge (all difficult to quantify) are also lacking, or non-existent.

Many of the inventories have focused on wildlife, notably waterbirds, and as such have biased the information in terms of the 'waterbird' benefits. Wetlands are also critical habitat for more than 90% of the freshwater fish in the region but little attention is given to this group of economically important species.

Added to the problem of quantifying values is the wide range of monetary values in the region. Economies have undergone significant expansion and contraction in the past two decades making data comparison extremely difficult.

In general, given the data analysed, wetland values are not quantifiable at a national or even individual wetland level except in cases where research is underway to look at very specific issues (eg annual monetary value of fuelwood from mangroves or fisheries production for specific wetland dependent species).

4.3 Conservation Status

4.3.1 Land tenure and management structure

4.3.1.1 Regional inventories

Site inventories provide a useful tool for monitoring land tenure status of wetlands in the region. Scott and Carbonell's (1986) work established the basis for monitoring changes to the protective status of internationally important wetland sites (Table 9). The Ramsar database also provides a tool for monitoring land use changes at designated Ramsar sites with the inclusion of new ones and the 'updating of information on existing sites'.

4.3.1.2 Subregional inventories

The South American wetland assessment (Canevari et al 1997) provides some land tenure information, but in general, it is sporadic in its treatment of this information. The Central American wetland conservation report provides a list of protected areas and management authorities in the country responsible for, or involved in, activities at these sites. The World Bank completed a study on critical natural habitats in Latin America and the Caribbean which contains detailed information on land ownership for many protected and critical wetland areas in the region (Ledec et al 1997).

4.3.1.3 National inventories

The Costa Rican wetland inventory provides detailed information on the land tenure situation. The Brazilian inventory provides land tenure information for those sites managed by IBAMA, the government natural resources agency. The Argentina inventory provides some information on land tenure status of individual sites and management authority.

Table 9 Conservation status of wetlands in the Neotropics (Scott & Carbonell 1986)

Country	Neotropical Wetland Directory 1986		Total # totally protected sites	Total # partially protected sites
	Sites	Area (ha)		
Argentina	60	5942 278	18	10
Bolivia	31	2419 100	7	3
Brazil	42	68079 473	11	11
Chile	50	9243 963	19	2
Colombia	40	1943 000	10	17
Ecuador	22	992 530	9	3
Guyana	15	63 800	-	-
French Guiana	4	337 700	-	-
Islas Malvinas	9	44 300	5	-
Paraguay	7	5718 732	1	-
Peru	48	22397 727	7	1
Suriname	14	1325 000	2	1
Trinidad and Tobago	9	21 280	4	4
Uruguay	12	773 500	2	1

Table 9 continued

Country	Neotropical Wetland Directory 1986		Total # totally protected sites	Total # partially protected sites
	Sites	Area (ha)		
Venezuela	30	285508 555	15	2
Belize	19	56 406	1	-
Costa Rica	12	81 755	2	1
El Salvador	8	81 100	1	-
Guatemala	24	224 487	3	5
Honduras	6	649 000	3	-
Nicaragua	17	6127 491	2	1
Panama	22	646 012	5	4
Anguilla	10	321	-	-
Antigua and Barbuda	6	4 901	-	-
French Antilles	14	12 525	-	3
Dutch Antilles	11	5 329	6	1
Bahamas	21	383 606	5	1
Barbados	3	52	-	-
Bermuda	9	76	8	-
Cuba	17	1746 500	4	-
Dominica	4	90	1	-
Grenada	7	170	1	-
Haiti	11	52 900	-	-
Cayman Islands	15	7 310	5	2
Turks and Caicos Islands	110	26 669	-	-
Virgin Islands (B)	4	614	1	1
Virgin Islands (US)	15	978	15	-
Jamaica	15	13 609	12	3
Montserrat	2	20	1	1
Puerto Rico	15	25 865	5	3
Dominican Republic	15	36 221	5	2
San Christobal & Nevis	4	352	-	-
Saint Vincent	3	1 000	-	1
Saint Lucia	3	316	-	-

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4.3.2 Rate and extent of wetland loss and degradation

Measurements of wetland degradation and loss require baseline information compiled over time using similar methodologies. Information on general wetland loss and degradation from a national or even departmental\ state\ municipal level does not exist. National inventories do include an analysis of the threats to wetlands.

Wetland loss information for specific wetland types exists in some countries, especially where data on mangroves has been measured. Table 10 provides a summary of information presented by mangrove specialists at a workshop held in Florida in 1993 (Suman 1994).

Table 10 Mangrove loss in select countries in the Neotropical Region (Suman 1994)

Country	Loss (% or ha)
Cuba	30%
Colombia	20%, 25.4% mortality along Pacific coast as evident by extent of dead forests*
Ecuador	20%
El Salvador	20%
Honduras	4300 ha lost between 1973-91 along Pacific coast
Puerto Rico	45% loss since 1970 (original extent ~ 24300)

From Sanchez and Alvarez (1997)

Additional information for Central America shows significant variation and in some cases even wetland mangrove extent increasing dramatically in areas where it is highly unlikely that this has been the case.

Canevari et al (1997) provide an analysis which qualitatively describes the conservation status of wetlands based on documented threats and opportunities in 19 wetland ecoregions of South America. Although extent of wetland loss and degradation is not provided, a score of low, medium, or high based on direct and indirect threats to the wetland, is listed.

Olson et al (1997) completed a conservation assessment of 117 freshwater ecoregions and ecoregion complexes for the entire Neotropical Region. In reference to their conservation status, 10 (9%) ecoregions were considered critical, 44 (38%) endangered, 42 (36%) vulnerable, 19 (16%) relatively stable and 2 (2%) relatively intact. Overall, 82% of the freshwater ecoregions were either vulnerable, endangered or critical. Critical ecoregions include: Caribbean lowlands, Maraciabo basin, Lake Poopo, Atacama deserts, Parano-Platense delta and the Mediterranean ecoregions of Chile. Two of the most endangered habitat types are flooded river plains such as floating meadows and varzea forests, threatened by logging and conversion to pasture, and cataracts, lost over vast areas due to dams and water diversions (Olson et al 1997). A map and a list of habitat types are provided in Appendix 4.

Finally, data from the Bryant et al (1997) on the status of coral reefs in the Neotropical Region shows that at least 29% of the reef habitat in the Caribbean are listed in the highest threat category while 55% in the Atlantic Ocean (excluding the Caribbean) are also listed under the same category. Coral reefs of the Neotropical Region represent fewer than 10% of the global extent of coral reefs.

4.3.3 Wetland creation

There is little mention of the extent of new wetlands created as a result of human and natural activities. Major reservoirs have been created throughout many of the large watersheds of South (eg Amazon, Sao Francisco, Parana) and Central America (eg Lerma, Panama). Although many are responsible for wetland loss, especially riverine types, large expanses of wetlands have also been created and probably far exceed the amount of wetland lost as a result of flooding and habitat destruction. What has been lost in many cases is wetland function and although new wetlands have been created, their functions in many cases have not.

5 Discussion and conclusions

5.1 Adequacy of information base

Although regional efforts to assess wetlands (and freshwater ecosystems) were completed recently, no supra-national or regional inventories exist that fully assess the extent of wetland resources in the Neotropical Region. A map that was produced as a by-product of the South American wetland assessment (Canevari et al 1997) project provides an accurate portrait of wetland distribution in South America (Figure 1). However, at a scale of 1:4 000 000, it is not able to detect many of the smaller wetlands scattered throughout the vast continent (eg the Pampas, Llanos, and Patagonia regions).

Only the Brazilian wetland inventory (Diegues 1994) provides sufficient baseline information on wetland extent in the Neotropical Region. Given that Brazil represents 49% of the total land surface area of South America, this is a significant contribution. Lacking from this analysis are detailed maps and associated data which would enable a national monitoring process to be implemented. The Costa Rican inventory (Cordoba et al 1998)is by far the most advanced in terms of recording information and mapping relevant sites. Despite lacking basic information on coral reefs and coastal littoral as part of the overall inventory (although it is believed that compilation of this information is planned), the overall extent of wetlands is not likely to increase substantially and therefore probably accurately reflects the extent of wetlands in Costa Rica, plus or minus 5%. Additional wetland inventories which are reported to be underway in Ecuador and Paraguay were not available during the duration of the analysis period.

Compilation of information is generally done at the national or sub-national level. Successful wetland conservation is often dependent on a broader ecosystem or watershed approach. Inventories of wetlands, using this approach, were completed and included in this report and offer an alternative method for collating information on wetlands. The draw back to this approach is the need for coordination between one or more countries, and the added problems of then involving many national stakeholders in conservation activities.

5.1.1 Important site inventories

Including entries from the Neotropical Wetland Directory, all countries in the region have an inventory of wetlands of international importance. However, this data was published in 1985 and although the only resource of its type, is more than 14 years old. Significant developments have occurred during the last two decades which undoubtedly have affected wetlands of the region.

National wetland inventories for Argentina (1998), Brazil (1994) and Costa Rica (1997) were recently completed. Each has its limitations but is an important first step towards establishing a database on wetlands which will serve as a useful basis for future monitoring.

Efforts are underway to support new wetland inventory databases using information gathered during the completion of the South American wetland assessment. Size and habitat detail is lacking in the original work and will need to be augmented if future inventories are to be useful.

Efforts to update the Neotropical Wetland Directory (Scott and Carbonell 1986) may be useful but greater emphasis on support to national inventories may be more cost effective *over the long term and would likely result in obtaining more detailed information that could later be compiled in a regional update.*

The Ramsar Bureau maintains an active database on designated sites and given the commitment, these sites may serve as useful areas for monitoring change.

Site information gathered to date, except for that which is included in recently completed national inventories, does not provide a good estimate of the true extent of a country or region's wetlands. Not only do they represent only a portion of a country's wetlands, but in many circumstances estimate areas which are not covered by the Ramsar definition – in some cases, even 'dryland' or 'open water' areas appear to be included. Site selection or identification is also biased towards sites of biological interest – often areas of importance to migratory waterbirds.

Collectively, the Ramsar Bureau, IUCN, WWF and Wetlands International have been instrumental in elevating the profile of wetlands in the region and are largely responsible for supporting inventory efforts in a number of countries. *A greater effort to encourage and support wetland inventories within the framework of national planning exercises, is required before useful monitoring of wetlands can begin. At present, most of the wetland management decisions are based on qualitative information.*

5.1.2 Wetland type inventories

Wetland type inventories exist for several important wetland types including mangroves, peatlands, coral reefs, flooded forests, lakes and ponds, and human-made structures. Most of these databases were generated as part of a global comprehensive effort to understand the extent of such resources.

Several of these wetland types are of economic importance, especially those associated with wood production. The TFAP was a useful program in this respect and helped to generate basic data on several forest types of economic interest.

The most inventoried wetland type is mangroves. This is particularly true from a national perspective. Few if any national peatland, eel grass or coral reef inventories are included in national environmental reports. Again, much of this can be attributed to their economic value and ease by which they can be surveyed.

The freshwater ecosystem assessment provides a useful means of assessing wetlands but because of its broad focus, only from those ecosystems which were themselves 'the wetland' (eg Pantanal), was it possible to extract useful quantifiable information. Otherwise, discrete wetlands were treated as part of a complex which includes terrestrial ecosystems (wet pampas) which is a complex of small wetlands interspersed between terrestrial ecosystems.

Sites of importance to migratory species were also inventoried and may provide useful information from a biological perspective (ie to better understand population variability, habitat use, etc). However, information available indicates that these databases are rich in qualitative information and very poor in quantifiable data (except for species and population accounts).

5.1.3 Other inventories

A variety of other inventory type information was collected and serves to augment or corroborate existing information. Land use plans and strategies as well as natural resource reviews and national environmental action plans all provide information. Most often though, it is only a piece of the picture that is provided. The detailed information which is necessary for undertaking meaningful analyses, is often lacking or incomplete. For example, it is useful to have an estimate of peatlands of east coast of Nicaragua, but without quantitative (and even qualitative) information on their distribution, extent and status, this information only allows for basic trend analysis which is most often inadequate for developing meaningful conservation activities.

5.1.4 Wetland extent in the Neotropics

A reliable figure for wetland extent is not possible from the information that is currently available. Table 11 provides an overview of data on wetland extent compiled from various sources. The Neotropical Wetland Directory (Scott & Carbonell 1986) reports the greatest extent of wetlands. Its coverage includes most of the major wetland areas including a portion of the vast flooded Amazon varzea and wet grasslands, the Venezuelan Llanos, the wet Pampas, the Chaco, the Pantanal, the Beni, the Guatemalan Peten, the high Andean Lakes, the Guayana coastal mangrove forests, the Chilean fiordland, and the steppe Patagonia wetlands. Taking only these wetlands into account, the entire wetland area for the Neotropical Region is approximately 414 996 613 ha, an area half the size of the United States or four times the size of Colombia. If the Ramsar wetland definition were adhered to, this estimate would increase significantly due the addition of shallow coastal areas and riparian areas. It is suggested that this figure could rise to much more than 20% of the surface area of the Neotropics. Riverine wetlands and marine habitats (eel grass beds, coral reefs, mudflats and beach) are the main wetland types missing from the inventory.

More precise data on the true extent of wetlands in the vast Amazon flood plain are now being collected using improved satellite monitoring techniques which can identify wet areas below forest canopy.

Table 11 Wetland extent in the Neotropics.

Wetland inventory	Best current estimate for area (ha)	Comments
mangrove	11 221 600	from WCMC dataset – does not include Peru
freshwater swamp forests	13 725 600	from WCMC dataset – does not include data from Honduras, Costa Rica, Panama and El Salvador, Bolivia, Venezuela, Colombia and from the Caribbean, includes only Cuba, Guadeloupe, Jamaica
coral reefs	2 310 000	from WRI 1997 dataset – does not include very small areas along Pacific coast
peatlands	8 980 600	from Lappalainen 1996 – figures for Ecuador and Paraguay not available, and figure for Malvinas(1 150 000) considered erroneous given island area is less than this amount. Belize and British Honduras both have figures associated with them – both are different names for the same country. Both have different figures. The lower one was considered consistent with the region. Information is dated (1985).
national wetland inventories – Argentina, Brazil, Costa Rica	n/a 111 707 200350 000	for only three countries with completed inventories: • information qualitative, some figures available • excellent compilation, general maps • excellent compilation – does not include small area of coral reefs or riverine wetlands (except for Cocos Islands
regional wetland inventory	414 996 613	from Scott and Carbonell (1986) – includes information

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		on important wetlands for all of South and Central America and all the Caribbean except for a select few small islands along the north shore of South America
database on Ramsar sites	14 211 407	from Ramsar's list of designated wetlands of international importance

* Total land area for: Neotropical region is approximately 2 051 800 000 ha (does not including many of the small Caribbean Islands); South America is 1 752 926 000 ha; Central America is 50 964 000 ha (WRI 1992).

5.2 Methodologies

In the 1980s, standard inventorying methods were developed as part of a major effort to inventory wetlands of importance worldwide. This effort involved coordinating specialists from each country within a region who would compile standard information on wetlands. Due to the general success and ease by which these types of inventories can be compiled, the methodology has become standard practice. More recently, these inventory techniques have been modified for use at the national level and are focused on inventorying all wetlands as defined by the Ramsar Convention. Earlier inventories focused on wetlands, especially those recognised by the waterbird conservation community.

In an effort to refine this methodology, Wetlands International and World Wide Fund for Nature (WWF) approached wetland inventories and assessments from a hydrological perspective. In its assessment of South America's wetlands, Wetlands International identified 19 wetland ecoregions. Based on shared characteristics (eg morphological, geographical, biophysical) these ecoregions were in large part a function of shared watersheds (or groups of watersheds). For each wetland ecoregion, an inventory of wetlands was completed and an assessment of their status provided a tool for identifying priority wetlands for conservation. Together with WWF, a similar initiative, identified 117 freshwater ecosystems and used these as units for determining conservation status. Both these approaches recognise the inherent link of wetlands to hydrological processes. In this manner, it is possible to identify common approaches to conservation opportunities or challenges within an ecoregion which may comprise one or many wetlands. The drawbacks to this approach is one of jurisdiction. Many ecosystem borders cross political boundaries. Political borders do not lend themselves to coordinated conservation action. However, as society becomes more aware of the inter-linkages between systems, employing wetland ecoregional boundaries or even watersheds as the unit of conservation, may prove to be effective in the long-term. After all, conservation of wetlands is a long-term effort.

Future inventories must be developed in tandem with GIS systems to ensure data is stored in a standard format that is easily up-dated. Inventories should be living documents and constantly updated when new information is made available. The Costa Rican database is a good example of this.

5.3 Use of inventory information to identify sites for monitoring trends in wetland status

5.3.1 Inventories of important sites

Inventory information from important sites can be used to monitor trends in wetland status. However, most inventories, except for national ones, do not provide enough detailed information to enable this. Generally, wetland inventories are based largely on qualitative information and lack appropriate data to define concrete boundaries. Future inventories need to be designed so that information is collected which is quantitative and can be used to monitor changes to wetlands (eg water quality, actual wetland area by wetland type, populations of endemic species, etc).

Information gathered from inventories should help to identify representative wetlands within a country or even wetland ecoregion. A network of protected representative wetlands sites would be a useful tool for monitoring trends. This approach is being used in many countries worldwide to ensure that representative ecosystems are conserved. Ramsar sites may very well provide this venue since they are already well described and in many cases protected.

Conservation International's AquaRAP program is attempting to inventory remote wetlands by first identifying and mapping wetland habitat types, then 'ground truthing' by 'parachuting' experts into these areas and completing rapid detailed inventories (Olivieri pers comm, Conservation International). Information that is being gathered may provide baseline data on the status of relatively pristine wetlands of Latin America and also used to evaluate the status of other similar wetlands in the region.

5.3.2 Wetland type inventories

These inventories offer the best opportunity for monitoring wetland change. The mangrove inventories of Colombia are an excellent example of how mapping using remote sensing data is combined with plot surveys. This allowed scientists to determine the state of mangroves along the entire Pacific and Caribbean coast. What is needed to complete this project is some form of standard evaluation which determines the status of mangroves at each survey plot. As it now stands, the mangrove inventory will serve as a baseline for measuring future change and providing information for informed decision making.

Wetland type inventories are useful for monitoring wetland extent, particularly for mangroves and swamp forest wetlands of the interior regions. Linking field data collection to mapping activities allows for future analysis of changes to habitat types. The recent inventory of mangrove forests in Colombia offers a useful example of how to achieve this.

Wetland inventories, as they pertain to areas frequented by large concentrations of migratory species, namely waterbirds, may also be useful to identify and monitor changes in wildlife populations. Birds are recognised indicators of habitat change and depending on the species, are often site specific, returning year after year to the same location.

5.3.3 Other inventories

These inventories are limited in their use as monitors of wetland status. Information is too general and often anecdotal.

5.4 Use of inventory information as a baseline for monitoring wetland loss/ gain

General wetland loss at a national or regional scale cannot be determined from the information gathered from the various inventories. There are no temporal studies established to provide this information. When completed, national wetland inventories will be able to monitor wetland loss on a site per site basis and for wetland types. Wetland type losses at a national level are available for some countries. Wetland creation needs to be measured to obtain net gain/loss ratios.

5.4.1 Important site inventories

Important site inventories can be used to monitor wetland loss when detailed information on extent and wetland condition are available. Unfortunately, the majority of site inventories do not contain sufficient information to allow for this analysis. The Brazilian inventory may provide enough data to measure losses but will depend on the sensitivity of the wetland area data obtained to date. Currently, wetland maps do not seem to have enough detail to provide useful measures of wetland loss. The Costa Rican wetland inventory is being developed to provide this information. Good maps and detailed area data was and continues to be collected. Detailed site information contained in the Ramsar site database may also provide sufficient data to enable a measure of wetland loss. However, current data do not allow this. Regular updating of site information (possibly every three years) would provide a measure of site loss and provide an early warning signal to site managers. Often, however, wetland loss is more than just a measure of physical loss. *Changes in hydrology, contamination, over exploitation of resources (eg wildlife) can drastically alter wetland function without much visible indication of wetland loss. A scale of wetland degradation may be needed.*

5.4.2 Wetland type inventories

At present, there are no consistent wetland type inventories which provide reliable data on wetland loss at a regional level. The detailed nature of wetland type inventories lend themselves to analysis of wetland loss at the national and sub-national levels. The study of Colombian mangroves provides a useful baseline for future measurements of wetland loss. Physical loss of mangrove habitat is also easy to discern from satellite imagery. Wetland type inventories for coral reefs and peatlands may also be useful for determining wetland loss although details on the exact methods of measuring and mapping their extent were not available during the course of this study.

Inventories of loss of wetland type at specific sites is available throughout the region such as the mangroves of Tumbes, Peru, coral reefs of Belize and other Caribbean nations, and a number of individual sites along the Colombian coast where dead mangrove are easily detected.

Inventories of new reservoirs may provide a useful measurement of wetland creation – a situation which will likely increase in some regions of the Neotropics (eg Brazil where more than 300 new dams are proposed along the Amazon).

5.4.3 Other wetland inventories

Anecdotal information on wetland loss is provided but a lack of consistent data collection and often general nature in which the data is collected does not provide a useful basis for measuring wetland loss or gain.

6 Recommendations

- Encourage the development of national wetland site inventories throughout the Neotropical Region which incorporate means of collecting useful data which can be used to monitor trends in wetland status.
- Map the current extent of wetlands ecoregions throughout the Neotropical region and based on this information, identify specific wetlands and wetland types. The WWF and Wetland International wetland assessment maps for Latin America and the Caribbean, and South America, respectively, are useful templates from which to begin this effort.
- Assess the utility of using wetland ecoregions as the basis for developing inventories in the Neotropics and throughout the world based on an agreed upon classification system that is linked to hydrological processes.
- Review the usefulness of identifying representative wetland types in each country (or wetland ecoregion) and use them to monitor wetland status. These may be Ramsar sites.
- Consider looking at mechanisms to assess the net gain in wetlands.
- Establish agreed upon criteria when developing and undertaking wetland inventories to ensure standard analyses can be conducted and the results compared amongst countries (or ecoregions). This includes agreeing to a standard mapping format (currently, it is like comparing apples and oranges). A guide book detailing the results of successful inventories may be useful.
- To establish baseline data for future monitoring, methods of inventorying wetland types need to be developed. Inventories of mangroves, coral reefs, peatlands, swamp forests, eel

grass beds, and other wetland types should also build upon existing inventories, improving them where ever possible.

- National inventories should feed into regional inventories. Ramsar could take the lead on ensuring that national inventories are completed once every 9 years and use the Ramsar CoPs dates (once every third CoP) as a means of establishing a time line. National reporting could be streamlined to fit into this schedule.
- Synthesize and distribute data so that it is readily available to a wide range of audiences including managers, policy makers, donor agencies, academic institutions, and the general public.
- Compile existing information on wetland values and benefits and produce a publication with detailed case studies from around the world looking at representative wetland types and their contribution to local and national economies.
- Develop a system for ranking wetland status. Although wetland loss is a measurable event, it is not always possible to observe loss or degradation of wetland function.
- Place greater emphasis on using fish species as indicator species of wetland health. To date, birds have been the focus of wetland studies. Fish are vastly under-represented in wetland studies. Given that as many as 99% of all freshwater fish rely on wetlands during their life history, effort to recognise their importance is needed.
- Promote Wetlands International as an institution with the capability to collate and manage a global wetland data base. There is an acute need to centralise current and future information on inventories.
- Provide guidance on delineating wetland boundaries in areas seasonally inundated by floods as well as areas which, although dry for extended periods of time, are flooded only once every decade or even century.

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Appendix 1 List of Ramsar Wetland Types

The codes are based upon the Ramsar Classification System for 'Wetland Type' as approved by Recommendation 4.7 and amended by Resolution VI.5 of the Conference of the Contracting Parties. The categories listed herein are intended to provide only a very broad framework to aid rapid identification of the main wetland habitats represented at each site.

Marine/Coastal

A. Permanent shallow marine waters less than six metres deep at low tide; includes sea bays and straits.
B. Marine subtidal aquatic beds; includes kelp beds, seagrass beds, tropical marine meadows.
C. Coral reefs.
D. Rocky marine shores; includes rocky offshore islands, sea cliffs.
E. Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems.
F. Estuarine waters; permanent water of estuaries and estuarine systems of deltas.
G. Intertidal mud, sand or salt flats.
H. Intertidal marshes; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes.
I. Intertidal forested wetlands; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests.
J. Coastal brackish/saline lagoons; brackish to saline lagoons with at least one relatively narrow connection to the sea.
K. Coastal freshwater lagoons; includes freshwater delta lagoons.

Inland Wetlands

L Permanent inland deltas.
M Permanent rivers/streams/creeks; includes waterfalls.
N Seasonal/intermittent/irregular rivers/streams/creeks.
O Permanent freshwater lakes (over 8 ha); includes large oxbow lakes.
P Seasonal/intermittent freshwater lakes (over 8 ha); includes floodplain lakes.
Q Permanent saline/brackish/alkaline lakes.
R Seasonal/intermittent saline/brackish/alkaline lakes and flats.*
Sp Permanent saline/brackish/alkaline marshes/pools.
Ss Seasonal/intermittent saline/brackish/alkaline marshes/ pools.*
Tp Permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation waterlogged for at least most of the growing season.
Ts Seasonal/intermittent freshwater marshes/pools on inorganic soil; includes sloughs, potholes, seasonally flooded meadows, sedge marshes.*
U Non-forested peatlands; includes shrub or open bogs, swamps, fens.
Va Alpine wetlands; includes alpine meadows, temporary waters from snowmelt.
Vt Tundra wetlands; includes tundra pools, temporary waters from snowmelt.
W Shrub-dominated wetlands; Shrub swamps, shrub-dominated freshwater marsh, shrub carr, alder thicket; on inorganic soils.*

Xf Freshwater, tree-dominated wetlands; includes freshwater swamp forest, seasonally flooded forest, wooded swamps; on inorganic soils.*
Xp Forested peatlands; peatswamp forest.*
Y Freshwater springs; oases.
Zg Geothermal wetlands.
Zk Subterranean karst and cave hydrological systems.

* As appropriate, includes floodplain wetlands such as seasonally inundated grassland (including natural wet meadows), shrublands, woodlands or forest.

‘Man-made’ wetlands

1 Aquaculture (eg fish/shrimp) ponds.
2 Ponds; includes farm ponds, stock ponds, small tanks; (generally below 8 ha).
3 Irrigated land; includes irrigation channels and rice fields.
4 Seasonally flooded agricultural land.**
5 Salt exploitation sites; salt pans, salines, etc.
6 Water storage areas; reservoirs/barrages/dams/impoundments; (generally over 8 ha).
7 Excavations; gravel/brick/clay pits; borrow pits, mining pools.
8 Wastewater treatment areas; sewage farms, settling ponds, oxidation basins, etc.
9 Canals and drainage channels, ditches.

** To include intensively managed or grazed wet meadow or pasture.

Appendix 2 IUCN wetland classification system (Dugan 1990)

Salt water

1.1. Marine
- 1. Subtidal
- 2. Intertidal

1.2. Estuarine
- 1. Subtidal
- 2. Intertidal

1.3. Lagoonar

1.4. Salt Lake

Freshwater

2.1. Riverine
- 1. Perennial
- 2. Temporary

2.2. Lacustine
- 1. Permanent
- 2. Seasonal

2.3. Palustrine
- 1. Emergent
- 2. Forested

Man-made wetlands

3.1. Aquaculture/Mariculture

3.2. Agriculture

3.3. Salt Exploitation

3.4. Urban/Industrial

3.5. Water-storage area

Further detailed description of the third level (eg Freshwater\ Riverine\ Perennial) is provided in Dugan (1990).

Appendix 3 World Wildlife Fund/Wetlands International freshwater ecoregions of Latin America and the Caribbean

Major Freshwater Habitat Types

Major Freshwater Habitat Types (MHT) are geographical areas that share environmental conditions, habitat structure, and patterns of biological complexity (beta-diversity), and that contain species with similar guild structures and adaptations. MHT classifications are roughly equivalent to biomes.

Analytical criteria for both biological distinctiveness and conservation status should be tailored to the ecological dynamics, patterns of biodiversity, and responses to disturbance characteristic of each MHT. Each ecoregion was categorised by one of 9 major freshwater habitat types used for the LA/C region:

- Large Rivers
- Large River Deltas
- Montane Streams & Rivers
- Wet Region Rivers & Streams
- Xerix Region Rivers & Streams
- Xeric Region Endorheic (closed) Basins
- Flooded Grasslands & Savannas
- Cold Streams, Bogs, Swamps, & Mires (eg montane or low latitude)
- Large Lakes

Freshwater Ecoregion and Ecoregion Complexes

1. Baja California Peninsula	14. Río Salado	25. Central American Caribbean
Colorado River Basin Complex	**Lerma/Santiago Complex**	26. Talamancan Highlands
2. Colorado Delta	15. Santiago	27. Catemaco
3. Sonoran	16. Chapala	28. Coatzacoalcos
Sinaloan Coastal Complex	17. Lerma	29. Grijalva-Usumacinta
4. Sinaloan Coastal	18. Patzcuaro	30. Yucatán
Rio Grande Complex	19. Manatlan/Ameca	31.Guatemalan Highlands
5. Rio Bravo	**Río Panuco Complex**	32. Central American Karst Highlands
6. Pecos	20. Río Panuco	33. Hondurasn/Nicaraguan Highlands
7. Guzmán	**Balsas Complex**	34. Lake Nicaragua
8. Mayran/Viesca/Tlahulilo	21. Balsas	**Isthmus Atlantic Complex**
9. Cuatro Cienegas	**Pacific Central Complex**	35. Isthmus Atlantic
10. Llanos El Salado	22. Pacific Central America	**Isthmus Pacific Complex**
11. Conchos	**Atlantic Central Complex**	36. Isthmus Pacific
12. Lower Río Bravo	23. Papaloapam	**Bahama Archipelago Complex**
13. Río San Juan	24. Belizean Lowlands	37. Bahamas

Western Insular Caribbean Complex	65. Pacific Coastal Deserts	91. Maranhao
38. Cuba	**Lake Titicaca/Poopó Complex**	**Mata-Atlantica Complex**

39. Hispa iola	66. Lago Titicaca	92. Northeast Mata-Atlantica
40. Jamaica	67. Lago Poopó	93. Eastern Mata-Atlantica
41. Cayman Islands	**Galápagos Complex**	94. Southeastern Mata-Atlantica
42. Florida Keys	68. Galápagos	**Sao Francisco Complex**
Eastern Insulas Caribbean Complex	**Mediterranean Chile Complex**	95. Caatinga
43. Puerto Rico and Virgin Islands	69. North Mediteranean Chile	96. Cerrado
44. Windward and Leeward Islands	70. South Mediterranean Chile	**Upper Paraná Complex**
Chocó Complex	**Juan Fernandez Islands Complex**	97. Upper Paraná
45. Chocó	71. Juan Fernandez Islands	**Beniana Complex**
South American Caribean Complex	**Southern Chile Complex**	98. Beniana
46. Magdalena	72. Valdivian Lowlands	**Paraguay Complex**
47. Depresión Momposina – Río Cesar	73. Chiloé Island	99. Pantanal
48. Ciénaga Grande de Santa Marta	74. Chonos Archipelago	100. Lower Paraguay
49. Guajira Desert	75. Magallanes/Ultima Esperanza	**Southern Atlantic Complex**
50. Maracaibo Basin	**Subantarctic Complex**	101. Jacuí Highlands
High Andean Complex	76. Subantarctic	102 Lagoa dos Patos Coastal Plain
51. Páramos	**Venezuela Coast/Trinidad Complex**	**Chaco Complex**
52. Peru High Andean	77. Venezuelan Coast/Trinidad	103. Chaco
53. Bolivian High Andean Complex	**Llanos Complex**	**Pampas Complex**
54. Arid Puna	78. Llanos	104. Parano-Platense
55. Sierras Pampeanas y Subandinas	**Guiana/Orinoco Complex**	105. Río Salado and Arroyo Vallimanca
56. South Andean Yungas	79. Eastern Morichal	106. Northwest Pampas Basins
Inter-Andean Dry Valleys Complex	80. Orinoco Delta	107. Pampas Coastal Plains
57. Inter-Andean Dry Valleys	81. Southern Orinoco	108. Southwest Pampas Basins
North Andean Montane Complex	82. Guiana Watershed	**Patagonia Complex**
58. North Andean Montane	**Amazon Complex**	109. Rio Colorado
59. Humid Andean Yungas	83. Amazon Delta	110. Rios Limay – Neuquen – Rio Negro
60. Chuquisaca and Tarija Yungas	84. Amazon Main Channel	111. Northeast Meseta Canquel-Meseta Somuncura
61. Salta and Tucumán Yungas	85. Northern Amazon Shield Tributaries	112. Rio Cubui – Rio Chico
62. Sierra de Córdoba	86. Río Negro	113. Rio Deseado
Puyango-Tumbes Complex	87. Upper Amazon Piedmont	114. Rio Santa Cruz
63. Puyango Tumbes	88. Western Amazon Lowlands	115. Rio Coyle
Atacama Complex	89. Central Brazilian Shield Tributaries	116. Rio Gallegos
64. Atacama/Sechura Deserts	90. Tocantins-Araguaia	117. Rio Grande
Pacific Coastal Deserts Complex	**Northeast Atlantic Complex**	

Appendix 4 List of Neotropical Countries

Anguilla, Antigua & Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bolivia, Brazil, British Virgin Islands, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Fernando de Noronja Island, French Guiana, French Antilles, Grenada, Grenadine Islands, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Islas Malvinas\Falkland Islands, Montserrat, Navassa Island, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, St. Kitts & Nevis, St. Lucia, St. Pierre et Miquelon, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, US Virgin Islands, Uruguay and Venezuela.

Review of wetland inventory information in North America

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Contents

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This report is considered a 'living' document and serves as the basis for updating and adding new information as it becomes available.

1 Introduction

The North American Region covers Canada, Mexico and the United States (U.S.) including Hawaii, Alaska, Puerto Rico, U.S. Virgin Islands, and the Samoan Islands (figure 1). The area encompasses approximately 2 029 626 km5 (World Resources Institute 1992) with a diversity of ecosystems extending from the Arctic to the tropics, and below sea-level to heights in excess of 6000 metres. The North American continent is bordered by four major bodies of salt water: the Caribbean, the Atlantic, Pacific and Arctic Oceans. A west coast mountain range extends from Alaska southward to the Mexico-Guatemala border. Several large river basins cover much of the continent and include the Mississippi, Saint Lawrence, MacKenzie, Rio Grande, Usamacinta, Fraser, Colombia and Colorado Rivers. Five great lakes in the interior of the continent – Superior, Michigan, Huron, Ontario and Erie – have a significant influence on the hydro-regimes. Much of Canada and northern United States experience temperatures below 0˚C causing most bodies of water to freeze for periods of up to six months in the extreme north. This has a significant effect on wetlands and their functions.

The following report summarises and analyses existing wetland data as part of a global effort to assess wetland inventories. There are eight sections to this report including references and annexes which contain valuable information summarised from existing reports. Recommendations based on the analysis are presented in the final section of this report.

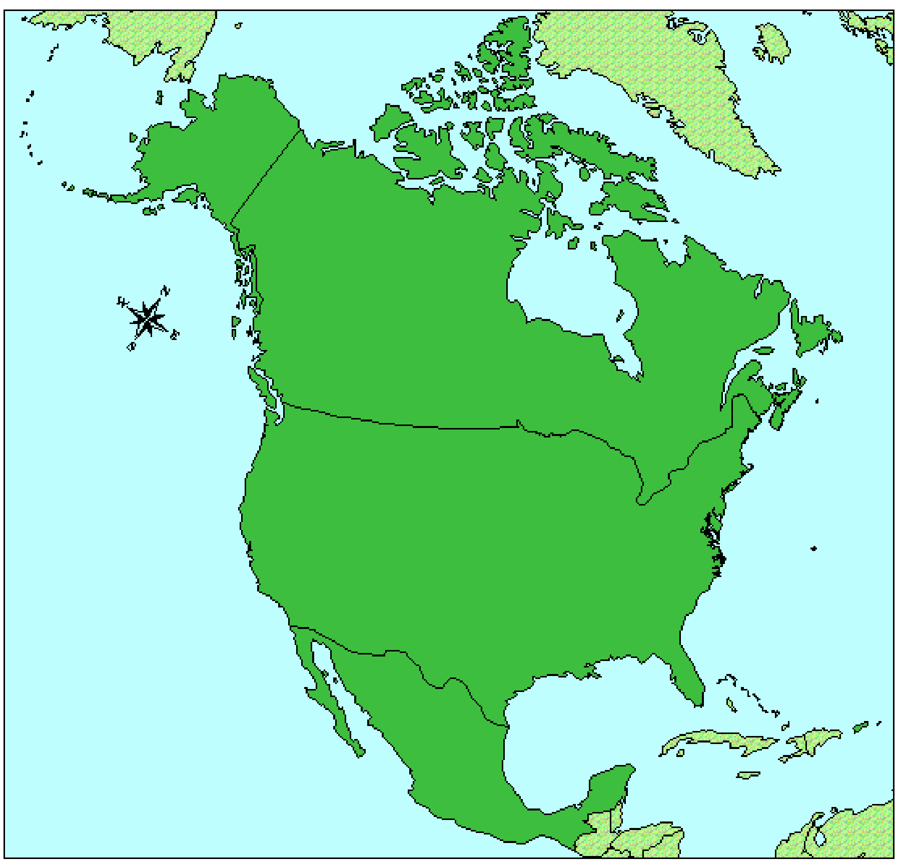

Figure 1 The North American region

2 Information sources

2.1 Methods used to obtain wetland inventory information

A variety of sources were consulted to determine the most up-to-date and reliable information on the extent, value and status of North America's wetlands. Information for the United States and Canada was readily available from natural resource agency libraries in Washington and Ottawa. Information for Mexico, however, was extremely difficult to obtain due to lack of data and a central clearinghouse mechanism to access information.

In Canada, the wetland office of the Canadian Wildlife Service (CWS) provided extensive information that was used as a baseline for collating additional resources in the country. In the United States, the National Wetland Inventory office of the United States Fish and Wildlife Service (USFWS) provided significant support in identifying relevant information, much of it now available on the Internet. In Mexico, Wetlands International's office and Secretaria de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAP), provided valuable data sets. However, without a national or even state wetland inventories, it was extremely difficult to secure reliable data.

In summary, wetland information was gathered from:

- Wetlands International's library
- Other libraries
- Internet
- Contact with government representatives responsible for wetlands
- Questionnaires

Only a small portion of the total information collected was used in the analysis for this report. A significant proportion of the available information was already synthesised into comprehensive summaries. To select relevant information, an effort was made to use only that information at the state, province, territorial, national or multinational level. In the case of North America, it was felt that states and provinces were significantly large to justify including data from these areas.

2.2 Summary of information reviewed

Over 150 discrete sources of information were reviewed. Of these 29 were selected as sufficient to provide the necessary coverage for this report. Additional inventories reviewed but not included are listed in Appendix A.

For the United States, information on wetlands is summarised on a state by state basis for nearly each of the 50 states. The United States Fish and Wildlife Service has undertaken to complete a national wetland inventory which provides state by state information on wetland description, types, function, value, distribution, form, jurisdiction and conservation (to mention just a few categories).

A similar national wetland inventory does not exist for Canada. However, regional and provincial inventories exist for most areas, although the territories lack this data. Canada's immense area, its relative remoteness and extensive coverage of wetlands has made it nearly impossible to map the northern wetlands to date.

Information on wetlands in Mexico is lacking. Most of the information was gleaned from reports on discrete wetland regions, although some inventories have been carried out by Wetlands International, Ducks Unlimited Mexico (DUMAC), Conservation International (CI) and the USFWS.

Ramsar National reports were reviewed but provided very little information on inventories.

Table 1 is a summary of the documents included in this report. Although not exhaustive, the information contained within these documents provides a good overview of the results from wetland inventories carried out over the last two decades. Much of this information was collected in the last five years and is relatively current.

Table 1 Wetland inventory documents used in the analysis for the North American Region

Ontario Wetland Map Summary
Wetlands of the Maritime Provinces
National Topographic Data Base – Canada
Canadian Peat Harvesting and the Environment
Peatlands of Canada
Land Use Change on Wetlands in Southern Canada: Review and Bibliography
Soil Landscapes of Canada
Sensitive Ecosystems Inventory of East Vancouver Island and Gulf Islands
Wetland Distribution and Conversion in Southern Ontario
Canada's Wetlands – Maps of Wetland Regions and Distribution in Canada
Wetlands of Canada: Wetlands of International Importance (Ramsar)
Habitat Inventory Program
National Heritage Information Centre
Alberta's Wetlands: Water in the Bank!
Wetlands of the St Lawrence River Region 1950–1978
Wetlands of the Fraser Lowland : An Inventory
Wetlands: Red Para La Conservacion de Los Humedales, Mexico
Boletin Humedales de Mexico
Guia Regional para el Conocimiento, Manejo y Utilizacion de Humedales del Noroeste de Mexico
National Water Summary on Wetland Resources
A User's Guide to the Wisconsin Wetland Inventory (for information on available data)
Summary Report 1992 National Resources Inventory
National Water Summary on Wetland Resources
Wetlands of the United States: Current Status and Recent Trends
Status and Trends of Wetlands and Deepwater Habitats in the Conterminous U.S. 1950s to 1970s
Wetlands Status and Trends in the Conterminous United States: Mid-1970s to mid-1980s
Wetlands of the United States
National Wetlands Inventory Database
A Directory of Neotropical Wetlands

Table 2 Attributes of the wetland inventory documentation

Attribute	Analysis (n = 29)
Inventory type:	14 national (6 Canada, 2 Mexico, 6 U.S.) 15 sub-national (10 Canada, 1 Mexico, 4 U.S.)
Publication date:	oldest: 1983 newest: 1998 period: 7 (1980–89); 22 (1990–99)
Coverage:	each country is covered and in the U.S. almost every state is inventoried and mapped
Language:	almost entirely in English except for data from the province of Quebec, Canada
Publication format:	mixture of publications, maps, databases, World Wide Web based
Inventory format:	32% wetland directories
Implementation agencies:	71% government, remaining by sub-regional governments and international, national and sub-regional NGOs
Funding sponsor:	71% funded by national governments, remaining funded by sub-regional governments and international, national and sub-regional NGOs

3 Extent and adequacy of wetland inventory information

3.1 Objectives

The objectives of a wetland inventory can vary depending on the type of information required. Wetland inventories are compiled for various reasons including: to determine wetland status; to provide background information for future monitoring; and to identify important habitats for wildlife, economic interests and other functions.

Inventories included in this report are divided into four categories based on their objectives and include:

1. General wetland inventories
2. Inventories of wetland sites of international importance
3. Wetland type inventories
4. Other inventories

General wetland inventories

The first category describes inventories with the common objective of identifying wetland location, extent and type. In the United States, the National Wetland Inventory (NWI) Office inventories wetlands on a state by state basis and, although it is thorough in its coverage, does not secure the level of detailed information achieved through site inventories such as the *Directory of Neotropical Wetlands* (Scott & Carbonell 1986). Instead, the NWI maps delineate wetland areas and identify wetland types using Cowardin et al's (1979) classification system (refer to Appendix B). The NWI provides standard map products including more than 50 800 maps covering 88% of the conterminous United States, 30% of Alaska and all of Hawaii and the U.S. Territories. Current mapping efforts use a scale of either 1:24 000 or 1:63 360 (Alaska). The NWI is also preparing a geographically digital database for wetlands so that wetland information can be placed into geographic information systems for use with computers.

To date, almost 18 800 maps representing 29% of the United States have been digitised. Statewide databases have been digitised for Delaware, Hawaii, Indiana, Illinois, Iowa, Maryland, Minnesota, New Jersey, Washington and West Virginia. Digitisation is in progress for Florida, North Carolina, South Carolina, South Dakota and Virginia. Wetland digital data are available for parts of 35 other states (Fretwell et al 1996).

The Coastal Wetland Habitat Program of the U.S. National Oceanic and Atmospheric Administration (NOAA) provides data on coastal wetland habitats and adjacent uplands to monitor changes in these habitats. The database contains excellent data on aerial extent and distribution of coastal wetlands in conterminous United States and serves as a basis for comparative temporal studies.

The USDA National Resources Inventory (NRCS 1995) is the most comprehensive database ever assembled on natural resources on non-federal lands of the United States – 74% of the nation's land area (refer to USDA Natural Resources Conservation Service Website). Data on acreage for marine, estuarine, riverine, lacustrine and palustrine habitat systems is presented. It is assumed that much of this data comes from soil type maps.

The U.S. Geological Survey produced the *National Water Summary on Wetland Resources* (Fretwell et al 1996). This extremely comprehensive study on wetlands provides an overview of the current state of wetlands including a state-by-state summary of wetland extent and loss.

The National Oceanic and Atmosphere Administration (NOAA) oversees a major coastal habitat monitoring project and has inventoried most of coastal United States including its wetlands.

The Canadian government published a map of wetland regions in 1986 (Environment Canada 1986). These wetland ecoregions were defined as areas within which similar characteristic wetlands develop in locations that have a similar topography, hydrology and nutrient regime. Subdivisions of the wetland ecoregions were made based on the distribution of these wetlands, the relative abundance of the various kinds of wetlands, or development trends somewhat divergent to those in the rest of the region. For each region, wetland types were defined as bog, marsh, fen, swamp and shallow water (Canadian Energy Mines and Resources 1986a). Five regions are recognised: Arctic, Boreal, Prairie, Mountain and Oceanic. Regions are further subdivided into 20 sub-regions which in turn are further subdivided into another 28 'micro' sub-regions. This inventory does not identify specific wetlands, rather it delineates wetland regions within which one would expect to find wetlands with similar wetland characteristics. Wetland inventories for regions defined by watersheds (eg the Great Lakes), ecological boundaries (eg the prairie region) and by political boundaries (eg provincial or territorial borders) also exist. However, each has been designed to meet the needs of the primary user. As such, a national standard has not been widely accepted and makes for difficult analyses. A list of selected initiatives are included in Appendix A.

In Mexico, the objectives of the few wetland inventories that exist are site based rather than national in scope.

Inventories of wetland sites of international importance

A second category includes important site inventories. The objectives of these inventories are primarily based on specific characteristics of a site which confer upon it an international recognition. This is usually based on biodiversity characteristics, eg breeding grounds for birds or nurseries for fish. Inventories of important wetland sites, particularly those of international importance in Canada, are coordinated through the CWS, however, most site inventories are managed by provincial government and non-governmental organisations (NGOs) like Ducks Unlimited. The United States government has invested significant resources to determine the extent of wetlands through a National Wetland Inventory (NWI) project coordinated by the USFWS. However, the NWI does not exclusively identify internationally important wetland sites. A detailed regional inventory was completed for northwestern Mexico and analyses the status of each coastal wetland (Cervantes 1994).

In Mexico, priority wetlands were identified by SEMARNAP in 1994 and serve as the most comprehensive inventory of wetland sites at a national scale. This effort is being evaluated and a system using watersheds to define wetland regions is under completion (H Berlanga, SEMARNAP, pers comm 1999).

Important wetland sites for staging and breeding waterbirds have also been identified and inventoried in Canada, United States and, to some degree, Mexico through the efforts of the North American Waterfowl Management Plan (NAWMP) and the Western Hemisphere Shorebird Reserve Network (WHSRN). A GIS mapping inventory of wetlands of importance to migratory waterbirds for much of Mexico's Caribbean coast (not including the Yucatan) is being completed by Ducks Unlimited Mexico (DUMAC). These data have not been published but are available upon request.

Ramsar databases have been published for Canada and the United States and provide basic information on each internationally important site (Gillespie et al 1991).

Wetland type inventories

A third category of inventories focuses on specific wetland types such as peatlands, forested wetlands, coral reefs, flood plains, mangroves and estuarine habitat. A major initiative to map and inventory Canadian peatlands was recently completed by Tarnocai and Labelle (in development) and provides detailed information on peatland distribution and maps dominant peatland types at a national scale. A review of peatlands was also published by the North American Wetland Conservation Council–Canada (Keys 1992) and provides valuable information on peatland extent for each Canadian province and territory. An ongoing review on the extent and condition of United States coral reefs provides useful information on sites in both southern United States, the Caribbean and Polynesia (NOAA 1998). Large areas of prairie pothole regions of central United States and Canada have been mapped by Ducks Unlimited.

Other inventories

A fourth category combines various other natural resource inventories whose objectives in part include obtaining information on wetlands. In Canada, the National Topographic Data Base (NRCAN 1998) provides specific reference to 'water saturated soils'. This includes areas of wetlands, tundra and bog. Most of Canada has been mapped at a scale of 1:250 000 while maps at 1:50 000 exist for most of the southern and more populated regions. The State of Canada's Environment (Environment Canada 1991) provides a status report on wetlands of Canada but the initiative was discontinued in the mid-nineties. The USDA Forest Service has completed detailed maps of forested habitat including lowland, flooded wetlands.

3.2 Wetland definition and classification

3.2.1 Wetland definition

Wetland definitions vary significantly within and among the three countries. In the United States, Cowardin et al's (1979) wetland classification system is widely used and defines wetlands as:

> lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have one or more of the following three attributes: 1) at least periodically the land supports predominantly hydrophytes; 2) the substrate is predominantly undrained hydric soils; and 3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

In general terms, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on the surface. Although there are many other definitions in use in the United States, this definition has become the standard of the NWI and those who use its data.

In Canada, the National Wetland Working Group (NWWG 1988) definition states:

> A wetland is defined as land that has the water table at, near or above the land surface or which is saturated for a long enough period to promote wetland or aquatic processes as indicated by hydric soils, hydrophytic vegetation, and various kinds of biological activity that are adapted to the wet environment.

In many cases, this definition has been adopted and slightly modified to meet the requirements of other specific inventories. However, a number of researchers developed their own definition and classification of wetlands making a comparison of inventory data difficult. Lynch-Stewart and Rubec (1995) concluded that compatibility of 18 major Canadian wetland databases was limited by the use of different classification systems.

In Mexico, the Ramsar Convention's definition of wetlands is used in most publications referring to wetlands. Ramsar defines wetlands as:

> areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.

For various reasons, Ramsar's definition is not widely used in Canada or the United States. This may be due to its lack of profile up until the early 1990s, and also a regulatory need in the United States to establish a more concrete operational definition. With the advent of a 'no net loss of wetlands' policy, it was necessary to develop a well defined wetland classification system in order to properly define, delineate and monitor wetlands.

3.2.2 Classification systems

The purpose of a wetland classification system is to group like elements into units that can be defined and characterised. Wetland classifications were used in all of the national wetland inventories. Numerous classification systems have been developed and are in use particularly at the regional, state, provincial or thematic level. These are not discussed in this report. The following information summarises those classification systems currently used to inventory wetlands at a national level.

Cowardin et al’s classification system is widely used in the United States and serves as the basis for the NWI. The structure of this classification is hierarchical, progressing from Systems and Subsystems, and Dominance Types. Modifiers for regime, water chemistry and soils are applied to Classes, Subclasses and Dominance Types (named for the dominant plant or animal forms). Special modifiers describe wetlands and deepwater habitats that have been either created or highly modified by man or beavers.

Five major systems are recognised by Cowardin et al (1979):

- Marine (two Subsystems: Subtidal and Intertidal)
- Estuarine (two Subsystems: Subtidal and Intertidal)
- Riverine (four Subsystems: Tidal, Lower Perennial, Upper Perennial and Intermittent)
- Lacustrine (two Subsystems: Littoral and Limnetic)
- Palustrine (no Subsystem)

A widely used wetland classification system does not exist in Canada. However, the National Wetland Working Group (NWWG) proposed a national system to classify wetlands in Canada that builds on systems already established in the United States and Europe.

The Canadian Wetland Classification System (CWCS) contains three hierarchical levels: 1) class, 2) form, and 3) type. Five wetland classes are recognised on the basis of overall genetic origin of wetland ecosystems. Seventy wetland forms are differentiated on the basis of surface morphology of underlying mineral soil. Wetland types are classified according to vegetation physiognomy. The five wetland classes are:

- bog
- fen
- marsh
- swamp
- shallow water

Ramsar’s wetland classification system (Ramsar Bureau 1998b) has not been adapted to North America. A generally accepted classification system for North America is unlikely. The United States classification system is widely in use but is of limited value in Canada because most of Canada’s wetlands are peatlands. According to Zoltai (1988), the United States system has been designed for use where non-peaty wetlands predominate. Its application in Canada would be difficult, as about 96% of the wetlands in Canada would fall into the category of the Palustrine system, leaving very little room for the differentiation of classes.

3.3 Geographical scale

National level inventories were available for each country. Primary emphasis in this report was placed on securing information at the national level. Information on state or provincial inventories was obtained for areas which were not covered by national inventories. One multinational review was used to obtain national level information on Mexico's internationally important wetland sites.

Most of the information for the United States was synthesised in the National Water Summary on Wetland Resources (Fretwell et al 1996). This document summarises existing information from the NWI and provides new or complimentary data which were published up until 1996. A national wetland map of the United States was published in 1990 by the USFWS (USFWS 1990).

In Canada, the Canadian Energy Mines and Resources (1986b) published a map of wetland ecoregions and their distribution. The sheer number of wetlands made it virtually impossible to discretely map Canadian wetlands, especially since a vast majority are too small to plot on standard maps (1: 7 500 000). Therefore, wetland regions were mapped based on percentage of wetland coverage. The lack of a detailed site inventory required compilation of information from various regional databases. An emphasis on using databases with at least provincial or multi-provincial coverage was necessary given the great amount of available information. Numerous smaller sub-provincial inventories exist across Canada.

Wetland inventories of Mexico are poor. Only the northwest coastal region has been adequately covered. A national wetland map (published by Conservation International and SEDESOL – now called SEMARNAP) illustrates the location and distribution of Mexico's important wetlands but does not provide detailed information.

In summary, a standard national wetland inventory is only available for the United States. Canadian wetlands regions have been mapped on a percentage basis but a standard national inventory has yet to be produced. Provincial inventories have been completed for most provinces. Inventories of Mexican wetlands consist of an overview of priority wetland sites identified by Scott and Carbonell (1986) and Cervantes & Abarca (1996), and a map sponsored by Conservation International which delineates wetlands but does not provide any associated data.

3.4 Inventory methods

3.4.1 General wetland inventories

In general, national wetland inventories rely on either aerial photographs as the basis for interpreting wetland type and extent and\or depend on soil maps. The latter method often involves ground truth surveys to verify interpreted data. Information can be geo-referenced and stored in large electronic data sets. Efforts are underway to completely digitise wetland maps in the United States and add geo-referenced material, all of which can be accessed through the World Wide Web.

3.4.2 Important wetland site inventories

Identifying important wetlands is largely a function of photo-interpretation and mapping. Site inventories generally secure information on a wide range of issues including size, type, land use, land tenure, biodiveristy, conservation status and threats. Similar methods are employed in Canada, particularly at the provincial level where most of the effort is focused on determining baseline information on wetlands. Some inventories, such as a major mapping project completed for southern Ontario by the Ontario Ministry of Natural Resources, relied heavily on ground truthing as a means of mapping thousands of wetlands and determining their classification (Ontario Ministry of Natural Resources 1984).

Compiling data for the *Directory of Neotropical Wetlands* required national expertise to coordinate the gathering and synthesis of information on a range of issues including wetland size, biological importance, status, threats, conservation, and ownership.

3.4.3 Wetland type inventories

Inventory methods are similar to those obtained for important wetland sites. Wetland type inventories focus on specific wetland habitats. In tropical regions, mangroves, coral reefs and swamp forests are the focus of wetland type inventories. Often these wetland types provide economically important resources (eg peat, timber, fish) or services (eg flood control, fish nurseries, filtration) to society. Peatland studies were often based on soil maps.

3.4.4 Other inventories

Many natural resource inventories are carried out in a similar fashion to those completed for wetlands. Soil inventories are a common source of information on wetlands. The presence of certain soil types are indicative of wetlands and can be easily mapped and verified. Forest inventories also provide valuable information although only recently has it been possible to more accurately differentiate between flooded and dry forest habitats. Many forested wetlands such as black spruce and tamarack swamps, mangrove and some bottomland hardwoods are easily identified and mapped. Inventories of riparian habitat also provide data on wetland areas.

3.5 Extent and adequacy of wetland inventories

Detailed inventories of wetlands exist for both the United States and Canada and provide fairly accurate data on general wetland extent. Specific state and provincial inventories also exist for Canada and the United States. Very little information exists for Mexico.

North American wetland inventories tend to provide a broad overview by state or province. Information on specific sites, however, is limited due largely to the huge number of wetlands. At a scale of 1:24 000 and 1:63 360, wetland maps of the United States provide extensive coverage for every state and territory. This information is extremely useful for monitoring trends in wetland loss and gain. The NWI provides information on extent and type but does not provide the level of detail found in the *Directory of Neotropical Wetlands*. Digitising this information and adding geo-referenced material will make the NWI an extremely powerful tool for analysing changes to wetlands throughout the United States. The NWI is a good source of information on specific wetland types, their extent and distribution.

Developed by the NWWG, the Canadian approach to a national wetland inventory identifies units containing similar wetlands based on shared morphological characteristics. By using this system it is impossible to monitor changes to individual wetlands. Instead, we are presented with regions defined by percentages of wetlands per unit area. The NWWG wetland classification system is at odds with the more focused approach of the NWI. It is therefore necessary to turn to provincial and regional wetland inventories which in many cases attempt to identify and classify discrete wetlands. Unfortunately, many of the inventories employ unique methods for determining wetlands and are therefore difficult to compare. In some cases it is like comparing apples to oranges. A standard national approach to identifying and classifying wetlands would provide a basis for future monitoring. However, given the tremendous number of wetlands in northern Canada alone, the feasibility of this sort of inventory may not be possible given the limited available resources. Individual provincial wetland inventories may be useful if the same methodologies are adhered to over time.

Wetland type inventories provide excellent coverage for peatlands in Canada and good coverage for coral reefs in the United States. During the report preparation, no information was obtained on the mangrove extent in the United States and limited information for Mexico. Information on rice growing areas, reservoirs and other man made wetlands is incorporated into NWI state reports. This information was not readily available for Canada and Mexico, although a list of reservoirs was reviewed for Mexico but lacked any information on potential wetland extent.

Wetland inventories did not include all wetlands as defined by Ramsar. In particular, shallow coastal waters are not included in any of the material provided. Nor is much attention given to riparian areas. Finally, very little information was obtained on human made wetlands despite knowledge of their existence. Rice farms, aquaculture pools, reservoirs and water impoundments, irrigated lands, and waste water treatment facilities may contribute significantly to wetland creation in North America, particularly in the United States. However, it is unlikely that these areas will reverse the general trend in wetland loss at the national or state level.

3.6 Extent and adequacy of updating activities

Wetland inventories have been periodically updated throughout the past three decades. This includes identifying new wetlands, enhancing information on wetlands for which data was incomplete, and re-assessing old inventories to determine if changes have occurred. The latter provides vital information for analysing trends in wetland loss and creation. A majority of the wetland inventories identified as part of this study provide sufficient information to serve as the basis for monitoring wetland loss, particularly inventories which delineate wetlands using standard or generally accepted classification systems.

Trend analysis for at least one-third of North America is possible due in large part to a significant investment by the United States government over the last three decades to complete a national wetland inventory. Even more importantly, information on the original extent of U.S. wetlands before Europeans settled across the country was recently completed (Dahl 1990). This provides a unique opportunity to analyse trends since the 1780s. In Canada, several long-term datasets allow for analysis particularly in agricultural areas such as southern Ontario (Snell 1987), the Maritimes (Hanson & Calkins 1996, parts of the prairie region and the lower Fraser River valley (see Appendix A for a list of selected wetland inventory databases). In Mexico a recent effort to re-evaluate wetlands of national priority was recently completed and may provide useful data for future trend analysis.

The following summarises information on the extent and adequacy of updating activities as they relate to each of the four wetland inventory categories.

3.6.1 General wetland inventories

The United States government published a report entitled *Wetlands: Losses in the United States, 1780s to 1980s* (Dahl 1990). To obtain these estimates, a ‘picture’ of wetland extent in the 1700s was developed based on current and historical land use information data. Trends in wetland loss were obtained by comparing the difference between the historical and current data sets. This information is provided in Appendix C. Efforts to update wetland information in Canada have been completed for discrete and generally populated areas of Canada. This information is neither uniform nor was it collected with a common set of objectives in mind. Comparing data from one region to another is practically impossible given the variation in data collection techniques. In some cases, inventories were primarily used to identify key waterfowl areas while others concentrated on potential agricultural lands or areas for natural resource extraction. A general wetland inventory for Mexico has yet to be completed.

3.6.2 Important wetland site inventories

Comprehensive inventories of important wetland sites in the United States and Canada were not found. In the United States, the NWI supersedes this need. In Canada, the immense number of wetlands makes identifying internationally important sites nearly impossible. Gillespie et al (1991) published an overview of existing Canadian Ramsar sites which contains good information on location, size, land tenure, designations and accessibility. However, new sites have since been nominated and the existing sites represent a fraction of the potential existing international sites. The *Directory of Neotropical Wetlands* (Scott & Carbonell 1986) was the first inventory of its kind to systematically identify wetlands of international importance throughout the region. Since its release in 1986, no new directories have been completed to improve and or augment information on Mexican wetlands except for a site profile of priority wetland sites identified by Cervantes & Abarca (1996) based on earlier work of a wetlands coalition. Wetlands of international importance to migratory birds were mapped along Mexico’s coast but little if any detailed habitat information is available (RIG Morrison, CWS, pers comm 1999). A recent attempt to identify wetlands of national importance was completed by SEMARNAP (H Berlanga, SEMARNAP, pers comm 1999) and may provide useful information for trend analyses.

3.6.3 Wetland type inventories

Information on activities to update wetland type inventories is sparse. Peatlands, mangrove, swamp forests and cranberry bogs are potential habitat types for which temporal information exists and may be used to obtain wetland loss information. In addition, the extent of newly constructed aquaculture ponds and rice fields may be recorded but represents an almost negligible percentage in terms of total wetland extent for each country. However, at some state levels, the percentage may be significant.

3.6.4 Other inventories

Soil, forest, water resources, and even topographic mapping initiatives all provide information that may be periodically updated. Soil maps can identify changes to water content and may indicate areas which have been drained or altered. Forestry maps provide an inventory of timber resources and, once mapped, can be used to monitor change in forested wetland areas. Topographic maps identify wetlands and are constantly updated. However, these maps were shown to significantly underestimate wetland extent (C. Rubec, Canadian Wildlife Service, pers comm 1999). Wetland identification may vary depending on the interpreter, season and even quality of aerial photos.

4 Use of inventory information to assess the status of wetlands

4.1 Extent and distribution

The quality of information on wetland extent varies significantly amongst the three countries. The NWI provides an unparalleled effort to inventory wetlands in the United States. The results provide a fairly accurate picture of wetland extent by state and territory. Indeed, information on wetland extent by state and territory before European settlement began has also been documented. In Canada, a national effort to inventory wetlands was completed by the Canadian Energy, Mines and Resources (1986a,b) and resulted in a map of wetland 'ecoregions' with associated percentage of wetlands. An inventory of Mexican wetlands relies heavily on important site information (Conservation International et al 1992, Cervantes & Abarca 1996). Wetland distribution maps exist for each country and a summary of these is included in this section.

4.1.1 General wetland inventories

Table 3 summarises information on wetland extent in Canada (NWWG 1988) and the United States (Dahl 1990). A steady decline in wetland extent is observed for conterminous United States. An increase in wetland extent in Canada is likely a result of improved data interpretation. Mexico has not yet completed a national wetland inventory despite the publication of a national wetland distribution map.

Table 3 Wetland extent (ha) in the United States and Canada based on the results of national wetland inventory information

Country	Wetland extent (ha) (1780s)	Wetland extent (ha) (1980s)	Wetland extent (ha) (1985)	Wetland extent (ha) (1988)	Wetland extent (ha) >1988
United States (conterminous only)	89 488 127 [a]	42 238 851 [a]	41 366 092 [b]	-	40 900 000 [b]
United States (Includes Alaska and Territories)	158 389 525 [a]	111 056 479 [a]	-	-	-
Canada	-	-	-	127 199 000 [c]	150 000 000 [d]

a published Dahl (1990)

b USFWS (1998)

c published NWWG (1988)

d approximate number based on recent data indicating total wetland extent in Canada may be as much as 150 000 000 ha based on information indicating increase in peatland area (Polestar Geomatics unpubl.)

4.1.2 Internationally important wetland sites

Although internationally important sites include specific wetlands of importance to wildlife, these inventories have not been included in this report since they only provide partial coverage of the total number of sites. Important inventories include the Ramsar site databases and, for Mexico, wetlands of international importance identified as part of the *Directory of Neotropical Wetlands* (Scott & Carbonell 1986). It is interesting to note that as much as one-tenth of Canada's wetlands have been designated as Ramsar sites (table 4).

Table 4 Number of sites and extent included in national wetland inventories of important sites.

Country	Ramsar sites [a]		Directory of Neotropical Wetlands [b]		Priority Mexican wetland sites [c]	
	Number	Extent (ha)	Number	Extent (ha)	Number	Extent (ha)
Canada	35	13 038 408	-	-	-	-
Mexico	6	1 095 414	40	3 374 900	32	3 064 977
United States	15	1 163 690	-	-	-	-

a List of wetlands of international importance designated under Ramsar, 04/98 (Ramsar Bureau 1998a)

b Scott and Carbonell (1986)

c Cervantes & Abarca (1996)

4.1.3 Wetland type inventories

Wetland type inventories of peatlands, forested wetlands (including mangroves), coral reefs, sea grass beds and several others have been completed for various regions yet very little standardised data are available. Table 5 illustrates the relative amounts of wetland types in the conterminous United States.

Table 5 Extent for selected wetland categories in conterminous U.S. (from USFWS 1998)

Wetland	Extent (ha)
Estuarine (includes subtidal area)	9 355 421
Palustrine*	38 773 693
Lacustrine (not including Great Lakes)	8 256 715
Riverine	2 237 458
Total	**58 623 287**

Palustrine wetlands include forested swamps and flood plains which alone occupy an area of 19 398 543 ha in conterminous United States.

Figures for total wetland extent differ between table 3 and table 5 and may be explained by the inclusion of deepwater habitat for lacustrine, riverine wetlands and subtidal estuarine areas. The figure of 40 900 000 ha is generally considered to be accurate.

Coral reefs

The extent of coral reefs in North America is provided for the United States. Data on coral reef extent for Mexico were not available during the compilation of this report. Delineating coral reefs is difficult and varies amongst inventories. Data included in table 6 do not account for coral reefs to the north of the Florida Keys and a series of patch reefs in the Upper and Lower Keys. In addition, coral reefs extending beyond the U.S. 200 nautical miles exclusive economic zone in the mid-Pacific were not included.

Table 6 Extent of Coral Reefs in North America – United States (NOAA 1998)

Region	0–3 nm (00ha)	3–200 nm (00ha)	Total (00ha)
U.S. Virgin Islands	200	na	200
Puerto Rico	500	na	500
Florida Keys	143	182	325

Texas\Louisiana	0	2	2
American Samoa	271	25	296
Guam	69	110	179
Main Hawaiian Islands	1 655	880	2 535
Northwestern Hawaiian Islands	2 430	9 124	11 554
Northern Mariana Islands	45	534	579
Johnston	130	75	205
Howland	5	0	5
Baker	10	0	10
Jarvis	8	0	8
Palmyra	396	4	400
Kingman Reef	39	10	49
Wake	32	0	32
Total	**5 933**	**10 946**	**16 879**

* nm: nautical miles

According to the data presented in table 6, the area of coral reefs within U.S. jurisdiction (1 687 900 ha) represents a fraction of the total extent of coral reefs worldwide (61 700 000 ha).

The extent of coral reefs in Mexico was not determined. Significant areas exist in the Yucatan, especially along Mexico's border with Belize.

Peatlands

A peatland is a wetland in which extensive organic material has accumulated (NWWG 1988). Detailed information was readily accessible for peatlands in Canada. Information was also available on peatlands in the United States, but with less detail on the extent of peatlands by state or territory. More time is required to secure data on United States peatlands. Table 7 provides a summary overview of peatland extent in North America.

Table 7 Peatland extent in North America

Country	Extent (ha)
Canada (NWWG 1988)	111 327 000
Mexico (1)	1 000 000
United States (2)	61 100 000
Total	**173 500 000**

(1) data from Farnham (1980)

(2) data from Lappalainen (1996)

NWWG (1988) estimates that peatlands cover 111 327 000 ha of Canada's land and freshwater area (close to 12% of the nation's surface area) (table 8). This comprises approximately 90% of the wetlands in Canada (Keys 1992). A recent study completed by Tarnocai et al (1995) estimates that Canadian peatlands occupy an area of 122 383 400 ha, a slight increase in the total amount estimated by NWWG (1988). A distribution map of peatlands is currently under production (Tarnocai & Labelle, in development). Combined, North America has 40% of the world's peatlands.

Table 8 Extent of Canadian peatlands

Province or Territory	Peatland (ha x 1000)	% of area of Province or Territory	Wetland (ha x 1000)	% of area of Province or Territory
Alberta	12 673	20	13 704	21
British Colombia	1289	1	3120	3
Manitoba	20 664	38	22 470	41
New Brunswick	120	2	544	8
Newfoundland	6429	17	6792	18
Northwest Territories	25 111	8	27 794	9
Nova Scotia	158	3	177	3
Ontario	22 555	25	29 241	33
Prince Edward Island	8	1	9	1
Quebec	11 713	9	12 151	9
Saskatchewan	9309	16	9687	17
Yukon Territory	1298	3	1510	3
Canada	**111 327**	**12**	**127 199**	**14**

Source modified from NWWG (1988)

Mangroves

Mangroves are restricted to tropical coastal zones. Mangrove forests are found throughout southern Florida and the Keys. Larger expanses of mangrove occur along both coasts of Mexico, particularly along the Yucatan coast. Compared with the 660 000 ha estimated by (Blasco 1988), the extent of mangroves in the United States is minimal. Only Brazil has larger expanses of mangrove forest in the Americas. The NWI does not delineate mangrove forests which are included with shrubs and forests under Cowardin’s classification system. A complete inventory of Mexico’s mangroves was not available. Various estimates based on coastal resource inventories have been completed and provide a basis for estimating current mangrove extent. Data are believed to be available and future efforts to secure this information are needed.

Freshwater forested (palustrine) wetlands

A national inventory of freshwater forested wetlands has not been undertaken. However, as part of the NWI, it is possible to determine the extent and location of these wetland habitat types. In the United States, there are currently 18 878 531 ha of forested wetlands (Frayer 1991). Estimates for Canada and Mexico were not available. More data are required.

Human-made wetlands

Inventories of rice fields have been undertaken for some agricultural regions. Data on the total extent of rice fields and other related human-made wetlands was not encountered during this study. This includes reservoirs, aquaculture ponds, irrigated lands and water diversion projects. More data are needed.

Seagrass beds

Seagrass beds occur along coastal areas throughout North America. Very little data on seagrass beds were obtained for this report although Orth et al (1990) provide some data on extent of this vegetation in 10 states which are summarised in table 9.

Table 9 Extent of seagrass beds for select States in the U.S.

State	Extent (ha)
New York	78 100
New Jersey	12 624
Virginia-Maryland	17 353
North Carolina	80 972
Florida – Atlantic coast	2800
Florida – Gulf coast	913 700
Alabama	12 300
Mississippi	2000
Louisiana	4100
Texas	68 500
Total	**1 192 449**

4.1.4 Other inventories

Natural resource inventories provide valuable information on wetland extent in North America. Both Canadian and United States mapping and classification efforts relied on soil maps to identify wetland areas. Many federal agencies, particularly in the United States and Canada (eg NOAA, EPA, USDA Natural Resources Conservation Service, Agriculture Canada, USDA Forest Service, Fisheries Canada), have complete resource inventories which include wetlands. None, however, provide the complete extent and distribution offered by the NWI and NWWG efforts.

4.2 Wetland benefits and values

Many of the inventories analysed provide both quantitative and qualitative information on wetlands values and benefits. Fretwell et al (1996) summarise wetland benefits and values for each state, providing both a general overview as well as specific examples for various activities.

For example:

Arizona	–	In 1978 more than 46 000 visitors to 3 wetlands in southern Arizona generated more than $US 5 million in tourism revenue or approximately $US 12 370 per acre.
Hawaii	–	Native Hawaiian communities depended on wetlands for cultivation of Taro and other staple food crops and for coastal fisheries.
Louisiana	–	Shellfish and finfish revenues from coastal and inland waters estimated at $US 680 million annually, as flood control devices it has been stated that 1 mile of marsh reduces a storm surge by approximately 1 foot.
Michigan	–	Was one of five states that together produced 75% of the peat harvested in the United States.
Mississippi	–	Coastal wetlands are important in supporting a $US 50 million commercial and recreational fishery.
New Jersey	–	More than 3000 acres of cranberry bog were under private management in 1992.

North Dakota	–	The prairie pothole region extending across most of the state accounts for 50% of the duck crop in North America in an average year.
Oregon	–	50% of shellfish depend on wetlands during their life-cycle.

In his report to the North American Wetland Conservation Council–Canada, Keys (1992) found revenues from horticultural peat in 1990 exceeded $US 70 million and provided employment for thousands of residents in rural areas of Canada. The total value of peat products sold annually in Canada now exceeds $US 75–80 million (Keys 1992).

The NWWG (1988) summarised various benefits of wetlands including costs associated with replacing wetland functions (eg fish production, wildlife breeding, nutrient removal), expenditures of recreational users at specific wetland marshes, and the value of the fisheries industry in Canada during a specific year. A summary of the economic benefits of wetlands was costed at $US 4–8 billion annually.

The *Directory of Neotropical Wetlands* (Scott & Carbonell 1986) provides a site profile of wetland benefits which, although general, is useful. Site inventories generally do not provide this level of detail in Canada and the United States.

NOAA's Website identifies several economic benefits of coral reefs. These include data that indicate: visitors spend about $US 1.2 billion annually in the Florida Keys where the reef tract is a primary attraction; coral reefs in Hawaii are central to a $US 700 million marine recreational industry; and the value of reef fisheries off the Florida Keys and Hawaii is estimated at $US 48.4 million and $US20 million, respectively.

4.3 Land tenure and management structure

Land tenure and management issues are addressed in many of the inventories. From a state, provincial or territorial perspective, this information is of minimal use except to identify the agencies who are responsible for their conservation and/or management. Detailed information from national level inventories on the management and responsibilities of federal agencies is provided. For Mexico, there is little information on land tenure and management issues at the national level. Provincial, state and territorial coordinated inventories tend to provide more detailed information on land tenure issues, particularly when these inventories are carried out at the site level. Wetland coverage and available resources to carry out each inventory probably have an influence on the level of detail obtained.

In the United States, the Natural Resources Conservation Service (NRCS) undertakes an inventory of the natural resources on non-federal lands every five years. This provides a 'snap-shot' of resource conditions on all the nation's farms, non-federal forests and grazing lands (except Alaska) – approximately 74% of the land area or 541 million ha. Although it doesn't specify who has ownership of wetlands, it does provide information on land cover/ use in the following categories: crop land, pastureland, rangeland, forest land, rural land, developed land and water areas (NCRS 1994). It also identifies the type of land ownership as well as appropriate conservation practices. Other federal agencies with mapping responsibilities include the USFWS which oversees mapping and inventory of all the nation's wetlands. The USFWS also oversees management of wildlife refuges throughout the United States. Many of these reserves were established to protect wetlands and adjacent habitats.

NOAA deals with coastal wetlands associated with marine resources. The USDA Forest Service, Bureau of Land Management, Department of Defense, and the National Park Service all have responsibility for managing federally owned wetlands in the United States. Section 4.1.2 describes the area protected as Ramsar sites.

In Canada, significant areas of crownland (government owned) are managed by the federal government. A federal policy on wetlands guides land use decisions for most of Canada's crownlands and is administered by Environment Canada. Section 4.1.2 describes areas designated as Ramsar sites. According to this data, 10% of Canada's wetlands are designated Ramsar sites. Territorial governments in northern Canada are now responsible for managing large tracts of wetlands. Nunavit, Canada's newest territory, occupies most of the northern lands in the central and northern Arctic region – an area of extensive tundra wetlands. Canada's national park system protects representative wetlands in every province and territory. Although most of these parks provide strict protection for a variety of habitat types, a significant number of parks were established to protect nationally important wetlands.

Table 10 Status of important wetland sites in Mexico

Inventory name	Number sites	Area (ha)	Completely protected %	Partially protected %
Directory of Neotropical Wetlands	40	3 374 900	12.5 % (5 sites)	2.5% (1 site)
Zonas Humedas Prioritarias	32	3 064 977	34% (11 sites)	na

In Mexico, SEMARNAP is responsible for overseeing the conservation and management of wetlands on federally owned land. Management of wetlands at the state level is relatively new although initiatives are underway in Tabasco and Nayarit (M Cervantes, Wetlands International, pers comm 1999). The *Directory of Neotropical Wetlands* (Scott & Carbonell 1986) lists 40 internationally important sites and provides general information on the protected status of each site. An inventory of priority wetlands in Mexico (Cervantes & Abarca 1996) notes protective status for 11 (34%) sites (table 10).

4.4 Rate and extent of wetland loss and degradation

Several thorough reviews of wetland loss have been published over the last two decades for the United States and parts of Canada. The NWI provides an extremely useful tool for monitoring wetland loss over the short and long-term. Canada's various regional inventories also offer excellent opportunities for monitoring trends in wetland loss and/or degradation. However, a standard format for measuring wetland loss across Canada varies given the different parameters used to establish baseline data on wetlands. Preliminary data from Cervantes & Abarca (1996) provides a figure for wetland loss and degradation in Mexico. Table 11 offers a national perspective on wetland loss and degradation in North America.

Table 11 Loss and degradation of original wetland extent

Country	Original extent (ha)	Current extent (ha)	Loss %
Canada (1)(2)(3)	147 905 810 (pre-European settlement)	127 199 000 (1988)	~14%
Mexico (4)(5)	4 479 975 (since 1800s)	3 318 500 (1993)	~35%
United States – all (6)	158 389 525 (c1780s)	111 056 479 (c1980s)	~30%

1 Data on current extent from NWWG (1988).

2 Data from C. Rubec, pers. comm concerning original extent and % wetland loss.

3 Recent data from Polestar Geomatics (unpubl.) indicate substantial increase in peatland area which may increase current wetland extent in Canada to as much as 150 million ha.

4 Data on wetland extent from Olmsted 1993.

5 Original extent determined based on information on wetland loss from Cervantes & Abarca (1996).

6 Data from Dahl (1990). Original extent determined for NWI. Dates listed as circa 1780s and circa 1980s. Wetland loss at the state level is available.

In her assessment of land use change on and adjacent to wetlands in southern Canada, Lynch-Stewart (1983) concluded that there are significant gaps in available information, making a national overview of wetland conversion difficult to achieve. As a result, numerous examples of wetland conversion are provided but a national perspective is not possible using current available data. Wetland losses are greatest in populated regions of Canada including the Fraser River valley of British Colombia, southern Ontario and Quebec and parts of New Brunswick and Nova Scotia. Conversion rates in the Province of Ontario are some of the highest – exceeding 1 200 000 ha or 70% loss of total wetland area in the most populous region of Canada. Conversion of the prairie pothole wetland region of Alberta, Saskatchewan and Manitoba to grain and forage crops has been extremely aggressive over the past 150 years. Ducks Unlimited manages a mapping meta-database on the wetlands of this region and has access to wetland loss data (Ducks Unlimited 1991).

Wetland loss as a percentage by state varies from 9% for New Hampshire to 91% for California. Wetland loss in the conterminous United States between 1780s and 1980s is 53% or equivalent to 5% of the total land surface area (Dahl 1990).

5 Discussion and conclusion

5.1 Adequacy of information base

Large amounts of information have been gathered from national and sub-national wetland inventories in both Canada and the United States. The United States government maintains and continues to update information through the national wetland inventory. Canadian wetlands have been inventoried but not with the perspective of contributing to a national effort. Canadian inventories have tended to focus provincially, often relying on unique classification systems adapted to meet a province's specific objectives. Although this has occurred in the United States, a national inventory standard was accepted and is being used. This facilitates regional and national level monitoring. Mexico has focused its resources on inventorying nationally and internationally important wetlands. Many wetlands are not considered on this priority list and as a result, a complete picture of the status of wetlands is unavailable. For now, the Mexican government is focusing on priority wetland areas, where it will target its conservation resources.

In most instances, inventories from the United States and Canada provide useful and often quite detailed information that can assist managers, planners and policy analysts to make informed land use decisions.

5.1.1 General wetland inventories

Information from the United States NWI on extent, type and location is stored electronically and information is now geo-referenced to ensure accuracy of data collection. Efforts to fully digitise these data will make them readily available on the World Wide Web. Widespread implementation of the NWI has enabled the United States government to develop a powerful tool for analysing long-term trends in the status of wetlands (eg Dahl 1990, Dahl & Johnson 1991). Efforts to determine wetland extent during pre-colonial times have helped to establish a benchmark for monitoring wetland loss and/ or change over a 200 year period. This is important for determining appropriate land use treatments to minimise or even reverse the impact of wetland loss and/or change.

The NWWG has developed a different methodology for classifying wetlands. In contrast with the NWI, the NWWG classification system considers the ecological characteristics of a wetland or wetland complex as opposed to its hydrological characteristics. Using this system, the wetlands of Canada have been mapped according to shared characteristics. A map of wetland distribution (on a percentage wetland basis) superimposed on a map of wetland ecoregions enables the user to assess the percentage area of each wetland ecoregion. Although viewed as an important achievement, the NWWG classification system has not been widely used. As a result, many inventories have been carried out throughout Canada and vary enough to make it difficult for data comparison.

5.1.2 Important site inventories

Unlike other regions, comprehensive site inventories of nationally and internationally important wetlands were not available for the United States and Canada. Only Mexico has recently produced several national inventories of wetlands of importance or priority (Scott & Carbonell 1986, Cervantes & Abarca 1996). Interestingly, data on the extent of Mexican wetlands from the *Directory of Neotropical Wetlands* (Scott & Carbonell 1986) are almost the same as data published by Olmsted (1993) in *Wetlands of the World*.

Using data from important site inventories to determine wetland extent is limited. First, the data only partially represent all wetlands. Many wetlands remain unidentified and therefore, the data undervalues the true wetland extent. Second, these inventories tend to be biased towards larger wetlands. Third, they are often selected because of their biodiveristy value.

5.1.3 Wetland type inventories

National wetland type inventories for many wetland types (eg peatlands, swamp forests, estuarine habitat, coral reefs and seagrass beds) have been compiled for North America.

Peatlands have been the most intensively and extensively inventoried. Information gathered from various sources tend to compliment one another although new information suggests that current figures still underestimate the true extent in Canada by as much as 5–10% (C Rubec, CWS, pers comm 1999).

Information on coral reefs is lacking for Mexico. In the United States, the most extensive coral reefs have been inventoried and are being monitored. The figures presented in this report are preliminary and although they provide an overview of coral reef extent, at least for the United States, the data is probably conservative. Methods for determining coral reef extent in the U.S. Virgin Islands and Puerto Rico are lacking and estimates for Hawaii are considered preliminary because coral coverage estimates for much of the northwest region are based on the assumption that existing hard bottom areas contain corals.

Summary information on mangrove extent in North America exists for Mexico and was published in a recent report by Cervantes & Abarca (1996). Although data on mangroves for the United States was not obtained, extent of ‘marine intertidal forested and scrub\shrub’ habitat from Frayer and Hefner (1991) is assumed to be comprised of mangrove (to what extent was not determined during the compilation of this report).

Although not explicitly inventoried nationally, the extent of freshwater forested wetlands has been determined through the NWI using Cowardin et al's (1979) classification scheme.

In general, inventories of wetland types tend to be more defined in their approach and therefore provide useful information for monitoring. This is particularly true for habitat types which are readily identifiable. Some wetland types are difficult to determine, especially those that may require a knowledge of the hydrology. For example, delineating forested wetlands requires some knowledge of flooding conditions which can in some cases significantly increase a wetland area. Given the temporal nature of floods, aerial photos may not capture this information.

5.1.3 Other inventories

Due to the large amount of information available on wetlands in Canada and the United States, other inventory types were not extensively analysed. In Mexico, however, land use surveys may serve as the basis for undertaking national or sub-national inventories should this be a priority of the government or other interested organisations.

5.1.4 Summary of wetland extent information

Sufficient information exists to provide estimates of wetland extent in Canada and the United States. For Mexico, data estimates are still preliminary. However, there does seem to be general consistency among the published figures. Olmsted's (1993) figure for total wetland extent is presented since other published figures represent a compilation of areas from site inventories which are not considered complete. Data for wetland type habitats at the national level are presented as the best estimates to date. New information is constantly being published and may replace existing data. Information on seagrass beds, coral reefs, mangroves, forested wetlands, and peatlands are presented in table 12.

Table 12 Summary of wetland extent in North America

Inventory	Extent (ha)	Reference	Notes
Peatlands			(table 7)
Canada	111 327 000	NWWG (1988)	More recent estimate of 134 million (Polestar Geomatics 1999)
United States	61 100 000	USDA (1994) and Farnham (1980)	figure taken from table in Lappalainen (1996)
Mexico	1 000 000	Malterer in Lappalainen (1996)	unsubstantiated and may include other wetlands
Forested wetlands			No estimates available for Canada and Mexico
United States	18 878 531	Frayer (1991)	as per classification used by NWI
Coral reefs			(table 6)
United States	1 687 900	NOAA (1998)	no information from U.S. Virgin Islands, Puerto Rico – information includes only coral within U.S. waters
Mangroves			
United States & Mexico	660 000	Blasco (1988)	in report prepared by Flores (1996)
Sea grass			(table 9)
United States	1 192 449	Orth et al (1990)	for Eastern Atlantic and Gulf of Mexico coasts

Ramsar sites			
Canada	13 038 408	Ramsar (1998a)	
Mexico	1 095 414	Ramsar (1998a)	
United States	1 613 690	Ramsar (1998a)	
Directory of Neotropical Wetlands			(table 4)
Mexico	3 374 900	Scott & Carbonell (1986)	for 40 important sites
National Wetland Inventories			(table 3)
Canada	127 199 000	NWWG (1988)	new data indicate may increase to 150 million ha
United States	111 056 479	Dahl (1990)	Includes U.S., Alaska and Territories. NWI information also available at State level.
National Overview			
Mexico	3 318 500	Olmsted (1993)	in *Wetlands of the World* (Olmsted 1993)

5.2 Methodologies

Methodologies for inventorying wetlands within North America vary. The United States has adopted Cowardin et al's system since the early 1980s and it has become a standard of federal and state agencies throughout the country. One of its main strengths is its wide scale acceptance and implementation. The standards adopted facilitate analysis of general trends by wetland type (class) or geographic region (state). Digitisation of the information to improve electronic access will facilitate information use. Currently, information contained in the NWI is basic and does not provide comprehensive data on biophysical and socio-economical parameters which influence wetland form and function.

A system for classifying Canadian wetlands was presented by the NWWG in 1998 and used to complete a general inventory of Canada's wetlands. However, the system has not been widely adopted at the regional level and several other systems have been implemented to suit the objectives of specific inventories. Compilation of data from the many and varied inventory sources is time consuming and presents a challenge. It was concluded that future efforts to compile and synthesise existing inventories should not be undertaken and data sources for particular regions or wetland types be used as the basis for regional information (Polestar Geomatics 1995). Lack of a national inventory with a standard classification system makes it virtually impossible to monitor wetlands at the ecosystem level except in those areas which have developed their own inventories. Advances in remote sensing technologies combined with a wealth of information on wetlands in Canada may facilitate the development of a national database. However, there are no known plans to undertake this task.

In Mexico, a national classification system based on Cowardin et al's work was presented by Cervantes & Abarca (1996) but has not been implemented. Development of a national classification system for Mexico would help to establish a useful database for monitoring wetlands.

5.3 Use of inventory information to identify sites for monitoring trends in wetland condition

Current information from wetland inventories is being used to monitor wetland trends in the United States, Canada, and to some degree in Mexico.

5.3.1 General wetland inventories

The NWI has identified 'most' wetland sites in the United States. However, NWI databases contain limited information on the status of each wetland since it focuses mainly on wetland classification and extent. For example, the loss of wetlands at any given site may be recorded, but data indicating the cause may not. However, some information on land use and other features can be added as 'modifiers' to the current classification system, thus providing additional detail on wetland status. Geo-referenced data sets may also facilitate a greater understanding of changes to any given site.

Regional inventories in Canada may provide useful information for identifying wetlands for monitoring trends. Examples include extensive datasets managed by Ducks Unlimited–Canada (Ducks Unlimited 1991) for the prairie pothole region and databases held by the Ontario Ministry of Natural Resources with information on 2400 sites in southern Ontario (OMNR 1984). The latter data set contains maps and extensive information on each wetland. Other sites in the Pacific and Northern regions of Canada are likely to contain valuable information for monitoring trends.

5.3.2 Important site inventories

In Mexico, several important site inventories have been carried out since 1986. These include detailed inventories of priority wetland sites for conservation throughout Mexico. The broad geographic representation and the availability of information on these sites make this data set useful for considering as the basis for identifying sites for monitoring trends in wetland condition.

Databases with information from inventories of Ramsar sites should also be considered. Although largely protected in the U.S. and Canada, these sites are still under significant pressure in Mexico and elsewhere and may present a more realistic perspective of wetland trends.

5.3.3 Wetland type inventories

Valuable data on wetland types exist and could be used as the basis for monitoring changes to specific wetland habitat types, eg mangroves or coral reefs. However, current inventories of these wetland types provide limited information. Peatlands may prove to be excellent sites for monitoring wetlands and their effect on carbon sequestration. As major carbon sinks, monitoring changes in these habitats may help to understand their role in regulating green house gases. Extensive databases on wetland information exist in Canada and the United States and could serve as the basis for identifying areas or regions where more extensive data collection could begin.

5.3.4 Other inventories

Again, extensive information on wetlands in North America already exists for most areas of North America. However, inventories containing information on related issues may compliment data already gathered. For example, information on protected areas could help to build a useful picture of the extent of wetlands protected in a given region.

5.4 Use of inventory information as a baseline for monitoring wetland loss

Inventories provide valuable information for monitoring change. The NWI has been particularly useful from a national and state perspective by securing baseline information necessary to analyse change. In addition, estimates of wetland extent have been documented for each state dating back to the 1780s – a period when wetlands were considered to be relatively unaffected by European colonisers. Every ten years, the U.S. government has committed to producing a status report on the wetlands of the United States. Data from the NWI provides the basis for these reports. The first publication on wetland trends was released by the USFWS in 1990 (USFWS 1990).

Important site inventories in Mexico have measured wetland extent but mapping efforts are generally lacking. Mapping inventories created by groups like Ducks Unlimited–Mexico and Conservation International have helped to demonstrate the utility of such inventories in conservation and management. Ducks Unlimited's efforts to map areas of particular importance to waterfowl may be useful for monitoring long-term changes.

6 Specific recommendations

6.1 Efforts to promote a standard national wetland classification system in Canada and Mexico would facilitate a better understanding of the resource and its status. However, regional efforts are also important and provide a focused approach adapted to the needs and realities of a specific area.

6.2 Many regional inventories in Canada and the United States exist and provide an ideal framework within which to identify a network of sites for monitoring change. Included in a selection of sites are Ramsar sites. These internationally recognised sites could serve as nodes for wetland monitoring efforts across the continent.

6.3 In order to understand national trends, greater emphasis on providing a tool for disseminating results from wetland inventories is needed. This is particularly the case for Canada where tens of regional inventories have generated excellent data but the data are generally inaccessible to the public.

6.4 A continental project to map North America’s wetlands would help to provide a unique multinational perspective on the conservation of these highly productive ecosystems. Because they are dominated by water, and water is very much a shared commodity between the three countries, wetlands offer an excellent vehicle for fostering cooperation on wetland and water issues.

6.5 Methods of easily assessing the economic value of a wetland needs to be developed and data should be included in inventory projects underway. These data are critical for building an awareness of wetland value. Very little information is currently available or is, at best, anecdotal.

6.6 Training to develop the capacity to manage wetlands at the local level is critical. Local communities need to be actively engaged in monitoring and inventorying wetlands. Through their participation greater stakeholder involvement will likely occur. Local communities are also a source of information on wetlands which has been gathered over generations. This knowledge base is not available through standard methods of gathering information (eg aerial photo interpretation). Empowering local communities to become custodians of ‘their’ data is key to ensuring local community involvement in wetland conservation. Again, the World Wide Web may facilitate this, especially in Canada and the United States.

6.7 ‘Hot spot’, ‘vital’, or ‘representative’ wetlands need to be identified based not only on their importance for birds but all biodiversity (including fish, reptiles, amphibians). In the past, many important wetlands were identified as priority areas based on their significance as staging, breeding or feeding habitats for birds. ‘Hot spot’ wetlands could include a representative wetland for each geographical region or wetland ecoregion. This method of identifying ‘vital’ wetlands could be used to strategically designate Ramsar sites so that they represent the world’s variety of wetland ecosystems. Wetlands of tremendous importance to humans both through the services and functions they provide as well as their cultural value, should be incorporated into this ‘hot spot’ approach.

6.8 Either the Cowardin, NWWG or Ramsar model provides a method for classifying wetlands. Each was developed to suit a particular purpose. Efforts to develop a national standard to classify and inventory Mexican wetlands would help establish the basis for a national wetland monitoring program. Mexico is a unique position to develop an appropriate classification system based on the strengths of existing models.

6.9 Governments need to work closely with and support the NGO sector in developing local capacity to access and use wetland inventory information. Ideally, local groups should be involved in monitoring programs. The World Wide Web may help to facilitate this issue.

6.11 Current information on the extent of human made wetlands is not readily available. These areas can and do have a large impact on wildlife, human communities, climate and a range of related issues. A knowledge of how they impact on humans and natural resources would be useful for habitat managers.

6.12 Peatlands, and potentially Ramsar sites on peatlands, may be extremely useful areas for establishing climate change monitoring stations. Peatlands are recognised as important carbon sinks but their potential effect on climate is still unknown. Given predicted global climate warming in the rich tundra peatland regions of northern North America, greater effort to understand the role of peatlands is vital to our understanding of changes which may affect current peatland management and conservation practices.

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Appendix A List of Select Regional Inventories

Canada

1. Great Lakes Wetlands Conservation Action Plan 1994–2000, 1995, Ontario Ministry of Natural Resources.
2. Land Use Change on Wetlands in Southern Ontario, 1983, Environment Canada.
3. Location, Amount, Cover Type and Productivity of Wetlands of Potential Interest to Ducks Unlimited in parts of Northwestern Ontario, 1985, Ducks Unlimited.
4. National Role in Providing Fish Habitat in Canada, 1996, R Bailey.
5. Geographic Information System Wetland Database, 1995, Nova Scotia Department of Natural Resources.
6. Environmental Atlas of St Lawrence, Wetlands: Habitats on the Edge of Land and Water, 1991, Environment Canada.
7. Soil Landscapes of Canada, 1996, Agriculture Canada.
8. Ontario Wetland Map Summary, 1983, Federation of Ontario Naturalists.
9. Wetlands of the St. Lawrence River Region: 1950–1978, 1985, Environment Canada.
10. Natural Heritage Information Centre, 1997, OMNR.
11. Sensitive Ecosystems Inventory of East Vancouver Island and Gulf Islands, 1997, BC Ministry of Environment, Lands and Parks.
12. Annotated list of large prairie wetlands, 1967, Canadian Wildlife Service.
13. Wetland Distribution and Conservation in Southern Ontario, 1986, Environment Canada.
14. Fraser Lowland Wetland Inventory, 1989, Canadian Wildlife Service.
15. Wetlands of the Maritime Provinces. 1996, Canadian Wildlife Service.
16. Distribution of Wetlands in the St Lawrence Plain, 1988, Quebec Soil Survey Unit.
17. The Peatlands Areas of Nova Scotia, 1988, Nova Scotia Department of Mines and Energy.
18. Peat Resources in Newfoundland, 1993, Peat Conference Proceedings.
19. Prince Edward Island Freshwater Wetlands Inventory, 1981, CWS, Atlantic Region.
20. An Investigation of the Peat resources of New Brunswick, 1974, NB Department of Natural Resources and Energy.
21. Peatlands of Alberta, 1992, BJ Nicholson, LA Halsey & DH Vitt.
22. Agricultural Use and Extent of British Colombia Wetlands, 1989, Agriculture Canada.

United States of America

23. Alaska Wetlands and Hydrography, 1996, Alaska Wetlands GATF Project.
24. Eastern South Dakota Wetlands, 1997, South Dakota State University and USFWS.

25. Florida Wetlands Status and Trends: 1970s to 1980s, 1991, USFWS.

26. Mid-Atlantic Wetlands: A Disappearing Natural Treasure, 1987, USFWS and US EPA.

27. Pennsylvania's Wetlands: Current Status and Recent Trends, 1990, USFWS.

28. Status of Alaska's Wetlands, 1994, USFWS.

29. Texas Coastal Wetlands: Status, Trends, Mid-1950s to Early 1990s, 1997, USFWS.

30. West Virginia's Wetlands: Uncommon Valuable Wildlands, 1996, USFWS.

31. Wetlands of the California Central Valley: Status and Trends 1939 to mid-1980s, 1989, USFWS.

32. Wetlands of Maryland, 1995, USFWS.

33. Wetlands Resources of Illinois: An Analysis and Atlas, 1994, Illinois Natural History Survey.

(and many others from each state)

Appendix B Cowardin’s Classification System of Wetlands and Deepwater Habitats

Classification hierarchy of wetlands and deepwater habitats, showing Systems, Subsystems, and Classes. The Palustrine System does not include deepwater habitats.

System	Subsystem	Class
Marine	Subtidal	Rock Bottom
		Unconsolidated Bottom
		Aquatic Bed
		Reef
	Intertidal	Aquatic Bed
		Reef
		Rocky Shore
		Unconsolidated Shore
Estuarine	Subtidal	Rock Bottom
		Unconsolidated Bottom
		Aquatic Bed
		Reef
	Intertidal	Aquatic Bed
		Reef
		Streambed
		Rocky Shore
		Unconsolidated Shore
		Emergent Wetland
		Scrub-Shrub Wetland
		Forested Wetland
	Tidal	Rock Bottom
		Unconsolidated Bottom
		Aquatic Bed
		StreamBed
		Rocky Shore
		Unconsolidated Shore
		Emergent Wetland

Appendix B continued

Riverine	Lower Perennial	Rock Bottom
		Unconsolidated Bottom
		Aquatic Bed
		Rocky Shore
		Unconsolidated Shore
		Emergent Wetland
	Upper Perennial	Rock Bottom
		Unconsolidated Bottom
		Aquatic Bed
		Rocky Shore
		Unconsolidated Shore
	Intermittent	Streambed
Lacustrine	Limnetic	Rock Bottom
		Unconsolidated Bottom
		Aquatic Bed
	Littoral	Rock Bottom
		Unconsolidated Bottom
		Aquatic Bed
		Rocky Shore
		Unconsolidated Shore
		Emergent Wetland
Palustrine		Rock Bottom
		Unconsolidated Bottom
		Aquatic Bed
		Unconsolidated Shore
		Moss-Lichen Wetland
		Emergent Wetland
		Scrub-Shrub Wetland
		Forested Wetland

Appendix C Wetland Losses in the United States: 1780s to 1980s (Dahl 1990)

State	Estimates of Original Wetlands Circa 1780s	Estimates of Existing Wetlands Circa 1980s	% Wetland Lost
AL	7 567 600	3 783 800	50%
AZ	931 000	600 000	36%
AR	9 848 600	2 763 600	72%
CA	5 000 000	454 000	91%
CO	2 000 000	1 000 000	50%
CT	670 000	172 500	74%
DE	479 785	223 000	54%
FL	20 325 013	11 038 300	46%
GA	6 843 200	5 298 200	23%
ID	877 000	385 700	56%
IL	8 212 000	1 254 500	85%
IN	5 600 000	750 633	87%
IA	4 000 000	421 900	89%
KS	841 000	435 400	48%
KY	1 566 000	300 000	81%
LA	16 194 500	8 784 200	46%
ME	6 460 000	5 199 200	20%
MD	1 650 000	440 000	73%
MA	818 000	588 486	28%
MI	11 200 000	5 583 400	50%
MN	15 070 000	8 700 000	42%
MS	9 872 000	4 067 000	59%
MO	4 844 000	643 000	87%
MT	1 147 000	840 300	27%
NE	2 910 500	1 905 500	35%
NV	487 350	236 350	52%
NH	220 000	200 000	9%
NJ	1 500 000	915 960	39%
NM	720 000	481 900	33%
NY	2 562 000	1 025 000	60%
NC	11 089 500	5 689 500	49%
ND	4 927 500	2 490 000	49%
OH	5 000 000	482 800	90%
OK	2 842 600	949 700	67%
OR	2 262 000	1 393 900	38%

Appendix C continued

PA	1 127 000	499 014	56%
RI	102 690	65 154	37%
SC	6 414 000	4 659 000	27%
SD	2 735 100	1 780 000	35%
TN	1 937 000	787 000	59%
TX	15 999 700	7 612 412	52%
UT	802 000	588 000	30%
VT	341 000	220 000	35%
VA	1 849 000	1 074 613	42%
WA	1 350 000	938 000	31%
WV	134 000	102 000	24%
WI	9 800 000	5 331 392	46%
WY	2 000 000	1 250 000	38%
SUBTOTAL (Contermin ous U.S)	221 129 638	104 374 314	53%
Alaska	170 200 000	170 000 000	0.1%
Hawaii	58 800	51 800	12%
TOTAL U.S	391 388 438	274 426 114	30%

1 Wetland distribution and changes vary dramatically within states dependent on both geographical and/or land use patterns

Review of wetland inventory information in Oceania

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Contents

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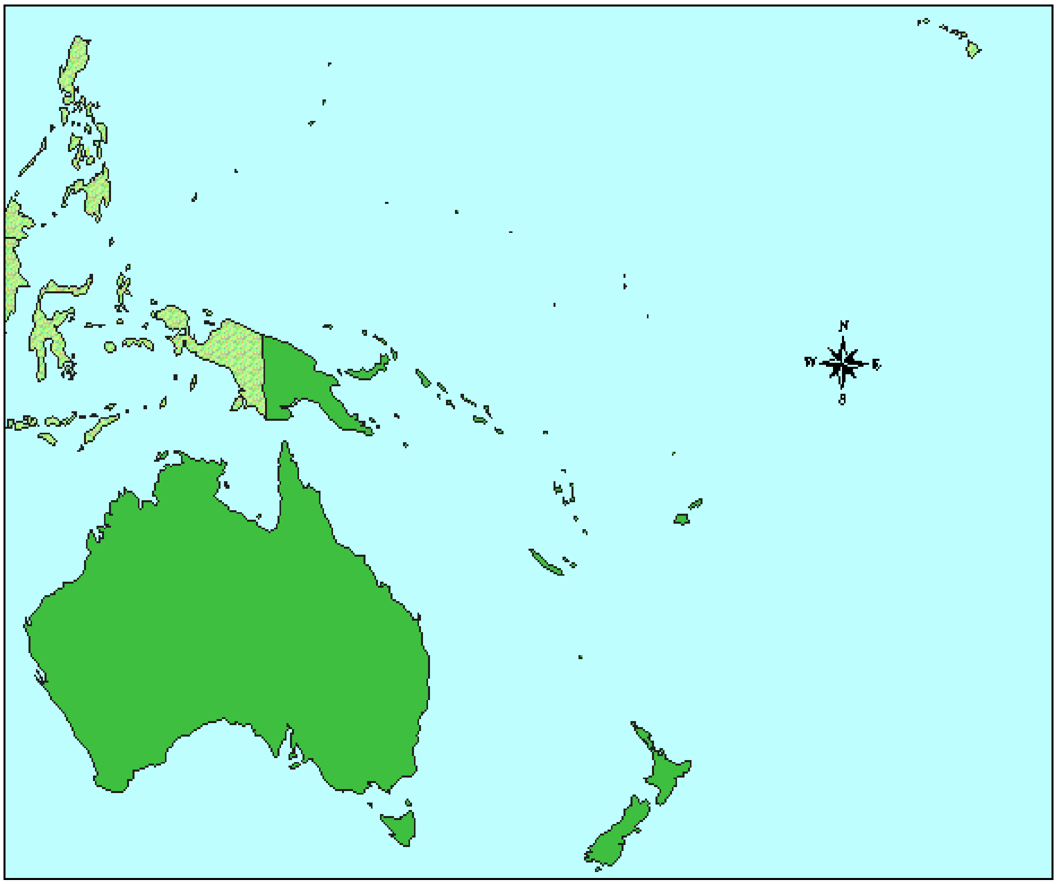
1 Introduction

This report analyses the extent and adequacy of wetland inventory information in the Oceania Region. The Oceania Region is defined as including Australia, New Zealand, Papua New Guinea and east into the Pacific to include a further 13 countries and 8 Territories (fig 1).

This report analyses the extent and adequacy of the wetland inventory information in the Oceania Region as defined by the Ramsar Bureau. Countries and Territories included in this region are listed in table 4.



Boundaries are not authoritative

Figure 1 Map of the Oceania region

2 Information sources

2.1 Methods used to obtain wetland inventory information

The objective of this project was to review published inventories of wetlands at the national and supra-national (regional) levels to determine their value as a baseline for studies on the trends of wetland degradation and loss. However, because most of the inventories examined did not give a complete picture on the area of wetlands in the countries considered, some supplementary reference material was also examined.

Four approaches were used to identify wetland inventories and other materials:

- review of materials held by Wetlands International–Oceania
- computerised library search in Australia
- Internet search
- correspondence and other communication with wetland experts in the region.

This analysis has been prepared by the Wetlands International–Oceania. The analysis is based on the available published inventories and the additional information obtained from correspondence during the short period of the review. The study focussed on material at the national and regional level. In the case of Australia, several examples of sub-national inventories were included.

2.2 Summary of information sources reviewed

Wetland inventory information at the national and supra-national scale was found to be very limited. In Oceania 26 sources of inventory information were reviewed (table 1). Three of these covered many countries. The total number of country reports reviewed was 56.

The analysis of information on wetland inventory shows the diversity of materials and approaches that have been used (Annex 2). Key points from the analysis are detailed in table 2 below. Most of the material analysed was of recent origin (since 1980) from published sources funded by both governmental and non-governmental organisations. A substantial proportion were stored in electronic form, thus facilitating access and reproduction.

Table 1 Inventory reports used in the analysis for the Oceania region

Inventory Title	States included (see Annex 1 for codes)	Year
Regional Inventories of Important Sites		
A Directory of Wetlands in Oceania	ASM,FSM,FJI,PYF,GUM,KIR,MHL,NRU,NCL,MNP,PLW,PNG,SLB,TON,TUV,VUT,WLF,WSM	1993
A Directory of Asian Wetlands	PNG	1989
Data Book on World Lake Environments – Asia and Oceania	NZL,AUS	1995
National Inventories of Important Sites		
A Directory of Important Wetlands in Australia Second Edition	AUS	1996
Australian Ramsar Sites	AUS	1997
A Directory of Wetlands of New Zealand	NZL	1996
WERI database (Wetlands of Ecological and Regional Importance)	NZL	1990
Sub-national Inventories of Important Sites		
Tasmanian Wetland Inventory Project	AUS	1991
Victorian Marine and Coastal Environment GIS	AUS	1995
Victorian Wetlands and Wetlands Systems Listed under the Ramsar Convention	AUS	1996
A Survey of the Coastal Wetlands South-eastern Victoria	AUS	1976
Wetland Resources of the South East of South Australia	AUS	1983
Wetlands Atlas of the South Australian Murray Valley	AUS	1996

Wetland Type Inventories		
World Mangrove Atlas	AUS,FSM,FJI,GUM,NCL,NZL,PNG,SLB,TON,VUT,WSM	1997
Conservation or Conversion of Mangroves in Fiji	FJI	1990
Fiji Lands Department Estimate of Mangroves (LD33/41)	FJI	1986
Freshwater Lakes of Papua New Guinea	PNG	1987
Other Wetland Inventories		
Coastal Resource Inventory	NZL	1990
SSWI (Sites of Special Wildlife Interest)	NZL	1986
Feasibility Report on a National Wetland Survey	AUS	1978
Aspects of Australian Wetlands	AUS	1985
Wetlands & Waterbirds in Northwestern NSW	AUS	1994
Victoria: Wetland _1788 & Wetland_1994	AUS	1997
Coastal Lands of Australia	AUS	1984
Inventory of Declared Marine and Estuarine Protected Areas in Australian Waters	AUS	1984
Terrestrial and Marine Protected Areas in Australia (1977)	AUS	1997

Table 2 Key attributes of the wetland inventories reviewed

Attribute	Analysis (n = 26)
Inventory type:	58% of the inventories were classified as site directories.
Publication date:	Half of the information has been published since 1990.
Publication format:	Information has been published by a diversity of organisations, the most common being government formal publications (31%) and other government reports (23%).
Language:	All of the information identified was available in English.
Publication format:	The most common format of the information source was paper documents (43%).
Availability of information:	Most of the information reviewed was from published sources (65%).
Data storage:	Most of the information is stored as paper products (43%). Electronic storage accounted for (39%).
Implementation agencies:	Inventory studies had been implemented by national governments (38%) and sub-national government agencies (30%).
Funding sponsor:	The most common primary funder of inventory information was national government organisations (46%).

3 Extent and adequacy of wetland inventory information

3.1 Objectives

The most important attribute of the inventories is their objective(s). The review found that inventories could be divided into four major categories based on their primary objective and hence the type and coverage of the data included. The four categories are discussed below (table 3).

Table 3 Summary of the number and types of inventories reviewed

Inventory type	Number reviewed	Number country records
Important site inventories	6	25
Wetland type inventories	6	17
Sub-national inventories (Australia)	6	6
Other inventories	8	8
Total	26	56

The first group is inventories that included wetlands primarily on the basis of their biodiversity value. These have been termed ‘important site inventories’. This type of inventory has been published at the national level for New Zealand (Cromarty & Scott 1996) and Australia (Australian Nature Conservation Agency 1996). A third publication, *A Directory of Wetlands in Oceania* (Scott 1993), covers the other countries in Oceania.

In Oceania, 23% (n=26) of the inventory information reviewed were categorised as ‘important site inventories’. The majority of these inventories were compiled to identify or describe wetlands of national and international importance based on the criteria of the Ramsar Convention. These inventories are presented in the form of ‘site directories’ which contain an account of each wetland site. Important site inventories include only a sample of the wetlands in the country and are biased towards larger less modified wetlands and protected areas.

The second group of inventories focus on a particular wetland ecosystem or habitat type such as mangroves (Spalding et al 1997), freshwater lakes (Chambers 1987) or coastal wetlands (Galloway et al 1984). Seven or 27% of the inventories reviewed are of this nature.

The third group included in the Oceania analysis are sub-national inventories from Australia. They were included because in Australia land and water management is the responsibility of sub-national governments. They were included as examples of information available at the sub-national level. Their inclusion also was appropriate because of the large land area of Australia, which is a small continent compared with the relatively small land areas of each of the Pacific Island countries and territories. Many sub-national inventories in Australia covered areas far greater than the areas of many of the Pacific Island countries.

The final category groups the remaining inventories into ‘other’. This category includes a variety of approaches and objectives, with studies ranging from waterbird surveys (eg Kingsford et al 1994) to sites of special interest for wildlife (eg New Zealand Sites of Special Wildlife Interest database) and protected areas (eg Cresswell & Thomas 1997).

3.2 Wetland definitions and classifications

Definition of wetlands

Approximately half (57%) of the inventories contained a definition of the wetland resource, while in a further 19% of cases it could be inferred. The definitions and classifications used in the inventories varied according to the objectives and the implementing agencies.

The Ramsar Convention on Wetlands defines wetlands as:

> areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres (Ramsar Convention Bureau 1997).

The Ramsar definition of wetlands was used in 38% of the inventories.

All of the inventories of important sites used the Ramsar definition of wetlands. This is to be expected as these inventories were developed in response to initiatives related to the Ramsar Convention. Other inventories adapted the wetland definition to the specific objective of the inventory.

For inventories based on map products (Paijmans 1978, Paijmans et al 1985, Chambers 1987) wetlands were defined by their topographic representation. For example, for the inventory of freshwater lakes of Papua New Guinea using 1:100 000 maps, Chambers (1987) indicated that all standing bodies of freshwater shown on the maps were included. Paijmans et al (1985), in their study of Australian wetlands, defined wetlands as land permanently or temporarily under water or waterlogged, but were reliant on the accuracy of air-photo interpretation used by the producers of the 1:250 000 maps on which the study was based.

Classification of wetlands

A wetland classification system was used in 11 of the 26 inventories reviewed.

In four cases the wetland classification is compatible with the 1990 Ramsar classification (Davis 1994). These inventories were developed as part of the Australian Government's activities related to implementation of the Ramsar Convention. The Directory of Important Wetlands in Australia (Australian Nature Conservation Agency 1996) classified three additional wetland types to more fully describe Australian wetlands: non-tidal freshwater forested wetlands, rock pools and karst systems. In each inventory the classification was used to describe the range of wetland types at each site. No maps of the wetland types or information on the extent of each wetland type is presented in these inventories.

No wetland classification was used by the compilers of two of the inventories of important sites (Scott 1993, Cromarty & Scott 1996). No explanation was given in each case.

The assessment of coastal lands in Australia (Galloway et al 1984) examined a 3 km wide strip inland from the high tide mark and classified points on aerial photographs into geology, landform, vegetation and landuse categories.

The Australian wetland survey by Paijmans et al (1985) used the topographic classification details from 1:250 000 maps. This enabled six categories (lakes, swamps, land subject to inundation, rivers and creeks, tidal flats, coastal inshore waters) to be identified. These were further divided into classes based on permanency of water and frequency of flooding.

3.3 Geographic scale

The 'geographical scale' of inventory information varies widely. Information reviewed for Oceania in this study included:

- 1 global (covers global extent of wetland type)
- 3 supra-national (more than one country)
- 16 national (complete country)
- 6 sub-national (part of a country).

The global inventory examined the distribution and extent of mangroves, presenting information on a national basis (Spalding et al 1997). It is an example of an inventory that assessed the total extent of one wetland type within the geographic scope of the inventory. It draws to some extent on national or sub-national studies, eg Galloway (1982) for Australia.

This 'full assessment of the wetland resource' approach contrasts the other inventories reviewed. Most only assessed part of the wetland resource with the geographic scope of the inventory. For example the *Data Book of World Lake Environments* (Kira 1995) has a geographic scope covering Oceania, however, it contains only two wetlands in Australia and two in New Zealand.

Presentation of information in supra-national and global inventories in the form of country reports (Scott 1989, 1993; Spalding et al 1997) is particularly valuable. It enables analysis of information at the global, regional and national level.

3.4 Inventory methods

The methods for undertaking the inventories differ markedly according to the objectives of the inventory.

Important site inventories

The important site inventories primarily used collation of existing information, topographic and other maps, and ground surveys at selected sites to supplement the available data. In one of the nine inventories (New Zealand Wetlands of Ecological and Regional Importance database), a systematic sample program was used to select the wetlands for inclusion.

In most cases inventories are in the form of site directories, using standard headings such as: location; area; elevation; wetland type; site description; significance; land tenure; current land use; disturbances and threats; conservation measures taken; management authority and jurisdiction; references; and compiler and date (Australian Nature Conservation Agency 1996). None of the important site inventories contain maps or information on the extent of the wetland types within each site. Review and collation has been the primary methodology used to prepare the inventories. A further limitation of this type of inventory is that the wetland component of listed sites may be only a small percentage of the total area of the site (see 4.1.1).

Wetland type inventories

Inventories of mangroves made extensive use of existing map products, aerial photography and satellite imagery. Aerial photography provided the information base for the assessment of Coastal Lands in Australia (Galloway et al 1984). In the case of the inventory of freshwater lakes in Papua New Guinea, wetlands were identified from 1:250 000 topographic maps (Chambers 1987).

Other inventories

A range of methodologies were used to develop other inventories. Two Australian studies identified wetlands from 1:250 000 map products (Paijmans 1978, Paijmans et al 1985). The GIS on wetlands of Victoria, Australia, was based on interpretation of aerial photographs (Department of Natural Resources and Environment 1997b). Information in inventories of protected marine and estuarine areas was limited to location and size (Ivanovici 1984, Cresswell & Thomas 1997).

3.5 Extent and adequacy according to inventory types (objectives)

3.5.1 Overview

No national or supra-national inventories were identified that included all wetlands within the geographic extent of the inventory. This reflects the tendency for inventories to have been developed for purposes (eg inventory of wetlands of high or special biodiversity value) that did not necessarily require all wetlands to be included. This lack of comprehensive inventories of the extent of wetland types at the national and supra-national level creates major difficulties for developing estimates of the extent of wetland resources.

The Directory of Wetlands in Oceania contains qualitative comments by the authors of country chapters on the comprehensiveness of the national account (Scott 1993). There are no qualitative assessments of the comprehensiveness of the national account.

A profile of the wetland inventory information reviewed according to main objectives (type) of the inventory is shown in table 4.

Table 4 Summary of wetland inventory information reviewed for the Oceania region

Country and Territories	Number of inventory records	Inventory type			
		Important wetlands	Wetland type	Sub-national	Other
American Samoa	1	1			
Australia	17	2	3	6	6
Cook Islands	1	1			
Fiji	4	1	3		
French Polynesia	1	1			
Guam	2	1	1		
Kiribati	1	1			
Marshall Islands	1	1			
Federated States of Micronesia	2	1	1		
Nauru	1	1			
New Caledonia	2	1	1		
New Zealand	6	2	2		2
Niue	1	1			
Northern Mariana Islands	1	1			
Palau	1	1			
Papua New Guinea	4	2	2		
Solomon Islands	2	1	1		
Tonga	2	1	1		
Tuvalu	1	1			
Vanuatu	2	1	1		
Wallis and Futuna	1	1			
Western Samoa	2	1	1		
Total	**56**	**25**	**17**	**6**	**8**

3.5.2 Important wetland site inventory

The major limitation with assessing the extent and adequacy of important site inventories is that they have not been developed from a systematic assessment of national wetland resources. A second difficulty arises from the criteria used to assess sites as internationally or nationally important (eg under the Ramsar Convention), as these tend to be qualitative in nature rather than quantitative. As such, it is not possible to determine the level of adequacy of important site inventories.

The New Zealand Wetlands of Ecological and Regional Importance database was based on an earlier systematic national survey of important ecological areas. The database is considered to have comprehensive coverage of palustrine and lacustrine wetlands in New Zealand (C Richmond pers comm).

Inventory work in Victoria, Australia, provides an example of the level of coverage of important site inventories (table 5). Sources of information for the three levels of inventory are the Ramsar Bureau Web site, Directory of Important Wetlands in Australia (Australian Nature Conservation Agency 1996), and Wetlands_1994 database (Department of Natural Resources and Environment 1997b).

The data are not directly comparable because some of the Ramsar and national directory listed sites include non-wetland habitat. The sub-national inventory does not include shallow marine areas which constitute approximately 100 000 ha of the Ramsar and national directory listed sites. This example illustrates both the under-representation of smaller wetlands in national inventories and Ramsar listing, and the difficulty of making comparisons between inventories.

Table 5 Comparisons of the level of coverage of inventories in Victoria, Australia

Level of Inventory	No. sites	Area (ha)
Ramsar listed	10	252 893
National Directory	121	395 104
Sub-national inventory	13 114	535 453

3.5.3 'Wetland type' inventory

Wetland type inventories tended to be more comprehensive in coverage. The World Mangrove Atlas (Spalding et al 1997) provide estimates for the extent of mangroves in most countries of Oceania. Comprehensive coverage is also a feature of the two national assessments of mangrove extent (Watling 1985, Lal 1990).

The inventory of coastal land around Australia also has comprehensive coverage within its limited scope. This inventory was restricted to the coastal lands within a 3 km strip inland of the mid-tide mark (Galloway et al 1984).

The inventory of freshwater lakes in Papua New Guinea includes all lakes shown on 1:100 000 topographic maps.

Sub-national inventories

Half of the sub-national inventories reviewed covered all of the wetland resources within their defined geographic scope. These inventories tended to become more comprehensive as the size of the geographic area decreased. These are primarily wetland resource assessments rather than wetland site inventories (eg Jensen et al 1996).

Other inventories

Only one inventory attempted to estimate the number of wetlands at a national scale (Paijmans et al 1985). The methodology used in this inventory was to identify wetlands from 1:250 000 topographic maps. The approach was developed as part of a feasibility study for a national wetland survey in Australia in the mid-1970s (Paijmans 1978). A full survey has not been commissioned in Australia although it is an ongoing topic of discussion between State and Commonwealth Government agencies. Most of the problems for conducting a national wetland inventory identified in the 1978 report still remain (eg funding, nationally agreed methodology). Digital information on wetland features is now available from the 1:100 000 map sheets of Australia, but this information has yet to be presented as wetland inventory information.

3.6 Extent and adequacy of updating activities

Updating activities for wetland inventory takes two main forms. One is a reassessment of the area and condition of the wetland resource, and the second is an extension process to include additional sites or more information on existing sites.

No updating activities were identified that involved a reassessment of the extent and condition of the wetland resource. One activity did involve a retrospective study to predict the extent of wetlands in Victoria, Australia, at the time of European settlement (Department of Natural Resources and Environment 1997b).

Two of the important site inventories had been updated to include additional data on existing sites and to extend the number of sites included (Atkinson 1991, Australian Nature Conservation Agency 1996).

4 Use of inventory information to assess the status of wetlands

4.1 Extent and distribution

The availability of information on the extent and distribution of wetlands varies considerably according to the objectives of the inventories.

4.1.1 Important wetland sites

Inventories of important wetland sites can only yield information on the number and area of the identified important sites in a particular country (table 9). The number and extent will vary considerably according to the specific criteria used for the selection of sites and the resources available for the survey. Most inventories of important wetlands model their criteria on those of the Ramsar Convention.

A limitation common to all important site inventories reviewed was that information on the extent of wetlands referred to the total site. In many cases the sites include several wetland types and at times non-wetland habitat.

The inclusion of non-wetland habitat is exemplified by the case of the Kakadu listing in the Directory of Important Wetlands in Australia and Ramsar Convention ‘List of Wetlands of International Importance’. While the area of the listed site is 1 375 940 ha the wetland component is only 16% (Australian Nature Conservation Agency 1996). This non-wetland habitat represents over 20% of the total area of Ramsar listed wetlands in Australia. Other large Ramsar listed sites in Australia in which non-wetland habitat contributes significantly to the total area of the site include Coongie Lakes.

4.1.2 Wetland type specific

Mangroves

Mangrove is the most comprehensively inventoried wetland type in the Oceania region. The key source of information was derived from a global mangrove atlas project by the International Society for Mangrove Ecosystems (Spalding et al 1997). Data were obtained from a wide variety of sources and entered into a GIS system at the World Conservation Monitoring Centre, Cambridge, United Kingdom. Previous national estimates of the extent of mangroves were also reviewed, along with details on the loss of mangroves at selected sites.

‘Best estimates’ of the area of mangroves in the countries and territories of the Oceania region are presented in table 8. The data are primarily from Spalding et al (1997), however, as this does not cover all of the countries and territories, it is supplemented with information from

Scott (1993). Spalding et al (1997) present new estimates of mangrove extent, based on GIS mapping, for eight countries. This estimate is considered the 'best estimate' in 5 cases (62%).

Table 8 Best estimates of mangrove extent for the Oceania region

Country or Territory	Best estimate (ha)	Reference
American Samoa	50	Cole et al (1988)[@]
Australia	1 150 000	Galloway (1982)[#]
Cook Islands	nil	Scott (1993)[@]
Fiji	38 500	Anon. (1993)[#]
French Polynesia	nil	Scott (1993)[@]
Guam	90	Spalding et al (1997)[#]
Kiribati	no info.	Scott (1993)[@]
Marshall Islands	no info.	Scott (1993)[@]
Federated States of Micronesia	8600	Ellison (1995)[#]
Nauru	2	Scott (1993)[@]
New Caledonia	45 600	Spalding et al (1997)[#]
New Zealand	28 700	Spalding et al (1997)[#]
Niue	nil	Scott (1993)[@]
Northern Mariana Islands	no info.	Stinson (1993)[@]
Palau	4710	Cole et al (1987)[@]
Papua New Guinea	539 900	Ellison (1995)[#]
Solomon Islands	64 200	Ellison (1995)[#]
Tonga	1000	Ellison (1995)[#]
Tuvalu	30	Scott (1993)[@]
Vanuatu	1600	Ellison (1995)[#]
Wallis and Futuna	nil	Scott (1993)[@]
Western Samoa	700	Ellison (1995)[#]
Total	**1 883 700**	

Note: [#] – best estimate made by Spalding et al (1997).
[@] – information from Scott (1993).

Freshwater swamp forest and forested peatlands

The extent of peat swamps in tropical Oceania has been reviewed by Rieley et al (1996):

Papua New Guinea	500 000–2 890 000 ha
Fiji	4000 ha
Australia (Queensland)	15 000 ha

The authors note that there are great variations in estimates for extent of peatlands mainly because estimates in large countries have been made from aerial photographs and, more recently, from satellite imagery. With these methods it is impossible to accurately determine the boundaries between peat and adjacent waterlogged mineral soils, since both support forests of similar structure and vegetation composition.

Lakes

Chambers (1987) estimated that there were 5383 lakes in Papua New Guinea, of which 22 had an area greater than 1000 ha. In Australia, Paijmans et al (1985) estimated that there are

5050 lakes covering an area of 520 000 ha. These estimates were both developed from the representation of lakes shown on topographic maps.

4.1.3 Sub-national and other inventories

Paijmans et al (1985) is the best example of an inventory with the objective of developing a national overview of wetlands. This study was based on analysis of 1:250 000 topographic maps. The study developed an estimate of the number of wetlands and produced a set of maps of wetland types at 1:2 500 000. However, there are many limitations to using this as baseline information for Australia, including:

- the scale of the study (1:250 000) which is too small to detect many wetlands
- the inherent inaccuracy of topographic representations of wetlands
- there is no information on the extent of wetlands.

In New Zealand a number of resource inventory databases have been developed from which estimates of wetland extent have been generated (Cromarty & Scott 1996). Estimates are given for rivers, lakes and wetland vegetation associations. However, this work has not generated information on the extent and boundaries of individual wetland types. A new national program to address this issue is being developed (C Richmond pers comm).

At the sub-national level, studies have generated more specific information on wetland extent and distribution. In Victoria, Australia, a GIS has been developed, at a scale of 1:25 000, on wetland distribution for the years 1788 and 1994 (Department of Natural Resources and Environment 1997b). This has generated estimates for 1994 of 13 114 wetlands covering 534 453 ha (Department of Natural Resources and Environment 1997a).

Extensive resource and land use studies have been conducted in the Murray-Darling River Basin in Australia (Crabb 1997). The region covers over 1 000 000 km^2 or approximately 14% of Australia. Estimates of the extent of wetlands have been developed for parts of the catchment (New South Wales 53 388 ha; Victoria 31 039 ha; South Australia 138 290 ha) and a comprehensive database is being developed.

Data are also available on wetland distribution for much smaller regions of Australia. This information has been generated to address specific resource management issues (eg Jensen et al 1996, Pen 1997). In the Busselton-Walpole region of south-western Australia, a systematic overview of environmental values of wetlands has been conducted to guide water resource allocation and management (Pen 1997). In the Darling system and adjacent areas of south-western Australia, Semeniuk (1988) has undertaken thorough mapping and classification of wetlands at a large scale. This approach is being used as a model for extending the work to other parts of the State.

4.2 Wetland benefits and values

The wetland inventories examined included very few overall quantitative estimates of wetland benefits or values of the wetlands described.

Directories for important sites did include categories for description of land-use, economic and social values, important fauna and special floral values. In most cases the entries are qualitative rather than quantitative, except in the case of numbers of waterbirds or endangered species. It is therefore not possible to make an overall assessment of the values of the wetlands or to extrapolate on their importance within a country. The only analysis possible would be to summarise the number of sites of importance for different benefits, but since the data sheets vary in the level of information, this may not yield meaningful outcomes.

A detailed economic evaluation of mangroves has been conducted in Fiji (Lal 1990). However, the assessment of changes in the extent of mangroves was apparently an incidental component of the study.

4.3 Land tenure and management structure

To obtain information on land tenure and management structures, inventories need to use a methodology that enables specific wetlands to be identified and for information to be collated on the individual sites. This type of information is contained in wetland directories.

The three major national and supra-national wetland directories all contain information on land tenure and management. One item of information from these inventories which can, to some extent, be extracted and analysed is the degree of protection (table 9).

Table 9 Number, area and protection status of sites in the key wetland directories that cover the Oceania region (Scott 1989, Scott 1993, Cromarty & Scott 1996, Australian Nature Conservation Agency 1996)

Country or territory	No. of sites/ systems in the directory[1]	Area of sites in the directory[2]	Area under some form of protection[3,4]	Area totally protected[5]
American Samoa	4	203	73	0
Australia	698	** 24 201 797	not analysed	not analysed
Cook Islands	5	** 550	0	0
Fiji	11	16 661	0	0
French Polynesia	14	** 8 901	2 750	2 750
Guam	19	836	17	0
Kiribati	11	** 76 366	70 653	70 653
Marshall Islands	0	0	0	0
Micronesia, Federated States	4	10 616	0	0
Nauru	1	3	0	0
New Caledonia	5	** 8 200	** 2 060	** 1 060
New Zealand	73	** 1 145 601	not analysed	not analysed
Niue	0	0	0	0
Northern Marianas	6	270	0	0
Palau	8	2 022	0	0
Papua New Guinea	33	10 123 861	599 556	0
Pitcairn Islands	3	5 620	3 700	0
Solomon Islands	9	** 130 600	1 000	1 000
Tokelau	1	10	0	0
Tonga	7	9 830	2 835	2 835
Tuvalu	1	40	0	0
Vanuatu	13	** 6 103	0	0
Wallis and Futuna	1	43	0	0
Western Samoa	7	** 720	0	0
Total	**934**	****35 748 853**	***	***

1 Data for Papua New Guinea are from Scott (1989), data for Australia are from Australian Nature Conservation Agency (1996), data for New Zealand are from Cromarty and Scott (1996) and data for the others are from Scott (1993).
2 Area in some cases includes dry land, e.g. where whole catchments or whole islands are listed in the directory.
3 Categories for some form of protection include: National Natural Landmark, Special Management Area, Government Owned Land and Conservation Preserve (USA territories); Protected Area (New Caledonia, Tonga); World Heritage Area (Pitcairn/United Kingdom); and Wildlife Management Area (Papua New Guinea).
4 Some wetlands, including several in Pacific Island countries, have been included in 'conservation areas' since the directories were published.
5 Categories for total protection include: Strict Nature Reserve, Special Botanical Reserve and Special Faunal Reserve (French territories), Wildlife Sanctuary (Kiribati, Solomon Islands).
** indicates that the account for this country/territory includes wetland of unknown area; thus the area stated is a minimum.
*** Totals were not calculated for these columns because the project resources did not permit analysis of data in the Australian and New Zealand directories with respect to protected area status.

4.4 Rate and extent of wetland loss and degradation

None of the national or supra-national inventories reviewed provided quantitative information on changes in the extent of wetlands. This is to be expected because the inventories were of important sites (ie a different objective) or, in the case of the mangroves, the inventory aimed to develop a baseline against which future assessments could be made.

At the sub-national level, the Victorian wetland GIS has been used to assess the extent of wetland loss since European settlement (table 10). It shows that up to 70% of some wetland categories have been lost since 1788 (Department of Natural Resources and Environment (1997b).

Table 10 Extent of wetland loss in Victoria, Australia (adapted from Department of Natural Resources and Environment 1997a)

Wetland category	Pre-European area (ha)	1994 area (ha)	% loss
Deep Freshwater Marshes	154 800	46 440	70
Freshwater Meadow	172 700	98 439	43
Permanent Open Freshwater	79 100	74 354	6
Permanent Saline	142 200	139 356	2
Semi-Permanent Saline	61 300	57 009	7
Shallow Freshwater Marsh	15 800	6320	60

5 Discussion and conclusions

5.1 Adequacy of the information base

This project aimed to identify how national and supra-national wetland inventories could be used to establish global baseline information for considering trends in wetland conservation or loss. To develop this baseline it is necessary to have detailed information on the extent and distribution of wetland types in the region.

This review has found that regional and national wetland inventories in the Oceania region are limited in number and scope. In Australia and New Zealand the national environment agencies have recognised the inability of the existing inventory base to provide data on the extent and distribution of specific wetland types. Consequently, Environment Australia and the New Zealand Department of Conservation are developing new inventory initiatives to address this need (B Edgar pers comm, C Richmond pers comm). Existing State-based initiatives such as the coastal wetlands database being developed by the Australian Marine Conservation Society (E Hegerl pers comm) could provide a suitable model and/or data management system for a national inventory.

The key wetland inventories for the region, the Directory of Wetlands in Oceania (Scott 1993), Directory of Wetlands of New Zealand (Cromarty & Scott 1996) and the Directory of Important Wetlands in Australia (Australian Nature Conservation Agency 1996), were not designed to yield information on the extent and distribution of wetland types. These inventories are of limited value in providing a baseline (table 11) because:

- they cover only a portion of the wetland resources in a country
- the sites included are biased towards large wetlands in protected areas

- they do not contain site maps or details on the extent of wetland types
- some site extent information includes large areas of non-wetland habitat.

The only wetland type for which there is an appropriate inventory to provide a baseline on wetland extent is mangroves (table 11). This is attributable to the ability to readily identify mangrove stands from aerial/satellite imagery, interest in harvesting of mangrove timber and the focus of a number of international programs on this ecosystem over the past 20 years. The key mangrove inventory (Spalding et al 1997) was specifically designed to provide a baseline on the extent of mangroves. Even in this study Spalding et al (1997) defer to the estimates of other researchers in 38% of the countries of Oceania (table 8).

An economic interest in timber harvesting from freshwater and peat forests has contributed to the development of inventory material of these types of wetlands. However, estimates of the extent of swamp forest vary significantly (eg Papua New Guinea 500 000–2 890 000 ha) because of differing definitions and the difficulty of interpretation of remotely sensed data (Rieley et al 1996).

Sub-national inventories for Australia contain additional data on wetland extent (table 10). Normally this information cannot be integrated with information from other sub-national inventories. Some of the sub-national inventories for Australia have spatial information stored as digital data sets. While it may be possible to integrate the spatial data set, problems will exist due to the different wetland classification systems used.

Table 11 Summary of wetland extent information, Oceania

Inventory	Area (ha)	Key reference	Comments
mangrove	1 883 700	Spalding et al (1997) and other (table 8)	'best estimate'
peat swamps	519 000	Rieley et al (1996)	minimum estimate
inventories of important wetlands	35 748 853	table 9	qualification: these include a sample of the wetland resources; sample is biased towards wetlands of high biodiversity value; the areas include non-wetland habitat; inventories may overlap with 'wetland type' inventories
Ramsar-listed sites	5 730 548 (Australia: 5 096 756 ha; New Zealand: 38 868 ha; Papua New Guinea 594 924 ha)	Ramsar Bureau (D Peck) pers comm & site nomination data held by Environment Australia as at 13/11/98	qualification: these include a smaller sample of wetlands than the inventories of important wetlands; sample is biased towards wetlands of high biodiversity value; the areas include non-wetland habitat; inventories may overlap with 'wetland type' inventories

5.2 Methodologies

Three groupings of national and supra-national wetland inventories were identified in Oceania; important site, wetland type and other inventories.

The **important site inventories** presented information on a site by site basis. The strength of this approach was the ability to store information on site attributes such as tenure, management, benefits and values. The weaknesses of these inventories were:

- lack of a systematic assessment of the sites to be included
- no information on the comprehensiveness of coverage

- the sites included were biased towards large wetlands in protected areas
- they do not contain site maps or details on the extent of wetland types
- some site extent information includes non-wetland habitat.

While valuable for wetland conservation, the important site inventories do not yield the data needed on the extent of wetland types. The current wetland inventory dataset is inadequate for assessing changes to extent for almost all wetland types in Oceania. This information on wetland extent is essential to enable informed decisions on natural resource management. A new approach to wetland inventory is required.

The existing Ramsar-derived approach of developing inventories of important wetlands has been successful in promoting the conservation of individual sites. These directories should be maintained and extended to become comprehensive inventories of wetlands of national importance. In other parts of Oceania the socio-economic and cultural conditions are such that the publication of national wetland directories is likely to remain a low priority. A cost effective approach would be to continue the approach of a regional directory.

Wetland type inventories appear to be the most useful to determine a baseline for monitoring the loss in extent of wetlands. These inventories tend to use remote sensing techniques. The leading example is the World Mangrove Atlas (Spalding et al 1997).

Other inventories. A large number of sub-national inventories are available for Australia and a sample was reviewed for this report. There is a high demand from state government agencies, local government, community groups and private land holders for detailed wetland inventory information at the scale of 1:50 000. At present there are a number of initiatives (eg Jensen et al 1996, Pen 1997) to develop wetland maps for specific purposes. It may be possible to link these separate initiatives in order to provide information for a national inventory.

No inventories were identified in Oceania that involved elements of monitoring wetland condition. Developing components within inventory programs to monitor wetland condition would appear to greatly add to the complexity of an inventory program. Opportunities may exist, using remote sensing techniques, to collect data on particular attributes of wetland condition (ie water temperature, turbidity and quality in lake systems, or tree cover in forested wetlands; occurrence of major fires, flooding or drainage).

The lack of agreed wetland classification systems will present ongoing problems for the global quantification of wetlands. Additional attention needs to be given to ensuring that classification systems are hierarchical. This will enable national and sub-national inventories to have high levels of classification while maintaining the potential for global integration of data.

5.3 Use of inventory information as a baseline for monitoring wetland loss

The World Mangrove Atlas (Spalding et al 1997) was the only inventory identified at the national and supra-national level which provided an adequate baseline for monitoring future changes in wetland extent.

The sub-national wetland inventory for Victoria, Australia compared the current extent of wetlands with that at the time of European settlement (Department of Natural Resources and Environment 1997a). Future updates of this GIS based inventory would enable contemporary assessments of changes in wetland extent.

These inventories are generally prepared from remote sensing information and usually do not include information on wetland condition, so probably are not very useful for monitoring changes in condition.

Additional problems exist with the ability of remote sensing to determine wetland classes. Further evaluation of the optimum assessment methods for specific wetland types is needed.

6 Specific recommendations

Recommendation 1 Directories of important wetlands (New Zealand and Australia)

The directories of important wetlands in New Zealand and Australia should continue to be revised to increase the number of sites included and update/extend the information on sites.

Recommendation 2 Directories of important wetlands (other parts of Oceania)

The Directory of Wetlands in Oceania should be revised before the next Conference of Contracting Parties to the Ramsar Convention (2002) to increase the number of sites included and update/extend the information on listed sites.

Recommendation 3 Development of inventories of wetland extent

The Governments of Australia and New Zealand should develop inventory methodologies and programs to derive national assessments of the extent of individual wetland types.

Recommendation 4 Wetland classification

Classification systems used for wetland inventory should be consistent with the Ramsar classification to enable data to be used from global assessment of wetland resources.

Recommendation 5 Standard inventory techniques for wetland types

The Ramsar Bureau and Partner organisations should promote standardised inventory methods for specific wetland types.

Recommendation 6 Inventory data storage

Spatial data sets of wetland extent and distribution should be stored in Geographical Information Systems to facilitate ongoing assessment of changes in wetland extent. This is particularly important to enable the integration of data from sub-national inventories.

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Annex 1 Index to Country Codes in Oceania

ISO Code	Name	Long Name
ASM	American Samoa	Territory of American Samoa
AUS	Australia	Commonwealth of Australia
FSM	Federated States of Micronesia	Federated States of Micronesia
FJI	Fiji	Republic of Fiji
PYF	French Polynesia	Territory of French Polynesia
GUM	Guam	Territory of Guam
KIR	Kiribati	Republic of Kiribati
MHL	Marshall Islands	Republic of the Marshall Islands
NRU	Nauru	Republic of Nauru
NCL	New Caledonia	Territory of New Caledonia and Dependencies
NZL	New Zealand	New Zealand
MNP	Northern Mariana Islands	Commonwealth of the Northern Mariana Islands
PLW	Palau	Republic of Palau
PNG	Papua New Guinea	Independent State of Papua New Guinea
SLB	Solomon Islands	Solomon Islands
TON	Tonga	Kingdom of Tonga
TUV	Tuvalu	Tuvalu
VUT	Vanuatu	Republic of Vanuatu
WLF	Wallis and Futuna	Territory of the Wallis and Futuna Islands
WSM	Western Samoa	Independent State of Western Samoa

Annex 2 Analysis of the Wetland Inventory Data Set for Oceania

		Number	%
	Attribute	26	
Scale of Inventory of Material			
	Global Scale	1	4
	Supra-Regional Scale	2	8
	Regional Scale		
	Sub-Regional Scale	1	4
	National Scale	16	62
	Sub-National Scale	6	23
Source is a Directory			
	Yes	15	58
	No	11	42
Type of Source Material			
	Peer Review Journals	1	4
	Peer Review Books	2	8
	Chapters in Books		
	Conference or Keynote Presentation		
	Article in Conference Proceedings		
	Internal Government Reports	2	8
	Government Formal Publications	8	31
	Other Government Material	6	23
	NGO reports		
	NGO Formal Publications	2	8
	Consultancy Reports	4	16
	Newsletter Articles		
	Practitioner Periodical Article		
	Database Manual		
	Electronic Database		
	World Wide Web Article		
	Thesis		
	Other		
	Unknown		
Language of Study			
	English	26	100
	Other		
	Unknown		

Format of Study			
	Paper	11	43
	Electronic text	1	4
	Electronic Database	6	23
	Personal Communication		
	Web Presentation	2	8
	Part of GIS or GIS Output	1	4
	Map Based	2	8
	Other Format		
	More than one format	3	12
	NA		
Circulation of Study			
	Published	17	65
	Interdepartmental (unpublished)		
	Internal (unpublished)	8	31
	Restricted (unpublished)	1	4
	Unrestricted (unpublished)		
	Other Types		
	Unknown		
	More than one type		
	NA		
Data Storage Media			
	Paper	13	50
	Web (electronic)		
	Other Electronic (not web or DB)	3	6
	Electronic Database	5	19
	GIS	3	6
	Hard Copy Map		
	Digitised Map		
	Other		
	Unknown or Ambiguous		
	More Than One Medium	2	8
Study Implementation			
	International NGO	2	8
	National NGO	1	4
	Sub National NGO		
	Local NGO		
	Inter GO		
	National GO	10	38
	Sub National GO	7	30
	Local GO		
	Private Agency/Individual		

	Consultancy Agency		
	Academic Institution	2	8
	Other body		
	Unknown		
	More than one Agency or Body	4	16
Study Funding			
	International NGO		
	National NGO		
	Sub National NGO	5	19
	Local NGO		
	Inter GO	1	4
	National GO	12	46
	Sub National GO		
	Local GO		
	Private Agency/Individual	2	8
	Consultancy Agency		
	Academic Institution	1	4
	Other body		
	Unknown		
	More than one Agency or Body	5	19
Statement of Objectives			
	Objectives Explicitly Stated	22	85
	Objectives Not Explicitly Stated	1	4
	Unknown	3	11
Main Objective of Study			
	General Biodiversity		
	Biodiversity Research		
	Baseline Biodiversity	21	81
	Repeat Survey/Surveillance		
	Management Tool for Biodiversity		
	Biodiversity Monitoring		
	Wetland Products	1	4
	Geographical	1	4
	International Designation		
	Baseline Inventory		
	Academic Research		
	Land Use Planning	3	11
	Wetland Services		
	Public Education		
	Other Research		
	Other		
	NA		

Wetland Definition			
	Definition Provided	15	57
	Definition Implied	5	19
	No Definition Provided or Implied	3	12
	Unknown/Ambiguous	3	12
Ramsar Definition			
	Ramsar Definition Used	10	38
	Ramsar Definition NOT used	13	50
	Use of Ramsar Definition Unknown	3	12
Ramsar Classification			
	Ramsar Wetland Types Used	4	15
	Other Wetland Classification Used	9	35
	Wetland Classification Varies		
	Unknown	3	12
	Not Applicable	10	38
Extent of Coverage			
	All Wetlands		
	Part of Wetland Resource	26	100
	Ambiguous		
Basis of Selection			
	Geography / Jurisdiction	4	15
	Land Cover or RS Data	1	4
	Landform Type		
	Suprahabitat	1	4
	Habitat Type	4	15
	Floral / Faunal Groups or Species		
	Climate		
	Wetland Function		
	Hydrology		
	Biodiversity Value	11	42
	Cultural Value		
	Artefact of Data Collection	1	4
	Other Basis	1	4
	Unknown or Ambiguous		
	More than One Basis	3	11
Data Collection Methodology			
	Collation or Review	10	38
	Ground Survey		
	Remote Sensing	5	19
	Questionnaire Survey		
	More Than One Methodology	11	42
	Unknown Methodology		

Extent of Ground Survey (if remote?)			
	Total		
	Partial	5	19
	Unknown		
Type of Remote Sensing			
	Satellite Imagery	1	4
	Aerial Photography	3	11
	Videography		
	Radar Imagery		
	LIDAR Imagery		
	Map Product	1	4
	Unknown	1	4
Summary Provided			
	Summary Provided	15	58
	Summary NOT Provided	11	42
	Not Known if Summary Provided		
Extent of Wetlands			
	Yes	13	50
	No	12	46
	Not known	1	4
Area by Wetland Type			
	Full details on area per Wetland Type	3	11
	PARTIALLY on area per Wetland Type	8	31
	No info. on area values per Wetland Type	12	46
	Not known	3	11
Wetland Loss and Degradation			
	Sources providing info. on Loss &/or Deg.	5	19
	Sources NOT providing info. on Loss &/or Deg.	21	81
	Not known		
Wetland Status Description			
	Overall Wetland Status Description Included	6	23
	Overall Wetland Status Description NOT Included	20	77
	Unknown		
Values and Benefits			
	Some Level of Information	3	11
	Always		
	Most of the time		
	Commonly		
	Sometimes		
	Rarely		
	Never	18	69
	Unknown	5	20

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Global review of wetland resources and priorities for wetland inventory

***eriss* note**

'The status of global wetland inventory'

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***eriss* note pages 1, 4**
***eriss* note pages 2, 3**

(print and fold to produce 4 page colour brochure)

Global review of wetland resources and priorities for wetland inventory

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We welcome your feedback and further contributions of wetland inventory information