Pan–Arctic Shorebird / Wader Monitoring and Research Workshop in Denmark 3-6 December 2003

on

Long-term monitoring of populations and breeding performance of Arctic shorebirds / waders

&

A study of climate effects on breeding populations and breeding performance of Arctic shorebirds / waders

Organised by

Hans Meltofte, Elin Pierce, Aevar Petersen, Liv Wennerberg & Thomas B. Berg

and

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Booklet of abstracts

Working synopsis on shorebird breeding conditions in the Arctic

- to be opposed, falsified, modified or supported during the workshop.

Hans Meltofte

The biotic and climatic breeding conditions in the Arctic differ a lot not only between the Low Arctic and the High Arctic, but just as much between different parts of the Arctic. Obviously, food availability – for adults and young – is the main distributing factor e.g. behind the fact that breeding densities are more than a factor 100 higher in certain parts of the Northeast Siberian and Alaskan Low Arctic than in the extreme High Arctic.

Furthermore, in certain parts of the Arctic, conditions are so maritime with spells of cold winds, sleet and rain during many summers that breeding densities and success are further limited. This is particularly so e.g. in parts of Svalbard, where the only common shorebird, the Purple Sandpiper, feeds extensively in the littoral zone because food here is more abundant than on the tundra (this is not possible in most other parts of the high arctic due to ice-cover well into July or even August).

The same difference apparently exists between High Arctic Siberia and High Arctic Greenland (and large parts of the Canadian High Arctic?). The north Siberian breeding grounds are much influenced by the Arctic Ocean giving more precipitation, a later snow-melt and consequently later arrival of the shorebirds than in continental High Arctic Greenland (the “Arctic Riviera”). Furthermore, extended periods of poor weather during chick rearing frequently reduce chick growth and survival in Siberia, as opposite to High Arctic Greenland, where such events are uncommon and with limited impact.

Pre-breeding spring snow cover and arthropod availability (again governed by snow cover and temperature) are important determinants of breeding distribution, population density and timing of egg-laying of Arctic shorebirds, since they have to find the resources for egg formation after arrival on the breeding grounds, and because they are dependant on sufficiently large snow free areas to avoid too heavy nest predation. Furthermore, clutch size is reduced at late egg-laying, whether this is a result of a late snow-melt or relaying after initial depredation. We have little knowledge about the impact, but most likely ultimate breeding success (the number of juveniles making it all the way to the wintering areas) is influenced by timing of breeding, so that there is a strong urge to breed as early as conditions allow. This may work both through optimal timing of chick hatching and growth in relation to arthropod peak abundance in July and time needed for build up of juvenile body conditions before departure on the first post-nuptial migration (the latter may be more important e.g. in High Arctic Greenland and Northeast Canada, where the juveniles have to make it across the North Atlantic to Northwest Europe and many of them even have to cross the Greenland Icecap at >2000 m a.s.l.).

If the breeding conditions related to climate is much different between Siberia and Greenland, the differences in importance of predation may be even more so. Siberian shorebirds face highly fluctuating and cyclic predation pressure related to fox numbers and search effort, which again is related to lemming abundance. The impact of this may override food availability as a (short to mid term) population density regulating factor. This has never been shown for Greenland shorebirds, while in the North American Arctic, microtine cycles vary so much between areas and species that overall shorebird breeding success does not fluctuate as much as in Siberia. Both lemmings and predation pressure do fluctuate, but not at all to the extent and regularity as in Siberia. Maybe lemming numbers never reach the same levels in High Arctic Greenland as in the Siberian Arctic.

Different topography of the two areas may also play a role. Northern Siberia seems to hold much more uniform tundra over extensive stretches of land, where conditions do not differ that much. As opposite to this, High Arctic Greenland and much of High Arctic Canada is mountainous with tundra restricted to valley floors and foreland areas. Hence, the differences in spring snow cover etc. found from west to east in Siberia may to almost the same extent be found between valleys only 50-100 km apart in the New World High Arctic. Conditions on the low rolling tundra of the central Canadian and Alaskan Low Arctic may be more like in Siberia?

Due to these pronounced environmental differences in the breeding conditions, potential impacts of climate change may differ a lot between different parts of the Arctic. First of all, the High Arctic is much more restricted in area, and so to say “squeezed” in between the Arctic Ocean and the extensive Low Arctic biome. The risk exists that the expected climate amelioration may “push the High Arctic out into the Arctic Ocean” following expansion to the north of the Low Arctic. As part of this, the disappearance of dense ice cover on large parts of the Arctic Ocean may cause the climate to become more maritime-dominated in the High Arctic – approaching present Svalbard conditions!? Hence, as opposite to the Low Arctic, where climate amelioration may cause an earlier snow melt and a prolonged summer season, a more maritime climate in the High Arctic will involve a thicker and more extensive snow pack, and hence a later snow melt (since summer temperatures are not expected to increase much).

That the High Arctic shorebirds are particularly at risk may be indicated by the narrow population bottlenecks that the few studied High Arctic shorebird species have experienced during Eem and the sudden warmth of the end of the Weichselian ice age. One may actually ask how many High Arctic shorebird species or populations that disappeared altogether in an environment, where e.g. the number of reproducing female Red Knots were down to a few thousand?

The Low Arctic may not be at risk to the same extent. First of all this biome is much more extensive, and secondly, Low Arctic conditions may expand into the present High Arctic areas while converting into sub-Arctic scrub in the south. At least, the sub- and Low Arctic breeding Dunlin does not seem to have been through similar narrow population bottlenecks as the studied High Arctic species/populations. Hence, since the Low and the High Arctic face differential climatic regime shifts, shorebirds breeding in these two regions may respond quite differently to climate change.

On top of all this come the changes that Arctic shorebirds may face during non-breeding, both in the form of changes caused by climate change (e.g. sea level rise and changes in prevailing wind patterns during long migratory flights) and in the form of human activities. Again, the High Arctic species may be most at risk, since many of them are dependent on intertidal flats and perform very long non-stop flights.

How to measure wader recruitment?

J.A. Clark, N.A. Clark, R.A. Robinson & P.W. Atkinson, British Trust for Ornithology, U.K.

Although assessing productivity of arctic breeding waders through intensive or extensive field-based observation has many attractions, it is logistically fraught with difficulties. However, by shifting the focus to look at recruitment into the adult population, i.e. the number of juveniles surviving to reach the wintering grounds, it becomes possible to conduct monitoring in countries with a substantial logistical infrastructure. Juvenile recruitment is also a key demographic parameter.

We use data on numbers of adult and juvenile waders cannon-netted in the winter months in Britain since 1992 to estimate annual juvenile recruitment into the British wintering population. We explore various analytical methods in calculating these indices to provide the best estimates of juvenile recruitment with associated errors and confidence limits.

It proved possible to calculate good annual indices for a number of species, and even to produce regional indices for some species, where different breeding populations are thought to winter in different parts of the country.

We discuss various ways in which these indices might be used for routine monitoring of wader demography, taking into account their differing migration and wintering strategies.

The apparent influence of climate variations on spring arrivals of waders in Iceland during the 20th century

Hugh Boyd, National Wildlife Research Centre, Canadian Wildlife Service, Environment Canada, Raven Road, Carleton University, Ottawa, Ontario, Canada K1A 0H3

First sightings of 13 breeding waders were reported in most years. Most species winter in western Europe or northwest Africa. Most first sightings were earlier in 1935-1950 (when there were most observers) than before or since. Decadal mean spring temperatures rose from 0.8°C in 1901-1910 to peak at 2.5°C in 1951-1960, cooling to 1.7°C in 1981-1990. Though earliest sightings were delayed in cool springs, the means of all first sightings in 1935-1950 seemed little affected by spring weather. Arrivals were delayed after winters in which the North Atlantic Oscillation had been high, and in springs when westerly or cyclonic systems were dominant over the British Isles. There were few reports of High Arctic passage migrants before 1950, due to lack of observers in the right places. Ruddy Turnstones have been later in cool springs, but Knot arrivals show no weather effects.

The climate of Iceland was warmer in the 20th century than in the previous 1000 years. Some climatic modelling suggests that major changes in the North Atlantic thermohaline circulation may occur during the 21st century, which would return Iceland to cold conditions. Yet the breeding species will probably persist, if arriving later and in smaller numbers.

Are Arctic waders generally in decline?

Simon Delany, Lieuwe Haanstra & Ward Hagemeijer, Wetlands International

The publication by Wetlands International in 2002 of *Waterbird Population Estimates – third edition* (WPE3) involved wide consultation of the world's waterbird experts and provides a useful starting point for the evaluation of numbers and population trends of waterbirds. About one quarter of the species recognised as "waterbirds" by Wetlands International are waders, and information is presented in WPE3 on all 209 of the world's wader species. 100 biogeographical populations of 37 wader species have been identified as "Arctic nesting", and a summary of the information presented for these in WPE3 revealed that estimates of numbers exist for 96% of these populations, and estimated population trends (whether increasing, stable or decreasing) for 52%. These figures indicate that Arctic nesting waders are better known than waders as a whole, but there is considerable room for improvement in the quality of both population estimates and trends. The estimated trends of Arctic nesting waders presented in WPE3 break down as follows: Increasing: 12%, Stable: 42%, Decreasing: 44%, Possibly extinct: 2%.

The International Waterbird Census (IWC) has been running for more than 35 years, and has amassed a large volume of January count data on Anatidae, but rather fewer data on other groups of waterbirds. Waders have been counted as a routine part of IWC in most European countries since the late 1980s, but some problems with the IWC data from species other than Anatidae have yet to be solved. Progress is being made, and it is now possible to present preliminary population trends for many species, including seven species of Arctic nesting waders counted in Europe in January.

The monitoring of arctic wader populations in the Dutch part of the Wadden Sea during the past 30 years

Meinte Engelmoer, Marc van Roomen, Ebel Nieboer, Klaas Koopman & Gerard Boere

Regular trapping and counting activities started in the Dutch Wadden Sea about 30 years ago with pioneering ornithologists/ecologists as Jan Rooth, Arie Spaans, Gerard Boere, Ebel Nieboer and Piet Zegers. They laid the basis for organising regular counting and trapping activities. Since the first count organised by Jan Rooth in 1963 more than 100 counts of the whole area have followed. Gerard Boere and Ebel Nieboer started most trapping activities around 1970. Since then, 35,000 waders were trapped. Nearly all younger Dutch ornithologists/ecologists nowadays working in the Wadden Sea got inspired while being involved in these counting or trapping activities in the area. Many of them exported their experience to other parts of the world.

The major aim over all these years of organising counts and trapping activities was (1) to monitor the population changes and (2) to get insight in the (changes in) population composition of the species involved. This aim was and is of utmost importance to understand the proper ways of protection of the area as a whole.

Since this meeting concentrates on the arctic species, our contribution is focusing on the numerical trends and changes in population composition of the arctic wader species being regularly present in the area during non-breeding. The involved species are: Ringed Plover *Charadrius hiaticula*, Grey Plover *Pluvialis squatarola*, Knot *Calidris canutus*, Sanderling *Calidris alba*, Curlew Sandpiper *Calidris ferruginea*, Dunlin *Calidris alpina*, Bar-tailed Godwit *Limosa lapponica* and Turnstone *Arenaria interpres*. Some of these species also have low-arctic or temperate zone breeding populations being regularly present in the Wadden Sea. We show the *numerical trends* of these species in the area. We also present information on population composition in terms of:

(1) *Geographical breeding origin*. Morphometric studies make it possible to produce quantitative estimates of the population composition of mixed wader populations. These estimates are produced with the aid of multivariate data analysis, which includes the comparison of the measurements of birds of the mixed Wadden Sea population with the measurements of breeding wader populations. Migrant waders in the trilateral Wadden Sea have a mixed breeding origin but the degree of mixing differs per species. Measurements of the Wadden Sea migrants were used to test these new multivariate methods in order to estimate the proportional occurrence of the various breeding populations in the Wadden Sea during migration and wintering.

(2) *Age composition*. Juveniles and adults are known to show partly separate site choice when visiting the Wadden Sea. Thus, trends in age composition have to pay attention to spatial differences.

(3) *Primary moult patterns*. Mass-data analysis requires information on the moulting stage of the birds involved, since moulting adults generally tend to stay longer than non-moulting adults during post-breeding. Thus, attention was paid to primary moult patterns before body mass analysis. In addition, the various areas in the Wadden Sea appear to be used differently with some areas being more frequented by quick passage non-moulting migrants and others by moulting adults.

(4) *Body masses*. Seasonal variation in body masses additionally gives insight in the migration strategies of the involved species and populations.

Confronting spatio-temporal data with large-scale climatic dynamics: a retrospective look at Arctic waders

Mads C. Forchhammer, Department of Population Ecology, Zoological Institute, University of Copenhagen, Universitetsparken 15, DK-2100 Copenhagen, DK; email: mcforchhammer@zi.ku.dk

Understanding the ecological consequences of climatic variability is as complex as disentangling the dynamics of climate and ecology alone. In recent years, ecosystem models of varying complexity have been proposed. However, model predictions of ecological consequences of climate change can never leave the realms of good guesses without accurate observations to validate them and to show that such models do indeed reflect reality. The accumulation of ecological time series has, however, recently provided us with the opportunity to specifically test whether species life histories and population dynamics do in fact respond to changes in large-scale climate.

Here, I confront spatio-temporal data with long-term changes in the behaviour of the North Atlantic Oscillation (NAO), which is the most prominent and recurrent pattern of large-scale atmospheric circulation variability in the Northern Hemisphere. Specifically, I address the general issue of performing retrospective analyses of long-term autocorrelated data in relation to climatic changes. Furthermore, I illustrate how these may be performed on the long-term data of Arctic wades by presenting preliminary results on the association between the temporal changes in wader population dynamics and the NAO.

Breeding success of arctic waders measured in the Wadden Sea

Klaus Günther, WWF Deutschland, Norderstrasse 3, 25813 Husum, Germany, guenther@wwf.de, http://www.vogelmonitoring.de

The Wadden Sea along the North Sea coast from Denmark to the Netherlands is the most important wetland with tidal flats for migratory waders on the East Atlantic Flyway. Approximately 6-7 million mainly arctic waders visit the Wadden Sea each year. After the breeding period, adult birds of many wader species stay for several weeks from July to September/October for their wing-moult. Juveniles arrive later than adults in August and September. It is possible to identify them by their age specific plumage, mostly by buff-fringed coverts and tertials on the back and creamy brown body feathers. During autumn, identification of juveniles gets more difficult due to bodyfeather moult and fading of the brownish feather fringes.

Since the early 1990s we tried to measure the breeding success of arctic waders (and geese) in the Wadden Sea by field-observations with telescopes in autumn each year. This is quite easy with geese due to the fact that they use to stay together as families during autumn and winter, but it is different and more difficult with waders. In contrast to geese, juvenile waders migrate later and they have different habitat preferences than the adults. Due to that and many other factors influencing the measurements it is difficult to get as precise results as in geese but of course a classification of the breeding success is possible.

Other methods than measuring juvenile percentages are used to get an impression of the breeding success. Immature birds of Grey Plover, Bar-tailed Godwit and Red Knot spend their first summer (with an age of one year) in the Wadden Sea and therefore mid-summer numbers (when all adult birds have left to the arctic) may be used to classify the breeding success of the previous year also. In that case population-specific measurements are possible, since for example summering immatures of Red Knots are supposed to belong to the *C.c. islandica* population breeding in Greenland and north-east Canada. For species like Little Stints, where adult bird migration in the Wadden Sea is completed by the end of August and almost only juvenile birds are present in September, the September-numbers can be taken as total number of juveniles as a measure of breeding success.

Implementation of the Arctic portion of the North American 'Program for Regional and International Shorebird Monitoring (PRISM)'

R.B. Lanctot, US Fish and Wildlife Service (USFWS), Anchorage, Alaska, USA
P. Smith, Canadian Wildlife Service (CWS), Yellowknife, Northwest Territories, Canada
J. Bart, US Geological Survey (USGS), Boise, Idaho, USA
S. Brown, Manomet Center for Conservation Sciences, Manomet, Massachusetts, USA
H.L. Dickson, CWS, Edmonton, Alberta, Canada
G. Donaldson, CWS, Gatineau, Quebec, Canada
V. Johnston, CWS, Yellowknife, Northwest Territories, Canada
B. McCaffery, USFWS, Bethel, Alaska, USA
R.I.G. Morrison, CWS, Ottawa, Ontario, Canada

The arctic portion of PRISM recommends periodic, comprehensive surveys of breeding shorebirds in the arctic region of North America to estimate population size and trends, and to provide information on distribution, abundance, and habitat relationships. PRISM relies on a double sampling method that includes intensive and rapid surveys at a sample of plots selected randomly within a study area and stratified by habitat suitability. An overall shorebird detection rate for the rapid plots is estimated by conducting intensive surveys on a small sample of plots that are also surveyed using the rapid method; the goal is to develop species-specific detection rates eventually. After data have been collected at a large number of locations, regression models are built that predict the number of birds that would be recorded on rapid surveys covering every plot distributed throughout the entire study area. These numbers are summed across all the plots and divided by the detection rate developed from the intensive plots. Once implementation is begun, the entire arctic portion of North America will be surveyed within a 5-7 year period, and this sampling will be repeated every 15-20 years. Estimates of shorebird population trends developed from other portions of PRISM may prompt us to conduct arctic surveys more frequently.

Methods for conducting rapid and intensive surveys were developed in the National Petroleum Reserve and Colville River Delta of Alaska between 1998 and 2001. A peer-review of arctic PRISM protocols is scheduled to occur during the winter of 2003/2004. The current design aims to have at least two-thirds of the breeding range of each species surveyed, and at least an 80% power to detect a 50% decline occurring over 20 years with alpha = 0.15, a two-tailed test, and a procedure that acknowledges effects of potential bias. The double sampling protocol is assumed to reduce potential bias to negligible levels. Data collected in prior years and extension of the method to other portions of the arctic in 2001 and 2002 (e.g., Arctic, Alaska Maritime and Yukon Delta National Wildlife Refuges in Alaska; and Walker Bay, Somerset Island, Alert, and Northern Quebec in Canada) provided preliminary data to estimate detection rates and variance components. This knowledge allowed estimation of the number of rapid and intensive plots needed within each survey area to achieve the accuracy target described above.

An important assumption of the double-sampling approach is that all or nearly all items of interest (e.g., territorial males, nests) are detected on the sample of intensively searched plots. This assumption was tested in 2003 when biologists at four camps distributed throughout the arctic used 2-3 independent survey teams, two survey approaches (i.e., area search and rope-drag) and mark-recapture methodologies to estimate the number of birds being missed on intensive plots. The results from these analyses will be presented in more detail in Copenhagen. To date, a lack of funds and the desire for a peer--review of arctic PRISM has delayed full implementation of the program. Biologists from Canada and possibly Alaska plan to survey 2-4 additional sites in 2004 given adequate funding.

Monitoring and trends of Arctic wader populations passing Sweden during migration

Åke Lindström, Department of Animal Ecology, Lund University, Ecology Building, 223 62 Lund, Sweden, and Ottenby Bird Observatory, Pl. 1500, 380 65 Degerhamn, Sweden.

I review information about population trends, and variation in numbers between years, of ten species breeding partly or wholly north of the Arctic Circle: Ringed Plover, Ruff, Common Sandpiper, Wood Sandpiper, Broad-billed Sandpiper, Curlew Sandpiper, Dunlin, Knot, Temminck's Stint and Little Stint. The analysis is based on the regular trapping in autumn of migrants at Ottenby Bird Observatory in southeast Sweden, with data available since 1946. All populations are either stable or declining, and variation between years in some species is to a large extent correlated to lemming cycles on the Siberian tundra. Data quality ranges from good to tentative. The advantages and disadvantages of monitoring populations at a migration sites are also discussed.

Factors Affecting the Timing of Wader Breeding in Western Alaska

Brian J. McCaffery, U. S. Fish and Wildlife Service, Yukon Delta National Wildlife Refuge, P.O. Box 346, Bethel, Alaska, 99559, USA (brian_mccaffery@fws.gov)
Craig R. Ely, U. S. Geological Survey, Alaska Science Center, 1011 East Tudor Road, Anchorage, Alaska, 99503, USA (craig_ely@usgs.gov)

Many current models of global climate change suggest that impacts will be most dramatic at higher latitudes; such changes could dramatically affect the timing of breeding events in arctic and subarctic waders. In this study, we used correlational analyses to explore the relationships between environmental variables and the timing of breeding events for waders on the Yukon-Kuskokwim Delta in western Alaska.

Is there evidence for climate change in this region? Long-term temperature increases have been documented for average surface temperature in the North American arctic, mean annual temperature in Alaska, and mean annual temperature in western Alaska. Spring temperature increases may have the most dramatic effects on the timing of reproductive events in waders. A significant spring warming trend has been documented over the last 30 years in western Alaska. In addition, the primary first-order weather reporting station on the Yukon-Kuskokwim Delta, Bethel, has documented the highest single-season change in mean temperature among 20 first-order stations in Alaska, a spring increase of 3.7°C between 1971 and 2000.

At the local level, however, there is a discrepancy between long-term patterns of temperature change and certain conspicuous phenological benchmarks. Although there is a significant 40-year warming trend in April temperatures in Bethel, there is no such significant trend for May over the same period. There is no trend in the break-up date of the Kuskokwim River at Bethel, nor are there trends in the timing of river break-up, lake break-up, or snow-free dates at field study sites near the Bering Sea coast of the Yukon-Kuskokwim Delta.

Are there temporal trends in spring arrival dates for waders on the Yukon-Kuskokwim Delta? There are no temporal trends in spring arrival dates at Bethel between 1987 and 2003 for 5 common species of waders; similarly, there are no trends on the outer Delta over the last quarter-century (1977-2003) for 14 species of waders.

Are environmental conditions correlated with wader arrival dates in the spring? For four of five wader species at Bethel, there are no significant correlations between spring arrival dates and three potential indices of spring timing (mean April temperature, mean May temperature, Kuskokwim River break-up). All three indices, however, are significantly correlated with the Bethel arrival date of Pacific Golden-Plovers (*Pluvialis fulva*). On the outer Delta, arrival dates for 9 of 14 species are significantly correlated with mean April temperature and mean May temperature, as well as local patterns of snow-melt and river break-up. Among the species lacking such correlations, 3 of 5 are either exclusively or predominantly migrants, rather than local breeders. In this region, arrival dates predict the precision of migration timing, both among years and relative to local environmental conditions. Surprisingly, arrival dates are not correlated between Bethel and the outer Yukon-Kuskokwim Delta for the two species common to both sites, Western Sandpiper and Wilson's Snipe (*Gallinago delicata*).

Is there evidence for a shift in the timing of breeding in Western Sandpipers between 1966-1968 and 1998-2003? Richard Holmes studied Western Sandpipers on the outer Yukon-Kuskokwim Delta from 1966 to 1968; we and our colleagues have studied the same species at a nearby study site since 1998. To evaluate differences in the timing of breeding between the two periods, we first compared 16 spring weather variables (8 each in April and May). The only significant difference was that the latter period was snowier during April. Next we compared laying chronology between the two periods. There were no differences in the median or peak clutch initiation dates, but the seasonal duration of laying was longer during the more recent years.

Is there an advantage to early nesting by Western Sandpipers? The timing of clutch initiation and the timing of clutch depredations both exhibit significant annual variation. The mean initiation dates for all clutches as well as just first clutches are significantly correlated with the timing of clutch depredation. Despite this correlation, the length of the time lag between peaks in initiation and depredation varies annually, and ranges from 9 to 20 days. The length of the lag predicts late season nest success (the greater the lag, the lower the late season nest success). The daily survival rate of nests initiated prior to the mean initiation date was greater than those initiated after the mean date in only two of six years; the 6-year means of early vs. late nest survival did not differ. Although early nesting may not always lead to higher nest success *per se*, other potential advantages of nesting early include: 1) increased opportunities for re-nesting, 2) increased fledging success and/or post-fledging survival, and 3) increased survival for adults able to leave the breeding grounds earlier. Further analysis of our data should allow for at least partial tests of all three of these hypotheses.

Effects of climate and predation on breeding performance of Old World wintering Nearctic waders

Hans Meltofte, Dept. of Arctic Environment, National Environmental Research Institute, Denmark (mel@dmu.dk)

Nine out of Greenland's 11 species of breeding waders are confined to the High Arctic zone or have their main distribution there. The most common species are *Charadrius hiaticula*, *Calidris canutus*, *C. alba*, *C. alpina* and *Arenaria interpres*. The fluctuating dynamics of the Greenland-Canadian population of one of these High Arctic species, *Calidris canutus*, are probably related to periodic differences in adult mortality and juvenile production a.o. influenced by summer weather conditions (Boyd & Piersma, Ardea 89: 301-317, 2001). However, by contrast, little is known about the actual climatic variables affecting breeding conditions and output, except that snow cover early in the season (1st half of June) has a significant effect on timing of egg-laying, which vary up to 2-3 weeks between areas and seasons (Meltofte, Meddr Grönland, Biosci. 16, 1985). Also years with periods of inclement weather in June may have devastating effects on adult mortality and breeding performance.

Of the nine seasons of monitoring of High Arctic breeding waders at Zackenberg Research Station in central Northeast Greenland, three seasons were dominated by adverse conditions: late snowmelt in 1999 and snowstorms in July 2000 and June 2001, respectively. Surprisingly, only the late snowmelt in 1999 apparently resulted in more than locally reduced juvenile production in just one of the breeding species, *A. interpres*. One season, 2002, had unprecedented high ambient temperatures in late May and early June, resulting in a factor 3-13 times higher arthropod availability than recorded in other years, which coincided with onset of egg-laying that was among the earliest ever recorded in High Arctic Greenland. This may illustrate that not only snow cover working through accessibility of nesting habitats and reduced predation risk influence timing of breeding, but that also food availability is important, since Arctic waders find resources for egg production on the tundra (Klaassen et al., Nature 413: 794, 2001).

Mean predation pressures on nests ranged 27-53 pct. between species (note that nest predation recorded may be biased by our visits at nests) and displayed a positive, but non-significant relationship to the abundance of arctic fox ($R^2 = 0.44$, $p = 0.10$). There was no correlation between predation and previous winter's abundance of lemmings ($R^2 = 0.01$), nor between numbers of arctic foxes encountered and lemming abundance the previous winter ($R^2 = 0.24$).

Population densities in the 19 km^2 census area have been rather stable through the years. Numbers of *C. alpina* may have increased, while numbers of *C. canutus* have decreased. *A. interpres* seems to have been negatively affected by the three consecutive problematic breeding seasons mentioned above.

Getting laid at Alert: what can the Turnstone egg tell us?

R.I.G. Morrison, Canadian Wildlife Service, National Wildlife Research Centre

Measurements and masses of Ruddy Turnstone eggs/clutches found at Alert from the early 1990s to 2003 will be examined in relation to climatic variables and estimates of thermostatic costs during the period of egg laying to determine whether climatic factors may influence size and mass of eggs.

Exploring the suitability of migration results from eastern North America for assessing productivity of Arctic-breeding shorebirds.

R.I.G. Morrison & H. Boyd, National Wildlife Research Centre, Canadian Wildlife Service

Counts of shorebirds have been made at two-weekly intervals during the period of southward migration at sites in the Maritime Provinces on the east coast of Canada since 1974. Data from the surveys will be analysed to develop estimates of relative numbers of adult and juvenile shorebirds passing through the region. These estimates will be examined in relation to weather variables from different regions of the Arctic to determine whether Arctic weather patterns can be related to apparent breeding success.

Monitoring Arctic breeding success via the percentage of juveniles in wader populations in Australia

Clive Minton, 165 Dalgetty Rd, Beaumaris Melbourne, Australia, VIC 3193

The practical difficulties of measuring, on a long-term basis, reproduction rates of arctic breeding waders are briefly reviewed. The benefits and shortcomings of achieving a quantitative measurement of breeding success via the percentage of juveniles in catches of waders made for banding are outlined, together with procedures necessary to maximise reproducibility. "% juvenile" data on seven species, gathered by the Victorian Wader Study Group over a period of 25 years in S.E. Australia, is presented together with similar information on a wider range of species generated by the Australasian Wader Studies Group/Broome Bird Observatory in N.W. Australia during the last five years. There is a marked variation in apparent breeding success between species and between years, often with little synchrony. Some of the breeding success data correlates well with population counts in Australia. Potential correlation with climate and predator conditions on the Arctic breeding grounds will be outlined in a separate presentation (by Mikhail Soloviev *et al.*).

The effects of weather on adult body mass, breeding success and survival of the Semipalmated Plover in Churchill, Manitoba

Erica Nol & Katherine A.R. Graham. Trent University, Peterborough, ON K9J 7B8, Canada, enol@trentu.ca; kgraham@trentu.ca

Using data from a twelve year study on the biology of the Semipalmated Plover (*Charadrius semipalmatus*) breeding in the Canadian sub-arctic, we examined the effects of weather fluctuations on (1) individual body condition (using weather 24 h prior to weighing), (2) population level breeding parameters including clutch initiation dates, clutch size, hatching success and breeding population size (using weather during relevant parts of the breeding season) and annual survival rates (using average breeding season weather both for that year and the subsequent year). Weather on the day prior to capture did not impact mass for either sex. Minimum temperature during the average arrival dates for the population was the only weather variable (negatively) associated with date of clutch completion. Weather in the early breeding season negatively impacted local population size, but only when the average minimum temperatures went below freezing, presumably through the effects on the ability of plovers to feed. Local survival estimates were not related to breeding season temperatures nor to the Southern oscillation index (SOI). We conclude that Semipalmated Plovers, despite their 'tropical like' lower critical temperature of 23^{o}C, are surprisingly resilient to temperature fluctuations at this location.

Monitoring of Icelandic Shorebirds/Waders. Will climate change influence Snipe populations?

Aevar Petersen & Sverrir Thorstensen, Icelandic Institute of Natural History, aevar@ni.is

Monitoring data on waders in Iceland is generally very scanty. The longest time series relates to arrival/departure data, for some species extending to the beginning of the 20^{th} century, and annual Christmas Bird Counts of wintering populations since 1952. The longest breeding population data series is from Flatey Island (W. Iceland), esp. since 1975 (7 wader species). Great many one-time censuses, using plots or transects, have been carried out, esp. in recent years. Study into census methodology is being undertaken, and total population censuses, density and habitat data have been used to estimate breeding wader populations in Iceland (11 regular species).

Common Snipe *Gallinago gallinago* breeding biology has been studied, in particular since 2000. Although the study begun, and has focused on explaining the unusually protracted breeding season of this species, information has also been collected indicating rainfall as an important proximate factor in influencing re-laying, and possibly breeding success, in Snipes. The key appears to be the vertical distribution of soil invertebrates, so important as food for Snipes. Dry periods are suggested to influence the total production of young per season, probably effecting the breeding population in the long run. However, direct linkages from productivity to population status is thwarted by complex population dynamics, esp. relating to immigration-emigration, on which no data are available. If climate change will generally result in drier weather, this may have long-term effects on the Snipe population and its distribution.

Measuring recruitment with telescopes: a pilot study of age-ratios of Red-necked Stints on the non-breeding grounds (poster presentation)

Danny Rogers, Johnstone Centre, Charles Sturt University, PO Box 789, Albury NSW 2640. Correspondence to D. Rogers, 340 Nink's Road, St Andrews, Victoria 3761; email: drogers@melbpc.org.au

Ken Rogers, 340 Nink's Road, St Andrews, Victoria 3761

Mark Barter, 21 Chivalry Ave, Glen Waverly, Victoria 3150

The breeding success of migratory waders differs from year to year; it is affected by factors such as lemming cycles and the time of snowmelt on the breeding grounds. Fluctuations in breeding success can be detected in Australia because they affect age-ratios in the non-breeding flocks of waders that we observe here. Documenting these age ratios can provide valuable information; it can help to interpret population trends revealed by wader counts; it improves our understanding of why breeding success varies from year to year, and as breeding success varies geographically, it can provide insights about where our waders breed. In the future it may play a large role in understanding the effects of global warming on wader populations. Australian wader banders, especially in Victoria, put a great deal of effort into catching and ageing large numbers of waders in summer so that age-ratios can be assessed. Some nice results are coming out of this work. However, huge efforts and large banding teams required are required to collect this data, so few sites can be tackled.

In the right circumstances, many species of waders can be aged accurately and objectively in the field with a telescope. In this presentation we demonstrate how Red-necked Stints can be aged in the field right through the austral spring, illustrating the methods by using photographs obtained through 'digiscoping'. Ageing is simple early in the spring, when first year stints have complete juvenile plumage. It becomes more difficult as post-juvenile body moult proceeds, but remains possible until the end of November.

Age-ratio data obtained in this manner are presented from a pilot study in at Werribee Sewage Farm, near Melbourne, during the austral springs of 2001 and 2002. We found that the great majority of juveniles had arrived before post-juvenile moult became too advanced for easy field ageing. Local distribution of juveniles was not homogenous; juveniles tended to cluster in small groups and spent far more time feeding at high tide than did adults. Implications of these findings for assessment of age-ratios by cannon-netting are discussed (in particular the sample sizes required for representative data), and we compare our overall age-ratios with those obtained through cannon-netting at the same site in the same years. We conclude that both cannon-netting and telescope observations can provide solid data on age ratios.

Despit its title, this presentation has discussed estimation of age ratios rather than of recuritment rates. Age-ratios can differ from site to site: e.g. at Werribee Sewage Farm in the summer of 2003/2004, Red-necked Stint juvenile ratios were low, only 3-5%. But at Point Cook, only 10 km north, juvenile ratios were around 23%. Regional variation such as this (which may happen on a still broader scale) makes calculation of recruitment difficult. If we are to develop realistic estimates of recruitment rates it would therefore be desirable to measure age ratios at many sites. This may be the greatest advantage of telescope observations, as they can be make by a single observer. They may also be valuable as a measure of age-ratios at sites where cannon-netting is not practical or on species that are difficult to catch.

Documenting a decline in nesting birds in northwestern Alaska: a comparison of the 1970s and the 1990s

Douglas Schamel & Diane M. Tracy, Department of Biology & Wildlife, University of Alaska Fairbanks, Fairbanks, AK 99709 USA

We studied nesting wader populations at Cape Espenberg, in western Alaska (66^o 30' N, 163^o 30' W), during the summers of 1976-79 and 1994-1999 & 2001. The 18 km^2 area is entirely tundra. Parallel low-lying dune ridges provide dry habitats; between these ridges is a mosaic of ponds, lakes, and wet marshes. We monitored avian abundance by: (1) one 25 ha nesting plot, (2) four 2 km X 25 m transects, and (3) qualitative notes on relative numbers of birds seen daily. We attempted to locate all nests in the 25 ha plot. Nests were monitored regularly to obtain nest fate data. Nest initiation dates were determined by finding nests during laying, by backdating from hatching, and (in the 1990s) floating eggs. We attempted to capture and color-ring all adults and chicks.

In total, we recorded 98 nesting species, including 11 wader species. Of these, 7 species were considered at least somewhat common nesting species. Comparing the 1970s with the 1990s, six species became less common nesters and only one species became more common (Black-bellied Plover, *Pluvialis squatarola*). Some species showed dramatic declines between the 1970s and 1990s. Nesting western sandpiper (*Calidris mauri*) and semipalmated sandpiper (*C. pusilla*) numbers in our nesting plot dropped from a mean of 24 nests and 19 nests, respectively, in the 1970s to a mean of 4 and 1 nest in the 1990s. Red (*Phalaropus fulicarius*) and red-necked (*P. lobatus*) phalaropes declined from a mean of 14 and 43 nests, to 8 and 22 nests, respectively.

The nesting success of all avian species, including waders, showed a statistically significant decrease between the 1970s and 1990s. Red-necked phalaropes showed the largest decrease, from a mean of 75% success in the 1970s to a mean of 12% success in the 1990s. The return rate of nesting adults also declined significantly. Red-necked phalaropes, our most closely monitored species, declined from 52 to 29% return rate of adults.

Although we have no data to explain the cause of the decreases in abundance of species between decades, we suspect that bird numbers were kept low in the 1990s by an increase in egg and bird predators. Arctic (*Alopex lagopus*) and red (*Vulpes vulpes*) foxes and sandhill cranes (*Grus canadensis*) were more common in the 1990s, but glaucous gulls (*Larus hyperboreus*) were significantly less common. In addition, nesting waterfowl, principally common eiders (*Somateria mollissima*) and long-tailed ducks (*Clangula hyemalis*), decreased 10-fold, thus removing a buffer from predation for nesting waders. In general, we found no compelling evidence for a change in mean nesting dates between the 1970s and 1990s; year-to-year variability was more pronounced than differences between decades. Weather data from nearby Kotzebue revealed no inter-decadal differences in May or June mean temperatures.

Arthropod availability, weather and chick growth in the Siberian tundra

Hans Schekkerman & Ingrid Tulp, Alterra, PO Box 167, 1790 AD Den Burg, The Netherlands

Arctic-breeding waders enjoy only a narrow window of time suitable for reproduction during the arctic summer. Snowmelt and the onset of autumn frosts set 'hard' limits to this window. Within these, timing of breeding may still have fitness consequences, e.g. because it affects breeding success or because birds leaving early gain competitive benefits at stopover, moult or wintering sites. Temporal matching of hatching dates with the midsummer peak in insect abundance has often been mentioned as a strong selection pressure on timing of breeding in arctic waders, but empirical data showing an effect of hatching date or insect abundance on chick growth or survival have been scarce.

We have studied the interplay between date, weather, availability of surface-active tundra arthropods and chick growth during five summers in Taimyr, Siberia. In all years, the surface activity of arthropods which form the prey of wader chicks showed both a seasonal trend and strong superimposed weather-dependence. Correlations between chick growth rate and arthropod availability were shown in different sites and years for Curlew Sandpipers, Knots and Little Stints. Little Stint broods ringed within a few days from hatching late in the season, after a decline in arthropod availability, were less likely to be encountered again more than 3 days later than earlier broods. The percentage juvenile Curlew Sandpipers in winter catches from South Africa over an 18-year period correlated with average temperatures on Taimyr during the 10 days in which most clutches hatch, after correction for effects of lemming cycles (Ardea 86: 153-168, 1998). Measurements of energy expenditure and time budgets of Knots however show that required intake rate is higher in older chicks than in newly born ones, so that a close match with the insect peak is not only important for hatchlings (Oecologia 134: 332-342, 2003).

During several of our field years, shorebird hatching dates fell slightly after the peak of insect availability, the date of snow melt seemingly precluding earlier start of breeding. However, the exact timing of insect peaks varies strongly from year to year due to weather effects, and 5 years are not enough to evaluate the 'optimality' of breeding phenology. Lacking data on arthropod abundance for more years, but noting the strong effect of weather, we derived regression models describing arthropod availability at Medusa Bay near Dickson in relation to date and temperature, and applied these to a 30-year temperature dataset to 'reconstruct' the temporal pattern in food availability in that period. Results indicate that wader hatching dates as observed in 2000-2002 match the period in which the food peak is most likely to occur. The weather data also seem to show a long-term trend of increasing variability in the timing of peak arthropod availability. This would mean that the time window in which wader chicks *may* find sufficient food to grow has widened, but the probability that they *actually do* so on a given date has decreased.

Effects of global change on the ability of shorebirds to match reproduction with a seasonal food peak may not only depend on temperature and precipitation during summer, but also on climate variables affecting the date of snow clearance, e.g. winter precipitation, wind and spring temperature. How the seasonal pattern of arthropod availability depends on the date of snow clearance is an important question in this respect.

Factors influencing nest site selection and reproductive success in the shorebirds of East Bay, Nunavut, Canada

Paul A. Smith, Canadian Wildlife Service, Yellowknife, NT, Canada

In structurally simple habitats such as tundra, nest success may be determined by factors other than habitat. I studied the influence of nest habitat, food, nest distribution and parental behaviour on the reproductive success of tundra breeding shorebirds at East Bay, Southampton Island, Nunavut. From 2000-2002, I monitored the nests of five species: Black-bellied Plover (*Pluvialis squatarola*), Red Phalarope (*Phalaropus fulicaria*), Ruddy Turnstone (*Arenaria interpres*), White-rumped Sandpiper (*Calidris fuscicollis*) and Semipalmated Plover (*Charadrius semipalmatus*). For each species, habitat differed between nest sites and random sites. In contrast, habitat differed between successful and failed nest sites only for White-rumped Sandpipers. Though nest success varied markedly between species, artificial nest experiments suggested that interspecific variation in predation rate was not related to habitat type. Shorebirds did not prefer to nest in habitats where food was most abundant. Instead, interspecific patterns of success are consistent with the hypothesis that risk of predation is related to the amount of parental activity near the nest.

Variation in behaviour within a species may also be related to predation risk. Red Phalaropes nesting in association with the aggressive Sabine's Gull (*Xema sabini*) took more frequent and longer incubation recesses than phalaropes nesting far from gulls. In 2000 and 2001, hatch success was 17-20% higher for phalaropes with nearby Sabine's Gulls, but this effect was reversed in 2002. Sabine's Gulls are able to defend their nests from avian predators only, and arctic foxes (*Alopex lagopus*) were abundant and lemmings (*Dicrostonyx groenlandicus*) scarce in 2002. An artificial egg experiment in 2002 failed to demonstrate an effect of Sabine's Gulls on nest or egg losses. I suggest that phalaropes select coastal sites near Sabine's Gulls, but that this association is beneficial to phalaropes only in years when arctic foxes prey mainly on lemmings.

‘Arctic Birds Breeding Conditions Survey’ (ABBCS) as a tool for monitoring of Arctic waders on breeding grounds

M.Y. Soloviev & P.S. Tomkovich, Dept. of Vertebrate Zoology, Moscow State University, Moscow 119992, Russia

Arctic Birds Breeding Conditions Survey was started in 1997 as a joint project of International Wader Study Group and Wetlands International's Goose and Swan Specialist Groups with the primary objective of evaluating breeding success of Arctic waterbirds on annual basis. This has been achieved by collating information about breeding conditions in the survey database, publishing it to project websites and summarizing in annual newsletters. The project scope was extended from waterbirds to all groups of Arctic terrestrial birds, but waders continue to be the focus of the research efforts. The database currently holds information for the period of 15 years from 1989-2002, generally falling into one of the two broad categories: descriptive data on breeding conditions in various Arctic localities (http://www.arcticbirds.ru) and data on abundance and breeding performance of individual bird species. The latter component of the database is also accessible on-line (http://arctic.ss.msu.ru/birdspec/) and contains over 3000 records on distribution, breeding status and abundance of individual wader species. The system created is easily expandable and can be adapted to the new types of monitoring data in case of necessity.

Nesting success of tundra waders, rodent abundance and weather from Taimyr to Chukotka

M.Y. Soloviev, P.S. Tomkovich & C. Minton

Nesting success of Arctic waders is presumed to depend on weather conditions and numbers of rodents as alternative prey for predators. However, these relationships were mostly demonstrated at scales ranging from local to at best regional, while assessment for flyway populations was difficult due to deficiency of data allowing formal quantitative processing. We used data for a period of 15 years from 1989-2002 accumulated in the framework of the Arctic Birds Breeding Conditions Survey (International Wader Study Group project) to study dependence of wader nesting success across ranges of selected species on rodent abundance and temperature regime during breeding season. Proportions of juveniles on Australian wintering grounds were used as independent source of information about breeding performance of wader species. Nesting success of Sharp-tailed Sandpiper, Curlew Sandpiper, Red-necked Stint and Turnstone significantly correlated with summer temperature in the Eastern Siberia, while influence of rodent abundance was less pronounced. Significant correlations of nesting success and juvenile proportions were found only in Turnstone and Curlew Sandpiper. Absence of this relation in other species may indicate relatively high contribution of chick/juvenile mortality to breeding performance, or reflect potential biases in the data from breeding or wintering grounds.

What does DNA analyses reveal about historical population sizes, genetic structure and population bottlenecks?

Liv Wennerberg, Zoological Museum, University of Oslo, Norway, liv.wennerberg@@nhm.uio.no

The genetic compositions of present day populations of waders have been shaped by evolution. Natural selecting has favoured certain mutations and others have been lost due to their negative effect on fitness. In addition, random processes (e.g. genetic drift) and changes in effective population sizes have affected the gene pool, including founder events, population bottlenecks and population expansions.

As important processes in the historic populations have affected the genetic variability of the species today, it is possible to get insight into the history of a species by analysing DNA from its now living relatives.

In my talk, I present the genetic variability in a selection of wader species and discuss the variation in genetic variability and some possible factors behind the patterns we see today. I also show examples of species for which genetic analysis indicate historic population expansions or bottleneck events.

I conclude that DNA analysis can be used for insights into historic population trends, but also point out that assumptions of mutation rates strongly influence the results and this should be kept in mind when interpreting the results.

Arctic Biodiversity Monitoring: How trends in waders and other taxa can contribute to the understanding of the driving forces for population changes

Christoph Zöckler, UNEP-WCMC, 219 Huntingdon Road, Cambridge CB3 DL

Waterbird monitoring has strongly advanced in recent years. Trend data of waterbirds and waders in particular are available from the Arctic and outside from major staging and wintering sites. Most of these data are captured in the ever more effective framework of the IWC (International Waterbird Census) by Wetlands International. However, the opportunities for spatial and intertaxonomic integration as well as the integration of observer networks have not yet been fully explored.

The incomplete, scattered and unevenly distributed status of trend data across the Arctic and northern temperate regions and between taxa has been recognised by the CAFF (Conservation of Arctic Flora and Fauna) biodiversity monitoring working group CBMP. The Arctic region has the great advantage of relatively few direct negative impacts from human activity. Because direct human impact in the Arctic remains at a very local level, most developments that have been observed there can be interpreted as natural effects or global phenomena, such as climate change and euthrophication. Current monitoring programmes mostly lack information on many relevant taxa, a bias towards harvested, and/or rare species, inconsistency of coverage, and perhaps most importantly, a lack of integrated analyses.

Rare species naturally receive more attention and are more likely to be monitored than common species. Therefore some changes may be recorded more readily among rare species. However, those factors affecting changes in numbers that are of a more global, overriding character can only be detected by monitoring commoner species. The decline in the non-breeding population of Dunlin in Japan might be caused by the same problems that affect the neighbouring Spoon-billed Sandpipers. As knowledge of the flyways used by different populations increases, it becomes possible to relate populations monitored in the non-breeding season to defined areas of the Arctic. Only more data on the larger wader populations can further indicate to the various hypotheses.

In order to elucidate on the reasons for declines in wader populations a web-based GIS interface or 'portal' is proposed to integrate efforts of monitoring biodiversity throughout the Arctic and those outside connected by a flyway. This will comprise of a collation of decentralised and distributed web databases containing trend data and other relevant spatial datasets. The design of a web portal for the Arctic will allow access to trend data, spatially referenced and possibilities to correlate this with physical variables such as climate data, nutrient levels and pollution. It will also allow access to other spatial data such as habitat type, protected area status and others, such as land use, acidification, water level changes, industrial & agricultural pollution and others such as reindeer density, mining sites and infrastructure. Many of the required data are not fully available. It should be designed to handle data at different scales and in different units, harmonised in a collation of databases, which will allow spatial integration, comparisons between regions and finally trend analyses. A prototype for the Arctic aims towards the design of a geo-referenced web portal starting with a selected set of available database applications that will allow preliminary integration and analyses of geographically harmonised data. These could include Polar Bears, seabirds and seals, as well as Arctic Char, Reindeer, geese, vegetation and waders. Further development will gradually improve access to more and more datasets. An introduction is given through a preliminary demonstration web version with only local database access at http://trinity.unep-wcmc.org/imaps/arcticBirds/viewer.htm.

Most noteworthy is the Arctic Breeding Conditions Monitoring programme run by Moscow University and supported by the Dutch Government. Similar programmes are in development for Reindeer, Arctic Char, and seabirds and to some extent for geese and some waders, but rarely on a circumpolar basis, involving more than just one country. A large number of wader populations breed in the Arctic region and the Wader Study Group is ideally positioned and well experienced to contribute substantially with their data to integrated monitoring of Arctic Biodiversity.

The potential output is enormous but will very much depend on the initial input and the maintenance of decentralised or distributed databases. Each participating organisation or data custodian will maintain their own specialist database, with regular maintenance and updates. The most obvious challenge lies in the analysis of biodiversity trend data, both in itself and in relation to factors such as climate change.

One output might be the development of "Arctic Species Population Trend Indices" in line with the Living Planet Index (LPI) currently undertaken by WWF and UNEP-WCMC or others. Depending on the variety of taxa included in the monitoring programme, regional subsets of the indices could be developed. A marine or terrestrial index would illustrate differences in trends between these biomes and regional subsets could highlight differences between regional seas or between selected terrestrial regions. Furthermore, the interface could be set up to allow habitat or ecosystem related indices. Another possible distinction in the interface could refer to migratory species, including whales, seabirds, geese and waders. Comparing trends of migratory taxa, such as waders with trends of sedentary taxa in the same sub-region, biome, flyway area (including e.g., mammals, freshwater fishes and plants) would provide further indications on the geographical origins of the observed trends.

Another valuable opportunity would be to correlate wader trend data with natural fluctuations, such as small rodent cycles, and also with anthropogenic impacts such as pollution (AMAP data), climate variables and others. With improvements in the quality and quantity of available data from various sources we should become more confident in our ability to distinguish climate-related changes or other anthropogenic factors from natural fluctuations.

Ideally, the structure of the interface should be designed in such a way that it can be transferred and made applicable for other regions and biomes. The advantages of starting with an Arctic prototype are:

- The relatively small number of species
- The opportunity to build on an existing intergovernmental programme (CAFF and AMAP) under the Arctic Council
- The opportunity to build on existing and well established networks, such as Wetlands International and the Wader Study Group
- The relatively low direct human impact in the region
- The opportunity to evaluate the potentially large regional impact of climate change.

The need to extend and enhance wader monitoring has frequently been highlighted. The continuing declines of many wader populations and speculation about the relative importance of the many reasons behind these declines would benefit from additional co-ordinated monitoring schemes and analysis with sophisticated modern database, GIS and web facilities. If funding for this approach can be obtained, it should also allow better networking between and within research groups and better co-ordination of monitoring as well as better use of modern GIS applications.