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Irrigational agriculture and conservation of biodiversity in Dzhankoi District of the Autonomous Republic of Crimea

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This publication is a result of implementing a part of Ukrainian-Dutch project 'Towards improved water Management in Ukraine' (Watermuk), which was aimed at revealing current state and perspectives of irrigational farming in Ukraine on the example of Dzhankoi District of the Crimean Autonomous Republic. The monograph is dedicated to the biodiversity of this area. It provides information on the main taxonomic groups of animals and plants; discusses changes in species composition and abundance under the influence of irrigation; identifies the most valuable for conservation of biota areas and measures to be taken in order to protect them. Taking into account that environmental conditions and state of habitats important for species with high conservation status are inseparably linked to the condition of the Sivash as a whole, a lot of attention is given to the problems of sustainable management of this unique waterbody.

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Contents

Introduction

This publication is a report on the results of part of a Ukrainian-Dutch project, 'Towards Improved Water Management in Ukraine' ('Watermuk'), which aimed to ascertain the current state of and prospects for irrigation farming in Ukraine, taking as an example the District of Dzhankoi in the Crimean Autonomous Republic. The report focuses on the biodiversity of this district. It provides information on the main taxonomic groups of animals and plants, discusses changes in species composition and abundance under the impact of irrigation, and identifies the areas most valuable for conservation of the biota and the measures to be taken in order to protect them. The aquatic area of Lake Sivash, the largest wetland complex of its kind in Ukraine and the most important in terms of its role in waterbird conservation at the international level, comprises more than a third of the district's total area. In view of the fact that environmental conditions and the status of habitats important for species of high conservation value are inseparably linked to the condition of Lake Sivash as a whole, a great deal of attention is paid to the problems of managing this unique water body sustainably.

The project was fully funded by the Government of the Netherlands. The Alterra Institute (Netherlands) implemented the project and coordinated the research effort. Staff of Wetlands International's Black Sea Programme coordinated the section of the report that assesses the impact of irrigation on the biodiversity of the region.

Since 1963, when the first stage of construction of the North Crimean Canal was complete, fresh water began to arrive in one of the most arid regions of Ukraine — the Prisivashie ('vicinity of Lake Sivash'). The arrival of fresh water radically changed the economic life of the region: huge areas were transformed into agricultural fields and covered with a dense network of irrigation or drainage canals. This stimulated the development of mutton, beef and dairy farming, and created the economic basis for a processing industry. Consequently, the number of settlements and villages increased, and the transportation network grew much denser. However, because of this radical transformation of the environment the areas with steppe ecosystems declined; the salinity of the Sivash fell, particularly in the east; dense reed beds developed on mudflats and saline land; and some wildlife species disappeared, while others showed a marked increase. Since the breakdown of the Soviet Union, however, during the transition from a centralised, planned economy to a market economy, the irrigated areas of the Prisivashie have decreased significantly. Under the new economic conditions (land privatisation, breakdown of the large collective farms and emergence of small private farms, rise in water and electricity prices) the future of irrigation farming in this area has been brought into question. The main task of the 'Watermuk' project was to clarify whether or not it was possible to continue with irrigation under the new conditions. The results of the study have shown that even today, when no easy solutions are to be expected in any sector, irrigation faming can be profitable and has the potential to recover and develop further. Careful business planning, marketing, the use of new technologies and integrated water management are the key components of success in the future.

Only a small part of the 'Watermuk' project was concerned with determining the current state of the biota and impact of irrigation on the environment and wildlife of Dzhankoi District. Limited financial resources and the limited amount of time available for project implementation prevented researchers from addressing all the topics in the detail that they would have wished. Unfortunately, these constraints are typical of scientific investigations carried out within the framework of such short-term projects. Many questions arise in the course of the study when it is already too late: budgetary restrictions or lack of time limit enthusiasm and curiosity. Nevertheless, the team of specialists from a number of scientific institutions in the Crimean Autonomous Republic, Melitopol and Kyiv have successfully concluded their research and obtained some interesting results.

In discussing the development of irrigation farming in Dzhankoi District environmental protection issues, which include wildlife conservation, must undoubtedly be taken into consideration. In economically developed countries that have a broad range of sectors, including agriculture, issues of environmental concern are increasingly coming to the fore. The many and varied results of economic growth that impact upon nature are increasingly frequently taken into account, and much effort is devoted to minimising their negative impact on the environment. In Ukraine, bringing agriculture up to date in environmental terms remains largely a theoretical task. Problems with land ownership, gaps in the

environmental legislation, lack of financial mechanisms to stimulate environmentally friendly land use, the low level of awareness of land users — all these prevent rapid and noteworthy progress in this area. However, whether we like it or not we will be facing the need to find solutions to these problems in the years to come. Either internal or external circumstances, such as the deterioration of the ecological situation in the country or desire to enter the developed world (through joining the EU or another international union) will mean that we will have to turn theory into practice.

Therefore we hope that the results of this study and recommendations proposed by the scientists who worked on the report will eventually be implemented. This will help to protect rare wildlife species and the valuable ecosystems of Dzhankoi District, as well as promote the sustainable development of agriculture in the area.

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Coordinator

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1. Brief Physiographic and Socio-economic Description of Dzhankoi District

The District of Dzhankoi is situated in the steppe zone of the Crimean Peninsula. It is bounded to the north and northeast by the waters of Lake Sivash. To the southeast and — partly — the south, the district is bordered by Nyzhniohirsk District and to the west by the Districts of Pervomaisk and Krasnoperekopsk. Dzhankoi District stretches 57 km from north to south and 63 km from east to west. It occupies an area of 2,667 km^2, 2,063 km^2 of which is terrestrial, with 604 km^2 being part of the aquatic area of Lake Sivash.

The local climate is moderately continental, semi-arid with considerable daily and annual fluctuations of air temperature; the average annual temperature is +11.5 °C. Alkali, leach-chestnut saline and dark chestnut saline soil types predominate (Podgorodetsky, 1988).

Dzhankoi District belongs to the sub-area of desert steppe. As well as the prevailing zonal steppe vegetation, intra-zonal types of meadow vegetation occur. According to the Geo-botanical zoning of the Ukrainian SSR (1977) the Prisivashie zone is part of the Azov and Black Sea Steppe Sub-Province, which in its turn is divided into three belts: motley—wormwood—fescue grass belt, wormwood—fescue grass belt and wormwood—grain grass belt steppes. The latter type of steppe includes a wormwood—fescue grass belt and wormwood—turf—grain grass belt, which, together the halophytic vegetation of the saline area, are typical for the Crimean part of the Prisivashie. There are no natural forests.

In the past, 85% of Dzhankoi District was covered by steppe and saline areas. Today, natural ecosystems are restricted mainly to the coast of the Sivash and occupy less than 10% of the district. The coastline of the Sivash is highly indented. Coastal cliffs may be 3–10 m high, and there are lowland depressions, which often merge with shallow bays.

The presence of both natural and transformed habitats accounts for the fairly high species diversity of the local flora and fauna.

Dzhankoi District is one of the largest administrative units of the Crimean Autonomous Republic (see Annex I, Fig. 1). It is governed by a district council (Rayonna Rada). The administration is divided among 26 village councils and two settlement councils, the town of Dzhankoi being the district's administrative centre. The total population of the district is 82,000 people, with more than 42,000 people living in the town of Dzhankoi.

The economy of the district is agro-industrial in character, and this has been determined by the environment. The black earth (chernozem) plains are areas of non-irrigated agriculture. In the dry steppe plains with chestnut soils it is impossible to cultivate land without irrigation; however the dry steppes and semi-deserts are suitable for cattle breeding (Kurakova, 1983). Dzhankoi District has a diversified agricultural industry: grains, vegetables, fodder plants, grapes and fruit are grown here. The district also produces various items for cattle farming and carries out industrial processing of raw materials.

The mineral resources of Dzhankoi District are represented by brick-clay raw materials, sand-gravel beds, mineral wells, iodine-rich thermal underground waters and gas deposits. Several key railroads and highways cross the district.

The processing industry plays a leading role in the district's industrial potential. Fruit and vegetable canning and food and wine industries have been developed, and large quantities of building materials are produced. The Azov Liquor Plant, the 'AgroPromService' (repair service for agricultural machines) and the Azov Bakehouse are the most important industrial enterprises.

The local agriculture is primarily horticultural. Eighty per cent of the area is occupied by arable land; the remainder is occupied by orchards (2.2%), vineyards (1.2%) and fallow land (1.2%). Almost half of the cultivated land is under irrigation. Pastures, which are mostly restricted to the north of the district, comprise more than 13% of the area. The major irrigated areas are located in the heart of the district.

However, throughout Dzhankoi District the majority of farms are on the verge of ruin. The local population can barely afford irrigation farming due to the high cost of water supplied from the North Crimean Canal, and the people tend to be involved in aspects of agriculture that do not require irrigation. Furthermore, a system of channels distributing water from the main canal branch has been destroyed. What has happened in the livestock-raising sector is typical: the majority of the sheep and cattle farms are no longer suitable for use. There are currently no cattle herds numbering more than a thousand head in Dzhankoi District.

2. Construction of the North Crimean Canal and its Consequences for the Regional Economy and Environment

The arid steppes of the Crimean Peninsula, where most agricultural fields are now situated, have always suffered from severe drought. In this zone the annual average precipitation does not exceed 300–350 mm, even in relatively favourable years. In some years dry periods may last for 90–96 days. Statistics show that the Crimean Prisivashie is normally dry for 30 years in every 50 (Irrigational farming ..., 1989). This is why before the construction of the North Crimean Canal a large area of agricultural land, particularly land in the north of the Prisivashie (where saline land predominates), was used mostly for cattle and sheep farming.

The idea of bringing water from the Dnieper River to the dry areas of Crimea was born as early as 1846, and subsequently proposed several times. However, it was not practicable to build a canal until the Soviet era: the first branch of the North Crimean Canal was opened in October 1963.

The North Crimean Canal is a unique hydrotechnical construction. Its huge size and complicated structure mean that it has no rival in Europe. The total length of the canal is 402.6 km; it is 100–150 m wide and up to 7 m deep. The volume of water supplied by the canal is 2.5 times greater than the total drainage of all the rivers of Crimea.

From 1966 to 1986 the area of irrigated arable land in Dzhankoi District grew by a factor of 3.4: in the early 1990s it comprised a total of 71,800 ha — two to three times larger than the areas in the neighbouring districts. However, very soon the negative impact of irrigation on the soil structure resulted in the need to take a further 61,500 ha of land for the construction of drainage systems; therefore by the early 1990s about 130,000 ha or 48% of the total area of Dzhankoi District was subject to the impact of irrigation in one way or another. Of course, the expansion of the area of arable land has been a driving force behind the further development of agriculture. As a result, a total of 214,000 ha of Dzhankoi District are now being used for various agricultural purposes. It is also important to point out that besides amelioration measures, taken to promote irrigation farming, numerous forest belts have been created in the region to protect crops from wind and retain snow on the fields. From 1963 to 1985, over 400 km of forest belts covering a total of 600 ha were planted. When areas subject to the impacts of amelioration (creation of both irrigation and drainage systems) in the neighbouring districts are compared to those in Dzhankoi District, it becomes clear that the latter has undergone the most significant changes (Table 1). The construction of the North Crimean Canal and introduction of intensive irrigation farming techniques have profoundly changed the way local agriculture affects the environment. In fact, this was the beginning of a progressive transformation of the aboriginal steppes into typical agricultural landscapes.

As a result of these changes, the intensive development of irrigational agriculture has led to the ruin of a large number of terrestrial ecosystems. The species diversity and numbers of many animals and plants have decreased significantly. The discharge of a huge quantity of fresh water from the fields into the aquatic area of the Sivash has been another negative consequence of the intensification of farming. Since the irrigation system has been in full operation the entire ecosystem of the Sivash has been constantly affected by the discharge of fresh water. Measurements of salinity taken from 1950 to 2004 show that the average mineralisation of the water of the Sivash has been subject to significant changes during this time. Three periods when

Table 1
Areas affected by amelioration in four districts in the Crimean Prisivashie by 1 January 1989

District	Irrigated area, ha	Drained area, ha
Krasnoperekopsk	36.8	20.1
Dzhankoi	71.8	61.5
Nyzhniohirsk	28.4	31.5
Krasnogvardiysk	31.2	3.9

Table 2
Average salinity of the Eastern Sivash at different periods

Period	Years	Average salinity (g/l) *	Min –max
First period	1950–1975	82.5	42.3–133.1
Second period	1976–2000	11.6	1.0–18.7
Third period	2004–present	17.1	10.6 –23.5

Note: * — Measurements taken in all parts of the Eastern Sivash were averaged.

these changes were particularly prominent are singled out, as follows:

1. Before the North Crimean Canal was opened (1975) the salinity of almost all the aquatic areas of the Sivash was relatively high. Only those areas that were close to the Straits of Tonka and Promoina were made somewhat less saline by being diluted by water from the Sea of Azov. The average salinity of the waterbody during the first period (1950–1975) was 82.5 g/l, although it varied greatly from place to place (Table 2) (Pavlov, 1960a).
2. Since the North Crimean Canal was opened, a massive quantity of fresh water has been discharged into the Sivash. Although the desalination of the Eastern Sivash proceeded gradually, the salinity in the second and third stretches (see Annex I, Fig. 2) of the Sivash changed dramatically. The total quantity of irrigational and drainage water that has been discharged from the Crimean side of the lake is estimated at 521 million m^3, with an additional c. 109 million m^3, from the Kherson Region. In 1989 the water salinity averaged 22.6 g/l, and in 1997 it was about 17.0 g/l. By the end of this period the salinity of the various bays fluctuated between 1 g/l and 18.7 g/l (average 11.6 g/l) at different times of year.
3. The third and most recent period began with a decrease in the quantity of fresh water discharged into the Sivash. According to different estimates, it declined by a factor of at least two or three. As a result, the salinity of all parts of the waterbody began to increase and now ranges from 10.6 g/l to 23.5 g/l (average 17.1 g/l).

It is well known that the level of salinity is a principal factor determining the species composition and abundance of aquatic organisms. Needless to say, it is the quantity of fresh water discharged into the Sivash that was and still is the main factor affecting its aquatic ecosystems.

3. The Study: Materials and Methods

In 2003–2004 several expeditions were organised in order to determine the current state of the biota in Dzhankoi District and examine the impact that irrigation farming had made on it. The expeditions used both boats and cars. Apart from the field investigations, a data set collected in 2002–2004 within the framework of the project, 'Towards Integrated Management Planning for the Sivash in Ukraine', was made much use of in the analysis, together with materials collected earlier, either within the framework of other projects or by individual researchers. References to the corresponding scientific publications, which were used whenever necessary as a source of information during the preparation of this report, are given in detail in each section of the account of the study methods.

Vegetation studies

An examination of the present condition of the vegetation in Dzhankoi District was carried out in 1993–2004 during a series of expeditions to the area. Data on the vegetation cover was collected and studied according to the Methodological recommendations on geobotanical description and classification of the Crimean vegetation (Golubev & Korzhenevsky, 1985). The biological flora of Crimea (Golubev, 1996) was used as a primary source of information for the analysis of the eco-biological structure. A total of 600 geo-botanical descriptions were made in the field. They covered both natural and transformed habitats including steppes and halophytic communities as well as the vegetation of vineyards, orchards, cultivated fields, fallow land and forest belts.

In 2003–2004 60 sites overgrown with natural vegetation were identified using satellite images (Lansat 7—ETM: 4 April 2001 and 8 August 2001; 14.23 m/pix). Some of these sites were investigated during expeditions in mid-May and late August 2003; the remainder were visited in early June and August 2004 (Fig. 1). The weeds of vineyards and orchards have been studied since 1993. In 2003 the fieldwork was focused on the areas closest to the Sivash, including some fields under cultivation, while in 2004 the study area was expanded further from the coast. In 2004 the vegetation of the pastures, farms, agricultural fields, fallow land and areas close to artesian wells received major attention.

To assess the degree of disturbance to the natural vegetation by cattle-grazing, a 5-grade system was used: 0 — undisturbed or very little disturbed, A — low disturbance, B — medium disturbance, C — high disturbance, D — total degradation.

0 — Natural state. The impact of grazing is very low or absent. Species are distributed evenly over the area occupied by vegetation. Growth is well stratified. There are extensive stands of tall grass, with grains and various species of broad-leaved motley-grasses typically predominating. The projective cover (foliage) is high. The weed element is poorly represented. At this stage the vegetation is represented mainly by feathergrass, grains and motley-grass communities, along with couch-grass and feathergrass communities. A small amount grazing pressure does not usually have a significant negative impact.

A — Initial stage of suppression under moderate permanent grazing pressure. This stage is characterised by a decrease in the overall number of plant species. The projective covering remains relatively high as some species of weeds, which are not edible to cattle, have been introduced into the community. At the same time, patches of forb steppe disappear. The spacing of species over the area occupied by the community is relatively even. At this stage the vegetation is represented mostly by the wormwood and couch grasses together with wormwood, fescue and grain—motley—grass communities.

B — Pasture stage. The grass is suppressed under the impact of strong and constant grazing pressure. The abundance of xerophytic plants increases. Graminoid species (Volga Fescue Festuca valesiaca[1], Bromus spp.) and legumes typically take over, and the coverage of perennial weeds expands. Spacing of species is uneven. At this stage the vegetation is represented by the wormwood—grain—motley grass and wormwood—grain communities.

C — Vegetation half-destroyed. This stage is recognised by the appearance of patches overgrown by typical vegetation. The height of the projective cover may vary. The spacing of species is extremely uneven. Weeds predominate and in addition a considerable number of adventive species appear. Annual species such

[1] Scientific names of plants are given following the checklist by S.K. Cherepanov (Vascular Plants of the USSR, 1981).

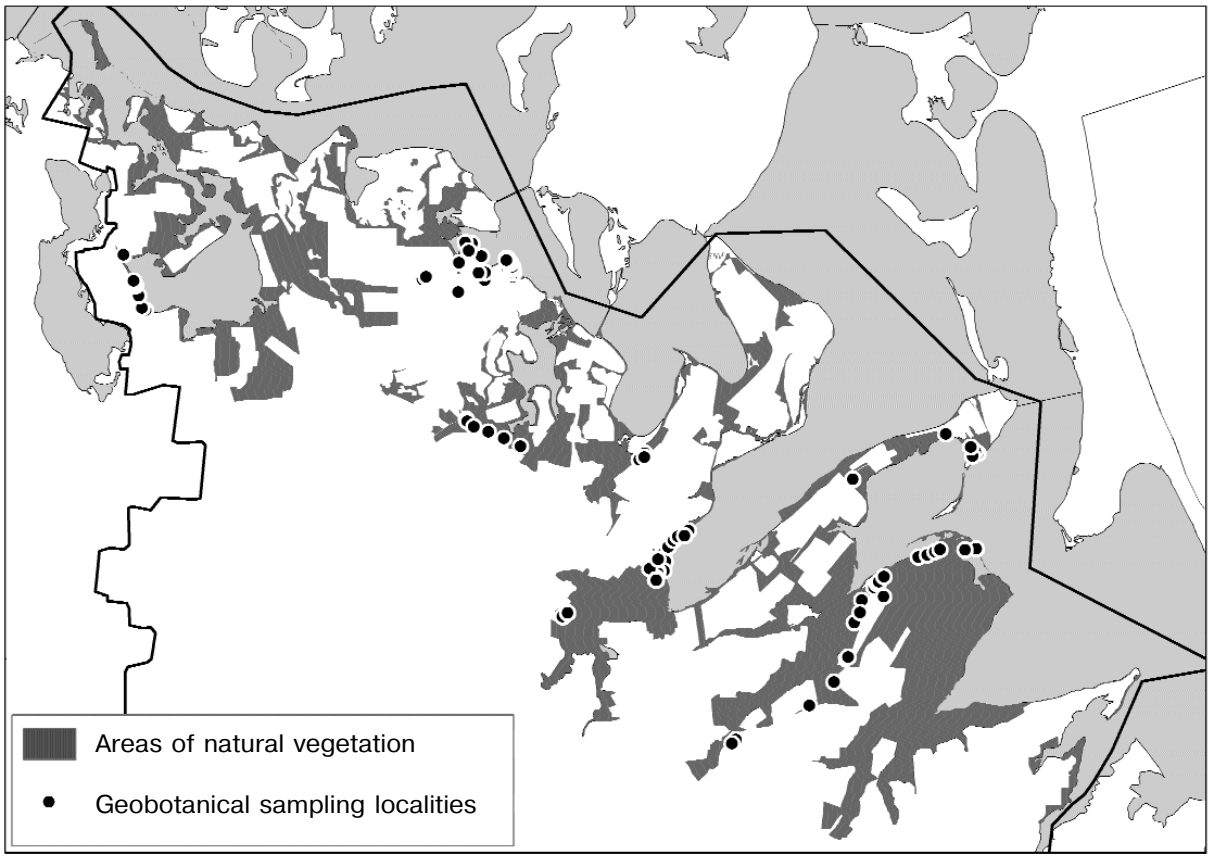

Figure 1. Areas and localities investigated in the course of floristic and geobotanical studies in Dzhankoi District.

as Onopordum spp. and Carduus spp. often grow in abundance. Communities are often dominated by Harmel Peganum harmala. The orach, wormwood—grain—motley—grass communities with wormwood predominating are also typical for this stage. This type of growth is defined as 'anthropogenically disturbed'.

D — Total degradation of vegetation. The growth is very thin and consists mostly of knot-grass, Harmel and other annual plants. This kind of vegetation also dominates in the areas occupied by cattle-breeding farms and along the roads.

Studies of fish and other aquatic organisms

Hydrobiological and ichthyological samples were collected in 2003 (August) and 2004 (June, August) at a number of previously identified localities (Fig. 2). Hydrobiological samples were taken according to the standard methods. The phytoplankton samples were processed according to the sedimentation method. Numbers of organisms were estimated using a Najott chamber (volume: 0.01 cm^3). Methods similar to those previously used for the study of zooplankton in this area were used in this study. The samples (100 l water) were filtered though a simple qualitative plankton net (Apstain's small qualitative net). The filtrate was fixed in 4% formalin and further processed in the laboratory. The quantity and biomass of zooplankton were calculated per cubic metre. Benthos was collected with a spring bottom-sampler with a sample area of 0.0225 m^2. The samples were washed through a # 28 sieve, fixed in 4–5% formalin and further processed in the laboratory. To identify species a number of identification guides were used (Identification guide ..., 1968, 1969, 1972; Anistratenko & Stadnichenko, 1994). A comparative method was used to identify mollusc species.

Samples of macrophytobenthos were collected using the standard geobotanical methodology, which was specially adjusted for underwater use (Petrov, 1964; Yeremenko, 1967; Kalugina, 1969; Gromov, 1973). Algae were surveyed using counting frames (S = 0.04 m^2 and S = 0.1 m^2) and a bottom sampler (15 × 15 cm). Wherever it was possible, at least five samples were collected at each locality. The counting frame was placed over the bed of algae and all macrophytes within it were collected for identification and frequency evaluation. A total of 83 quantitative samples were col-

lected between 18 and 25 June 2004; qualitative samples were also collected at the same time.

The fish studies were carried out using the standard ichthyological methods (Pravdin, 1960). A fry scraper (mesh size 6.5 mm) and gill nets (mesh sizes 18, 20, 25, 30, 35, 40, 45, 50, 55 and 60 mm) were used. Fish caught by amateur fishermen were examined to obtain additional material for analysis. A total of 23 fry catches and 15 net catches were carried out (820 fish specimens, 43 catches). In 2003 it was ascertained that the aquatic area of the Central Sivash contained no fish, so in 2004 efforts were focused on the aquatic area of the Eastern Sivash and freshwater bodies of Dzhankoi District (the Rivers Pobednaya and Stalnaya, the North Crimean Canal and ponds).

Insect studies

Data was collected in summer 2003 and 2004 (see Fig. 3 for spatial coverage of the investigations). Insects were located visually along footpaths and collected with an insect sweeper; in some cases lamps were used to attract insects. At some localities pitfall traps were installed to obtain samples of ground arthropods. Some information on the distribution of large and obvious insects was obtained from the local residents. All available published information concerning the insects listed in the Red Data Book of Ukraine was analysed.

Amphibian and reptile studies

The information on amphibians and reptiles is based on field research carried out in Dzhankoi District in 2000–2004 by T.I. Kotenko, as well as in all other districts of Lowland Crimea. In 2000–2001 this research was supported by the Research Support Scheme of the Open Society Support Foundation through an individual grant (# 1045/1999) for work on ascertaining steppe areas important for the conservation of biodiversity. In 2003–2004 the field study was continued within the framework of the Wetlands International project, 'Towards Integrated Management Planning for the Sivash in Ukraine'.

Sites potentially valuable for biodiversity study and conservation were selected using an approach developed earlier (Kotenko, 2003): patches with natural steppe vegetation were identified using a combination of conventional maps and satellite images; selected sites were briefly investigated; their boundaries were determined in the field using land management plans. The most valuable

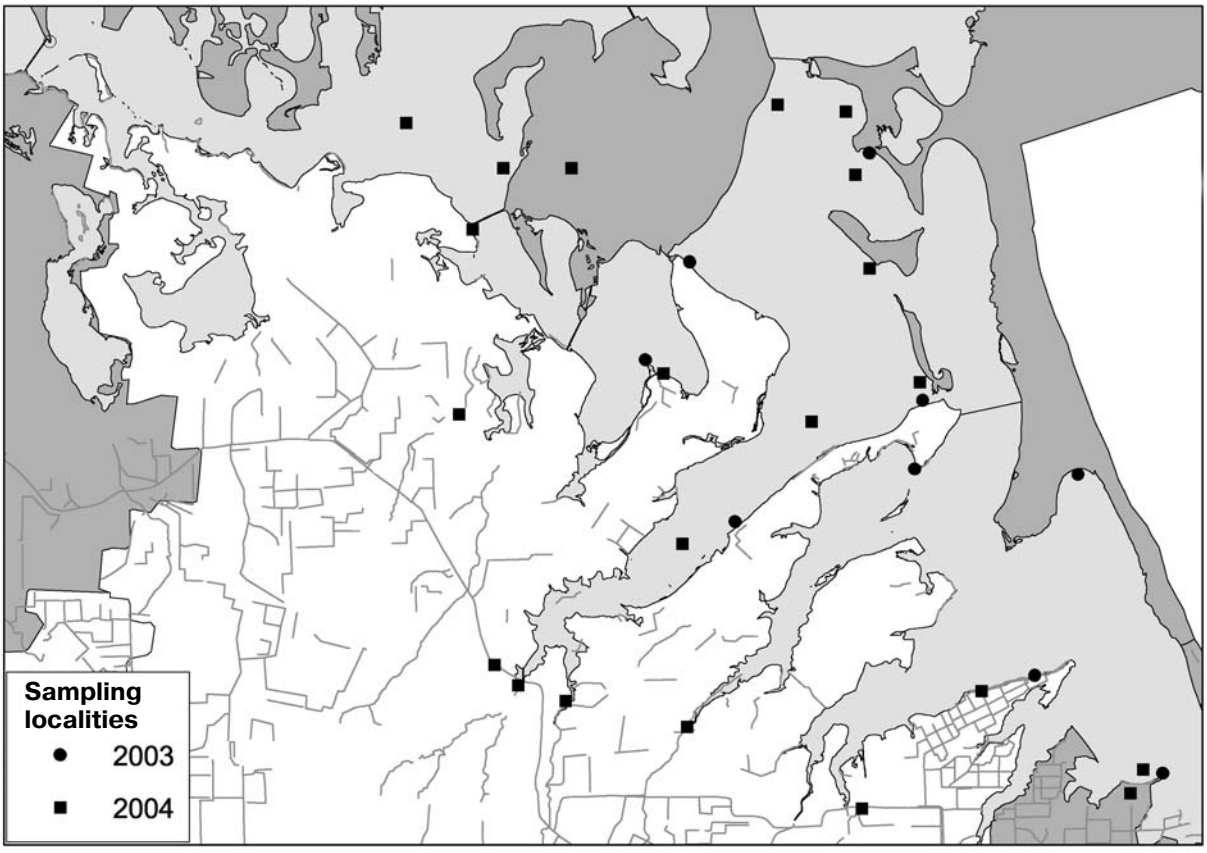

Figure 2. Localities sampled in the course of hydrobiological studies in Dzhankoi District in 2003 and 2004.

areas were described in detail and surveyed systematically with emphasis on reptiles and amphibians.

At each site the vegetation was described briefly and the degree of habitat transformation was assessed taking into account criteria such as the percentage of the area occupied by arable land, grazing pressure, the presence of irrigation infrastructure, open pits, roads, agricultural and residential buildings and the development of recreation.

Counts were carried out along 100-m or 1,000-m long and 2-m wide transects for terrestrial species and along the coastline for species restricted or related to wetlands. The results of transect counts were recalculated per unit of area. In some cases counts were carried out on small patches of steppe or open water areas.

A 5-grade scale (Pesenko, 1982; Kotenko, 1993) was used to avoid mistakes when comparing the abundance of different species because the population density of reptiles and amphibians varies greatly between species.

Bird studies

Data was collected in 1998–2004 within the framework of projects undertaken by the Black Sea Programme of Wetlands International. Published material and the results of counts carried out by the Azov-Black Sea Ornithological Station in 1986–2004 were also taken into account in the analysis. The ways and extent to which the introduction of irrigation affected different groups of birds were analysed separately for each period of their annual cycle. It is worth noting that retrospective data are not available for all species and seasons. The available data relates mainly to colonial birds, particularly those that breed on the islands, spits and — to a lesser extent — salt marshes. Unfortunately, data on birds breeding in other habitats has not been collected until very recently and therefore it is not really possible to perform trend analyses. There is a problem with birds that stage and winter in the Sivash: their numbers have been assessed in full only recently. In fact, systematic bird studies were begun in this area only in the late 1980s, due to the efforts of the Azov-Black Sea Ornithological Station; therefore the more-or-less reliable datasets that permit an analysis of changes in the avifauna of the Sivash by season refer mainly to the last 10–15 years.

Different census techniques were used depending on the species to be surveyed. Absolute counts were carried out in the colonial settlements on the islands. Counts of individual birds giving alarm calls were used to estimate numbers of birds breeding on the saline lowlands and in the reed beds and forest belts. Special attention was paid to discovering the numbers and distribution of waders, cranes and Anseriformes. The most complete census coverage was achieved in August 1998, when three mobile groups carried out absolute counts of all species over the whole of the Sivash within a 10-day period. Numerous and easily recognised wintering species were counted from cars. Smaller species, especially those occurring in the reed beds, on the agricultural fields and in forest belts, were counted along fixed routes.

A spatial model of the seasonal distribution of birds was created using a geodata set: ArcGIS shapefiles with polygonal objects representing areas of bird assemblages or areas surveyed (as they had been recorded in the field on the 1:100 000 topographic maps). The count results were tabulated, with total number of individuals in the assemblage or total numbers of breeding pairs and non-breeding individuals (for breeding-bird surveys) given separately. Density rasters were generated and integrated using the ArcInfo 8.1 Spatial Analyst extension. Different approaches were used for the data transformation depending on the count type. Polygons of seasonal gatherings were first converted into centroids and then into Kernel density rasters (search radius 500 m, resolution 500 m/pixel). Another method was applied to the breeding survey results. After normalisation of the numbers by the area of each polygon, two independent characteristics were derived: density of breeding pairs and density of non-breeding individuals. These polygonal layers were then converted into two rasters and each cell was assigned the average density values of the overlying polygons.

All rasters produced were reclassified to bring them into a uniform 9-grade density estimate system. Typically, each raster surface represented one count, but in the case of breeding surveys a single count was represented by two surfaces (1 — density of breeding pairs, 2 — density of non-breeding individuals). Reclassified rasters were summed by survey and season, being reclassified after each step of data integration.

At the end of analysis 4, reclassified seasonal distribution rasters (see Annex I, Fig. 8 a—d) were summed to obtain an integrated surface showing the relative importance of each pixel (a 500-m square in the field). With this estimation system each cell was characterised by cumulative values ranging from 3 to 22, indicating both bird numbers (density) and probability of repetition of assemblages in this location at any time of year.

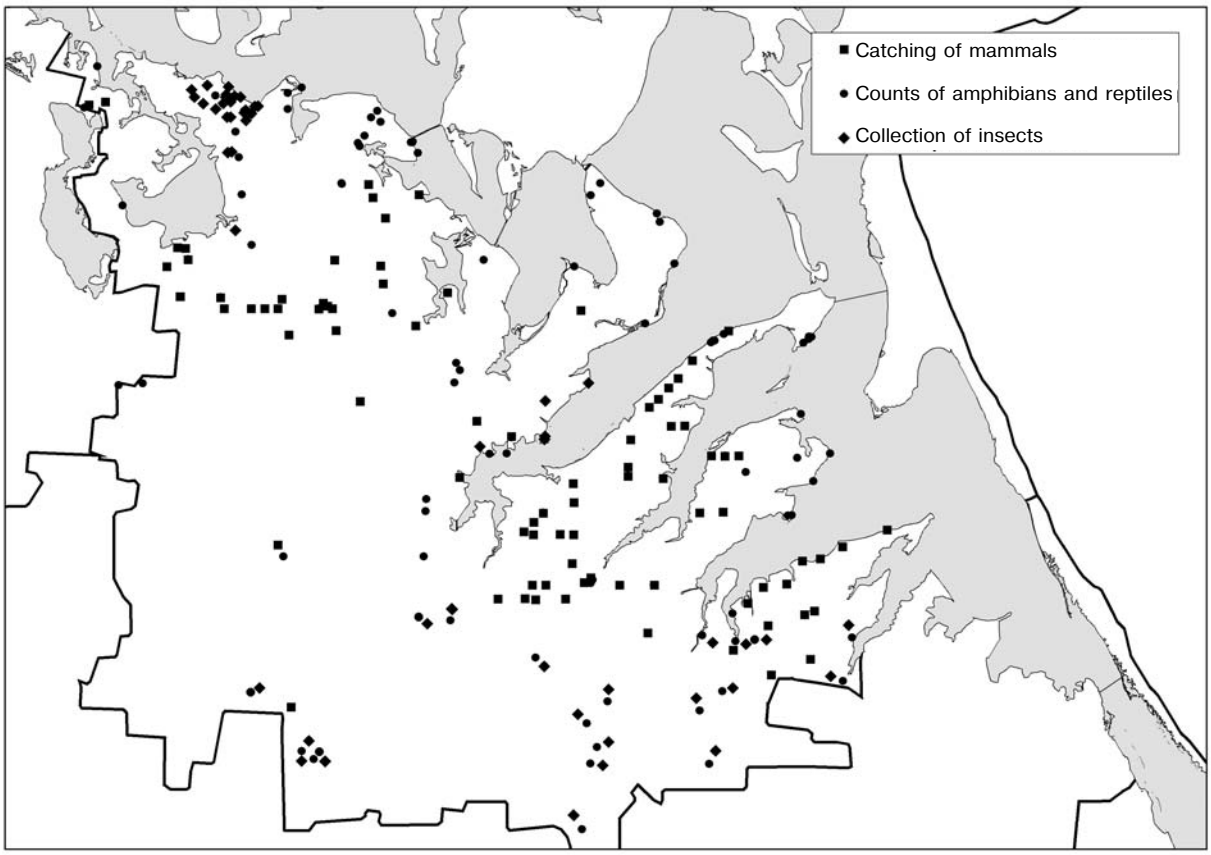

Figure 3. Counts of terrestrial animals: areas of Dzhankoi District covered.

Mammal studies

Data was collected in 1984–2004 in the course of constant monitoring of the epizootological situation in the Prisivashie. Localities visited and species counted are shown on the Fig. 3. Small mammals were counted using clap-traps of different sizes installed in lines of variable length. A total of 712 clap-trap counts were carried out in the vicinities of 67 human settlements in Dzhankoi District, the area covered by the clap-traps being over 850 km^2 (23,575 traps per night, 42.8% of all counts carried out in the Prisivashie).

Black-bellied Hamsters Cricetus cricetus were counted using a #1 spring trap. Little Sousliks Spermophyllus pygmaeus were displaced from their holes by pouring water into them. In addition, inhabited holes of both species were counted visually in their colonies (transect counts for hamsters and absolute density estimates for sousliks). The count transects were 500 m long and 10 m wide. Counts carried out in the forest belts were recalculated per hectare of habitat.

The contents of pellets left by predators (Long-eared Owl Asio otus, Short-eared Owl A. flammeus, Little Owl Athene noctua, Rough-legged Buzzard Buteo lagopus and Kestrel Falco tinnunculus) were analysed in order to obtain additional data on the distribution of some small mammals. This was of particular concern for species such as Migratory Hamster Cricetulus migratorius, Social Vole Microtus socialis, Sibling Vole M. levis, (Southern Vole M. rossiaemeridionalis and Northern Mole-vole Ellobius talpinus. Muskrats Ondatra zibethica were captured with a #1 clap-trap; the irrigation and drainage canals were also searched for traces of them. Numbers were assessed by counting traces of predatory mammals along the footpaths according to commonly recognised methods.

4. The Biological Diversity of Dzhankoi District and How It Has Changed with the Impact of Irrigation

4.1. Flora and vegetation

4.1.1. Main stages in the studies of the flora and vegetation of the region

The current state of Dzhankoi District, and of the steppe zone of Crimea as a whole, is characterised by profound changes in the ecosystems, caused by human activity. As mentioned above, more than 98% of the district is used for agriculture: 80% of the land is occupied by various agricultural crops, and only quite small areas, slightly more than 13% of the district, are pastures, where in some parts the native vegetation is still preserved.

Studies of the flora and vegetation of the area can be divided into three periods:

Period 1 — end of the 19th — beginning of the 20th centuries;

Period 2 — 1950s–1980s;

Period 3 — the most recent period of research.

An analysis of the floristic composition of Dzhankoi District has demonstrated that 425 vascular plant species were recorded in the district during the period from the end of the 19th to the beginning of the 21st century (see Annex II, Table 1). Of these, 281 species were recorded during the first period (1867–1936), 179 species during the second period (1946–1979), and 279 species have been discovered during the most recent period (since early 1980s). The species recorded during the first period were mainly taxa typical for natural plant communities, whereas during the second and the third (recent) periods species of anthropogenic habitats were also recorded, and the general species list for the area was extended, mostly by adding these anthropogenic taxa.

Floristic finds and records from the first period, which were made by N.M. Zelenetsky (1886), V. Aggeyenko (1894), V. Fedchenko (1904), A.S. Doych (alias Deutsch; 1914–1916), S.A. Dzevanovsky (1923–1929), M.I. Kotov, M.S. Shalyt (1921–1923), V.K. Astakhova, N.M. Chernova (1929), Z. Izvekova (1931), N.A. Desiatova-Shostenko, M.S. Shalyt (1935), M.V. Klokov, N.A. Desiatova-Shostenko (1936) and others (Desiatova-Shostenko & Shalyt, 1936; Izvekova, 1932; Klokov & Desiatova-Shostenko, 1936; Wulf, E.V. — Flora of Crimea, 1929, 1930, 1947, 1951, 1953, 1957, 1960, 1966, 1969; Additions ..., 1959), were confined mainly to the town of Dzhankoi, Solenoe Ozero and Novoseltsevo villages and the Chongar Peninsula. In the literature of this period data can be found on 281 vascular plant species occurring in this area; however, the records of 75 species have not subsequently been re-confirmed.

In the 1950s, botanical studies of the northern part of Crimea continued. These studies were stimulated on the one hand by the project to construct the North Crimean Canal, and on the other by an integral assessment of fodder stocks of pastures and hayfields of the Crimean Peninsula that was being carried out at that time. Therefore, in 1951–1961 detailed soil and geobotanical studies and large-scale mapping were undertaken in the area adjacent to the Sivash (the Nyzhniohirsk, Sovetskiy, Dzhankoi, Krasnoperekopsk and former Azov Districts), in the Krasnogvardiysk and the former Novoselovskyi Districts, and on the Kerch Peninsula. As a result of these studies, the basic patterns in the geographic distribution of the Crimean steppe vegetation, its phytocoenotic characteristics and basic floristic composition were revealed, and the soils and phytogeographical regions of the Crimean Sivash Lake area were mapped (Dzens-Litovskaya, 1950, 1951a, 1951b, 1953, 1954, 1970; Skarlygina, 1954, 1958, 1961, 1962, 1963a, 1963b; Loskot, 1974, 1976, and others). By the beginning of the 1970s the flora and vegetation of Crimea had been sufficiently described and a map of the reconstructed natural vegetation of the peninsula was compiled (Rubtsov, 1978; Rubtsov et al., 1964, 1966). Very important herbarium collections were made by N.M. Chernova, I. Novoseltseva, I. Krylova, G. Grin, Zelikson, L.V. Makhaeva, S.K. Kozhevnikova and others near the town of Dzhankoi and the villages of Zavet-Leninskiy, Yasnopolianskoe, Zelenyi Yar, Tomashevka, Martynovka, Solontsovoe, Medvedevka, Predmostnoe, Miturino and Chaikino and other areas. In publications of this period, and from the herbarium specimens available, distribution data for 179 species of vascular plants can be found, 44 of which were recorded

by the researchers only during that period of studies.

In 1993–2003 the authors of the present report carried out a new study of the flora and vegetation of Dzhankoi District, including both natural (steppe, halophytic) ecosystems and the habitats transformed by human activity (fallow land, vineyards, gardens, ploughed fields, forest shelter belts etc.). Moreover, plans were made for the establishment of a regional landscape park within the Kalinovka (Kalinovskiy) Military Zone, which is located in the north of the Eastern Sivash (between the Tiup-Tarkhan and Stephanovskyi Peninsulas, from which it is separated by Kalinovskiy Bay and the Stalnaya River). In 1991, 1995–1996 and 2001, surveys of the plant cover of the military zone were undertaken (Kotov, 2001, 2002; Kotov et al., 1991; Kotov & Vakhrusheva, 2003). Surveys of Dzhankoi District continued in 2004 on the sites outside the Sivash lakeside zone. Compared to the 279 plant species recorded there during 1993–2003, only 224 taxa were discovered in 2004.

Analysis of the literature and original data indicates that before the construction of the North Crimean Canal and large-scale land reclamation for agricultural purposes, the desert steppe zone complex, where Dzhankoi District is located, was composed mainly of wormwood—wheatgrass (Artemisia—Agropyron), wormwood—fescue (Artemisia—Festuca), wormwood—fescue—feathergrass (Artemisia—Festuca—Stipa), and wormwood—fescue communities in combination with saltwort (Salicornia) communities and halophytic meadows, plus halophytic communities (Artemisia—Limonium and Artemisia—Puccinellia), sometimes with the inclusion of large quantities of wheatgrass, together with halophytic communities on salt-marshes, saline and alkaline habitats). By the beginning of the 20th century, most steppe areas had been ploughed up for grain crops or tilled for gardens and vineyards. Other sites of natural vegetation were used as pastures. At present, as a result of the transformations caused by human activity as well as the impact of the irrigation system, it is possible to trace the development and establishment of a wetland-littoral landscape that includes several types of vegetation: aquatic, marsh[2] and wetland, meadow, halophytic and psammophytic communities. In addition, some plots of more or less transformed and/or disturbed steppe communities still remain in the area.

4.1.2. Assessment of the ecological status of plant communities

The analysis of the state of the vegetation, and also the general floristic structure of the study area, points to a significant transformation of the flora and vegetation of the area. As has already been mentioned, as a result of transfer of water from the Dnieper River (see section 2) to Crimea in general and to Dzhankoi District in particular a plavni vegetation complex (semi-aquatic and aquatic reed vegetation) has formed; it is dominated by Common Reed Phragmites australis and rush Juncus spp. communities. Due to the impact of the North Crimean Canal (development of irrigated agriculture, water leaking out through the bottom of the canal, etc.), the local water table (subsoil water level) has risen in some sites in the area, and secondary soil salination is also developing, therefore steppe and meadow vegetation is being replaced by halophytic communities adapted to saline and alkaline conditions. Concurrently, large areas occupied by freshwater (reed and rush) communities are now recorded at sites where saline vegetation has developed. In places where fresh water rises to the surface and the salinity level is higher, Bolboschoenus communities occur in combination with various species of rush (Juncus spp.) and typical plants of saline habitats (Halimione verrucifera, Taraxacum bessarabicum, Plantago salsa etc.).

Steppe vegetation occupied extensive areas in the past and was the main zonal type of vegetation. As a result of irrigation, ploughing and the development of large-scale cattle breeding, steppe-vegetation communities remain only within small areas of Dzhankoi District, mostly on the coast of Lake Sivash (see Annex I, Fig. 3). Usually such communities experience heavy anthropogenic pressure and are therefore mildly to strongly disturbed. Today all steppe sites show obvious signs of grazing impact, which is seen in the rapid expansion of various weeds and plants not consumed by livestock, such as spurges (Euphorbia spp.), Austrian flax Linum austriacum, thistles, etc., as the role of the native grasses declines. A characteristic feature of desert steppes is the constant presence in the herbaceous cover of a low-growing xerophilic sub-shrub, Crimean Wormwood Artemisia taurica, whose presence increases with the growth of anthropogenic pressure.

[2] The vegetation complexes are presented according to the scheme described by V.D. Dubyna and Yu.R. Sheliag-Sosonko (Plavni of Prichernomorie, 1989). Here the term 'marsh' is understood to mean coastal-aquatic vegetation, with a core composed of typical marsh species.

On the areas not adjacent to the Sivash, the steppe plant communities occur as isolated fragments near settlements. These areas are now used mainly as pastures. Weeds (ruderal vegetation) were dominant on the plots with obvious overgrazing; these communities were characterised by the domination of Harmel (also known as African-rue or Harmal Peganum), Crimean Wormwood, Wiregrass (or Bermuda Grass) Cynodon dactylon, knotgrasses Polygonum spp., cockleburs Xanthium spp. and various species of thistle. According to the classification used for this study, such communities belong to the 'anthropogenically disturbed vegetation' type. wormwood—grass, wormwood—grass—forb and wormwood—fescue communities were recorded in mildly to slightly disturbed sites.

The best-preserved fragments of steppe vegetation belonging to the Artemisia—Fescue—Agropyron, Artemisia—Agropyron—Elytrigia, Artemisia—Agropyron—Stipa and Stipa—mixed forb communities (with typical species such as Pectinate Wheatgrass Agropyron pectinatum, Creeping Wheatgrass Elytrigia repens, Elongate Wheatgrass Elytrigia elongata, feathergrasses Stipa spp. also present) were recorded in the north and northeast of the study area (on the Karacha-Kitai, Martyniachyi and Tiup-Tarkhan Peninsulas, Cape Bezymianny, in the northern and eastern part of Lake Aigulskoe, and also as narrow strips along the steep coast and on the islands of Sivash, in the vicinities of Tselinnoe and Tomashevka villages). In the remainder of the area (outside the Sivash shore zone) such sites have almost disappeared; they were found only near the villages of Vesioloe and Volnoe, within an area where agricultural use had been prohibited, and also in the vicinities of the villages of Solontsovoe and Volodino. These communities were characterised by their fairly high species diversity — no fewer than 76 species — some of which were weeds. In the herbaceous cover of these communities, tuft-forming grasses, such as Pectinate Wheatgrass (20–40%), Creeping Wheatgrass or Elongate Wheatgrass (20–40%) and Cliff Fescue Festuca rupicola (up to 10%) dominated, with Lessing's Feathergrass Stipa lessingiana occurring sporadically (10–20%) and Crimean Wormwood occurring only occasionally. Prickly Jerusalem-sage Phlomis pungens and Austrian Flax etc. were among the forbs recorded. The projective cover of the herbaceous layer ranged from 40–80%.

The dominant species in wormwood—grass and wormwood—grass—forb communities, which were most widespread in the area and belong to the pasture stage, were Crimean Wormwood (20–30%), annual grasses Soft Brome Grass Bromus hordeaceus, Corn Brome Grass B. squarrosus, Oriental Annual Wheatgrass Eremopyrum orientale, Cheatgrass Bromus tectorum, Downy Chess Anisantha tectorum and Rabbit Barley Hordeum leporinum (20–40%). Annuals with a short vegetation period occurred frequently; they included Spring Groundsel Senecio vernalis, Chamomile Chamomilla recutita and other species. Perennials of the forb ecological group were represented by Seguier's Spurge Euphorbia seguierana, Uncinate Thistle Carduus uncinatus and other taxa. The dominant species on the heavily disturbed steppe sites included Wiregrass, Door-weed Polygonum aviculare, Grey Thistle Cirsium incanum, Orach Atriplex sagittata or Tatarian Orach A. tatarica and Sand Kochia Kochia laniflora. The overall projective cover was 40–60%, depending on the degree of disturbance. These communities were noted for having the highest species diversity index (over 150 species); however, many species were weeds.

Fragments of wormwood—fescue communities dominated by Crimean Wormwood (20–40%) and Cliff Fescue (20–60%), with a smaller proportion of Uncinate Thistle, Field Eryngo Eryngium campestre and Round Sand Leek Allium rotundum, were recorded in Zavet-Leninskiy, Yasnopolianskoe and Tselinnoe villages.

The Artemisia—Elytrigia, Artemisia—Limonium—Elytrigia, Artemisia—Puccinellia and Puccinellia communities in the study area represented fragments of meadow vegetation (see Annex I, Fig. 4). Nearly all communities belonged to the halophyte meadow type and had developed in damp habitats with a fairly high water table; they often consisted of salt-tolerant plants. Species diversity of meadow vegetation communities comprised no fewer than 75 taxa.

The dominant species in Artemisia—Elytrigia and Artemisia—Limonium—Elytrigia communities were Crimean Wormwood or Santonica Wormwood A. santonica (10–30%), Creeping Wheatgrass and Elongate Wheatgrass E. elongata (20–60%), Meyer's Limonium Limonium meyeri or Caspian Limonium L. caspium (5–15%). Pectinate Wheatgrass, Tatarian Orach and Field Eryngo also occurred. There was a high proportion of weeds in the most disturbed habitats: 40–80% of the area on average. Within the survey area some slightly transformed communities

were found on the shore of Lake Sivash (near the villages of Medvedevka-Predmostnoe, Pridorozhnoe, on Karacha-Kitai, Tiup-Tarkhan and the Martyniachyi Islands and Cape Bezymianny), and also in the vicinity of Prostornoe, Svetloe and Blagodatnoe villages and Azov, Solontsovoe and Istochnoe settlements.

Artemisia—Puccinellia and Puccinellia communities dominated by Santonica Wormwood (10–20%) and Fomin's Alkaligrass Puccinellia fominii (20–60%), with an average projective cover of 50–80%, occurred in the vicinities of Zavet-Leninskiy — Yasnopolianskoe, Nizhnie Otrozhki and Slavianskoe villages.

Some areas of land not used for agriculture were occupied by saline vegetation communities; these were noted on the banks of reservoirs and watercourses, in lowlands and depressions and in the most overgrazed sites (see Annex I, Fig. 5).

The most typical and commonly occurring communities were those of Salicornia (saltwort), Salicornia—Halimione, Salicornia—Halimione—Puccinellia, Salicornia—Puccinellia, Salicornia—Tripolium and Halocnemum. These were recorded near the villages of Solenoe Ozero, Medvedevka, Turgenevo, Zavet-Leninskiy, Yasnopolianskoe, Zarechnoe, Stefanovka, Tselinnoe and Tomashevka, the Karacha-Kitai Peninsula, at the base of Cape Bezymianny and the Tiup-Tarkhan Peninsula, and on the shore of Lake Aigulskoe. In the centre of the area, which is located outside the Sivash shore zone, the largest fragments of this type of vegetation were recorded in the vicinities of Volodino, Solontsovoe, Slavianskoe and Prostornoe villages. Saline communities were poor in their species composition; no more than 16 species of vascular plants were recorded in these communities.

The herbaceous cover of halophytic communities was non-uniform. It was rather dense in less well grazed parts (60–70%), but the plants were not very tall, up to 20–25 cm only. Where the ground was heavily overgrazed, the herbaceous cover was reduced to 20–30%.

Communities of wetland vegetation were among the communities formed by only a few species (8–13 species), thus this type of vegetation was distributed mostly in the northeast of the area. It was restricted to the Rivers Pobednaya and Stalnaya, and also occurred along the banks of the North Crimean Canal (within its irrigational network), in rice fields, and in places where outlet ditches from rice fields and drainage canals flow into the Sivash (See Annex I, Fig. 6). However, it was also recorded in the northern part of the area (in the vicinities of Stefanovka, Mnogovodnoe, Pridorozhnoe — Miturino, Zeleny Yar and Yermakovo). This type of vegetation was represented mostly by reed associations dominated by Common Reed, which grew up to 3 m tall. In some places (for example, near the village of Pridorozhnoe) wetland vegetation was represented by reed-rush communities, rush associations dominated by Gerard's Rush Juncus gerardii and Sea Club-rush (or Cosmopolitan Bulrush) Bolboschoenus maritimus. Narrowleaf Cattail Typha angustifolia, Wood Cane Scirpus sylvaticus and other wetland species sometimes occurred in the reed communities.

Reed, bulrush and cattail communities were dominated by Gerard's Rush, Grey Club-rush Scirpus tabernaemontani and Sea Club-rush, with an insignificant proportion of other aquatic and wetland species. Species such as Common Spike-rush Eleocharis palustris, Celeryleaf Buttercup Ranunculus sceleratus, arrowheads Sagittaria spp. and Great Water Plantain Alisma plantago-aquatica were recorded in swampy habitats formed as a result of flooding from artesian wells near the villages of Borodino, Solontsovoe and Volodino.

As mentioned above, most of the survey area is used agriculturally, for vineyards, grain fields, fruit gardens and plantations, and other crops. Surveys of weeds were carried out in the 1990s in vineyards and gardens in Dzhankoi and other districts; these surveys have proved that the completion of the North Crimean Canal has resulted in a rise in the water table (aquifer) and changes in the hydrology and salinity, as a result of which 'drenching' has been noted in vineyards and gardens in recent years, and hydrophilous species (Common Reed, Juncus spp., etc.) are occurring.

Weeds are increasing in agricultural areas. Since the late 1980s the agricultural areas have declined, the area of fallow land has increased, and these areas have become overgrown with tall, dense weeds. Today, most of the fallow land is used as low-yield pasture.

Fragments of anthropogenic vegetation, mainly consisting of weed species, were noted near settlements, along roads and in places where livestock are grazed. Sometimes this vegetation occupied large areas, although its taxonomic structure was often characterised by few species (17–30); it was often represented by monodominant or almost monodominant communities.

In the most disturbed places (pastures, farmyards) Tatarian Orach, thistles Cirsium vulgare, C. incanum, Californian Cocklebur Xanthium californicum, Knotgrass or Door-weed and other weed species dominated. On less disturbed areas these species grew together with Crimean Wormwood, with a sometimes significant proportion of Diffuse Knapweed Centaurea diffusa, Harmel, Yarrow Achillea setacea and mulleins Verbascum spp.

Among the indices of vegetation transformation are the levels of synanthropisation and adventive species; these indices measure the degree of anthropogenic impact. The anthropogenic transformation of the flora has been accompanied by the immigration of alien (adventive, non-native) species. The past 10 years have been characterised by a particularly intensive immigration and expansion of alien species, which correlates positively with the expansion of human economic activity in the district. Dzhankoi District is located at a crossroads of transport routes in Crimea; it is a fairly advanced agricultural and industrial region with various types of economic activity and therefore the flora of the area is noticeably enriched by alien plant species. The list of alien species is also enriched by introduced species that have escaped from cultivation and have often become completely naturalised.

Naturalised species are plants that are able to complete their life cycle in a new range without any human interference, penetrate into natural communities, compete with local species, and survive periods of extremely adverse weather conditions.

In studying the flora of any region it is not only important to discover alien (adventive) species but also desirable to track the dynamics and routes by which they have entered and dispersed within the region, and to study how they survive, spread and interact with the native (indigenous) species.

Many alien plants have dispersed widely and expanded their secondary ranges in Crimea as a result of drifting as seed in the waters of the Dnieper River; such plants are especially abundant in fields.

No fewer than 215 alien species have been recorded in the flora of Crimea — 7.3% of the flora of the whole peninsula. According to the data in the literature and materials obtained during vegetation surveys in 1993–2004, of these at least 22 alien species were recorded in Dzhankoi District, i.e. no less than 8% of the flora of the district.

Alien species in Dzhankoi District

Ailanthus altissima
Amaranthus albus
A. blitoides
A. retroflexus
Ambrosia artemisiifolia
Conyza □anadensis
Echinochloa crus-galli
E. oryzoides
Elaeagnus angustifolia
Galinsoga parviflora
Iva (Cyclachaena) xanthiifolia
Kochia scoparia
Medicago sativa
Portulaca oleracea
Robinia pseudoacacia
Salix babylonica
Setaria glauca
S. verticillata
Xanthium californicum
X. italicum
X. spinosum
X. strumarium

Such a significant percentage of alien species permits the conclusion to be drawn that the local flora and vegetation have suffered a profound transformation. It should also be pointed out that before the early 1970s some alien species occurred only occasionally (Californian Cocklebur, Butterweed Conyza canadensis, purslane Portulaca spp., Marsh-elder Iva xanthifolia) or even rarely (e.g. Ragweed Ambrosia artemisiifolia). These species are now common and even widespread; they nearly all occur in some quantity in the zone of irrigated agriculture. They grow not only in fields but also on fallow land, in ruderal habitats and forest belts. Ragweed occurs more often in irrigated, ploughed fields as a co-dominant in communities with Grey Thistle. The Rice-field Barnyard Grass Echinochloa oryzoides occurs, although only occasionally, in the rice-growing zone and along canals. Further dispersal of species such as Monochoria korsakovii, which is native to the Far East, is quite possible; however, in Crimea it has already been discovered in Krasnoperekopsk and Razdolnensky Districts in rice fields (paddies), and also in ditches. In some years this species has been quite abundant.

The geobotanical survey of weeds in fields in Dzhankoi District has revealed more than 70 plant species. Associations such as Amarantho retroflexi-blitoidi, Ambrosio artemisifolia-Cirsietum setosi, Amarantho blitoidi-Echinochloetum crus-galli, etc., which were recorded earlier on black soils (chernozem) in the centre of Ukraine,

are now widespread in Crimea, including in Dzhankoi District. The dominant species in these communities are various alien species such as Mat Amaranth Amaranthus blitoides, Redroot Amaranth Amaranthus retroflexus, Ragweed and Barnyardgrass Echinochloa crus-galli. Most alien species are summer annuals with a ruderal life strategy, i.e. very vigorous species that quickly occupy large disturbed areas.

Butter-weed, Ragweed and several species of the genus Xanthium are widespread, not only in fields but also on fallow land. Fallow-field vegetation contains more than 105 plant species. Thus, communities with few species but a high proportion of weeds are dominant on newly fallow land. On old fallow land, which is in the second (regeneration) stage of succession, the total number of species increases and comprises more than 75 taxa because of the apophytic species (native synanthropic taxa). The range of basic plant forms also changes from being dominated by annuals to having a significantly high proportion of polycarpic herbaceous species.

4.1.3. Rare and endangered species and plant communities

During the study, 10 species of vascular plants with an official conservation status (i.e., included in the Red Data Book of Ukraine or various Red Lists) were recorded in Dzhankoi District (Table 3; Annex I, Fig. 7). They are Tartar Bread Plant Crambe aspera (or tatarica) (ERL — R), Lessing's Feathergrass (RDBU — II), Stipa ucrainica (RDBU — II), Asparagus litoralis (RDBU — II, ERL — I), Needle Grass Stipa capillata (RDBU — III), Dianthus lanceolatus (IUCN — R, ERL — I), Agropyron cimmericum (IUCN — I), Linaria biebersteinii (IUCN — I) and Schrenk's Tulip Tulipa schrenkii (RDBU — II). Most of these species are components of steppe communities. However, only five species were recorded during the last decade.

In addition to the species of high conservation concern there are a number of endemic species, most of which are also confined to areas overgrown with steppe vegetation. Six of these species belong to the Pontic (Arenaria zozii, Caragana scythica, Dianthus campestris, Dianthus lanceolatus, Goniolimon besserianum) and Black Sea (Cerastium ucrainicum) endemic complexes. Most of the rare or protected species were recorded in the steppe communities, as well as on areas of saline land, i.e. the majority are aboriginal types of desert steppe vegetation; hence the protection of original steppe and desert steppe vegetation should be of the highest conservation priority in the area.

Vegetation formations that include various feathergrass (Stipa) species are listed in the Green Data Book of Ukraine. Communities with feathergrass species occur sporadically; they have been found on the Karacha-Kitai Peninsula, Cape Bezymjanny, the northern part of the Lake Aigulskoe area, northeast of the village of Tselinnoe, and also on narrow strips along the steep shores of Lake Sivash and on Russkiy Island (see Annex I, Fig. 3). Before 2004 the communities that included Lessing's Feathergrass occupied significant areas near Vesioloe and Volnoe villages, but they have been almost totally destroyed as a result of ploughing and the construction of a poultry farm. Such communities are partly preserved within a restricted area east of Dzhankoi.

The presence of plant communities listed in the Green Data Book of Ukraine, populations of rare and protected species, and typical communities characterising the zonal type of vegetation all prove that the area is promising in terms of the inclusion of some sites in the network of protected natural areas.

Table 3
Rare plant species of Dzhankoi District

Species	Localities	Conservation status
Agropyron cimmericum	Korzhenevsky (! 1982) – Medvedevka.	IUCN – I
Asparagus litoralis	Astakhova, Chernova (! 1929) – near the Sivash, near Kata village (now abandoned; at the base of Martyniachyi and Karacha-Kitai Peninsulas).	RDBU – II, ERL – I
Crambe aspera	Krylova, Novoseltseva (! 1954) – Prisivashskoe branch of the '8th March' State Farm.	ERL – R
Dianthus lanceolatus	Sivash coastal slopes (Dzens-Litovskaya, 1950); Grin, Novoseltseva (! 1953) – Krechetovo; Chernova, Grin (! 1953) – north of Yermakovo.	IUCN – R, ERL – I
Linaria biebersteinii	Doych (! 191‘) – Novo-Krymskoe and Solenoe Ozero (cereal fields) (Wulf, E.V. – *Fl. Crimea*, Vol. 3, issue 3).	IUCN – I
Stipa capillata	Pivovarova, Osmanova, Kokinas (!) – Volodino; Astakhova, Chernova (! 1929) – The Dzhankoi (Wulf, E.V. – *Fl. Crimea*, Vol. 1, issue ‘); Chernova, Novoseltseva (! 1953, 195‘) – Sivash coast near Kopan; Bagrikova (2003*) – ‘Perekopsky’ State Farm; Naiman Peninsula, Yasnopolianskoe.	RDBU – I, GBU
Stipa lessingiana	Kokinas, Osmanova, Kozlov, Pivovarova (!) – The Dzhankoi District (Wulf, E.V. – *Fl. Crimea*, Vol. 1, issue ‘); Doych (! 1919) – Krasnaya Ravnina and Voinka (Add. to Vol. 1 of *Fl. Crimea*); Chernova, Novoseltseva (! 1953), Krylova, Novoseltseva (! 195‘), – vicinities of Yermakovo village, cape near Solontsovoe and Krechetovo villages; Bagrikova (1997*, 2003*, 200‘ *) – Martyniachyi and Karacha-Kitai Peninsulas, Cape Bezymianny, Tselinnoe village, northeast and southeast of Aigulskoe Lake, Veseloe village.	RDBU – II, GBU
Stipa ucrainica	Kozlov (!) - Tselinnoe village (Wulf, E.V. – *Fl. Crimea*, Vol. 1, issue ‘); Doych (! 191‘) – near Novoseltsevo (Add. to the Vol. 1 of *Fl. Crimea*); Kalinovka Military Range (Kotov *et al.*, 1991).	RDBU – II, GBU
Tulipa schrenkii	Kotov, (! 1927) – Dzhankoi and Solenoe Ozero (Dzens-Litovskaya, 1950); Kalinovskiy Regional Landscape Park (Kotov *et al.*, 1991; Kotov & Vakhrusheva, 2003); Bagrikova (2003*) – Russkiy Island.	RDBU – II

4.2. Aquatic organisms

4.2.1. Plankton

4.2.1.1. Phytoplankton

It is well known that phytoplankton biomass is a very important parameter of water quality in wetlands: it affects the amount of organic matter, biogenic elements and bacteria, water transparency, oxygenation regime, food availability, etc. A total of 20 species of algae belonging to five different groups were found in the Eastern Sivash in June 2004.

Species composition of phytoplankton in Lake Sivash within the boundaries of Dzhankoi District

Cyanophyta
- Oscillatoria animalis
- O. limosa
- Phormidium tenue

Chlorophyta
- Oocystis borqei
- O. pusilla
- O. solitariak
- Scenedesmus quadricauda
- Tetraedron spp.

Euglenophyta
- Trachelomonas volvocina

Pyrrophyta
- Gymnodinium splendens
- Permidium claudicans
- P. achlomaticum

Bacillariophyta
- Achnanthes hungarica
- Amphora ovalis
- Cocconeis placentula
- Cymbella cuspidate
- Gyrosigma balticum
- Pinnularia spp.
- Tabellaria fenestrataz
- Synedra acus

The bay to the north of the Tiup-Tarkhan Peninsula (second stretch, see Annex I, Fig. 2) is rather poor in terms of species diversity (7 species). Cyanobacteria are represented by only one species. There are three species of Peridinium algae: Peridinium claudicans, P. achromaticum and Gymnodium splendens. The phytoplankton of the third stretch is relatively richer: the Cyanobacteria are represented by two species of the genus Oscilstoria (O. animalis and O. limosa) and Phormidium tenue, and the Peridinium algae by Peridinium claudicans.

There are some quantitative differences between the phytoplankton in the second and third stretches (Table 4). The biomass in the second and third stretches is very similar; the numbers of algae are higher in the third stretch. Both aquatic areas are dominated by Peridinium species (Table 4).

4.2.1.2. Zooplankton

A total of 32 organisms, of which 23 have been identified, were discovered in the samples. Both in August and June the larvae of bottom animals dominated the plankton; these were mostly molluscs in the early stages of development, several species of polychaete worms, and a representative of the Cirripeda — Balanus improvisus. In addition, small foraminiferans, seed shrimps (Ostracoda) and single amphipods (Gammaridae: Erichthonius difformis, Amphothoe ramondi) were identified. Mysids and decapods were recorded only in samples taken in June. Only two species of medusa were encountered in August: Blackfordia virginica and Coryna tubulosa.

Encountering Eutherpina acutifrons in the waters of the Sivash was rather interesting: although this cosmopolitan species occurs in all the oceans, it had not previously been recorded in the Azov-Black Sea region (with the exception of several single records near the Bosphorus (Pavlova & Baldina, 1969). This has generally been attributed to the low salinity of the Black Sea, which has prevented the range of this species from expanding further east. The discovery of Eutherpina acu-

Table 4
Average biomass and quantity of phytoplankton in the Eastern Sivash, June 2004

Systematic group	Second stretch		Third stretch	
	Biomass (mg/l)	Cells (million/l)	Biomass (mg/l)	Cells (million/l)
Cyanophyta	0.55	1.68	0.33	14.7
Chlorophyta	1.08	1.80	2.82	7.8
Euglonophyta	–	–	–	–
Pyrrophyta	19.8	6.30	9.90	3.3
Bacillariophyta	0.58	0.30	7.40	7.2
Total	22.01	10.08	20.45	33.0

Note: For definition of 'stretches' see Annex I, Fig. 2.

tifrons in the Sivash may be interpreted as a first sign of its probable eastward expansion.

Species composition of zooplankton in Lake Sivash within the boundaries of Dzhankoi District

Foraminifera
- Ammonia ammoniformis
- A. compacta

Hydromedusae
- Coryne tubulosa
- Blackfordia virginica
- Campenularia johnstoni
- Moerisia maeotica

Rotatoria
- Brachionus quadridentatus
- Synchaeta spp.

Trematoda larvae
Nematoda spp.
Oligochaeta spp.
Nereidae spp.
Polychaeta larvae
- Microspie meznikowianus

Nephtidae
Copepoda
- Acartia clausi
- A. tonsa
- Centropages ponticus
- Pseudocalanus elongates
- Cyclopina spp.
- Halicyclops rotundipes
- Cyclops strenuous
- Oithona similes

Harpacticoidae
- Harpacticus spp.
- Eutherpina acutifrons
- Enhydrosoma spp.
- Tisbe spp.
- Metis ignea

Cirripedia
- Balanus improvisus

Ostracoda spp.
Branchiopoda
- Artemia salina

Amphipoda
- Erichthonius difformis

Gammaridae spp.
Corophiidae
- Corophidium bonelli

Mysidacea spp.
Gastropoda larvae
Bivalvia larvae
- Mytilaster lineatus

Veneriidae
Chaetognata
- Sagitta setosa

Numbers of zooplankton in the samples taken at different localities (Fig. 4) varied between 1,560 and 291,000 specimens/m^3 (Table 5): the lowest densities being found in the Central and the highest in the Eastern Sivash. Neither in June nor August were copepods found in such high numbers as occurred here in the mid–1950s. The plankton was definitely dominated by larvae of bottom-dwelling animals. Total numbers and biomass of zooplankton varied slightly between localities (Table 6). The highest biomass was recorded in the Central Sivash, which is explained by the high concentration of Brine Shrimp Artemia salina in this hypersaline part of the waterbody.

It is worth noting that all samples taken in the Sivash were characterised by rather poor species composition, however significant differences, both in biomass and predominant species, were recorded in locations that were not widely separated.

4.2.2. Benthos

4.2.2.1. Macrophytobenthos

A total of 12 species of benthic macrophytes were recorded in the Sivash within the boundaries of Dzhankoi District in the course of the study in 2004. Algae were represented by three species of Chlorophyta, one species of Phaeophyta, five species of Rhodophyta, one species of Charophyta and two species of Magnoliophyta. Among the species of the first three taxa, annotinous species comprised 77.8%, the remainder being represented by perennial and other species. Oligosaprobic species comprised 55.6%, mesosaprobic species 33.1%, polysaprobic species 11.1%. No protected species were found. Two species (Entonema effusum and Phymatolithon polymorphum) found in the samples at that time were new for the algae of the Azov Sea. It should be noted that in general the desalination of the Sivash is enriching the floristic diversity of the macrophytobenthos.

Species composition of the macrophytobenthos in Lake Sivash within the boundaries of Dzhankoi District

Chlorophyta
- Chaetomorpha crassa
- Ch. linum
- Cladophora siwaschensis

Phaeophyta
- Entonema effusum

Rhodophyta
- Phymatolithon polymorphum

Figure 4. Localities in Dzhankoi District sampled for zooplankton in August 2004.

Ceramium tenuissimum
C. pedicillatum
Polysiphonia denudata
Chondria tenuissima
Charophyta
Lamprothamniun papulosum
Magnoliophyta
Ruppia spiralis
Zostera noltii

4.2.2.2. Zoobenthos

A total of 34 species of benthic organisms were found in 2003 and 2004 in the aquatic areas of the Sivash within the boundaries of Dzhankoi District. Only two species, Chironomus salinarius and Brine Shrimp, were recorded in the Central Sivash, while in the Eastern Sivash 33 species were recorded. Molluscs were represented by the largest number of species (19: 13 of which were gastropods and six bivalves). There were 10 crustaceans in the samples.

Species composition of zoobenthos in Lake Sivash within the boundaries of Dzhankoi District

Errantia
Nereis diversicolor
N. succinea
Polydora cyliata
Gastropoda
Hydrobia mabilli
H. acuta
H. procerula
Pseudopaludinella leneumicra
P. maritima
P. pontieuxini
Retusa truncatella
Rissoa benzi
R. labiosa
R. rufilabrum
R. venusta
Thalassobia rausiana
Bivalvia
Abra ovata
Cerastoderma clodiense

Table 5
Numbers of zooplankton (specimens/m³) in the samples taken in the Central and Eastern Sivash in August 2004

Sampling locality	Total	Crustacea	Including Harpacticoida	*Artemia salina*	Rotifera	Larvae of benthic organisms
21	4,037.5	2,692.5	592.5	0	0	1,345
22	70,760	25,557.5	13,652.5	0	2,437.5	42,765
38	291,340	258,425	249,500	140	0	32,915
39	1,560	20	20	1,480	0	1,540
40	5,370	620	620	4,570	0	4,750

Note: Numbers of the localities cerrespond to those on Fig. 4.

Table 6
Salinity of water (g/l), numbers (specimens/m³) and biomass (mg/m³) of zooplankton in different parts of the Sivash

Month	Indices	Eastern Sivash		[illegible]
		Second stretch	Third stretch	
[illegible]	Salinity	17.90	13.85	89.11
	Numbers	413.9	2,603.7	2,541.0
	Biomass	16.42	2.67	888.00
[illegible]	Salinity	19.16	18.26	122.44
	Numbers	43,740.8	2,665.7	3,465.0
	Biomass	239.46	7.11	2,736.93

Note: For definition of 'stretches' see Annex I, Fig. 2.

C. glaucum
C. lamarcki lamarcki
Mya arenaria
Mytilaster lineatus
Cirripedia
Balanus improvisus
Artemia salina
Cumacea
Iphinoe maeotica
Isopoda
Idotea baltica basteri
Sphaeroma pulchellum
S. serratum
Amphipoda
Gammarus aequiqauda
G. subtipicus
Decapoda
Crangon crangon
Rhithropanopeus harisi tridentata
Diptera
Chironomus plumosus
Ch. salinarius

As Table 7 shows, the average zoobenthic biomass in the second and third stretches did not differ significantly. The hypersaline Central Sivash is characterised by having the lowest zoobenthic biomass. However, there were significant differences between the two stretches of the Eastern Sivash in numbers of benthic organisms: the largest density was observed in the second stretch (7,318 specimens/m²). Compared to the results of hydrobiological studies undertaken in the same area in the 1950s (Vinogradova & Vinogradov, 1960), the benthic biomass has increased significantly — especially in the third stretch, which has been subject to fairly intensive desalination (Table 7).

At most localities, bivalves (Abra ovata, Mytilaster lineatus, Cerastoderma clodiense, C. glaucum) predominated by biomass, making up to 50–90% of the sample. The remainder of the sample usually contained gastropods (Hydrobia spp., Pseudopalludinella spp.), polychaete worms, isopods (Idotea baltica basteri), amphipods and chironomid larvae. Other taxa occurred only rarely in the samples and barely exceeded 1%.

4.2.3. Fish

4.2.3.1. Fish species in the Sivash

There is little information in the literature on the fish of the Sivash. The earliest published data (Shikhov, 1923; Zubovsky, 1932; Tarasov, 1940) concerned mainly commercially important species (such as mullet) and ways to increase the mullet harvest. At that time it was already being pointed out that the Sivash might have great potential for developing fish-farming if its salinity were stabilised at an optimum level (Shikhov, 1923).

Table 7
Average biomass and density of macrozoobenthos in different areas of the Sivash, 2003–2004

Parts of the Sivash	Density, specimens/m ^{2}	Biomass, g/m ^{2}
Eastern Sivash (second stretch)	7,318	190.949
Eastern Sivash (third stretch)	2,189	196.092
Central Sivash	356	0.4

Note: For definition of 'stretches' see Annex I, Fig. 2.

V.P. Vorobyov (1940) compiled a list of fish occurring in the Sivash, which was at that time the most complete record and contained some data on the species' biology. However, his work was still focused primarily on ways to increase the productivity and efficiency of fishing in the Sivash rather than having fish themselves as the main subject; therefore Vorobyov's work was more of theoretical nature, while the data he used was rather inconsistent. At that time 18 fish species occurred in the Sivash, including species that visited it seasonally from the Azov Sea (Table 8). According to V.P. Vorobyov (1940), a further thirteen species were accidental visitors to the Sivash, rarely venturing far from the strait that connected it to the Sea of Azov.

Later, more accurate data on the fish of the Sivash was provided by P.Y. Pavlov (Pavlov, 1960b). He recorded 19 fish species (Table 8), and indicated that Golden Mullet Liza aurata, Flounder Platichthys flesus, Grass Goby Zosterisessor ophiocephalus and Big-scale Sand Smelt Atherina boyeri were among the most numerous species. Several species were also recorded in the Tonka Strait as occasional visitors: Black Sea Shad Alosa maeotica (both forms), Roach Rutilus rutilus, Danube Bleak Chalcalburnus chalcoides and Zander Sander lucioperca. A total of 22 fish species had already been recorded by A.N. Svetovidov (1964). The new species were fish that were only occasionally or rarely encountered: Azov Shad Alosa caspia tanaica, a red mullet Mullus barbatus ponticus, Leaping Mullet Liza saliens and Turbot Psetta maxima torosa. In spite of the scarcity of data, it can clearly be seen that until the middle of the last century there was only a little variation in the species composition of the fish in the Sivash. The total ranged from 18 to 22 species, which may be explained by the records of fish that occurred in small numbers or only occasionally; all of these species entered the strait by chance and later entered the Sivash at times of high winds and strong currents.

A total of 30 fish species have been recorded in the Sivash (Table 8). There have been some changes in the distribution, numbers and biology of the species compared to the middle of the previous century. Today, fish such as Starry Sturgeon Acipenser stellatus, Black Sea Shad (both forms), Mediterranean Horse Mackerel Trachurus mediterraneus ponticus, Roach, Danube Bleak, Straightnose Pipefish Nerophis ophidion, Azov Shad, a red mullet M. b. ponticus, Leaping Mullet and Turbot no longer occur in the Sivash. However, a number of new species have been recorded: Prussian Carp Carassius gibelio, Rudd Scardinius erythrophthalmus, Bleak Alburnus alburnus, Stone Moroco Pseudorasbora parva, Amur Bitterling Rhodeus sericeus, Southern Nine-spined Stickleback Pungitius platygaster, European Perch Perca fluviatilis, Syrman Goby Neogobius syrman and Mushroom Goby N. eurycephalus. Species dominating catches today are: Big-scale Sand Smelt, Three-spined Stickleback Gasterosteus aculeatus, gobies (Marbled Goby Pomatoschistus marmoratus, Tubenose Goby Proterorhinus marmoratus, Grass Goby), So-iuy Mullet Mugil soiuy and Golden Mullet.

There is no doubt that these changes in the fish populations came about as a result of the progressive desalination of the Sivash, which started with the opening of the North Crimean Canal. Thus, the abundance of freshwater fish found in the course of the survey in 2003–2004 has significantly increased. In 1940–1964 freshwater fish comprised 5–20% of the species list; they have now increased to 30% (Fig. 5). It worth noting that a particularly diverse species composition is recorded in the freshwater areas of the Sivash: close to river mouths and in places where irrigation water is discharged.

4.2.3.2. Fish of the North Crimean Canal

Although canals are generally recognised as stream ecosystems (and they do resemble riverine ecosystems to some extent), they differ significantly from rivers. Canals are straight, the lateral section is almost unchanged along the whole length, and there are no shoals, sand spits, bars, bays or deep gaps (Romanenko, 2004). Species that have entered the North Crimean Canal from the Kakhovka Canal (rather than the species inhabiting waterbodies of Dzhankoi District) dominate its fish fauna. This is particularly true of Bighead Carp Aristichthys nobilis, Silver Carp Hypophthalmichthys molitrix, Black Sea Sprat Clupeonella cultriventris and some species of gobies and pipefish. Unfortunately, there is almost no data on the fish of the North Crimean Canal before 2003. The first published list (Sustainable

Table 8
Fish species recorded in the waterbodies of Dzhankoi District since 1940 until present time

Species	Conservation status	Aquatic area of the Sivash (Vorobiev, 1940)	Aquatic area of the Sivash (Pavlov, 1960b)	Aquatic area of the Sivash	North Crimean Canal (main waterway and branches)	Artificial ponds	Rivers (Pobednaya, Stalnaya)
				Own data (2003–2004)			
Acipenser stellatus	C – II, Bern – III, Bonn – III	+					
Clupeonella cultriventris			+	P	O		
Alosa pontica	Bern – III		+				
A. maeotica		+	+				
Engraulis encrasicolus		+	+	O			
Alburnus alburnus				P	M	M	M
Carassius gibelio				P	O	M	M
Pseudorasbora parva				P	P	O	P
Scardinus erythrophthalmus				P		O	M
Rhodeus sericeus	Bern – III			P	P		P
Leuciscus cephalus					P		
Rutilus rutilus			+		O		O
Chalcalburnus chalcoides			+				
Cyprinus carpio		+	+	P	P	O	O
Ctenopharyngodon idella						O	
Abramis brama					P		
Hypophthalmichthys molitrix					P	P	
Aristichthys nobilis					P	P	
Esox lucius							P
Atherina boyeri		+	+	M			
Syngnathus typhle		+		O			P
S. abaster	Bern – III	+	+	P			
Nerophis ophidion		+					
Gasterosteus aculeatus			+	O		O	O
Pungitius platygaster				P		P	O
Lepomis gibbosus					P		
Sander lucioperca		+	+				
Perca fluviatilis					O		P
Trachurus mediterraneus		+	+				
Mugil soiuy				M		O	P
Liza aurata		+	+	M			
Mugil cephalus		+	+	P			
Symphodus ocellatus			+	P			
Neogobius fluviatilis	Bern – III	+	+	O	M	P	O
N. melanostomus			+	M			
N. eurycephalus	RDBU				P		
N. gymnotrachelus	Bern – III				P		P
N. syrman	Bern – III				P		
Proterorhinus marmoratus	Bern – III	+		O	P	P	P
Zosterisessor ophiocephalus	Bern –III	+	+	O			
Pomatoschistus marmoratus		+		M			
Knipowitschia caucasica		+					
Mesogobius batrachocephalus					P		
Platichthys flesus		+	+	M			
Total species		18	19	23	19	13	16

Note: M — numerous, O — common, P — rare, + — species present, Bern — Bern Convention, Bonn — Bonn Convention, C — CITIES, RDBU — Red Data Book of Ukraine. Animals (1994), II and III — appropriate annexes to the conventions.

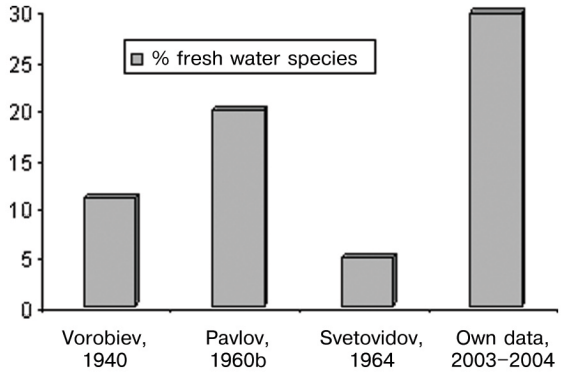

Figure 5. Percentage of freshwater fish of the total number of fish species in the Sivash.

Crimea, 2003) gives 14 species, although no details such as numbers or data on distribution are provided in the publication.

Our study recorded 19 fish species (Table 8). There are certain differences in the species composition between the main canal and its branches, which differ significantly in regard to their hydrological conditions (water speed, depth, transparency etc.). In the large waterways there are species that may have commercial value: Silver Carp, Roach, European Chub Leuciscus cephalus, Prussian Carp, Black Sea Sprat and a few others. There is a very specific fish fauna in the small canals and in those that are filled with water for a few months only. There are many Prussian Carp, Amur Bitterling and Stone Moroco fingerlings.

4.2.3.3. Pond fish

There are only a few ponds in Dzhankoi District currently being used for fish farming; freshwater ponds have been created on rivers or other waterways for purposes other than aquaculture. Some bays of the Sivash that are separated from the main aquatic area by dams are also used for fish farming (breeding of So-iuy Mullet, in particular). Some of the ponds found close to the villages of Tselynnoe, Zelenyi Ovrag and Zavet-Leninskiy were investigated: they contained typical freshwater fish species: Bleak, Prussian Carp and Rudd. These species are characteristic inhabitants of still ponds that are slowly becoming overgrown and silting up. Where the pond is used for fish farming, commercial species such as Silver Carp, Grass Carp Ctenopharyngodon idella and Common Carp Cyprinus carpio are usually introduced into it. Saline water bodies are used today exclusively for breeding So-iuy Mullet and some goby species can also be found there.

A total of 13 fish species have been recorded in the ponds of Dzhankoi District (Table 8); the numbers of commercial species are highly dependent on how determined the introduction effort was. There is no doubt that the existing fishponds have a great potential for increasing the fish productivity of the area; appropriate technology should be used to intensify the development of aquaculture.

4.2.3.4. River fish

The largest natural waterways in the area are the Rivers Stalnaya, Stepnaya and Pobednaya; there are also a few springs and smaller waterways, which may play a role in the conservation of fish in Dzhankoi District. Unfortunately, in the past these rivers received no attention from ichthyologists, therefore there is insufficient data to draw any conclusions about the impact of irrigation on the fish in the rivers.

A total of 16 species were discovered in the rivers of Dzhankoi District (Table 8), of which freshwater fish (Bleak, Prussian Carp and Rudd) were the most numerous. Fish requiring special hydrological and hydrochemical conditions (Amur Bitterling, Racer Goby Neogobius gymnotrachelus and a few others) have rarely been recorded. Local amateur fishermen catch Common Carp, Roach, Prussian Carp, European Perch and Pike Esox lucius. Commercial fishing is not allowed in the rivers of Dzhankoi District or in other Crimean waterways.

4.2.3.5. Protected fish species

Among the fish species listed in the Red Data Book of Ukraine only Danube Bleak and Mushroom Goby have been recorded in the study area. The latter is still occasionally recorded in the North Crimean Canal and its branches, while it seems that Danube Bleak has already disappeared (not a single record since the mid–1960s). Eight species listed in the annexes of the Bern Convention have been recorded, of which five inhabit canals, two are found in ponds, and four occur in rivers (Table 8). Starry Sturgeon (included in both CITES and the Bonn Convention lists), which occurred in the Sivash in the past, has totally disappeared following a dramatic decline over the whole of the Azov Basin. Further information on the protected species that occur in the waterbodies of Dzhankoi District is provided in Table 8. The conclusion may be drawn, therefore, that during the past few decades the number of fish species in Dzhankoi District has declined and two species of conservation concern, namely Starry Sturgeon and Black Sea Shad, have been lost.

4.2.3.6. Fisheries and fish farming in Dzhankoi District

With regard to commercial fisheries, the Sivash is the most productive aquatic area in Dzhankoi District; however, its importance has changed gradually as its waters have become less saline (Table 9). According to P.Y. Pavlov (1960b) in the 1950s the fish productivity of the Sivash was 3.0 kg/ha. There has been a constant increase in productivity since the canal was opened, as desalination has led to an increase in the aquatic areas suitable for some commercial fish. In the early 1980s salinity dropped to the optimum level and the fish harvest reached its peak of 6.4 kg/ha. The environmental changes stimulated by the development of irrigation were particularly favourable for Flounder, gobies, Big-scale Sand Smelt and some species of mullet.

Today, according to official statistics, overall fish productivity in the Sivash is about 0.2 kg/ha, which is much lower than at any time in the past, including the pre-irrigation period. Both the decline of fish stocks (Flounder, gobies, So-iuy Mullet) and weakening of controls over illegal fisheries account for the decrease in official catches, figures from which are being used to calculate fish productivity. Unfortunately, uncontrolled fishing, which causes serious damage to the commercial fish stock, is quite widespread in the district.

Other waterbodies in the survey area do not play a significant role in commercial fisheries: amateur fishermen use most of them only for recreational purposes. Attempts to introduce commercial species into some of these waterbodies (in the northern part of the district) have not yet been successful.

It seems very likely that the North Crimean Canal (particularly its main waterway, which is full of water all year round) has the potential for developing commercial fish farming. Silver Carp of harvestable size from the Kakhovka reservoir are currently being caught in the canal. Proper management would increase the fish-farming capacity of the waterway, at least for some freshwater fish.

Table 9
The fish harvest in the Sivash, 1951–2002

Years	Fish harvest , kg/ha
1951–1958	3.0
1975–1979	3.3
1980–1984	6.4
1985–1989	5.4
1990–1994	0.9
1995–2000	0.3
2001	0.2
2002	0.2

4.2.3.7. Major changes in the fish species in Dzhankoi District since the advent of irrigation

Using the waterways of the North Crimean Canal, fish species such as Silver Carp and Bighead Carp, Black Sea Sprat, Pumpkinseed Sunfish Lepomis gibbosus and Stone Moroco have moved into the waterbodies of the Crimean steppe. On the one hand they contribute to the overall fish productivity of the region, but on the other hand they are trash fish, which tend to increase in number and occupy the habitats of local species. As the discharge of fresh water led to the desalination of some bays and aquatic areas, freshwater fish started to spread across the Sivash. The proportion of freshwater fish in the Sivash has grown significantly in relation to the total number of species (Fig. 5). One of the trash fish species, Stone Moroco, is recorded at the outlets into the Sivash. In the very near future Pumpkinseed Sunfish is likely to increase in number and enter the freshwater bays; currently it is recorded only in the main canal but its arrival in the Sivash is probably just a matter of time.

The general decrease in average salinity (from 80 g/l to 20 g/l, and in places even lower) has not had a clear-cut impact on the fish of the Sivash: for some species the habitable aquatic areas have expanded temporarily, while a number of important commercial species have suddenly lost spawning areas (Flounder, So-iuy Mullet).

Species composition and abundance remain heavily affected by the hydro-ecology of the Sivash, which even today remains rather unstable due both to factors both biotic (changes in water level when the wind is strong) and abiotic (irregular discharge of fresh water). Because of this, there are considerable fluctuations in the biomass of benthos and zooplankton and their productivity.

It is interesting to note that some salt-water species are forced to inhabit the North Crimean Canal and its waterways because of the absence of favourable hydrological conditions in the Sivash; this is of particular concern for Mushroom Goby, Knout Goby Mesogobius batrachocephalus and Syrman Goby.

Today, the fish productivity of the aquatic area has fallen by a factor of almost 30 compared to that in 1980–1984. Although fisheries are declining throughout the whole basin, the spread of illegal fishing complicates an assessment of the real situation in the Sivash. In fact, there is no reli-

able information on the actual fish harvest in this waterbody. Nonetheless, it is obvious that it is the large-scale decline in the populations of major commercial species that accounts for the shadow that has fallen over the local fisheries, therefore the long-term consequences of the development of irrigation farming seem on the whole to be negative. The Sivash has lost its importance with regard to commercial fisheries, while trash freshwater fish from the North Crimean Canal are progressively populating the waterbody.

The re-salination of the Sivash, which is taking place currently because of overall decrease of fresh water discharge, is likely to increase the role of commercial fish species such as Flounder, So-iuy Mullet and Golden Mullet, which used to comprise up to 80% of the total fish harvest in the Sivash in the 80s. Increasing the aquatic areas suitable for spawning and fattening of Flounder and So-iuy Mullet would have a positive effect on the whole Azov-Black Sea populations of these species. Some increase in the salt content would not affect fish species diversity, although freshwater species are likely to decline in number.

If the discharge of fresh water increases to the levels recorded in the 1980s, the Eastern Sivash will become an increasingly freshwater wetland. This will benefit the freshwater fish populations, whose numbers and species composition are likely to increase. However, the Eastern Sivash cannot become a wholly freshwater body, and its potential for freshwater fish reproduction will remain rather limited, therefore fisheries based on freshwater species would require the development of aquaculture.

4.3. Insects of Dzhankoi District

Detailed studies of the enormous number of species in this group require much more time and financial resources than were possible under the project budget, therefore our efforts were focused primarily on the distribution of endangered species: those listed in the Red Data Book of Ukraine and on international lists of endangered species. It is obvious that the creation of the canal system and development of irrigated agriculture in the Crimean Prisivashie have led to quite significant changes in the numbers and diversity of insects found in this region. Although it has been suggested that insect numbers and species diversity are generally higher at irrigated plots (Minoransky, 1973, 1977, 1978, 1979, 1987), this may not be true in the case of rare and endangered species. This section of the report deals with the clarification of this question

4.3.1. Species composition

The insects of Dzhankoi District have been studied rather poorly compared to those in other parts of Crimea. This may be explained by a number of factors, but the main one is the inaccessibility of most sites that are interesting for insect studies. There have been no special publications on the insects of Dzhankoi District. The data obtained in the course of entomological studies in the Crimean Prisivashie have been published in a number of monographs (Medvedev, 1950; Boshko, 1973; Tobias & Kotenko, 1986; Yefetov & Budashkin, 1990). According to a very preliminary estimate, there are about 4,000 insect species belonging to 21 orders in Dzhankoi District (Dolin & Yermolenko, 1985; Kotenko et al., 1997), while over 29,000 species of insects occur in Ukraine as a whole. Most of these (more than 90% of species) belong to just six orders: Hymenoptera, Diptera, Coleoptera, Lepidoptera, Homoptera and Hemiptera (in decreasing order of number of species).

4.3.2. Main insect guilds (entomocomplexes)

The following natural insect guilds are found in the area:

Steppe

This insect guild is represented mostly by species associated with steppe vegetation; it is characterised by high species diversity. Hymenopterans, lepidopterans and xerophytic beetles predominate by number of species. The complex includes the majority of the endangered insects known for the study area.

Meadow

This insect guild is represented mostly by the species associated with halophytic meadows. Dipterans comprise the predominant group. The number of hymenoptera species is lower than the number in the steppe complex. However, there are some interesting, rarely collected species. There are few endangered insects in this guild.

Swampland

This insect guild consists of the insects associated with hydro- and hygrophilous vegetation, and also by their predators and parasitoids; dipterans are the predominant group. The consortial guild of the reed comprises species belonging to 7–10 orders. There are relatively few rare or endangered species.

Alkaline soils

The species diversity of this insect guild is significantly poorer than that of other insect guilds. Insects associated with halophytic vegetation (mostly flies and beetles) comprise its nucleus. Endangered species occur rather infrequently, but some rarely collected braconids (Hymenoptera: Braconidae) are found in this complex.

Natural waterbodies

This insect guild includes representatives of seven orders, but its species composition is inferior to that of the terrestrial insect guilds in species richness. Only the dragonflies (Odonata) include endangered species.

The group of anthropogenic insect guilds is also diverse:

Field and garden agrocoenoses

These associations are represented by the sets of species from the steppe and meadow complexes supplemented by eurytopic, polyphagous and specialised pests, as well as entomophagous insects that feed upon the latter. Rare and endangered species occur rarely.

Forest belts, parks, orchards and vineyards

These insect guilds may be considered as, to some extent, typical of the beginnings of impoverished forest and shrub communities. They contain mostly eurybiont species and other insects that use these green plantations as temporary refuges to hide from heat or bad weather. Polyphagous and specialised pest insects (tree-

and bush-living species) are widely represented here. Endangered species occur only rarely.

Rice fields and artificial reservoirs

These guilds are composed of species that were originally associated with water and swampland guilds. The composition of species in artificial reservoirs is determined mostly by how long the reservoir has existed, the structure of banks and bottom, size and depth, chemical parameters of the water, degree of contamination, and also (for the inflow and outlet streams) the speed of the current. If the required conditions are met, it is possible that an insect guild similar to a natural guild will develop in such a reservoir.

Ruderal

The representatives of these insect guilds occur mostly on waste and uncultivated plots, near abandoned cattle farms and other buildings. The insects associated with ruderal plants comprise the nucleus of this guild. Ruderal vegetation attracts species (both pests and their entomophages) from neighbouring coenoses. Occasionally, endangered species of hymenopterans and butterflies may occur on the flowers of ruderal plants.

Synanthropic

This insect guild is composed of the species associated with human dwellings. The representatives of this guild belong to 8–11 orders. There are no endangered species. However, observations suggest that the endangered Mammoth Wasp Scolia maculata and one of the carpenter bees Xylocopa spp. occur more often in or near small populated areas. This may be explained by the fact that the Mammoth Wasp, a parasitoid of the larvae of the Rhinoceros Beetle Lucanus cervus, searches for its hosts in dunghills, and the carpenter bee prefers old wooden buildings for nest construction.

4.3.3. Endangered (protected) insect species of Dzhankoi District

Twenty five endangered insect species, from six orders, that are listed in the Red Data Book of Ukraine have been reported from Dzhankoi District (Kotenko, in press). There is also a high probability of finding at least 15 more species here. These species are discussed below according to the orders to which they belong.

Dragonflies (Odonata)

Only one endangered species is known, Emperor Dragonfly Anax imperator. It is found at the mouth of the River Pobednaia on the coast of Dzhankoi Bay (in high numbers) and in the vicinity of Tselinnoe village.

Praying mantises (Mantoptera)

Only one endangered species is known, Iris polystictica. It is quite rare in the Prisivashie, but quite common at some Crimean sites (e.g. in Eupatoria). It is also probable that Short-winged Bolivaria Bolivaria brachyptera may be found in the Dzhankoi region.

Locusts and grasshoppers (Orthoptera)

Personal communications have been received about a record of Matriarchal Katydid Saga pedo, but this data requires confirmation.

Beetles (Coleoptera)

There are four endangered species listed in the Red Data Book of Ukraine. Recently, the ground beetles (Carabidae) Hungarian Ground Beetle Carabus hungaricus and Calasoma sycophanta have been recorded quite frequently. The weevil Leucomigus candidatus is rare. Sacred Scarab Scarabaeus sacer used to be quite common in the Crimea, but now seems to have totally disappeared from Dzhankoi District. Maid of Kent Beetle Emus hirtus was found near the village of Tselinnoe.

Lacewings (Neuroptera)

The only representative of this order, ascalaphid Libelloides macaronius, was found in small numbers in the Dzhankoi region in 2003 (Maltsev, in press). It is worth noting that this species was believed to have disappeared from the area about 30 years ago (Kostin et al., 1981).

Butterflies and moths (Lepidoptera)

Five species have been recorded. The Swallowtail Papilio machaon and Scarce Swallowtail Iphiclides podalirius are quite common and numerous. Bloodword Burnet Zygaena laeta occurs less frequently; Sooty Orange Tip Zegris eupheme and Eastern Dappled White Euchloe ausonia volgensis are difficult to find as they occur only in low numbers. It may be possible to find a further four-five species, primarily those belonging to the Arctiidae, Noctuidae and Sphingidae.

Wasps and bees (Hymenoptera)

Twelve endangered species are known: Mammoth Wasp, Scolia hirta, the sawfly Arge beckeri, Road Wasp Anoplius samariensis, Digger Wasp Stizoides tridentatus, Carpenter Bee Xylocopa violaceae, bees Melitturga clavicornis, solitary bee Rhophitoides canus and Alfalfa Leaf

Cutter Bee Megachile rotundata, and bumblebees Bombus armeniacus, B. argilaceus and B. fragrans. There is a high probability of finding at least a further seven-eight species of this order that are listed of the Red Data Book of Ukraine.

There are a few insect species that are still common in Ukraine but extremely rare and thus protected in Western Europe (the European Red List). These include the Large Copper Butterfly Lycaena dispar, Great Peacock Moth Saturnia pyri and Seathorn Hawk-moth Hyles hyppophaes.

A checklist of endangered insects of the Dzhankoi region is given in Table 10; new localities (records from 2004) are presented in Table 11 (see also Annex I, Fig. 7).

4.3.4. The impact of irrigation on insects as a whole, insect guilds and individual insect species

Impact of irrigation on insects as a whole

The xerophylous insects have been forced out by meso- and hygrophilous insect species on the irrigated areas. In general, the numbers of insect species have risen, but the ratio in which the orders are present has changed. The number and diversity of Diptera has risen significantly, as have the number and diversity of hemipterans (bugs, aphids, etc.) and beetles (especially species of Staphylinidae and Carabidae). V.N. Stovbchaty (1984) demonstrated that the number and species diversity of elaterid beetles increased significantly on irrigated land.

Table 10
Checklist of endangered insects recorded in Dzhankoi District up to the year 2004

Taxa	Conservation status			Relative occurrence
	RDBU category	ERL category	BC (II)	
Odonata				
Anax imperator	III			Rare
Mantoptera				
Iris polystictica	III			Rare
Coleoptera				
Calasoma sycophanta	II	V		Common
Carabus hungaricus	II			Rare
Emus hirtus	III			Rare
Scarabaeus sacer	II			Extinct?
Leucomigus candidates	III			Rare
Neuroptera				
Libelloides macaronius	II	K		Very rare
Lepidoptera				
Lycaena dispar		E	+	Rare
Iphiclides podalirius	II			Common
Papilio machaon	II			Common
Zygaena laeta	I			Rare
Euchloe austonia volgensis	II			Rare
Zegris eupheme	I			Rare
Hyles hyppophaes		V	+	Rare
Saturnia pyri		E		Common
Hymenoptera				
Arge beckeri	III			î ÷åí ü Rare
Scolia hirta	II			Common
S. maculata	II			Common
Anoplius samariensis	IV			Rare
Stizoi des tridentatus	IV			Rare
Xylocopa violaceae	II			Common
Melitturga clavicornis	II			Rare
Rhophitoides canus	II			Common
Megachile rotundata	II			Rare
Bombus armeniacus	II			Rare
B. argilaceus	II			Rare
B. fragrans	II			Rare

Note: RDBU — Red Data Book of Ukraine. Animals (1994); ERL — European Red List (1991); BC (II) — Bern Convention, Annex II (1979). Categories of conservation status in ERL: □ — endangered, K — data deficient, V — vulnerable; in RDB: I — disappearing, II — vulnerable, III — rare, IV — unidentified.

Table 11
New records of protected insects in Dzhankoi District (according to field investigations carried out in 2004)

Species	Closest populated place	Date
Scolia maculata	1.5–2 km to the SW of the village of Octiabr	7.06
Scolia maculata *S. hirta* *Papilio machao* *Xylocopa violaceae*	Vicinity of Maiskoe village	7.06
Scolia hirta	Vicinity of Svetloe village	7.06
Papilio machaon *Scolia hirta*	Vicinity of Nizhnie Otrozhki village	8.06
Cephus sp p.*n. aff. zahaikevitshi*	1.5 km to the north of Prostornoe village	8.06
Scolia hirta	Vicinity of Blagodatnoe village	8.06
Rhophitoides canus *Papilio machaon* *Scolia hirta*	Vicinity of Vesioloe village	9.06
Rhophitoides canus *Calasoma sycophanta* *Papilio machaon* *Xylocopa violaceae* *Saturnia pyri*	Vicinity of Yarkoe village	9.06
Lycaena dispar	Vicinity of Subbotnik village	10.06
Xylocopa spp.	Vicinity of Solontsovoe village	10.06
Papilio machaon, *Scolia hirta* *Iphiclides podalirius*	Vicinity of Yasnopolianskoe village	11.06
Anax imperator *Carabus hungaricus* *Emus hirtus*	Vicinity of Tselinnoe village	11.06
Xylocopa violaceae *Scolia hirta* *Libelloides macaronius*	Vicinity of Mysovoe village	16.06

By contrast, the numbers and species diversity of Tenebrionidae, Dermestidae, Curculionidae and Scarabaeidae on irrigated land has decreased. Of the lepidopterans, noctuid moths have become dominant. Hymenopterans are also rather sensitive to any change in the hydrological regime: the number and species composition of Hymenoptera has also changed noticeably. The species diversity of bees has become much poorer, and more dipteran parasitoids now occur among Hymenoptera parasites (Braconidae: Alysiinae, Opiinae, Diapriidae).

Impact of irrigation on the insect guilds

Since the creation of the irrigation system in the region, the areas occupied by the anthropogenic insect guilds have expanded considerably. The

valuable steppe complex has suffered most from irrigation. Most of the insects that were originally widespread in the steppe areas have been dislodged from their original localities to sites where steppe vegetation is preserved by chance (wasteland, slopes of open-cast mines and dams, military zones, etc.). A significant decrease in the areas occupied by virgin steppe has led inevitably to an increase in the grazing impact on the remaining pastures. Of more than 40 plots studied in 2004 only one plot appeared not to be overgrazed.

Impact of irrigation on the species with economic importance

There are many pest species — species of elaterid beetles (Elateridae), noctuid moths (Noctuidae), some grasshoppers (Orthoptera), aphids (Homoptera) and bugs (Hemiptera) — and their numbers have risen since the development of irrigation farming. A fairly dense network of forest belts has significantly improved overwintering conditions for the pest bug Eurygaster integriceps. The introduction of irrigation has caused the loss of breeding grounds for dendrophilous pests, Gypsy Moth Lymantria dispar, and other lepidopteran pests, e.g. Euproctis chrysorrhoea, E. similes and Hyphantria cunea and many Geometridae and Tortricidae.

Impact of irrigation on endangered species

The endangered species recorded in Dzhankoi District may be split to three main groups according to the degree to which they are affected by the development of irrigation:

- species that do not survive changes in their environment. Most species belonging to the steppe insect guild may be included in this group: praying mantises, Matriarchal Katydid, Hungarian Ground Beetle, Ascalaphid, Bloodword Burnet, Sooty Orange Tip, Eastern Dappled White and many hymenopterans.
- species whose numbers are determined in a variety of ways, but not by the type of habitat (e.g. Mammoth Wasp, Swallowtail and Scarce Swallowtail).
- species that appreciate changes in their environment. These are the species whose numbers have risen when their habitats have undergone changes (in particular, when field-protective forest belts were planted). These are Calasoma sycophanta and the carpenter bees (Xylocopa spp.).

4.4. Amphibians and reptiles

4.4.1. Amphibians

Three species of amphibians (of the total of five species recorded for the whole of Crimea) may be encountered in Dzhankoi District. They are Green Toad Bufo viridis, Lake Frog Rana ridibunda and Common Spadefoot Pelobates fuscus. The first two are the most numerous species, and occur throughout the whole of the district (Table 12). Green Toad occurs on the virgin steppe, pastures, abandoned land, fields, vineyards, forest belts, and within the boundaries of settlements: in orchards and gardens, parks, farms and wastelands. This species has become synanthropic to some extent. Lake Frog inhabits rivers, lakes, ponds, reed swamps, the North Crimean Canal, irrigation and drainage canals and rice fields. In the Tiup-Kangil Peninsula (Kalinovskoe Urochishche) these frogs were discovered on dry pasture, hiding in drinking bowls and puddles near an artesian well. However, this species primarily prefers ponds with still or slowly flowing water and well developed aquatic and emergent vegetation. In such places population densities and numbers may be very high.

Common Spadefoot is the rarest amphibian on the peninsula. It has been suggested recently that this species be included in the Red Data Book of Crimea. For many years there were only three sites in Crimea where Common Spadefoot was recorded: Karadag and in the vicinities of the towns of Simferopol and Dzhankoi. Recent studies show that the species is more widespread in Crimea than was previously thought (Kotenko, 2001b): the scarcity of records is explained largely by the difficulty in finding it in the field. Although Common Spadefoot was reported from Dzhankoi District over 50 years ago there is no doubt that this species still occurs in the area, and not only near Dzhankoi town. Common Spadefoot may inhabit a range of biotopes such as meadows, steppes, fields, gardens, wastelands, parks, shrubby areas, and different types of forests, generally preferring light sandy and sandy-loam soils.

It is worth noting that both Green Toad and Common Spadefoot are species of European conservation concern (both listed in Annex II of the Bern Convention, Table 12).

4.4.2. Reptiles

Seven species of reptiles have been recorded in Dzhankoi District (Table 12). In the future, two more species may be found in the area (Crimean Lizard Podarcis taurica and Diced Snake Natrix tessellata), but as yet no records exist. The first species is common in the Pervomaisk and Krasnogvardiysk Districts of the Crimean Autonomous Republic (personal observations); the second was recorded in the Chongar Strait (Karmyshev, 2002), on the Chongar Peninsula and Kuyuk-Tuk Island (Genichesk District,

Table 12
Amphibians and reptiles of Dzhankoi District

Taxa	Conservation status			Occurrence, grades	Population density, grades	Numbers, grades
	RDBU category	IUCN category	BC			
Amphibia						
Bufo viridis			+	5	2–5	5
Pelobates fuscus			+	1?	?	1?
Rana ridibunda				4	2–5	5
Reptilia						
Emys orbicularis		LR/nt	+	3	?	3
Lacerta agilis			+	5	1–5	5
Coluber (=Hierophis) caspius	II		+	2	1–2	2
Coronella austriaca	II		+	2	1–2	2
Elaphe sauromates	II		+	3	1–5	3
Natrix natrix				5	1–4	4–5
Vipera renardi *	II	EN	+	4	2–5	4

Note: Occurrence, population density and numbers were estimated according to an approach used in the past (Kotenko, 1993). RDBU — Red Data Book of Ukraine. Animals (1994), IUCN — IUCN Red List of Threatened Species (2000), BC — Bern Convention, Annex 2 (1998). Conservation status categories: RDB: II — vulnerable; IUCN: EN — endangered, LR/nt — lower risk of extinction. * — Vipera ursinii is listed in CITES Annex I, although this Annex concerns European populations and excludes the territory of the former USSR. This is why the species V. renardi, which occurs in Ukraine and an area further east, is not protected under CITES, although until very recently it was considered to be a sub-species V. ursinii renardi.

Kherson Region), and also near Lubimovka village, Nyzhniohirsk District (Kotenko & Kukushkin, 2003). All these localities are close to the border of Dzhankoi District.

European Pond Turtle Emys orbicularis inhabits various freshwater bodies but prefers lakes, ponds, canals and rivers with still or slowly flowing water and well-developed aquatic and coastal vegetation. In Dzhankoi District this species occurs in the North Crimean Canal, rivers and numerous ponds, including those located in Dzhankoi town (Kotenko, 2001c, 2004). No quantitative estimates of the population density of the turtle in the waterbodies of the district are currently available, but this species is very likely to be common in most of them.

Sand Lizard Lacerta agilis is very typical for the Prisivashie. It is the only lizard species that occurs in Dzhankoi District. Sand Lizard inhabits a wide range of habitats: steppes, halophytic meadows, abandoned fields, forest belts, slopes of canal dikes, road shoulders and railway embankments, field margins, old vineyards, parks and orchards. Locally, the population density of the species may reach more than 1,000 specimens per hectare.

Grass Snake Natrix natrix occurs over almost all of Dzhankoi District. This snake tends to inhabit places with high numbers of amphibians, which basically form its diet. These are often reed wetlands, banks of rivers, lakes and ponds, canals and rice fields, densely populated by Lake Frogs, as well as areas adjacent to settlements, which are preferred by Green Toads. It is a common, and in many places numerous, snake of the study area.

Large Whip Snake Coluber caspius is a fairly widespread species in Crimea, both in the steppe and mountainous areas. It prefers dry, well-lit, open spaces, particularly rocky slopes overgrown with shrubs. It also occurs in ruined buildings, vineyards, gardens, on various mounds and wastelands. In Dzhankoi District this species has been recorded in steppe areas in a few localities (Kotenko, 2001a; Kotenko & Kukushkin, 2003).

Unlike in the mountain-forest area of Crimea, where Smooth Snake Coronella austriaca is quite a common species, in the steppe zone of the peninsula it occurs very rarely. Most records come from the Prisivashie area, and Dzhankoi District in particular. The species was repeatedly reported from the steppes of the Tiup-Kangil Peninsula (a military zone in the past, which has recently received the status of a regional landscape park), an abandoned vineyard near the village of Zavet-Leninskiy and in the environs of the town of Dzhankoi (Kukushkin & Kotenko, 2003; Kukushkin & Sviridenko, 2003).

Dzhankoi District is among the most important areas for Pallas's Rat Snake Elaphe sauromates in Ukraine. The species inhabits virgin steppe areas (including overgrazed and salinised steppes), abandoned fields, old vineyards, forest belts, steep slopes of banks, dams and mounds, and rubbish dumps. It may also be encountered in settlements: in gardens, parks and wasteland. In some areas of Dzhankoi District, particularly in the Kalinovskiy Regional Landscape Park, this species may attain quite a high population density (Kotenko, 1998, 2001a; Kotenko et al., 1998; Kukushkin & Karmyshev, 2002; Kotenko & Kukushkin, 2003).

Steppe Viper Vipera renardi has disappeared from the most of its former distribution range in Ukraine, being currently restricted mainly to protected areas. However, it is still widespread and sometimes abundant in Crimea, and the Prisivashie area in particular. In Dzhankoi District this species inhabits virgin steppe areas (including those that are heavily grazed or that have become saline), abandoned fields, old vineyards, forest belts and various mounds. It is also sometimes found on the banks of the dikes of the North Crimean Canal. It is worth noting that in the Prisivashie the majority of the Steppe Viper populations that have a high density are confined to Dzhankoi District, and one such population has been recoded in the Kalinovskiy Regional Landscape Park (Kotenko, 1998, 2000, 2002a; Kotenko et al., 1998; Karmyshev, 1999; Kukushkin, 2003; Kukushkin & Kotenko, 2003).

Four reptile species (Large Whip Snake, Pallas's Rat Snake, Steppe Viper and Smooth Snake) are included in the Red Data Book of Ukraine; European Pond Turtle is on the IUCN Red List of Threatened Species. Six out of seven reptile species occurring in Dzhankoi District are included in Annex 2 of the Bern Convention (Table 12). It must be stressed that the Prisivashie area, and Dzhankoi District in particular, is extremely important for the conservation of Steppe Viper and Pallas's Rat Snake at the national level (Kotenko, 1998, 2001a; Kukushkin & Karmyshev, 2002; Kotenko & Kukushkin, 2003; Kukushkin, 2003; Kukushkin & Kotenko, 2003). In 2000–2004 several localities where reptiles listed in the Red Data Book of Ukraine occur were found (Fig. 7, Annex I).

4.4.3. The impact of irrigation on reptiles and amphibians

The results of amphibian and reptile studies carried out in Crimea before 1963 were summarised in a monograph by N.N. Shcherbak (1966). Unfortunately, this publication provides

insufficient information for faunal changes that have taken place in the area since then to be clearly identified. More detailed studies were begun here only in the 1990s; therefore most of the data refers to the period long after the creation of the irrigation system in Crimea.

Compared to the species list published by N.N. Shcherbak (1966), more recent studies have revealed three new species of reptiles, namely European Pond Turtle, Large Whip Snake and Smooth Snake. However, this does not necessarily mean that these species did not occur in the area before the construction of the irrigation system. It is very likely that both Large Whip Snake and Smooth Snake occurred here in the past. The same is true for European Pond Turtle: well before the construction of the North Crimean Canal it was reported from several localities on the River Salgyr. Furthermore, European Pond Turtle was recorded at several localities in the Prisivashie: in the vicinity of Sovetskiy and Sofievka settlements, Kirovsk District. It seems very likely that by that time it already occurred in rivers such as the Stalnaya, Pobednaya, Stepnaya and Mirnovka. In any case, it would have been just a matter of time before this species arrived in these waterways. European Pond Turtle is known to cover quite large distances over dry habitat. For example, it has been found in water-filled bomb craters in the military zone in the Kazachyelagerskaia area, as far as 8–12 km from the nearest wetland (Kotenko, 2000).

Dice Snake has been recorded from the area adjacent to Dzhankoi District — in canals near the estuarine zone of the River Salgyr (vicinity of Lubimovka village, Nyzhniohirsk District) (Kotenko & Kukushkin, 2003). Its distribution and population stability are determined mainly by the availability of small fish. It seems very likely that in the very near future this snake will be found in the canals or lower reaches of some small rivers in Dzhankoi District.

During the last 40 years there seem to have been no or only minor changes in the composition of the amphibians and reptiles of Dzhankoi District. By contrast, the distribution, population density and numbers of amphibians and reptiles have been subjected to significant change. Land reclamation is generally recognised as one of the most influential factors affecting species of these groups in the Southern Ukraine (Kotenko, 1993, 1999a). The following consequences of the development of irrigation farming, which directly or indirectly impact upon amphibians and reptiles, may be singled out:

- Construction of canals, water reservoirs, ponds;
- Appearance of waterbodies in formerly dry areas;
- Appearance of dams and embankments around the waterbodies;
- Desalination of the bays of Lake Sivash and development of reed beds;
- Waterlogging of low-lying lands;
- Rise of water-table;
- Secondary salination of soils;
- Ploughing up of extensive areas for cultivated crops;
- Creation of forest belts on virgin land along canals ;
- Creation of forest belts on arable land;
- Overgrazing;
- Invasion of new species;
- Invasion of genetically different populations from other parts of the species' distribution range;
- Agricultural pollution (pesticides);
- Eutrophication;
- Increase in motorised traffic.

The system of irrigation canals itself was not a great threat to the steppe reptile species: it was the development of agriculture — ploughing up of the virgin steppe, applications of pesticides, increase in traffic etc. — that has dramatically affected their distribution and abundance. Radical habitat transformation did not only affect land used for crop production: all the remaining non-cultivated land was being heavily exploited as pastures. In the 1970–1980s livestock breeding was at its peak of development. The grazing pressure was so high that many pastures were grazed bare and therefore almost completely lost their importance as habitat for reptiles. Secondary salination of soils (as a result of underflooding or excessive irrigation) has also had a negative effect on reptiles. Many amphibians and reptiles die under the wheels of vehicles on the roads: the mortality level is particularly high where roads intersect migration routes used by reptiles and amphibians to reach their wintering, breeding or feeding areas. Natural steppe vegetation on the coast of the Sivash is often restricted to narrow (c. 3–15 m wide) strips along coastal cliffs. The presence of dirt roads on such strips significantly reduces the chance of survival of threatened snake species. On the other hand, the development of irrigation has had a clear, positive effect on the populations of some amphibians (especially Lake Frog), European Pond Turtle and Grass Snake. It has led to the increase in their numbers and favoured the distribution of some of these species over previously uninhabited areas. In particular, as a result of the creation of the network

of irrigation and drainage canals and related waterbodies (ponds, pools, and reed-bed wetlands) Lake Frog has become a widely distributed and very abundant species in the Prisivashie. There are indications that the North Crimean Canal facilitated the southwards expansion of the nominative sub-species of European Pond Turtle, which could have had an impact on the gene pool of the local Crimean populations[3].

Both land reclamation work and the conversion of natural habitats for agricultural purposes have significantly contributed to the fragmentation of the steppe landscape. Under these circumstances, ecological corridors are very important for supporting the density and genetic polymorphism of reptile populations. In the Prisivashie such 'ecocorridors' are formed by the Sivash coast, narrow strips of steppe vegetation and tree plantations along railways and motorways, some forest belts, dikes of the North Crimean Canal and its branches, and military areas. Some virgin land has also been preserved near settlements; however, most of it has been heavily overgrazed or turned into rubbish dumps. In these areas reptiles suffer not only from overgrazing but are also killed by people and domestic animals (cats, dogs, pigs). The coast of the Sivash is one of the most important 'ecocorridors' in Ukraine for reptiles (Kotenko, 1999b). Thanks to the presence of this uncultivable strip of steppe, today the distribution of Pallas's Rat Snake and Steppe Viper is almost uninterrupted between the Kinburnskaia Spit (Nikolaev Region) and the Kerch Peninsula.

Large pastures and abandoned fields are very important for the conservation of snakes, especially where they abut one another and provide sufficient wintering sites. Such sites are found under the foundations of old or ruined buildings, on abandoned rubbish dumps and cattle burial grounds, various types of dams and embankments, hills and burial mounds. All these areas are at least slightly elevated, which prevents them from flooding (both saturation and seasonal surface floods); they also have many holes and fissures in the ground deep enough to provide shelters that do not freeze during the coldest period of a year. Such characteristics are of particular importance in the Prisivashie (with its low-lying land, significant levels of salination and high water table), especially after the creation of the irrigation system resulted in underflooding (Kotenko, 2000, 2001d). It is worth noting that the creation of dams and embankments along or around the canals, water reservoirs and ponds built as parts of the irrigation system has improved wintering (and also breeding) conditions for reptiles.

Some of the irrigation system infrastructure has a distinct negative effect on the reptile populations. For example, drainage wells can become real traps for animals. Many wells that had been part of the non-functioning drainage system were found on the abandoned vineyards near Zavet-Leninskiy village. These wells consisted of four-six concrete rings, but an additional upper ring was absent on the majority of wells, which is why the edges of the well were at surface level or projected only a little. Annual inspections in April-May 2000–2004 revealed snakes, lizards and frogs that had fallen into the wells and could not escape. Between three and 69 (!) individual Steppe Vipers were counted in the wells; Pallas's Rat Snake, Smooth Snake, Sand Lizard and Green Toad were trapped less frequently (1–2 specimens per well); only one Grass Snake was trapped. It may be the warm concrete that attracted reptiles into the wells. The Steppe Viper males could also have been attracted by the smell of females, which increased the total number of victims. Unfortunately, the local people take every opportunity to kill snakes, as was apparent from the presence of many deformed snake corpses in the wells. The effectiveness of the well-traps is illustrated by the fact that between 2000 and 2004 no live Smooth Snakes were recorded in the area of Zavet-Leninskiy, but in 2000–2001 three individuals were found in the wells. The impact of such wells on the population numbers of some threatened snake species is believed to be significant.

[3] The relationships between turtles from different parts of Crimea have yet to be studied in detail; therefore it is not quite clear how far hybridisation has progressed and how serious the threats to the genetically unique Crimean populations of European Pond Turtle are.

4.5. Birds

4.5.1. General notes

The construction of the North Crimean Canal and intensive development of irrigation farming led not only to the desalination of the aquatic areas but also to flooding of the adjacent lowlands in the study area. Swamps, salt marshes, ponds and reed beds have replaced solonchaks, mudflats, and saline and hypersaline waterbodies. The constant discharge of fresh water facilitated the distribution of freshwater species, which replaced chironomids (larvae) and Brine Shrimps (Chernichko & Kirikova, 1999). As a result, the overall productivity and biomass of food available for some waterbirds has decreased dramatically. The expansion of reeds over the mudflats, which started soon after the beginning of the freshwater discharge, resulted in the relocation of nesting, foraging and roosting sites for birds. Natural steppe vegetation was mostly replaced by crops or restricted to the coasts and areas not suitable for agriculture. The planting of forest belts along the canals and roads facilitated a southward dispersal of forest birds. Due to the increase in the human population, some synanthropic species showed an apparent increase in numbers. In the last 50 years the birds of the region have been subject to the significant impact of a range of factors, most of which were related in some way to irrigation.

During the period from 1980 to 2004 a total of 239 bird species were recorded from Dzhankoi District (see Annex II, Table 2); this is about 57% of the number of species recorded for the whole of Ukraine. One hundred and twenty nine species breed, 210 species migrate, and 94 species winter in the area. Of the breeding birds, those that breed colonially on the islands and spits of the Sivash comprise the most numerous group. During the period when the impact of the North Crimean Canal on the environment was most beneficial, the number of colonially breeding birds reached 31,000 pairs, but over the last decade their numbers have fallen to 19,000–20,000 pairs. The most numerous breeding species are Cormorant Phalacrocorax carbo, Yellow-legged Gull Larus cachinnans, Slender-billed Gull L. genei, Mediterranean Gull L. melanocephalus, Sandwich Tern Thalasseus sandvicensis, Gull-billed Tern Gelochelidon nilotica and Avocet Recurvirostra avosetta. Among the migratory birds, the Laridae family and shorebird species predominate (c. 200,000 and 180,000 individuals). Cormorants (c. 27,000), Ciconiiformes (c. 15,000) and Anseriformes (c. 14,000) also migrate through the area in significant numbers. The total number of birds wintering in Dzhankoi District varies between 250,000 and 400,000 individuals, depending on the weather conditions in any one winter. The most numerous wintering species are Coot Fulica atra (c. 120,000 individuals), Mallard Anas platyrhynchos (c. 20,000–30,000), White-fronted Goose Anser albifrons (c. 12,000–15,000), Laridae species (c. 8,000), Red-breasted Goose Rufibrenta ruficollis (4,000–4,500). Among wintering passerines Starling Sturnus vulgaris (c. 30,000 individuals), larks (12,000–20,000) and Rook Corvus frugilegus (c. 12,000) predominate.

4.5.2. Breeding birds

4.5.2.1. Breeding birds of islands and spits

The most numerous birds breeding colonially on the islands and spits of the Sivash are: Cormorant, Yellow-legged Gull, Slender-billed Gull and Sandwich Tern. Colonies of these species are known in the Central (Martyniachyi and Kitai Islands) and Eastern Sivash (islands and spits of the Tiup-Tarkhan Peninsula). Several colonies are located outside Dzhankoi District: on the islands of Lakes Aigul and Kartal and on the Chongar Islands (Kiselev, 1949; Soldatenko, 1956; Zubakin, 1975; Zubakin et al., 1975; Zubakin & Kostin, 1977). The numbers of breeding birds have been monitored fairly irregularly at most localities. The available data set covers different species at different periods of time, although there are some breeding colonies that have been monitored since the early 1940s (e.g. the colony of Yellow-legged Gulls on Martyniachyi Island (Matsura, 1999, 2000a, 2000b) (Table 13). As the figures in Table 13 show, the development of irrigation farming has not had a clear impact on the numbers and species composition of the colonially breeding species. There have been some fluctuations in numbers from time to time, but they cannot be related directly to the amount of water discharged.

It should be noted that colonisation of the Sivash by Cormorant at the beginning of the 1990s was a result of its expansion over the whole of the Black Sea region. It seems that the numerous fishponds that had been created in the area facilitated its population growth and distribution. Thus, birds breeding in 2004 on the island of Kitai were feeding their nestlings with freshwater fish (up to 30%) (V. Demchenko, personal communication).

4.5.2.2. Birds breeding on saline lowlands

The number of species breeding on saline lowlands in the last 20 years has tended to decrease.

Some species show a clear decline, in particular Little Ringed Plover Charadrius dubius, Kentish Plover Ch. alexandrinus, Avocet, Collared Pratincole Glareola pratincola, Black-winged Pratincole G. nordmanni, Little Tern Sterna albifrons and Stone Curlew Burhinus oedicnemus. There has been a general trend towards a decrease in aboriginal species and wider distribution of typical wetland birds (Garmash, 2000).

4.5.2.3. Birds breeding in reed beds

Reed beds are a new kind of habitat that did not exist in the Sivash in the pre-irrigation period; they developed in several stages. Most wetlands in the Eastern Sivash went through the first stage in the 1960s. This was the period of local desalination: reed growths were restricted to the upper reaches of waterways and shallows; they covered less than 10% of the area. The water depth at the sites overgrown by reeds ranged from 20 cm to 40 cm. The second stage began in the 1980s and was characterised by the expansion of swamp vegetation, which resulted in the decrease in openwater areas. Reeds quickly occupied the upper reaches and shores of the bays, straits and islands. The coverage of reed beds increased up to 60–70% and they overgrew areas with water depths ranging from 40 cm to 70 cm. In the third stage, which began in the late 1980s — early 1990s, reeds have largely replaced other types of vegetation and have overgrown coastal and shallow areas of a depth of less than 1 m. Currently most wetlands in Dzhankoi District are in the third stage of reed succession.

These changes have had a clear impact on the bird populations of the various habitats. Numbers of species such as Coot, Moorhen Gallinula chloropus and most ducks have risen sharply. Numbers of Great Reed Warbler Acrocephalus arundinaceus, Paddyfield Warbler A. agricola, Savi's Warbler Locustella luscinioides, Reed Bunting Emberiza schoeniclus and Bearded Tit Panurus biarmicus have also grown (Popenko & Diadicheva, 1999; Kinda et al., 2003). Several new species that had not previously been recorded in the area have also appeared (Black-headed Wagtail Motacilla feldegg, River Warbler Locustella fluviatilis, Marsh Warbler Acrocephalus palustris and Stonechat Saxicola torquata).

Impact of irrigation on colonially breeding Ciconiiformes

Herons are among the birds that have shown a clear response to the irrigation-induced changes of environment in the Prisivashie, and to the expansion of reeds in particular. Responding to the increasing discharge of fresh water in the mid–1960s, the majority of heron species that occurred in the region began to use the Sivash as a regular summering area. Some years later, in May 1978, the first heron colony was discovered in the Eastern Sivash (Kostin, 1983). It took the birds 10 years to start inhabiting the new biotopes that appeared as a result of irrigation (Ardamatskaya et al., 1988). Night Heron Nycticorax nycticorax was recorded in Dzhankoi Bay, in the Eastern Sivash, in 1980 (the first record in the whole of Crimea!). By 1981 there were already eight Ciconiiformes recorded in colonial settlements throughout the Sivash (Table 14). It is interesting that the birds started breeding in all the suitable nesting habitats in the Eastern Sivash almost simultaneously, virtually within two or three years; the majority of the colonies were found in Dzhankoi District. Nine colonial Ciconiiformes currently breed in the area: Great White Egret Egretta alba, Little Egret E. garzetta, Grey Heron Ardea cinerea, Purple Heron A. purpurea, Glossy Ibis Plegadis falcinellus, Night Heron, Squacco Heron Ardeola ralloides and Spoonbill Platalea leucorodia.

The increase in numbers of breeding Ciconiiformes continued throughout the 1980s. In this period numbers of Glossy Ibis and Night and Purple Herons reached their maxima (Table 14). In 1993 numbers of breeding Great White Herons also peaked. However, by 1993 the total number of breeding Ciconiiformes had already declined sharply, due primarily to a dramatic decrease in numbers of Glossy Ibis (by 94.6% of the maximum count) and Night Heron (by 89.5% of the maximum count), which occurred in the period from 1989 to 1993.

In the early 1990s, the colonies of Ciconiiformes in the Eastern Sivash clearly entered a new, apparently less favourable, phase. The smaller heron species showed the most rapid response to this crisis, while the reaction of the other species was less apparent (Fig. 6). Analysis of trends over the last 20 years shows a particularly sharp decline for Glossy Ibis ($r = -0.8240$, $p = 0.0119$) and Night Heron ($r = -0.8011$, $p = 0.0169$), which in the 1980s together comprised up to 77.39% of the total numbers of breeding Ciconiiformes in the Eastern Sivash. Nevertheless, numbers of breeding pairs of other species also tended to decline (though less significantly): (Squacco Heron: $r = -0.4622$, $p = 0.2489$; Purple Heron: $r = -0.4231$, $p = 0.2963$; Great White Egret: $r = -0.2732$, $p = 0.5127$; and Little Egret: $r = -0.2374$, $p = 0.5713$). Non-significant positive trends were recorded only for Spoonbill and Grey

Table 13

Numbers of some colonially breeding species in relation to the stage of development of irrigation farming (before 1963 — before creation of the canal, 1963–1993 — during full operation of the irrigation system, 1994–2004 — decrease in freshwater discharge)

Species	Before 1963			1963–1993*			1994–2004		
	min	max	av.	min	max	av.	min	max	av.
Martyniachyi Island									
Larus cachinnans	7	1000	327	238	2,600	810	20	650	318
Kitai Island									
Phalacrocorax carbo	0	0	0	34	1,176	648	660	1,534	922
Larus ichthyaetus	3	51	20	20	323	126	120	382	240
L. cachinnans	870	2,400	1,352	1,100	2,270	1,611	300	1,600	776
Hydroprogne caspia	30	400	231	0	0	0	0	0	0
Total			1,603			2,385			1,938
Islands of Lake Aigul									
Larus genei				1,000	1,400	1,200	120	3,846	1,440
L. cachinnans				30	30	30	60	735	318
L. melanocephalus	0	0	0	0	0	0	40	40	40
Gelochelidon nilotica				8	448	165	2	474	211
Sterna sandvicensis				0	0	0	12	12	12
S. hirundo				38	113	84	4	60	41
S. albifrons				10	97	54	0	0	0
Charadrius alexandrinus				20	20	20	20	45	33
Vanellus vanellus				7	10	9	3	35	12
Himantopus himantopus				1	20	10	8	75	37
Recurvirostra avosetta				9	118	57	20	299	118
Haematopus ostralegus				2	4	3	1	4	2
Tringa totanus				11	21	16	2	21	11
Total						1,648			2,275
Islands of Lake Karleut									
Charadrius dubius				0	8	8	0	0	0
Ch. alexandrinus				0	15	15	2	5	4
Himantopus himantopus				6	42	13	6	24	13
Recurvirostra avosetta				17	84	74	4	18	10
Tringa totanus				1	14	18	3	45	20
Larus melanocephalus				670	4,500	2,425	380	943	662
L. genei				920	1,300	1,140	0	0	0
L. cachinnans				1,129	1,553	1,395	600	810	701
Gelochelidon nilotica				31	31	31	24	164	103
Sterna sandvicensis				0	0	0	84	84	84
S. hirundo				86	86	86	48	455	160
S. albifrons				0	0	0	32	32	32
Total						5,205			1,789
Chongar Islands									
Phalacrocorax carbo	0	0	0	0	0	0	480	1,700	895
Charadrius dubius				2	11	6	4	4	4
Ch. alexandrinus				2	30	10	4	30	15
Himantopus himantopus				6	16	10	0	0	0
Recurvirostra avosetta				5	690	100	0	0	0
Haematopus ostralegus				2	17	5	0	0	0
Tringa totanus				11	310	106	2	83	31
Larus ichthyaetus				11	310	84	2	83	31
L. melanocephalus				2	645	255	0	0	0
L. cachinnans				2	3,000	1,156	307	3,527	1,707
Gelochelidon nilotica				13	1,057	302	28	181	105
Hydroprogne caspia				13	570	218	206	360	304
Thalasseus sandvicensis				1	2,562	474	200	200	200
Sterna hirundo				13	1,026	230	88	280	163
S. albifrons				12	900	225	84	180	135
Total						4,258			3,590

Species	Before 1963			1973–1993*			1994–2004		
	min	max	av.	min	max	av	min	max	av
Tiup-Tarkhan Island									
Recurvirostra avosetta				84	100	92	25	105	65
Haematopus ostralegus				2	8	5	4	7	5
Larus melanocephalus				0	0	0	1,200	1,200	1,200
L. genei				0	0	0	95	95	95
L. cachinnans				25	50	36	70	70	70
Gelochelidon nilotica				0	0	0	200	200	200
Sterna albifrons				235	235	235	2	2	2
Total						368			1,637

Note: * — data for 1962–1972 are not available.

Table 14
Numbers of breeding pairs, colonies and species of Ciconiiformes in the Eastern Sivash between 1983 and 2003

Species	Year							
	1983	1986	1989	1993	1996	1998	2002	2003
Egretta alba	153	221	188	253	129	150	144	187
Ardea cinerea	85	126	117	123	92	128	185	103
A. purpurea	378	260	340	221	218	210	385	155
Plegadis falcinellus	2,476	2,690	2,676	145	430	485	320	630
Nycticorax nycticorax	1,201	1,605	1,345	185	215	290	225	433
Egretta garzetta	272	642	770	190	310	355	445	373
Ardeola ralloides	183	252	590	50	65	155	100	105
Platalea leucorodia	1	4	9	12	15	128	20	40
Total individuals	4,751	5,804	6,041	1,179	1,474	1,901	1,831	2,081
Total colonies	7	7	7	7	7	8	13	12
Total species	9	9	9	8	8	8	9	9

Heron (Spoonbill: r = 0.4743, p = 0.2350, Grey Heron: r = 0.4381, p = 0.2777).

The predominance of negative trends in the dynamics of the Ciconiiformes populations can be explained first by the excessive development of dense reed beds. As the reeds grew older and covered a larger area of the shallows, the birds started to experience a shortage of nesting and feeding habitats. Naturally, the smaller species were the first to show a sharp and significant decline in response to these environmental changes. The collapse of irrigated agriculture could also have contributed to the decline in breeding Ciconiiformes, as the area of rice fields, commonly used by the birds as foraging habitats, has also decreased dramatically.

It should be pointed out that since the late 1990s there has been some increase in the total numbers of Ciconiiformes breeding in the Eastern Sivash. Some stabilisation of the breeding population is to be expected in the coming years, although at a much lower level than in the 1980s. A trend towards an increase in the total number of colonies has also been observed in recent years (Table 14). The birds seem to redistribute themselves over the Eastern Sivash, settling closer to the feeding areas. New colonies have been found in the trees close to the North Crimean Canal and in rice fields, for example.

Waterfowl and irrigation

There is no doubt that the irrigation-induced changes to the habitats have affected local waterfowl populations. Two species (Mute Swan Cygnus olor and Greylag Goose Anser anser) have shown an apparently positive response to the habitat transformation.

At the beginning of the 20th century Mute Swans nested at some localities in Crimea but only in very small numbers (Koshelev et al., 1990; Grinchenko, 1991a). There were no indications that the species bred in the Prisivashie area. In 1985 A. Grinchenko (Grinchenko, 1991a) found the first Mute Swan nest in the Eastern Sivash. Some years later populations began to be seen in all the suitable habitats in the Sivash, including artificial waterbodies and fish-breeding ponds. Mute Swan numbers peaked in 1990–1996, at 240–260 breeding pairs. At present, the Mute Swan population in the Sivash is slowly declining for the same reason as the decline shown by colonial Ciconiiformes (overgrowth of open water by reeds resulting in decrease in foraging areas).

In the 1970s the Greylag Goose was an infrequent migrant to Crimea. Only a few small groups of Greylag Geese were recorded, which, due to the lack of nesting habitats, could not breed and were considered to be summering birds (Kostin, 1983). The increase in reed-bed coverage created favourable conditions for migrating and summering Greylag Geese. In 1984 a summer gathering of as many as 2,000 birds was recorded at the mouth of the River Salgyr. In the same year several hundred birds were also observed in the neighbourhood of Yasnopolianskoe village. In the early 1980s pairs of Greylags were frequently recorded in the nesting habitats. The first confirmation of breeding came in 1983 when two pairs giving alarm calls were observed near the village of Pshenichnoe. In the following year, local fishermen found a Greylag Goose nest (Grinchenko, 1991b; Kinda et al., 2001). This was the beginning of the Greylag Goose's expansion over the Sivash, which by the mid–1990s resulted in a fairly wide distribution (Fig. 7)

At present, the Greylag Goose breeding population is declining in the Sivash. Of the 40–50 pairs that used to breed here in the most favourable years (the 1990s) numbers have fallen to 10–12 pairs. The same is true for summering birds: only around 200–300 individuals summer annually in the area today compared to thousands in more favourable times. The causes of this decline are most likely the same as for all the other species that were attracted by the development of freshwater vegetation but are now experiencing a shortage of breeding or foraging habitats due to excessive reed coverage. A sharp rise in the water level in the wetlands from 40–50 cm to 100–120 cm may also partly account for this.

4.5.2.4. Non-wetland birds and irrigation

The impact of irrigation on birds inhabiting open habitats is probably less apparent, but these species have also been affected in various ways (Andryushchenko et al., 1998). Before the development of irrigation farming a number of xerophilous species were using dry fields during both the breeding and migration periods. Beginning in the mid–1960s, when dry fields were turned into irrigated land, these species were gradually replaced by those that could cope better with the changes that occurred with irri-

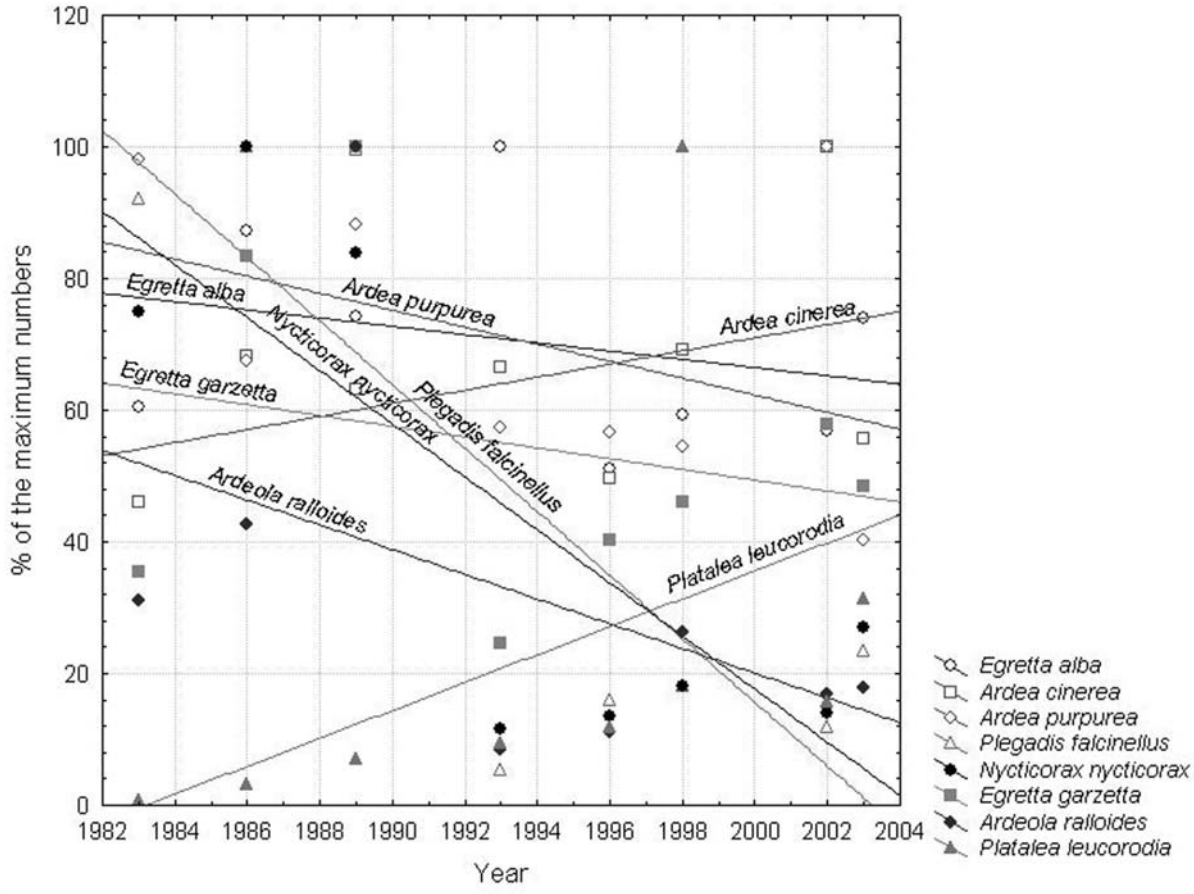

Figure 6. Trends in numbers of breeding Ciconiiformes, 1983–2003.

gation farming. Some species, such as Lesser Kestrel Falco naumanni, have almost totally disappeared, while others such as larks (Short-toed Lark Calandrella cinerea, Lesser Short-toed Lark C. rufescens and Crested Lark Galerida cristata) have been replaced by the widely distributed Skylark Alauda arvensis.

Goldfinch Carduelis carduelis, Linnet Acanthis cannabina, Chaffinch Fringilla coelebs, Greenfinch Chloris chloris, Lesser Grey Shrike Lanius minor, Kestrel, Red-footed Falcon Falco vespertinus and Syrian Woodpecker Dendrocopos syriacus have all benefited from the creation of numerous forest belts. Numbers of Golden Oriole Oriolus oriolus have significantly increased in the last 10–12 years for the same reason. The orioles' distribution clearly followed the line of the North Crimean Canal: they started to breed in plantations along the banks of the canal and then began to occupy old forest belts, parks and nearby orchards in large numbers. The numbers of Penduline Tit Remiz pendulinus on migration began to grow in the 1960s; soon it became a common passage species and in 1992 the first Penduline Tit's nest was found in trees close to the canal (on the northwest border of Dzhankoi District; Kinda et al., 2003). In the following years breeding expansion continued: Penduline Tit nests were discovered further down the canal.

Human population growth also stimulated the wider distribution and increase in numbers of synanthropic birds; these species, which are relatively uncommon for the steppe zone, included House Martin Delichon urbica, Swallow Hirundo rustica, Starling, Magpie Pica pica, Raven Corvux corax, Rook and Collared Dove Streptopelia decaocto.

4.5.3. Migrating birds and irrigation

As Table 3 (see Annex II) shows, over the past 35 years there have been some changes in the species composition and numbers of birds that occur in the Sivash area during the seasonal migrations. The changes primarily concern waterbirds,

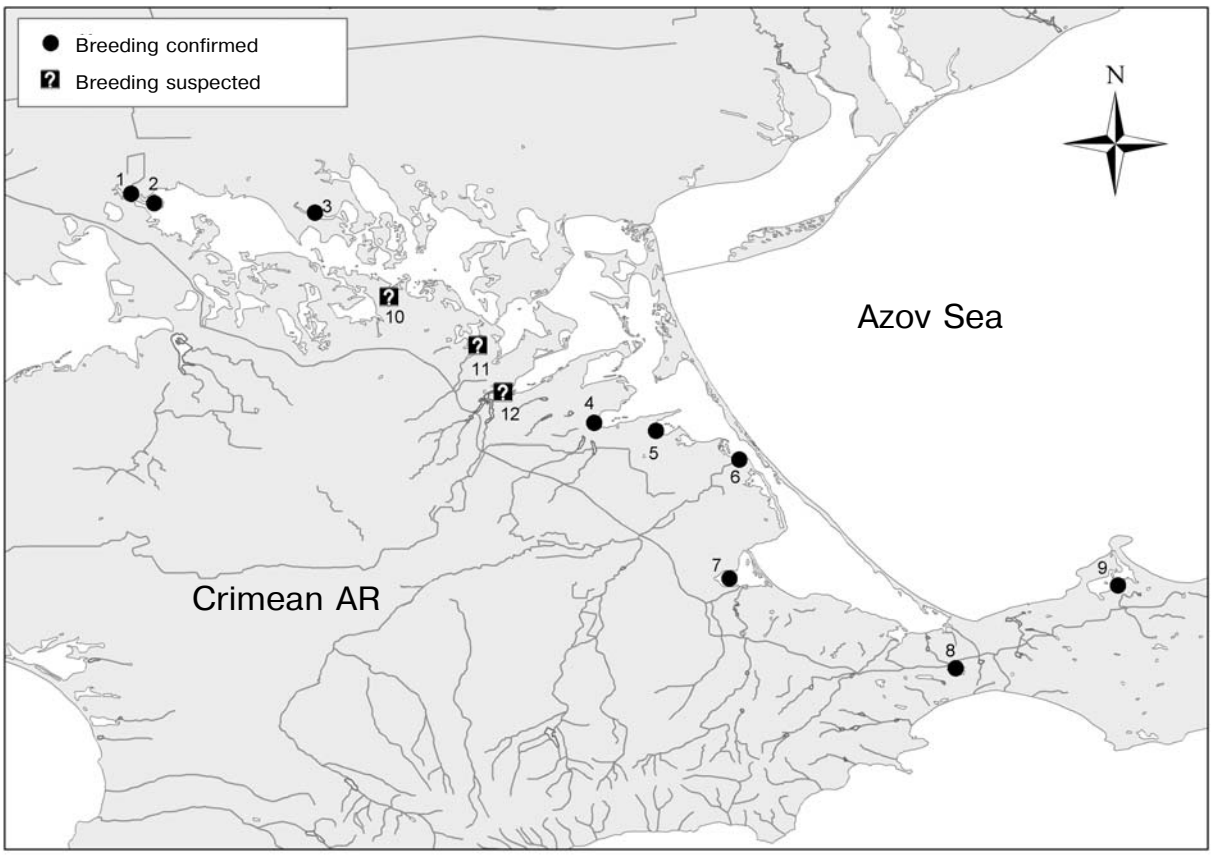

Figure 7. Distribution of breeding Greylag Geese in Crimea (after Kinda et al., 2001).

1 — Shpindiar Depression; 2 — Bay near village of Pervokonstantinovka; 3 — Freshwater ponds near village of Bratolubovka; 4 — Bay near village of Slavianskoe (Kalinovskiy Game Reserve); 5 — Bay near village of Pshenichnoe; 6 — Mouth of River Salgyr; 7 — Bay near village of Dmitrovka; 8 — Lake Akmonaiskoe; 9 — Astaninskie plavni; 10 — Algazy Bay; 11 — Southeastern part of Lake Yasnopolianskoe; 12 — Dzhankoi Bay.

particularly those species that stop over in the reed beds or use the reed habitats for foraging. These are Marsh Harrier Circus aeruginosus, all species of herons, Mute Swan, Water Rail Rallus aquaticus, Spotted Crake Porzana porzana, Little Crake P. parva, Moorhen, Coot, most species of warblers, Bearded Tit, Reed Bunting and a few others. Some species found better feeding conditions in the less-saline bays than they did before irrigation was introduced, and this increased the number of these species migrating through the area: Pygmy Cormorant Phalacrocorax pygmaeus, Squacco Heron, Spoonbill, Glossy Ibis, grebes (Great Crested Grebe Podiceps cristatus, Red-necked Grebe P. ruficollis and Black-necked Grebe P. nigricollis), surface-feeding (Mallard, Gadwall A. strepera, Pintail A. acuta, Shoveler A. clypeata and Wigeon A. penelope) and diving ducks (Pochard Aythya ferina, Scaup A. marila and Tufted Duck A. fuligula), waders (Black-winged Stilt Himantopus himantopus, Snipe Gallinago gallinago, Tringa, □alidris and Charadrius species) and marsh terns (Chlidonias spp.). The most important for migratory waterbirds localities were identified in the course of field investigations in 1998–2004 (see Annex I, Fig. 8 b–c).

Numerous forest belts planted on the irrigated land have significantly increased the attractiveness of the area for forest birds (see Annex II, Table 3). Such species as Dunnock Prunella modularis, Bluethroat Luscinia svecica, Black Redstart Phoenicurus ochruros and Icterine Warbler Hippolais icterina began to occur on passage as a result of the afforestation. Numbers of Scops Owl Otus scops, Wryneck Jynx torquilla, Kestrel, Red-footed Falcon, Woodpigeon Columba palumbus, Lesser Grey Shrike, Nightingale Luscinia luscinia, Golden Oriole, Phylloscopus spp., flycatchers and tits have also clearly increased.

Irrigated fields appear to be more attractive for migrating Ruffs Philomachus pugnax, Lapwings Vanellus vanellus and even, in some places, ducks. Fields under permanent grasses and cereals attract Mallards and geese (Greylag Goose, White-fronted Goose and Red-breasted Goose), which willingly forage on the agricultural land on spring and autumn passage.

However, irrigation has turned out to be harmful for a number of migrating species, either because of habitat transformation or disturbance; their numbers have decreased dramatically. Some species, such as Steppe Eagle Aquila rapax, Black-winged Pratincole, Sociable Plover Chettusia gregaria and Lesser Kestrel no longer migrate through the area at all. It would not be fair to attribute their absence exclusively to the impact of irrigation, but irrigation has had a negative impact to some extent. Nevertheless, in the course of the first three decades during which the North Crimean Canal was in full operation, the diversity and numbers of migratory birds have increased remarkably. In general, the environmental changes have been favourable for 105 species of birds, and 12 new species have enriched the list of migratory species. Five species dropped out of the list and 20 species have decreased in number (see Annex II, Table 3).

It should be noted that the current situation is somewhat different from that in the period up to the early 1990s: due to the development of the extensive reed beds, the total area of habitats available to some migratory species (waders in particular) has decreased markedly. It is expected that the process may threaten shorebirds, which use these kinds of habitats intensively during stopover.

4.5.4. Wintering birds and irrigation

Several localities that are the most important for wintering waterbirds were identified in the course of field surveys in 2000–2004 (see Annex I, Fig. 8 d). In general, the development of irrigation farming has had a positive impact on the feeding capacity of areas adjacent to the Sivash for birds that forage on the ground (such as geese, cranes, some waders, and gulls). These birds commonly consume the edible remains of corn, grains, sunflowers and also the seedlings and young plants of winter crops that will grow on the harvested fields in the following year. Needless to say, growing maize — the young plants of which are especially relished by geese — would not be possible in the arid conditions of the region without irrigation. The recent decline in irrigational agriculture has resulted in a reduction of the areas of maize plantation. Today the majority of farmers do not wish to grow maize at all. This has had a remarkable impact on the numbers of some waterfowl that winter in the Sivash area (Table 15). The species that were the most numerous in the early 1990s (White-fronted Goose, Greylag Goose and Mallard) show a fairly significant decline.

Due to the large-scale desalination of the Sivash, some species of aquatic plants and marine invertebrates that cannot tolerate hypersaline conditions have increased their coverage and biomass, providing much better wintering conditions for waterfowl. This particularly concerns swans, diving ducks and Coot, which forage on submerged vegetation or bottom invertebrates (Andryushchenko et al., 2001).

However, there are indications that salinity has gradually been increasing in recent years, in contrast to the general decline of agriculture. This may account for the somewhat lower number of Mute Swans (down from 4,000–5,000 to 3,000–4,000 individuals) wintering in the area; it also permits the prediction of a similar trend in the numbers of wintering Red-crested Pochard, Tufted Duck and Coot.

4.5.5. Conservation status of birds occurring in Dzhankoi District

A total of 239 bird species are currently recorded for Dzhankoi District. Of these, 123 (53%) are species of conservation concern in Europe. Thirty-two species are listed in the Red Data Book of Ukraine, nine species are included in the IUCN Red List of Threatened Species, and the annexes of the Bern and Bonn Conventions list 213 and 124 bird species respectively. Seventy-nine species are under the protection of the African-Eurasian Waterbird Agreement (AEWA) and 23 species fall within the remit of CITES (see Annex II, Table 2). The localities where birds listed in the Red Data Book of Ukraine were recorded in the period 2000–2005 are shown in Annex I, Fig. 7. This data shows how important this relatively small area is for bird conservation at both national and international levels.

Table 15
Changes in the numbers of some waterfowl species that use agricultural fields for foraging

Species	1991–1995	2001–2004
Anser albifrons	41,000–50,000	12,000–15,000
A. anser	1,000–1,500	50–100
Rufibrenta ruficollis	Hundreds	4,000–5,500
Anas platyrhynchos	30,000–40,000	20,000–30,000

The development of irrigation has had a positive impact on at least 80% of the total number of species recorded in the district. New species have appeared, and some species have increased in number as a result of the creation of the North Crimean Canal. Therefore, in order to continue to benefit birds the proper management of the irrigation system is undoubtedly an issue of high conservation priority.

4.6. Mammals

A list of terrestrial mammals recorded in Dzhankoi District with estimates of their numbers is given in Table 16. Rodents are the most numerous group in the study area. Long-term studies show that the most frequently trapped species (comprising over 75% of the total catch) are Sylvaemus arianus (4–6% of catches per 100 trap-nights on average), House Mouse Mus musculus (3–5%), Social Vole (2–4%) and Migratory Hamster (1–3%). In peak years the numbers of Social Vole can increase markedly (by a factor of 5–8) with up to 16–20% of catches per 100 trap-nights. This happens once in seven years, on average, when this species is found in virtually all habitats. A particularly high density of Social Vole is recorded on virgin land along the coast.

The development of irrigation farming has led to a radical transformation in the habitats in Dzhankoi District. A number of mammals that did not occur here in the past, primarily Muskrat, Southern Vole and Raccoon Dog Nyctereutes procyonoides, are now quite widely distributed over the irrigated area. The latter species reaches its highest density on the shores of the Sivash: on the Martyniachyi and Karacha-Kitai Peninsulas in the northwest of the district. According to the count results, the density of Raccoon Dog ranges from two to three individuals per 10 km^2. The intensive development of reed beds has created favourable conditions for Wild Boar Sus scrofa, which, after a series of occasional visits, has finally established a population in the area. In Dzhankoi District Wild Boars are concentrated mostly in the reed growths around the estuaries of rivers, which flow into the Sivash from both sides of the Kalinov Peninsula.

Steppe Mouse Mus spicilegus and Northern Mole-vole are fairly infrequently recorded rodents in Dzhankoi District. During the whole period of observations only two small populations of Northern Mole-vole were discovered, in the Kalinov military area (north of Prozrachnoe village). In 1991 a small population of this species was also found on the slopes of the bank of the Azov branch of the North Crimean irrigation system. Since then numbers of Northern Mole-vole at this locality have increased significantly: colonies have spread some 3 km along the canal and occupy both sides of it. The Steppe Mouse is recorded annually in the Kalinov military area but its numbers do not exceed 0.5% of catches per 100 trap-nights. Outside the military area this species was trapped in the spring of 1990 in the vicinities of Chaikino, Perepiolkino, Stefanovka, Aprelevka and Roskoshnoe villages. It is worth noting that areas around these villages are intensively irrigated, and there are rice fields near two of them (Stefanovka and Aprelevka). In the course of trapping in 1990 a total of 16 Steppe Mice were collected, while in the following years the species did not reach such a high density. However, single individuals are found in Long-eared Owl pellets in winter on an annual basis.

Recently, remains of Southern Vole have been found in the pellets of Long-eared Owl in Dzhankoi District. It should be noted that the night roosts of the owls (typically located in the artificial plantations of coniferous trees around the pumping stations of the irrigation system) have been monitored for as long as 15 years. The owls' hunting grounds are confined mainly to the open areas — winter crops and perennial grasses — therefore the invasion of Southern Vole from the River Chatyrlyk along the irrigation canals to the south of the North Crimean Canal is well documented and can be traced back for some time.

Muskrats occur in the estuaries of the rivers and canals flowing into the Sivash. In Dzhankoi District this species is recorded along the coastline; there are generally 2–5 holes per 1 km of census route. Muskrat has been recorded at a particularly high density in the extensive reed beds near Yasnopolianskoe, Yermakovo and Stefanovka villages. The southernmost locality where the species has been found is Tutovoe village.

Pre-irrigation, the Social Vole totally dominated the communities of small mammals of the virgin steppe areas, comprising 43–54% of the total catch (Poliakov, 1937a; Pesenko, 1982; Yemelyanov, 1994). Today its numbers have decreased, most likely due to a shortage of preferred habitats. Brown Rat Rattus norvegicus is particularly numerous on the coast (3–5 individuals per 1 km), especially at localities with an inflow of fresh water. Insectivorous animals in the study area are represented by Lesser White-toothed Shrew Crocidura suaveolens and Eastern European Hedgehog Erinaceus concolor. The first species is fairly abundant, while the Hedgehog commonly occurs in the forest belts, ranging in number from 0.5 to 3 individuals per 1 km of the census route. Little Souslik is a common although not very numerous species: populations can be found throughout the virgin steppe along the coastline of the Sivash on the Crimean side.

Great Jerboa Allactaga major, which is listed in the Red Data Book of Ukraine, is distributed

Table 16
Species composition and relative abundance of terrestrial mammals in Dzhankoi District

Species	Pre-irrigation period (before 1961)	After beginning of irrigation
Crocidura suaveolens	++	+++
Erinaceus concolor	++	+++
Lepus europeus	++	+++
Spermophyllus pygmaeus	+++	+
Allactaga major	+++	+
Sicista subtilis	+?	-
Rattus norvegicus	-	+++
Mus musculus	+	+++
M. spicilegus	++	+
Sylvaemus arianus	++	+++
Cricetulus migratorius	++	+++
Cricetus cricetus	+++	++
Ellobius talpinus	+++	+
Microtus socialis	+++	++
M. levis	-	+
Vulpes vulpes	++	+++
Nyctereutes procyonoides	-	++
Mustela nivalis	++	+++
M. eversmanni	+++	+
Sus scrofa	-	++
Total species	16	19

Note: + — rare species, found just in a few habitats, numbers are low; ++ — species commonly occurs throughout district, inhabits over 50% of habitats; +++ — species occurs throughout district, inhabits majority of habitats, fairly abundant; +? — species is likely to occur, but no records exist; - — species does not occur.

extremely unevenly; the largest populations are concentrated in the areas of virgin steppe close to the villages of Tselinnoe, Yasnopolianskoe and Riumshino and also on the Tiup-Tarkhan and Kalinovski Peninsulas. The species is recorded in these areas on an annual basis, and the density of its holes ranges from 1–3 per hectare of suitable habitat.

European Hare Lepus europeus is a common inhabitant of the area: throughout the study period its numbers remained fairly high (35–40 individuals per 1,000 ha). Least Weasel Mustela nivalis and Red Fox Vulpes vulpes are the most widespread predators. The former commonly inhabits coasts overgrown by reeds and forest belts. The population density of Red Fox varies from 2 to 5 individuals per 1,000 ha. In 1989, which was the peak year, its numbers reached 6.2 individuals per 1,000 ha. The population structure of the fox in the Prisivashie is rather unstable: the major factors that impact upon it are hunting and the difficulty of reaching the area where foxes are found from Kherson Region.

Epizootological studies carried out in the area continuously from 1984 to 2004 show that the number of persons per unit of time infected for the first time by a contagious disease has increased due to the complex anthropogenic impacts on the environment. Such natural nidal infections □s rabbit-fever, leptospirosis, gastrointestinal yersiniosis and pseudo-tuberculosis are generally rodent-borne. A very active hydrophobia nidus found in Dzhankoi District affects the whole of the Prisivashie; foxes carry this disease. Epizootic diseases break out in the cold periods (late November-February), although the leptospirosis nisus is active in summer and autumn, which indicates that it is a mouse-borne infection. Nidi of the rat-borne leptospirosis are active throughout the whole year. Gastrointestinal yersinios and pseudo-tuberculosis are the diseases most likely to break out during the period from March to November (Poliakov, 1937b).

Special attention should be drawn to the existence of a rabies nidus in the study region. Although it remains active throughout the year, the major outbreaks of hydrophobia are recorded in winter, during the fox's mating season. At this time the number of foxes moving from the mainland onto the Crimean Peninsula increases in a way that seriously destabilises the epizootological situation.

5. Areas Valuable for the Conservation of Biodiversity in Dzhankoi District

In this section experts provide information on the areas identified in the course of their studies in Dzhankoi District as being those with high conservation value. A description of each site is given in separate sub-sections (flora and vegetation, fish, amphibians and reptiles, and birds). The data is presented in this way because some of the designated sites overlap each other slightly (see Annex I, Fig. 9).

5.1. Flora and vegetation

As explained above, all the large sites in Dzhankoi District not used as arable land were surveyed in the study. These sites were mostly community pastures near rural settlements, pastures, fallow land and forest belts. The majority of the sites surveyed now belong to the category of land with mildly to strongly transformed vegetation. Locations with either slightly disturbed or restored vegetation occupy only an insignificant part of the area, basically in the north and northeast. A description of the sites is given below, from northwest to southeast (Fig. 8), according to data from the original research and the surveys of 1998–2004.

Russkiy Island

There are fragments of steppe (wormwood—grass—forb), meadow (wormwood—wheatgrass) and saline vegetation on the island. Local inhabitants confirm that Schrenk's Tulip was seen there several times in the past. The area is 155.9 ha.

Northwest and southeast shore of Lake Aigulskoe

The closest settlement is the village of Tomashevka. The northwest of the site is located on the border of Dzhankoi and Krasnoperekopsk Districts. The area is 730.0 ha. There are sufficiently large and well-preserved fragments of steppe and halophytic vegetation characteristic of desert steppes of the north of Crimea. The steppe vegetation is represented by Artemisia—Agropyron—Stipa (wormwood—wheatgrass—feathergrass) communities with significant numbers of herbaceous steppe plants (Austrian Flax, Galium spp., etc.). To the southwest of the village of Tomashevka, on the shores of the lake, significant areas are occupied by Artemisia—Agropyron and Artemisia—Agropyron—Elytrigia associations. Saline vegetation with Salicornia and Halocnemum associations is found in lowland areas and depressions. Grazing must be managed in order to preserve the vegetation cover.

Northwest of Istochnoe village

The nearest settlement is the village of Istochnoe. A variety of habitats are present within quite a small area. The area is 329.9 ha. The bottom of the ravine stretching from Istochnoe village to Lake Sivash is occupied by freshwater (reed) vegetation; in depressions this is sometimes replaced by saline (Salicornia) and meadow (Juncus and Elytrigia) vegetation. Wormwood—grass-forb communities with small fragments of wormwood—Elytrigia communities occur over most of the area. Shrubby communities of Oleaster are quite well represented. Halophytic vegetation, which dominated in the past, is being replaced by steppe vegetation due to the drainage and aridisation of the area. This area is considered to have good potential for species diversity preservation, partly because there are fewer cattle and small livestock on the site than there were in the 1980s.

Areas on the shores of the bay to the north of Tomashevka village and Martyniachyi Peninsula

Most of the area (3,223.1 ha) is occupied by farmland and fallow land. However, on the northern tip of the peninsula (Cape Martyniachyi), and also on the coast of the Sivash, there are quite large fragments of intact or restored steppe vegetation on fallow land and pastures (Artemisia—Agropyron, Artemisia—Agropyron—Elytrigia and Artemisia—Elytrigia communities). Saline vegetation (Salicornia, Salicornia—Suaeda, Salicornia—Halimione and other communities) is well developed in depressions.

Coast of Lake Sivash north of Tselinnoe village and Algazy sheep farm

There is a good representation of aquatic and coastal vegetation (reed and rush communities) developing along canals and ditches, with saline vegetation (Salicornia, Halocnemum, Salicornia—Halimione—Puccinellia communities) in depressions. The area is 1,548.2 ha. Steppe communities, represented mostly by wormwood—grass—forb,

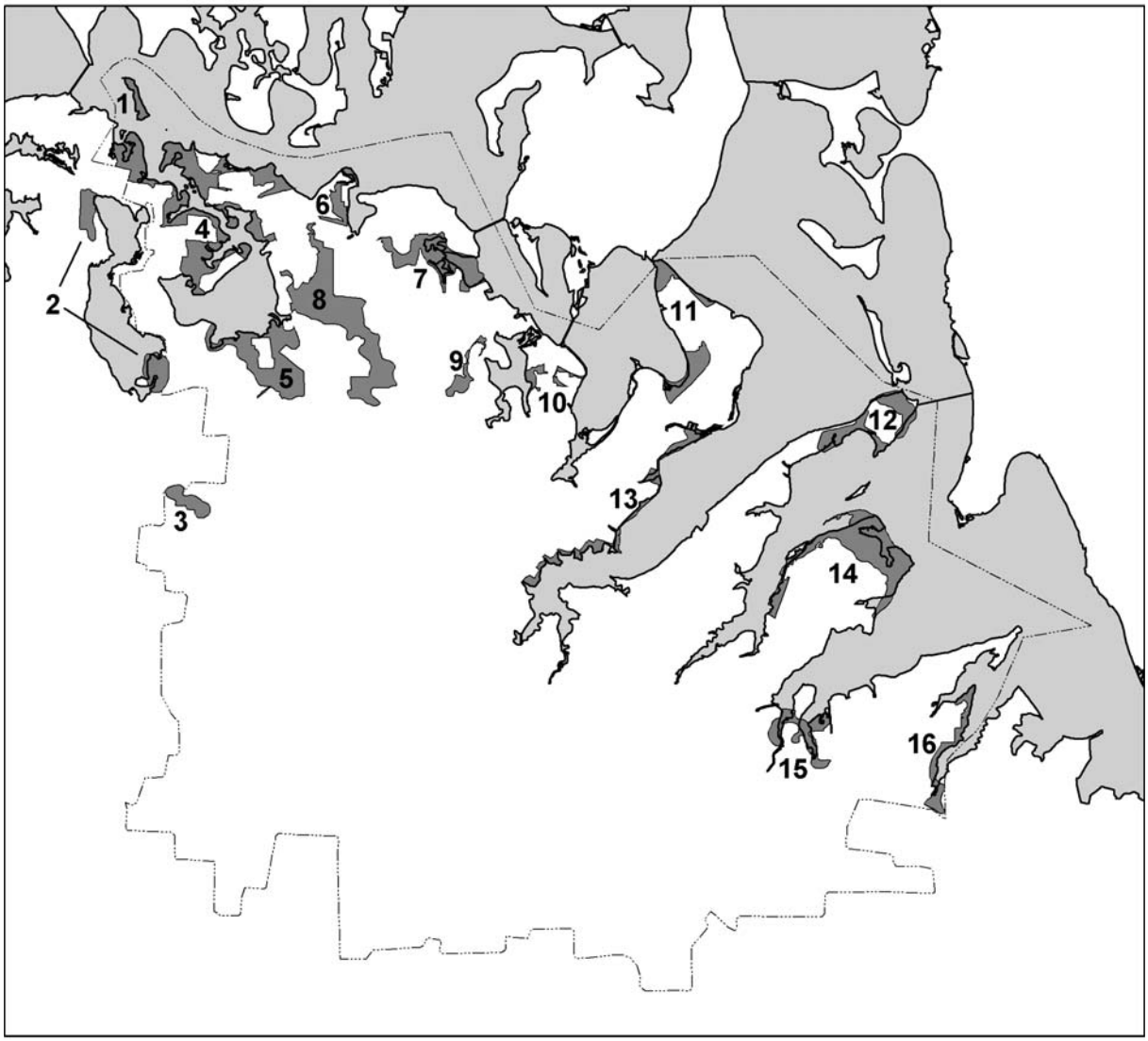

Figure 8. Areas important for the conservation of valuable vegetation types and floral species in Dzhankoi District.

Legend: 1 — Russkiy Island; 2 — Northwest and southeast shores of Lake Aigulskoe; 3 — Northwest of Istochnoe village; 4 — Areas on the shores of the bay to the north of Tomashevka village and Martyniachyi Peninsula; 5 — Coast of Lake Sivash north of Tselinnoe village and Algazy sheep farm; 6 — Karacha-Kitai Peninsula; 7 — Nayman Peninsula; Sivash coast north of Riumshino; 8 — North of Solontsovoe; 9 — Sites near the village of Yasnopolianskoe; 10 — Sites on the Taganash Peninsula north of Solenoe Ozero; 11 — Coast of Chongar Bay, Tiup-Dzhankoi Peninsula; 12 — Tiup-Tarkhan Peninsula; 13 — Shore of Lake Sivash, Dzhankoi Bay near Pridorozhnoe — Stolbovoe villages (mouth of the River Pobednaya); 14 — Kalinovskiy Regional Landscape Park; 15 — Site near the villages of Prostornoe and Slavianaskoe; 16 — East and southeast of Blagodatnoe.

wormwood—wheatgrass (Artemisia—Agropyron-Elytrigia) and feathergrass-forb associations, are recorded within a narrow belt on the elevated coast of Lake Sivash, in forest belts and pastures. In most of the site, steppe vegetation is at the last stage of pasture digression: severely overgrazed areas with barren spots of ground with a significant quantity of Harmel. The most interesting communities in this area are those with halophytic vegetation.

Karacha-Kitai Peninsula

Halophytic vegetation (Salicornia, Salicornia—Halimione, Salicornia—Petrosimonia and other communities) is in evidence on the low coast of the gulf; it has gradually been replaced by saline meadows (Artemisia—Limonium—Elytrigia communities) with distance from the shore. The area is 320.4 ha. The best preserved sites of Artemisia—Agropyron, Artemisia—Agropyron—Elytrigia and Artemisia—Agropyron—Stipa communi-

ties are recorded from this area. Red Data Book species, such as Lessing's Feathergrass and Hairy Feathergrass, are found in Artemisia—Agropyron communities.

Nayman Peninsula; Sivash coast north of Riumshino

In the past there were several sheep farms in this area, most of which are now abandoned. The area is 1,225.3 ha. Steppe vegetation fragments are markedly transformed; they are represented basically by wormwood—forb or ruderal communities. Artemisia—Stipa—Elytrigia associations (which include Hairy Feathergrass) are found in a narrow strip on the high coast in the east of the peninsula. The largest areas are occupied by halophytic communities dominated by Salicornia, Halocnemum and Puccinellia. Psammophytic vegetation is well represented on sand and coquina dunes and mounds. The restoration of typical semi-desert steppe vegetation is possible within this area if grazing is controlled.

North of Solontsovoe

The majority of this area is occupied by halophytic vegetation (Salicornia, Halocnemum, Salicornia—Halimione—Puccinellia, Puccinellia, Juncus, Bolboschoenus communities). The development of this kind of vegetation rather than desert steppes has come about mainly because of a rise in the water table as a result of the impact of well-developed irrigation systems, on the one hand, and, on the other, of high grazing pressure and, consequently, overgrazing. The total area is 2,542.7 ha. An interesting site to the north of the village of Solontsovoe is a fairly large oasis area fed by fresh water from artesian wells. This site is characterised by well-developed coastal and aquatic vegetation that includes Sea Club-rush, cattails (Typha spp.), spike-rush (Eleocharis spp.), rushes (Juncus spp.) and other taxa that in the past were fairly common in areas where water spilled from artesian wells on the shores of Lake Sivash. There is also a well-developed moss cover. Today most of the artesian wells no longer function. In addition to the plant communities mentioned above, Artemisia—Elytrigia and grass-forb communities with a significant quantity of Oleaster have also been recorded.

Sites near the village of Yasnopolianskoe

The site includes shallow aquatic areas and large areas of saline and alkaline habitats with Salicornia, Halocnemum and Puccinellia communities. The area is 237.9 ha.

Sites on the Taganash Peninsula north of Solenoe Ozero

The nearest settlement is the village of Solenoe Ozero. The area is 212.4 ha, most of which is covered by arable land. Fragments of steppe vegetation (Artemisia—Stipa—Agropyron, Artemisia — mixed forbs) still remain on the slopes on the elevated coast of Lake Sivash on the northern tip of the peninsula, and also along the railway embankment. Lessing's Feathergrass is dominant among the feathergrass species, although Hairy Feathergrass also occurs. Local inhabitants reported that Schrenk's Tulip had been abundant in the past, but this species was not found in the recent survey. Halophytic vegetation is well developed in depressions (in the west of the site).

Coast of Chongar Bay, Tiup-Dzhankoi Peninsula

The nearest settlement is the village of Predmostnoe. The majority of the coastal strip is covered by arable land; vegetation in the remaining non-cultivated area is represented by halophytic communities (Salicornia, Halocnemum), wormwood—grass and Artemisia—Limonium—Elytrigia associations, which are typical for the shores of Lake Sivash. The area is 796.7 ha.

Tiup-Tarkhan Peninsula

The nearest settlements are the villages of Chaikino and Mysovoe. The area is 843.3 ha. Most of the site is covered by arable land; however, near Mysovoe the largest areas of pasture contain fragments of wormwood—grass steppe. In the coastal strip there are fragments of wormwood—mixed grass and wormwood—wheatgrass vegetation, Salicornia—Halimione, Salicornia, Juncus and Artemisia—Limonium—Elytrigia communities. Psammophytic and halophytic vegetation is found on islands and spits.

Shore of Lake Sivash, Dzhankoi Bay near Pridorozhnoe — Stolbovoe villages (mouth of the River Pobednaya)

The nearest settlement is Pridorozhnoe. The area is 752.4 ha. Most of the area, in the upper reaches of Dzhankoi Bay, along the shore of the Sivash, is occupied by reed communities, which gradually intergrade into Bolboschoenus—Juncus, Puccinellia and Aeluropus communities. Saline (halophytic) vegetation occurs in depressions and on saline flats; it is represented by Salicornia, Halocnemum, Salicornia—Halimione, Salicornia—Suaeda and Limonium—Plantago communities. On the elevated sites these are replaced by wormwood—grass communities,

which are disturbed by grazing to some extent. Fragments of relatively intact steppe vegetation represented by wormwood—forb—grass and wormwood—wheatgrass communities (including Lessing's Feathergrass and Hairy Feathergrass) are found on the slopes of the elevated shore of Lake Sivash east of Stolbovoe and southeast of Yermakovo.

Kalinovskiy Regional Landscape Park

Kalinovskiy Regional Landscape Park (RLP), part of the National Nature Preservation Fund, was created on land formerly a military range. It is 12,000 ha in area, including a 5,583 ha aquatic area. The park was established on 29 May 1998 (Decision of Dzhankoi District Council No. 13/2–7 of 29 May 1998; Resolution of the Supreme Council of the Autonomous Republic of Crimea No. 913–2/2000 of 16 February 2000). The RLP is a biodiversity hotspot. Steppe and halophytic vegetation are well represented there, and significant areas are occupied by vegetation typical of fallow land.

Site near the villages of Prostornoe and Slavianaskoe

This site is characterised by its diverse biotopes. The area is 660.6 ha. There are well-developed reed communities along watercourses and in ponds; they intergrade into halophytic (with Salicornia and Halocnemum communities) and meadow (with Elytrigia, Artemisia—Limonium—Elytrigia communities) vegetation. The steppe vegetation on pastures is strongly overgrazed by cattle and other livestock, and therefore weeds are prevalent in the area.

East and southeast of Blagodatnoe

In the past there were large sheep farms in this area; these are now abandoned and destroyed. Ruderal vegetation has developed around the farm buildings and other constructions on common pastures. Most of the area is now used as arable and fallow land. Non-arable areas are found along a watercourse. Reed associations are present in the watercourse; they grade into meadow (Elytrigia, Artemisia—Limonium—Elytrigia communities) and halophytic vegetation (Salicornia and Halocnemum communities). The area is 530.3 ha.

The research into and survey of the vegetation cover of Dzhankoi District have shown that the natural vegetation represented by halophytic and steppe communities is still to be found on an insignificant area. The intensive development of cattle breeding, irrigated agriculture and the significant discharge of fresh water to the aquatic area of Lake Sivash have promoted the degradation of the zonal types of vegetation and intensified the development of wetland, coastal and aquatic (reed) vegetation over large areas, therefore one of the conservation priorities is the preservation and restoration of natural vegetation, even on small sites within the area. The value of the sites under consideration is determined not so much by the presence of Red Data Book species in the plant communities as by the existence of natural complexes (with zonal types of vegetation and other components of the biocoenoses) that used to be widespread and common in the past but have been destroyed almost everywhere in Dzhankoi District.

5.2. Fish

The characteristics of the most valuable aquatic areas are described below. Figure 9 shows the location of these areas.

Chongar Bay

This is a shallow, saline, aquatic area with a maximum depth of 1.5 m. The area is 4,561.7 ha. As large amounts of detritus are found here, the bay may be considered to be a potentially important site for Red-eyed Mullet in its pre-winter feeding period. There is the potential to develop fish farming in the bay. To make this site ecologically suitable for Red-eyed Mullet, salinity should be maintained at 20–30 g/l.

Sivash Bay to the north of the Tiup-Tarkhan Peninsula

The site has open water (depth 1.5–2.5 m, salinity 17–20 g/l) and is partly overgrown with aquatic vegetation. Shallows are found mostly in the western part of the bay. The area is 4,997.3 ha. Red-eyed Mullet gathers in sufficient numbers in the bay for it to be fished commercially. Commercially important species such as Big-scale Sand Smelt and European Anchovy Engraulis encrasicolus also spawn here. To protect the site there is a need to limit the use of motorboats during the spawning period, and all fishing should be prohibited in the area.

The lower reaches of the Rover Pobednaya

Shallow freshwater areas present at this site are important as spawning sites for freshwater fish. The creation of canals and dams that may have a negative effect on the hydrological regime of the river should be prohibited. Livestock density — and hence grazing pressure on the banks of the river — should also be regulated. The total area is 715.0 ha.

Stephanovski Bay and Cape to the north of Stefanovka

A system of irrigation canals with coastal ecotones and an openwater area of the Sivash (salinity of 2–7 g/l) fall within the boundaries of the site. The area is 1,527.8 ha. This is the area with the richest fish species diversity. Recommendations for the most urgent measures to protect the site are stabilisation of the discharge of irrigation water and assurance of water quality.

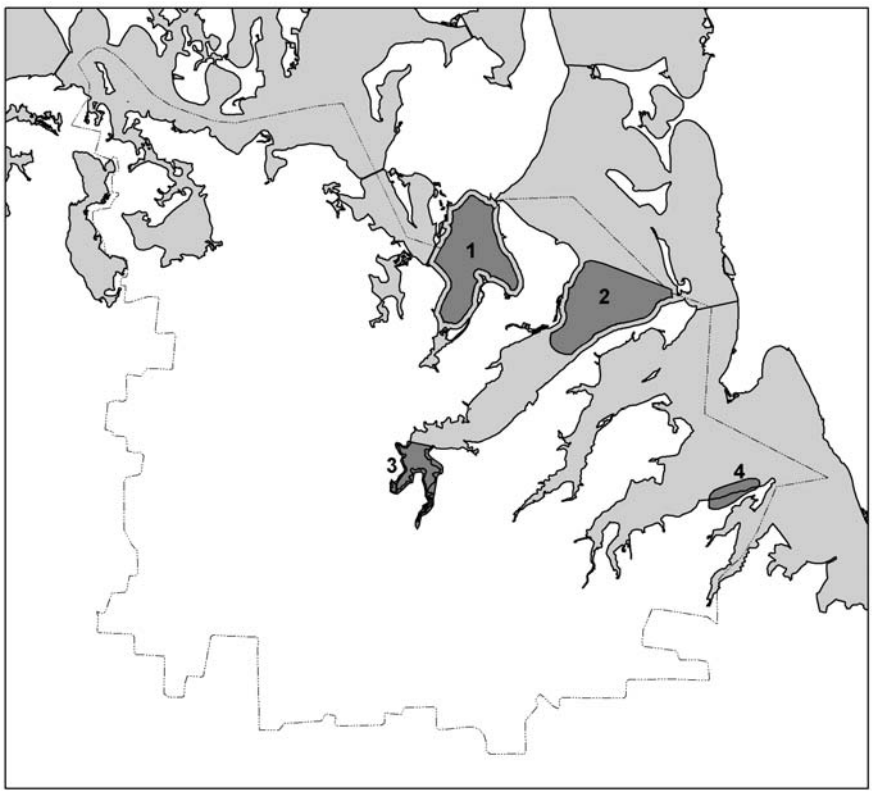

Figure 9. Areas important for fish conservation in Dzhankoi District.
Legend: 1 — Chongar Bay; 2 — Sivash Bay to the north of the Tiup-Tarkhan Peninsula; 3 — The lower reaches of the Rover Pobednaya; 4 — Stephanovski Bay and Cape to the north of Stefanovka.

5.3. Amphibians and reptiles

Some of the information on the areas of Dzhankoi District that are the most valuable for the conservation of amphibians and reptiles has already been published (Kotenko, 2000a, 2002b). The locations of three snake species with high population densities have also been identified earlier (Kotenko et al., 1998; Kotenko, 2000, 2001a, 2002; Karmyshev, 1999; Kukushkin & Karmyshev, 2002; Kukushkin & Kotenko, 2003; Kukushkin, 2003, 2004). Proposals have been made for the establishment of special herpetological reserves at some of these locations, at Kalinovskoe and Krainiaya[4] in particular, and also at some sites in the vicinity of Chaikino and Mysovoe villages (Kukushkin, 2003). This section gives information on all the most important sites found in 2000–2004 within the boundaries of Dzhankoi District. Fig. 10 shows where these areas are located.

Site 4–5 km northwest of Istochnoe village

This site is located on the border of Dzhankoi and Kresnoperekopsk Districts. The area is 83.3 ha. Here in the lower part of the gully (which starts at Istochnoe), along the railroad and motorway and on the embankment of the North Crimean Canal various habitats are found: steppe areas, meadows, forest belts, abandoned fields and freshwater bodies (canals and ponds) with reeds and aquatic plants. Species that are particularly abundant at the site include Sand Lizard, Steppe Viper and Lake Frog. Green Toad, Grass Snake and Large Whip Snake are common: European Pond Turtle may also be encountered here. Species such as Pallas's Rat Snake and Common Spadefoot are very likely to be found here in the future.

The north-eastern coast of Lake Aigulskoe

Most of the area (229.3 ha) falls within the boundary of Dzhankoi District, although part of the northern coast belongs to Krasnoperekopsk District. There are areas of well-preserved semi-desert steppe, including patches overgrown by Lessing's Feathergrass and rich herbaceous vegetation, pastures, halophytic meadows, saline land, abandoned fields and forest belts. Sand Lizard, Steppe Viper, Pallas's Rat Snake, Grass Snake and Green Toad are common here. Large Whip Snake is also likely to be present. It would be worth creating a landscape reserve, which would ensure the strict protection of snakes. Grazing pressure within the area should be controlled.

Russkiy Island

The island is 155.9 ha in size and includes areas of semi-desert steppe, halophytic meadows and saline land. Sand Lizard, Steppe Viper and Pallas's Rat Snake have been recorded at this site.

The coast of the Martyniachyi Peninsula; pastures around Algazy, Treshchevo and Basurman–2 farms

The area includes patches overgrown with steppe vegetation, located either in the vicinity of the sheep farms or around Lake Solionoe and along the northern and western coasts of the Martyniachyi Peninsula (1,971.6 and 294.1 ha respectively). A variety of steppe plant associations (most of which are subjected to heavy grazing pressure), saline land and abandoned fields, saline and desalinated lakes and freshwater pools around artesian wells are found within the site boundaries. Sand Lizard, Steppe Viper, Pallas's Rat Snake, Grass Snake, Green Toad and Lake Frog are common inhabitants of this area. There are also records of Large Whip Snake.

Karacha-Kitai Peninsula

There are well-preserved areas of virgin steppe (in the north of the peninsula), arable land (in the south and north-centre), saline land (on the coast of small bays), halophytic Wheat-grass meadows, and an abandoned sheep farm with several ruined buildings surrounded by a pasture (south-centre). The area, measuring 320.4 ha, is characterised by very interesting plant communities. To date only Sand Lizard and Steppe Viper have been recorded, but species such as Pallas's Rat Snake and Green Toad are very likely also to occur here. It would be worth establishing a landscape reserve on the peninsula to the north of where it is narrowest — an area of 350–390 ha in total. The agricultural fields that would lie within the boundaries of the reserve should be abandoned. The grazing pressure in the south should be decreased, while in the centre and north it would have to be increased to control the density of the vegetation cover (in this case, putting a few horses out to graze on it would be most effective).

Naiman Peninsula

There are patches of steppe vegetation, halophytic meadows, saline land, abandoned and cultivated fields and forest belts; most of the area is grazed. The area is 2,038.5 ha. There is a sheep farm in the cen-

[4] Fortunately, in 1998 these areas were included in the Kalinovskiy Regional Landscape Park.

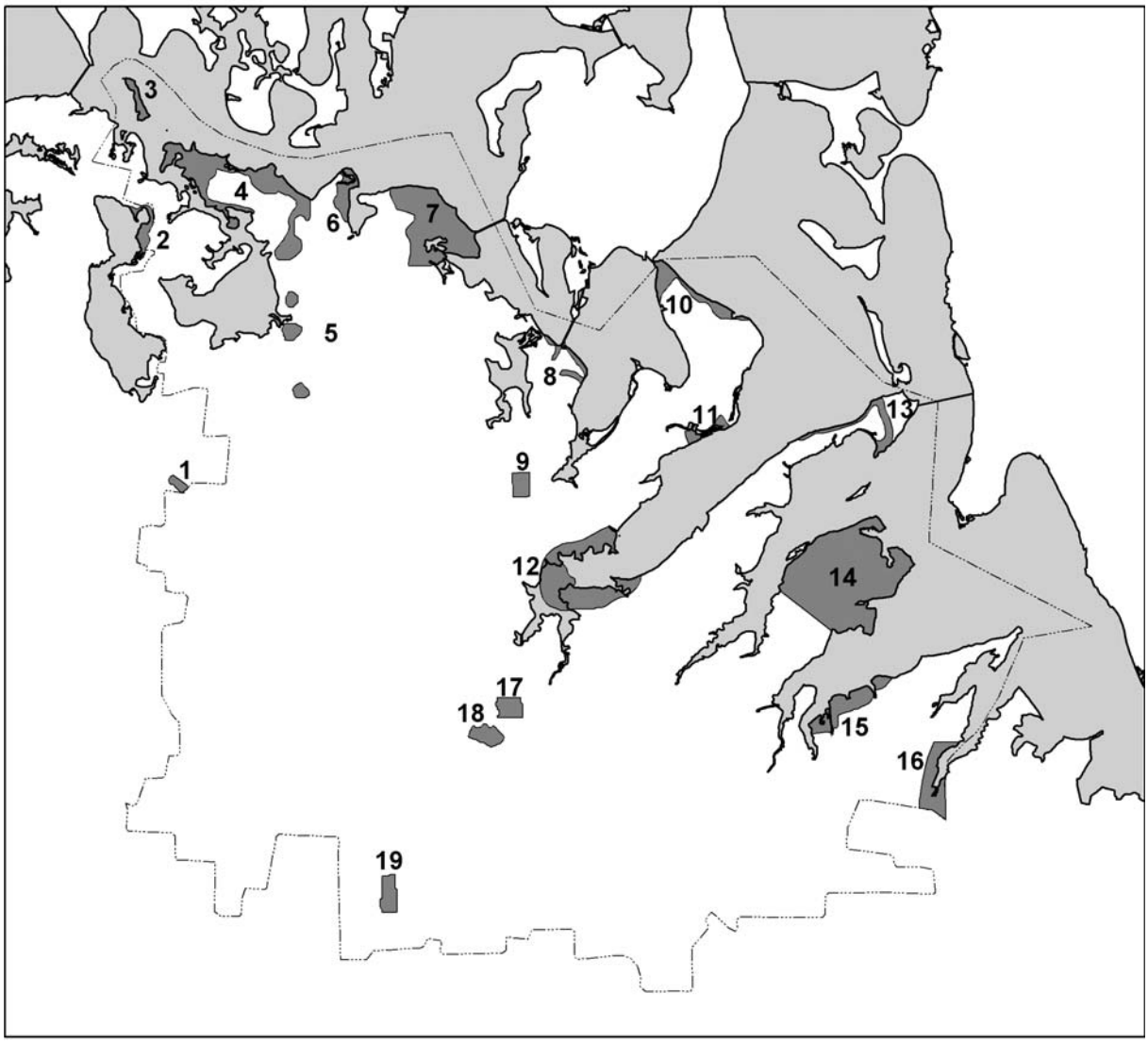

Figure 10. Areas important for the conservation of amphibians and reptiles in Dzhankoi District.

Legend: 1 — Site 4-5 km northwest of Istochnoe village; 2 — The northeastern coast of Lake Aigulskoe; 3 — Russkiy Island; 4 — The coast of the Martyniachyi Peninsula; 5 — pastures around Algazy, Treshchevo and Basurman-2 farm; 6 — Karacha-Kitai Peninsula; 7 — Naiman Peninsula; 8 — The northern part of the Taganash Peninsula; 9 — Old abandoned vineyards, located 2-4 km southeast of Zavet-Leninskiy village; 10 — The northern coast of the Tiup-Dzhankoi Peninsula; 11 — Outskirts of Turgenevo; 12 — Outskirts of Pridorozhnoe and Nizinnoe; 13 — The coast of the Tiup-Tarkhan Peninsula to the north and east of Mysovoe; 14 — Tiup-Kangil Peninsula (site of the former Kalinovskiy military area and adjacent land); 15 — Area to the north and northeast of Slavianskoe; 16 — Area to the east and southeast of Blagodatnoe; 17 — Site of the former military airfield to the southeast of Dzhankoi; 18 — Wasteland to the south of Dzhankoi; 19 — Site of the former air force garrison in the vicinity of Vesioloe, Nakhodka and Volnoe.

tre of the peninsula. A small settlement and abandoned sandpit are located at the beginning of the dam that stretches from the east coast of Naiman to the Chongar Peninsula. Sand Lizards are very numerous on the peninsula; Steppe Viper, Pallas's Rat Snake and Green Toad are common, Large Whip Snake occurs only occasionally. It would be worth creating a landscape reserve, which would include the whole area of the peninsula (1,500 ha in total). All the cultivated land within the boundaries of the reserve should be abandoned. On condition that grazing pressure is properly regulated and snakes are strictly protected, the area could be used as a pasture.

The northern part of the Taganash Peninsula

The site is located 3–6 km to the north of Solionoe Ozero. There are wide forest belts and

narrow strips of steppe along the railway, and a dry reservoir overgrown with steppe (Lessing's Feathergrass is a common species) and ruderal vegetation. The area is 211.8 ha. Narrow strips of steppe are also found along the high cliffs of the Chongar Strait. Sand Lizard and Steppe Viper are common and, in some places, numerous; Pallas's Rat Snake is sometimes recorded. Green Toad is also likely to occur. Major threats to the snakes within the last three areas include the collection of the reptiles for commercial purposes and killing by local people.

Old abandoned vineyards, located 2–4 km southeast of Zavet-Leninskiy village

The site, whose total area is 205.5 ha, includes good habitats for reptiles: various weed and ruderal vegetation species in combination with abundant rodents make this area attractive for Sand Lizard and Steppe Viper (both are numerous), Green Toad, Pallas's Rat Snake (common), Grass Snake and even Smooth Snake — the rarest snake in the Crimean steppe. Drainage wells are found all over the vineyards: Lake Frog occurs in those that contain water, however some of the others have become traps for threatened snake species. It would be worth creating a zoological reserve here, prohibiting land cultivation and restoring the vineyards. Naturalists from Dzhankoi Ecological Centre (located in Zavet-Leninskiy) could take an active part in the conservation of snakes by checking the drainage wells and releasing trapped reptiles.

The northern coast of Tiup-Dzhankoi Peninsula; outskirts of Turgenevo

These areas include narrow strips of steppe, saline land, sand spits, forest belts, abandoned fields and arable land; the total area of the site is 485.3 ha. Sand Lizard, Steppe Viper and Green Toad are common (in some places numerous) on the patches of steppe vegetation, waste land and various mounds. Pallas's Rat Snake and Grass Snake can also be found. Ponds and reservoirs are inhabited by Lake Frog and used as foraging habitats by Grass Snake and breeding sites by Green Toad.

Surroundings of Pridorozhnoe and Nizinnoe

In spite of the fact that all local steppe areas are subjected to heavy overgrazing, they remain quite important for a number of species: not only Sand Lizard but also Steppe Viper, Pallas's Rat Snake and even Smooth Snake (at a site near the village of Ostrovkoe) have been recorded here. The extensive reed beds are inhabited by Lake Frog and European Pond Turtle and used as foraging habitats by Grass Snake. Green Toad also uses the reed beds during its breeding period. It is very likely that the Common Spadefoot, which is rare locally, could also be found at the site: the nearest record (in the village of Dneprovka) is within the same catchment area (River Stepnaya) and only 10 km from this site. The total area is 1,796.0 ha.

The coasts of the Tiup-Tarkhan Peninsula to the north and east of Mysovoe

There are narrow strips of steppe, saline land, sand spits, forest belts, abandoned fields and arable land. The area is 397.7 ha. The composition of reptiles and amphibians is similar to that around Pridorozhnoe. In addition, on the broader end of the peninsula are canals and areas of shallow fresh water, where Lake Frog and Grass Snake are fairly numerous.

Tiup-Kangil Peninsula (site of the former Kalinovskiy military area and adjacent lands)

In accordance with a decree adopted by the Dzhankoi Regional Rada in 1998, the Kalinovskiy Regional Landscape Park was created in this area. Although some parts of the park have been ploughed, resulting in both cultivated and abandoned fields, today it is the largest steppe area in the Crimean Prisivashie. Some parts of the park are heavily overgrazed, but there also are patches with well-preserved steppe vegetation, as well as halophytic meadows, saline land, sand spits, reed beds and forest plantations. An area of 4,478.8 ha is particularly densely populated by amphibians and reptiles. Sand Lizard, Steppe Viper and Pallas's Rat Snake are among the common and in some places numerous species of reptiles recorded here. Smooth Snake has been recorded here several times. Lake Frog and Grass Snake occur in pools and drinking bowls near an artesian well, and Green Toad may also use these pools for spawning. The Kalinovskiy Regional Landscape Park is a very important area for the conservation of reptiles: this is where the natural steppe habitats of the three species included in the Red Data Book of Ukraine should be protected. Efforts should be also made to restore biotopes of this kind wherever possible. Needless to say, the catching and killing of snakes should be totally forbidden in the park. Snake conservation should be established as the top priority for the park administration. The cultivation of land in the park should be stopped: the area could be used as a pasture, but livestock density should be strictly regulated (horses and horned cattle, but not sheep). It is worth noting that before the 1990s

the whole of the Tiup-Kangil Peninsula was heavily grazed by up to 20,000 sheep. The animals destroyed vegetation to the extent that only Crimean Wormwood and Harmel remained, so that even today some of the virgin steppe areas look like abandoned fields.

Area to the north and northeast of Slavianskoe

This area is a game reserve (689.5 ha). It includes abandoned fields and small areas with steppe vegetation, canals and ponds, but halophytic meadows, saline land and reed beds predominate. Sand Lizard, Steppe Viper, Pallas's Rat Snake and Green Toad are common species in the area; Lake Frog and Grass Snake are numerous; Pond Turtle has also sometimes been recorded. Here, as in many other parts of Ukraine, local people commonly kill snakes, especially during haymaking. Educational programmes aimed at raising awareness among gamekeepers and local people should be implemented.

Area to the east and southeast of Blagodatnoe

There are small areas of steppe vegetation, but abandoned fields, halophytic meadows, saline land and reed beds predominate; there are also narrow canals. The total area is 650.5 ha. In the course of a brief inspection, Sand Lizard and Lake Frog were discovered. Nonetheless, the species composition of the area is very likely to be the same as around Slavianskoe.

Site of the former military airfield to the south-east of Dzhankoi

In the past this was a large area of steppe with numerous mounds — the remains of aircraft hangars. The site is 244.1 ha in area. Most of the area has been ploughed (leaving both cultivated and abandoned fields) and some parts have been dug up and covered with rubbish; as a result, weeds and ruderal vegetation are well developed. Steppe vegetation has survived only on small virgin plots and on the slopes of the mounds. According to the literature (Kukushkin, 2003), in the 1990s there was a large population of Steppe Viper on Dzhankoi airfield. Since 2004, after some of the land was transferred into the ownership of farmers, the number of snakes has declined. Green Toad and Sand Lizard are common here; Grass Snake also occurs; Pallas's Rat Snake has been recorded on the site, and Smooth Snake is very likely to be found in the future (it has been recorded 2 km west of the airfield, in the southern outskirts of Dzhankoi).

Waste land to the south of Dzhankoi

Sand Lizard, Green Toad and Grass Snake commonly occur on the embankments of railways and highways, and on waste land on the northern and southern outskirts of Dzhankoi. Steppe Viper and Pallas's Rat Snake have been recorded close to this site, on the airfield. In 2003 a Smooth Snake that had been killed was found near the town. Lake Frog and Grass Snake inhabit canals and ponds located around the town, especially on its southern outskirts. Pond Turtle numbers are critically low because local people regularly take them. Common Spadefoot is likely to occur on garden plots in Dzhankoi. Thus, the reptile and amphibian fauna of this relatively large town is quite rich. The area of this site is 255.0 ha.

Site of the former airforce garrison in the vicinity of Vesioloe, Nakhodka and Volnoe

Investigations carried out in 2003 showed that in this area there were well-preserved habitats for a number of species. There were patches of natural steppe vegetation, bushes and abandoned fields, as well as small pools with reeds and aquatic vegetation at the bottom of a limestone quarry. The area of the site is 274.5 ha. According to local people many snakes were found in the area until very recently. In 2003–2004 Steppe Viper, Sand Lizard, Green Toad and Lake Frog were recorded. Unfortunately, in 2004 rapid, large-scale reconstruction was being undertaken at this site: military buildings were being converted into sheds for a large poultry factory, and the limestone quarry was being actively exploited. It is clear that this interesting and valuable area will inevitably be lost in the very near future.

Thus, most of the areas important for the conservation of reptiles and amphibians are confined to either the narrow strip along the coast of the Sivash or the former military areas belonging to the Defence Ministry.

5.4. Birds

The freshwater bays and brackish, openwater areas have the highest importance of all the variety of habitats that support the range of birds that occur in the Sivash. This is related to the large amount of forage available in these areas, availability of breeding sites, and of roosting sites in the migration or wintering periods (see Annex I, Fig. 10 a—d, Fig. 11 a—b). Birds are also attracted to the coasts and aquatic areas because they are inaccessible to predators, as well as to humans. Numerous islands and island systems are particularly important for breeding birds. The creation of the North Crimean Canal has significantly changed the bird species diversity of the Sivash: a number of migratory and breeding species have appeared for the first time in the area. Terrestrial and aquatic areas that are the most valuable for the conservation of birds (including species listed in the Red Data Book of Ukraine) are shown in Figure 11. A short description of the sites follows:

Dzhankoi Bay

The villages of Predmostnoe, Turgenevo, Medvedievka, Pridorozhnoe, Ostrovskoe, Armeiskoe, Nizinnoe, Mityurino, Chaikino and Mysovoe are located on the bay, which has a total area of 10,146.4 ha. Predominant habitats include areas overgrown with reeds and marsh vegetation (with open water in the upper reaches of the bay), extensive mud flats, shallow water and saline land. The area is an important breeding site for herons and ibises, ducks, rails, crakes and shorebirds. Outside the breeding season many species use it either for foraging/roosting or as a source of drinking water. Several refuges covering the major habitat types — open water, reeds, islets, spits and shallows — need to be established. Breeding areas should be created on the saline land, adjacent shallows and steppe slopes. Burning grassland in spring in the areas overgrown by steppe vegetation should be prohibited. Fishing needs to be limited to decrease disturbance.

Solenoozernyi Bay

The bay is located in the vicinity of the villages of Solenoe Ozero and Ermakovo; it has a total area of 2,671.9 ha. Major habitats include reed beds with open water, shallow water and saline land. The area is an important breeding site for herons and ibises, ducks, rails, crakes and shorebirds. Outside the breeding season many waterbirds use the bay either for foraging/roosting or as a source of drinking water. Several refuges should be established on the spits and adjacent shallows and saline land in the upper reaches of the bay next to the dam. Burning grassland in spring in the areas overgrown by steppe vegetation should be prohibited.

Chongar Strait

The strait and its adjacent aquatic areas and islands lie within the site boundaries; the area is 3,788.6 ha in total. Major habitats include islands and spits, shallow water and small straits. The area is an important breeding site for ducks, gulls and shorebirds; outside the breeding season many waterbirds use it for foraging or roosting. A refuge should be created in the remote aquatic areas of the bay. The use of motorboats should be prohibited from September to April.

Zmeinye Islands

The islands are situated in the bay to the north of Rumshino between the Karacha-Kitai and Naiman Peninsulas; the area of the site is 2,590.6 ha in total. Major habitats include islands and spits surrounded by shallow water. The area is an important breeding site for ducks, gulls and shorebirds. Outside the breeding season many waterbirds use the site for foraging or roosting. A nature reserve should be created in the aquatic area surrounding the islands and spits. Fishermen should be prohibited from visiting the island from March to June.

Kalinovskiy Bay

To the north the bay borders the Kalinovskiy Regional Landscape Park; the villages of Novokonstantinovka, Slovianskoe, Aprelevka and Stefanovka are located to the south. The total area of the bay is 2,303.6 ha. The major habitats include freshwater shallows overgrown with marsh vegetation and openwater areas with aquatic vegetation. The area is important for breeding waterbirds. Outside the breeding season many waterbirds use the site either for foraging/roosting or as a source of drinking water. A refuge should be created in the remote aquatic areas and marshes.

Islands of Tiup-Tarkhan

The site is located to the south and northeast of the Tiup-Tarkhan Peninsula; it has a total area of 865.9 ha. Major habitats include islands and spits surrounded by shallow water, and small straits. The area is an important breeding site for ducks, gulls and shorebirds; outside the breeding season many waterbirds use it for foraging or roosting.

A nature reserve should be created in the aquatic area surrounding the islands and shallows.

Martyniachyi Island

This is a low-lying island of continental origin located in the north of Dzhankoi District on the border with Kherson Region; its total area is 9.6 ha. The island is particularly important as a breeding site for colonial gulls and terns. A nature reserve should be created on the island and adjacent aquatic area.

Kitai Island

This is a low-lying island (area 2.6 ha) of continental origin located in the north of Dzhankoi District on the border with Kherson Region. The island is particularly important as a breeding site for colonial gulls and terns; in some years Demoiselle Cranes Anthropoides virgo also breed here. A nature reserve should be created on the island and adjacent aquatic area.

The Aigul-Karleut Island system

The site is located in the west of Dzhankoi District; it has an area of 16,338.5 ha, which includes saline land and reed beds. Part of the area is overgrown with trees or steppe vegetation. This island, which is of continental origin, is an important breeding site for colonial birds: gulls, herons, ducks and waders. In some years Demoiselle Cranes also breed here. Outside the breeding season the site is used by waterbirds, which gather here during migration and stop over in winter. Nature reserves should be created on

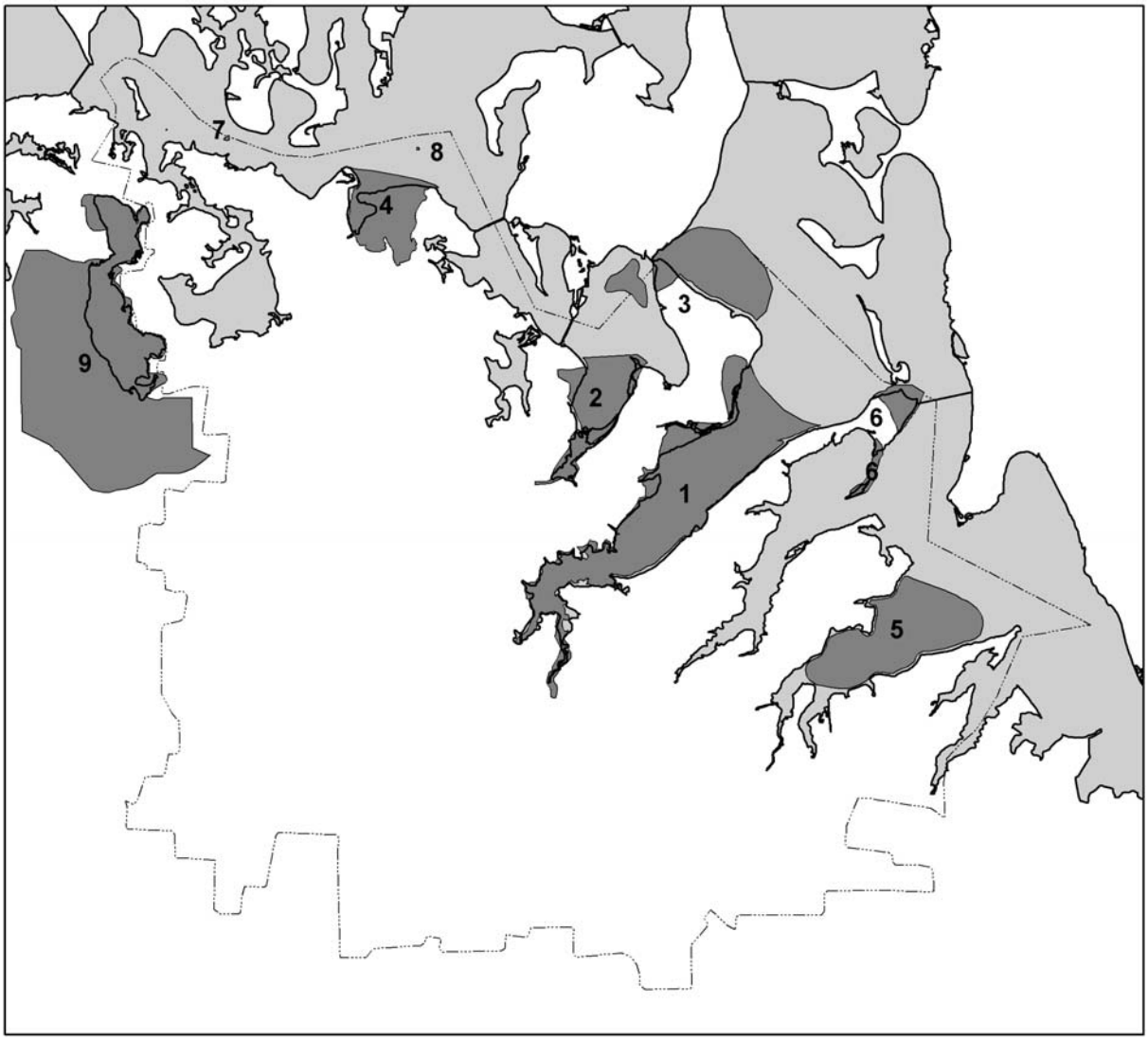

Figure 11. Areas important for conservation of birds in Dzhankoi District (in different seasons).

Legend: 1 — Dzhankoi Bay; 2 — Solenoozernyi Bay; 3 — Chongar Strait; 4 — Zmeinye Islands; 5 — Kalinovskiy Bay; 6 — Islands of Tiup-Tarkhan; 7 — Martyniachyi Island; 8 — Kitai Island; 9 — The Aigul-Karleut Island system.

the islands and adjacent aquatic area. Burning grassland in spring in the areas overgrown by steppe vegetation should be prohibited.

Plantations along the North Crimean Canal

Plantations cross the district from northwest to southeast; they are c. 80 km in total length. In the dry conditions of Crimea these plantations are very important habitats for a variety of forest birds all year round. They actually form an ecological corridor that stimulates extension of the breeding ranges and facilitates bird migration in various ways in relation to the presence of trees. There is an urgent need to stop illegal deforestation and organise recreation for local people, who disturb birds and fill the plantations with household rubbish.

Plantations along the railroad

These plantations cross the district from north to south; they are c. 45 km in total length. The plantations have the same significance for forest birds as those along the canal.

The boundaries of the sites described above were identified by experts, based on their long-term observations and experience. Of course, the descriptions are generalised to a great extent and give only an approximation of the actual distribution of the waterbirds. Nonetheless, the spatial modelling of the seasonal distribution of birds in Dzhankoi District revealed that waterbird density hotspots were largely found within the site boundaries identified by the experts (see Annex I, Fig. 12). However, the spatial model also showed that the year-round importance of some sites has been overestimated by experts, while some other important sites have clearly been overlooked. In particular, one of the sites that has been overlooked is the bay between the villages of Solionoe Ozero and Yasnopolianskoe. Density-raster modelling turns out to be particularly useful for zoning the area for waterbird conservation purposes. Under the conditions found in the Sivash, with its highly indented coastline and seasonal and daily variation in water levels, the observer-dependent bias in identifying year-round site importance for waterbirds can be minimised effectively by undertaking spatial analyses and probability modelling.

6. The Impact of Irrigation Farming on the Conservation of Biological Diversity in Dzhankoi District

Data provided in the previous chapters clearly illustrates that both terrestrial and aquatic biota have been exposed to significant changes as a result of the construction of the North Crimean Canal and development of irrigation farming. The whole ecosystem of Lake Sivash has changed because of the discharge of large amounts of fresh water from the farmland of Dzhankoi District, as well as from other districts in the Crimean and Kherson Regions that are adjacent to the lake. In analysing the negative outcomes of this process and looking for possible strategic solutions to the problems that have arisen, both data collected within the framework of the 'Watermuk' project and also information that has become available through implementation of the 'Towards Integrated Management Planning for the Sivash in Ukraine' project have been used.

Before the issues concerning the conservation and restoration of the biodiversity of Dzhankoi District can be considered, a review should be made of the state of the biota and major changes in the environment that have taken place over the course of the last 35–40 years.

- The network of irrigation and drainage canals has stimulated the expansion of arable land over vast areas. Areas covered by psammophytic, halophytic and steppe vegetation have decreased dramatically from 85% of the district to near zero. Nearly all natural habitats have been converted into agricultural fields. Only narrow strips of aboriginal vegetation remain along the shores of the Sivash.
- An enormous quantity of irrigation and drainage water has been discharged into the Sivash over several decades. In 1985 the discharge reached its maximum: 521 million m^3 from fields in Crimea alone and 109 million m^3 from the Kakhovka irrigation system, in Kherson Region. There was a sharp decline in discharge following the breakdown of the USSR in the early 1990s, when the quantity of fresh water entering the Sivash declined by almost 80% compared to the level in the 1980s.
- The opening of the North Crimean Canal noticeably affected the hydrological regime in the region. Two major effects have become apparent. First, the drainage of water directly from the main canal into the soil has increased the height of the water table. Second, the discharge of fresh water from the irrigation systems together with the rise in the water table has created a wide range of small freshwater bodies and new types of habitats.
- The desalination of the Sivash began the progressive expansion of reed growth over the extensive mud flats. Because of this, the area of shallow water is still decreasing, leaving no staging habitats for migratory birds. This is of particular concern for rare shorebird species.
- The upstream and downstream migration of fish has become impossible because of the hydrotechnical constructions (canals, drainage systems, waterways and dams) built in the small river catchments. These man-made barriers to fish migration have negatively impacted the size and diversity of populations of those species of that move seasonally between rivers and the sea.
- For many years pesticides and fertilisers have been used intensively in the region, and particularly large amounts have been used on the rice fields. Both terrestrial and aquatic ecosystems have become significantly polluted, but the latter have suffered most. Phytoplankton is particularly sensitive to chemical pollution by biogenic and various organic substances. Where there is significant organic pollution, extensive development of the pollution results in oxygen deficit and further stagnation of the whole ecosystem.
- The arrival of fresh water in this semi-arid region has stimulated the development of fish and animal farming. The latter, and sheep farming in particular, has resulted in the degradation of the remains of the steppe ecosystems due to heavy overgrazing. At present the situation has improved slightly because of the decline in livestock numbers, but fish farming still has a negative impact on the aquatic ecosystems. The rapid discharge of fresh water from the fishponds constantly changes the salinity of the surrounding areas, which makes the hydrological situation quite unstable and therefore unfavourable for the aquatic biota.

These environmental changes, which are directly or indirectly related to irrigation, have had a significant negative impact on the biodiversity of the

Sivash. The following impacts on the biota are the most apparent.

- Species related to steppe ecosystems have declined dramatically in number. Some species have disappeared and no longer occur in the region.
- Native bird communities formerly recorded from the Sivash have vanished (or decreased sharply in number) and have been replaced by wetland bird communities. The mud flats in the formerly saline bays, which played an especially important role for migratory waders, have been largely overgrown by reeds. The lack of these kinds of staging habitats may have a negative impact on the mortality and numbers of migratory waders on a continental scale.
- The fish-eating birds show an apparent increase in numbers. The status of the Cormorant is especially critical: this species not only causes serious problems for fish farmers but also displaces other birds from colonial breeding sites.
- Populations of marine fish (So-iuy Mullet, Flounder, species of the Gobidae family) that used to play a significant role in commercial fishing have decreased dramatically. These species are no longer harvested in the Sivash.
- In turn, freshwater fish numbers have increased, although this is not true of species that migrate between fresh water and the sea: these species can no longer migrate because of the regulation of nearly all the water flowing into the Sivash. As a result, freshwater fish now occur in those parts of the Sivash that were formerly saline. Two new species have been introduced into the area and now occur in the canals entering the Sivash, namely Stone Moroco and Pumpkinseed Sunfish.
- Due to extensive habitat transformation, particularly the creation of large wetland areas, some small mammals (mainly rodents) show a clear increase in numbers. The epidemiological situation in the area has worsened. A number of new reservoirs of infectious diseases including tularaemia, leptospirosis, pseudotuberculosis and hydrophobia have appeared, while existed reservoirs have been strengthened.

Today, as a result of the significant decline in freshwater discharge since the early 1990s, the overall salinity of the Sivash is rising. However, continuing economic growth, which is already apparent in the Ukrainian agricultural sector, may reverse the situation to a state at which the discharge of irrigation water is at the same level as it was in the past. Therefore, there is a very urgent need to establish strategic priorities for the conservation of the biota of Dzhankoi District, and of the Sivash as a whole, before the process spirals out of control. The following points should be taken into account:

- The North Crimean Canal and irrigation farming, which are vitally important for the regional economy, will continue to play a role in the ecology of the region. The quantity of irrigation water discharged into the Sivash will vary depending on the crops grown, agricultural techniques applied and general development of agriculture in the region.
- Native ecosystems, communities and species (populations) should be considered as the highest conservation priority. In view of the fact that the remains of natural ecosystems are now to be found mainly in the coastal zone of the Sivash and also the fact that this zone is particularly important for the conservation of the majority of native species, efforts should be focused on the coastal zone with its shallows, sand spits and islands. It is worth noting that rare fish species or other groups of aquatic organisms are virtually absent in the Sivash as it is a relatively new waterbody. Therefore, the conservation of habitats that are important for rare waterbirds and the restoration of commercial fisheries should be established as the highest priorities for further conservation management.

As a result of field investigations, analysis of data collected and discussions about Sivash management issues with a number of specialists, the following strategic priorities for the conservation and restoration of the biodiversity of Dzhankoi District and the Sivash as whole have been established:

- Optimisation of salinity: this would require restoration of the salinity level in the Eastern Sivash to 30 ppm, which would create favourable conditions for the commercially valuable fish (So-iuy Mullet, Flounder, species of the Gobidae family) to breed:
  - Maintenance of the water level in the Central Sivash, which is extremely low in its shallow zones. Unless this is done, the extensive shallow areas will drain and be able to support neither breeding nor migratory populations of waterbirds. However, it is worth noting that the water level in the Central Sivash is regulated by a number of factors (e.g. annual humidity, winds and artificial regulation of the water intake for industrial purposes), all of which should be taken into account.

— Total prohibition of rapid uncontrolled discharge of fresh water in summer and autumn. This would stabilise the salinity of the Sivash and create more favourable conditions for aquatic organisms.
— Modernisation of the drainage system to reduce the likelihood of flooding.
— Prevent of pollution: It is expected that, due to the development of agriculture, in the next 10 years the quantity of chemicals used on the fields will increase significantly. Measures should be taken to prevent pollution of the coastal and aquatic areas of the Sivash by pesticides and fertilisers.
— Conservation of saline openwater shallows as the most important habitats for foraging and resting shorebirds.
— Prevention of further reed-bed expansion and management of the reed beds for conservation purposes.
— Conservation of steppe, halophytic and psammophytic vegetation through the creation of protected areas, regulation of grazing pressure and creation of pastures on irrigated land.
— Restoration of natural vegetation on arable land in such a manner that, together with the protected areas, an ecological network that facilitates the migration of animals and distribution of plants is created. In this way, the detrimental effects of ecosystem fragmentation can be at least partly prevented.
— Strengthening of controls over poaching, theft of eggs of rare and colonially breeding bird species, destruction of breeding colonies of fish-eating birds.
— Zonation of the Sivash and preparation of management plans for each zone.
— Establishment of a reserve network for waterbirds (including specially managed agricultural fields), which would ensure their year-round protection.
— Creation of a co-ordinating committee for the management and conservation of the natural resources of the Sivash.
— Establishment of a system of biodiversity monitoring including monitoring of game species populations and the abiotic factors that affect them.
— Promotion of ecological education and awareness-raising among local people. Development of ecological tourism.

Apart from the strategic priorities listed above, recommendations aimed at the conservation of particular groups of animals have been made:

— Artificial spawning and wintering sites should be created for commercially important fish species to support their populations in the Sivash.
— Fish farming should be supported through the creation of fish breeding plants and small fish-ponds in some parts of the Sivash.
— Wintering populations of waterfowl should be supported through the sowing of crops (winter wheat, maize) that attract birds.
— Forest-belts along fields or roads should be restored or created, which would support many animal species.
— Drainage wells should be modernised in such a way that would make it impossible for snakes to become trapped in them. For this, the wells must have an outer concrete ring or a tight cover. Otherwise, an opportunity should be provided for snakes to escape.

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Annex I

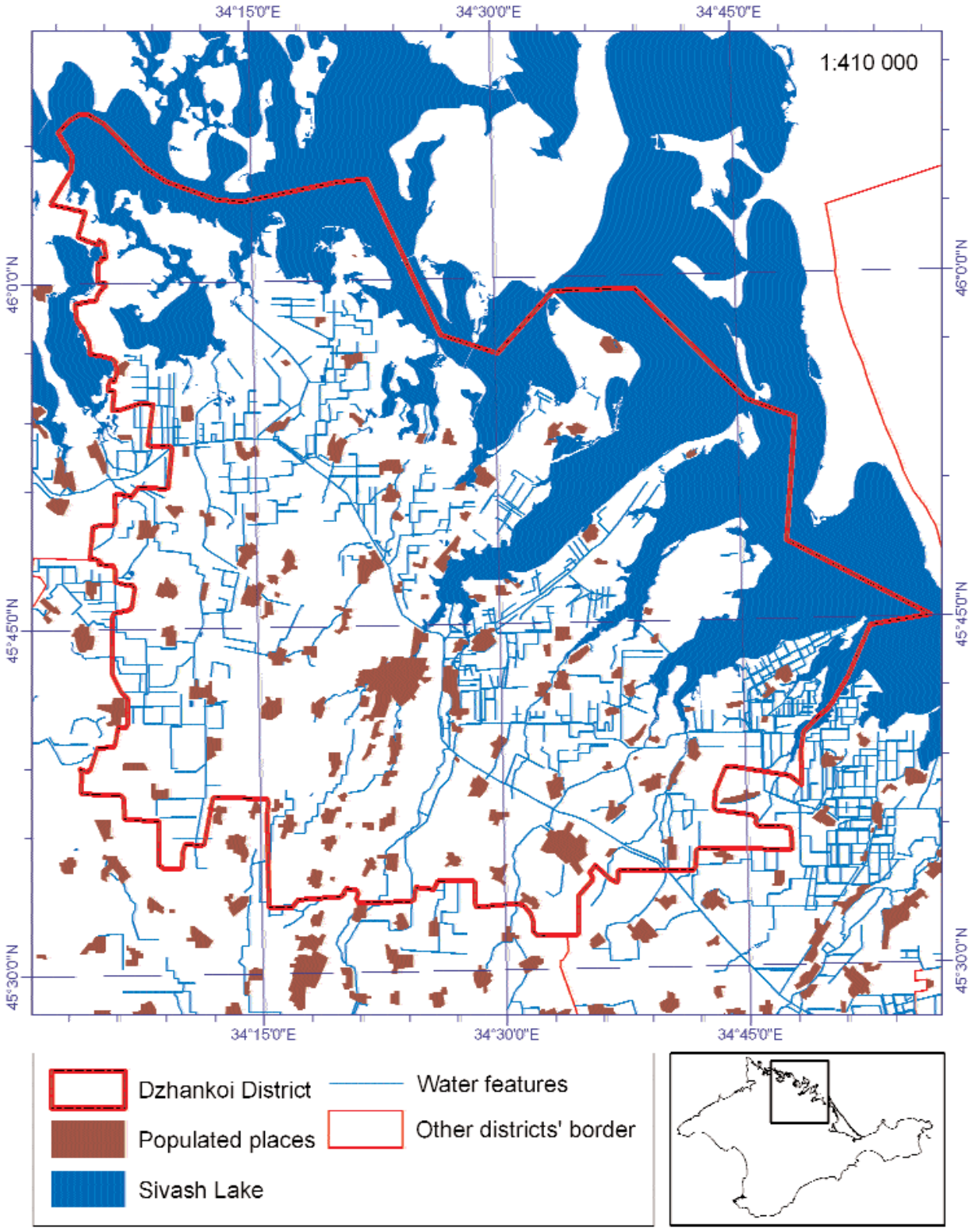

Figure 1. Administrative borders of Dzhankoi District.

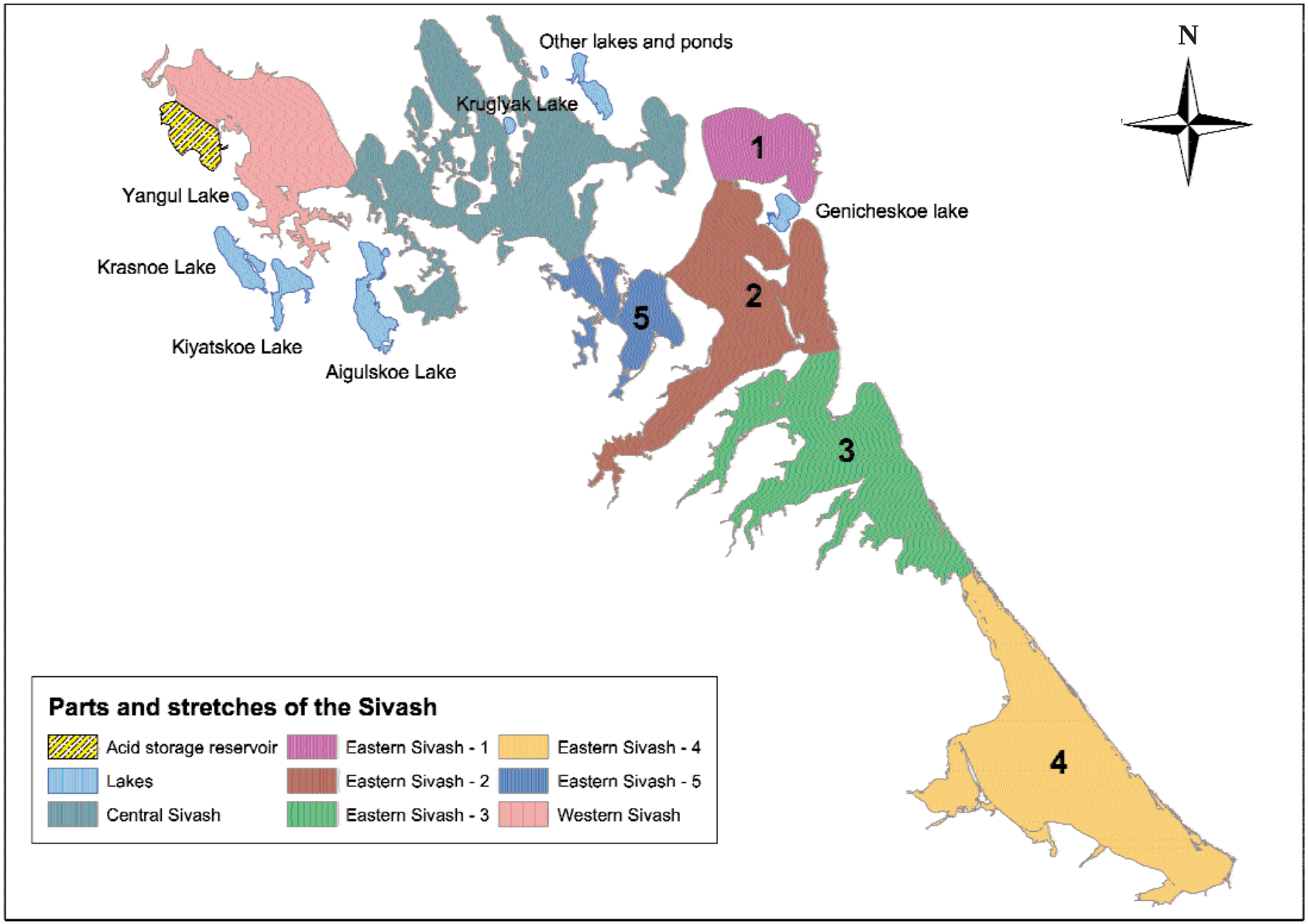

Figure 2. Division of the aquatic area of the Sivash into 'parts' and 'stretches'.

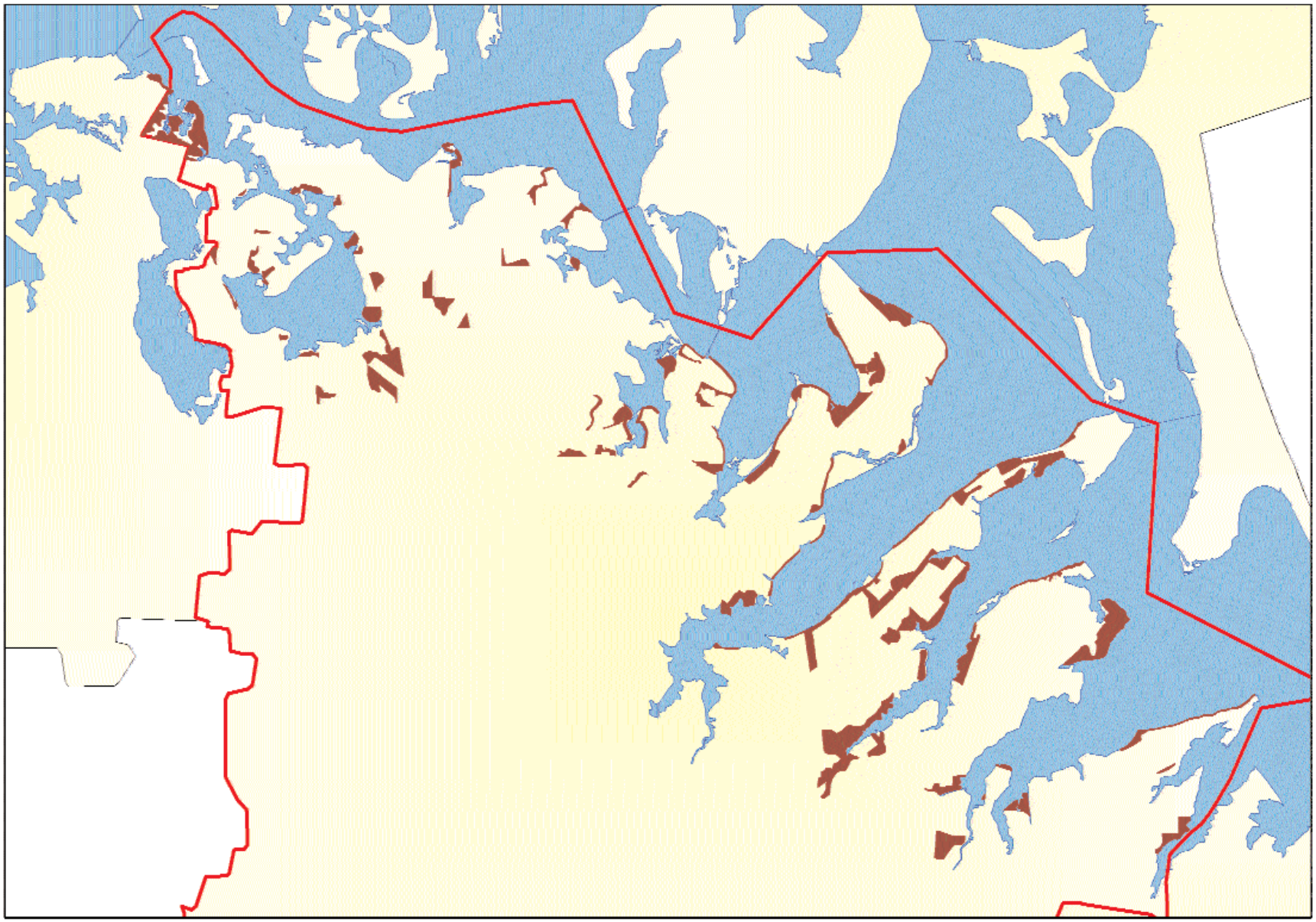

Figure 3. Distribution of steppe vegetation communities in the coastal zone of Dzhankoi District.

Figure 4. Distribution of meadow vegetation communities in the coastal zone of Dzhankoi District.

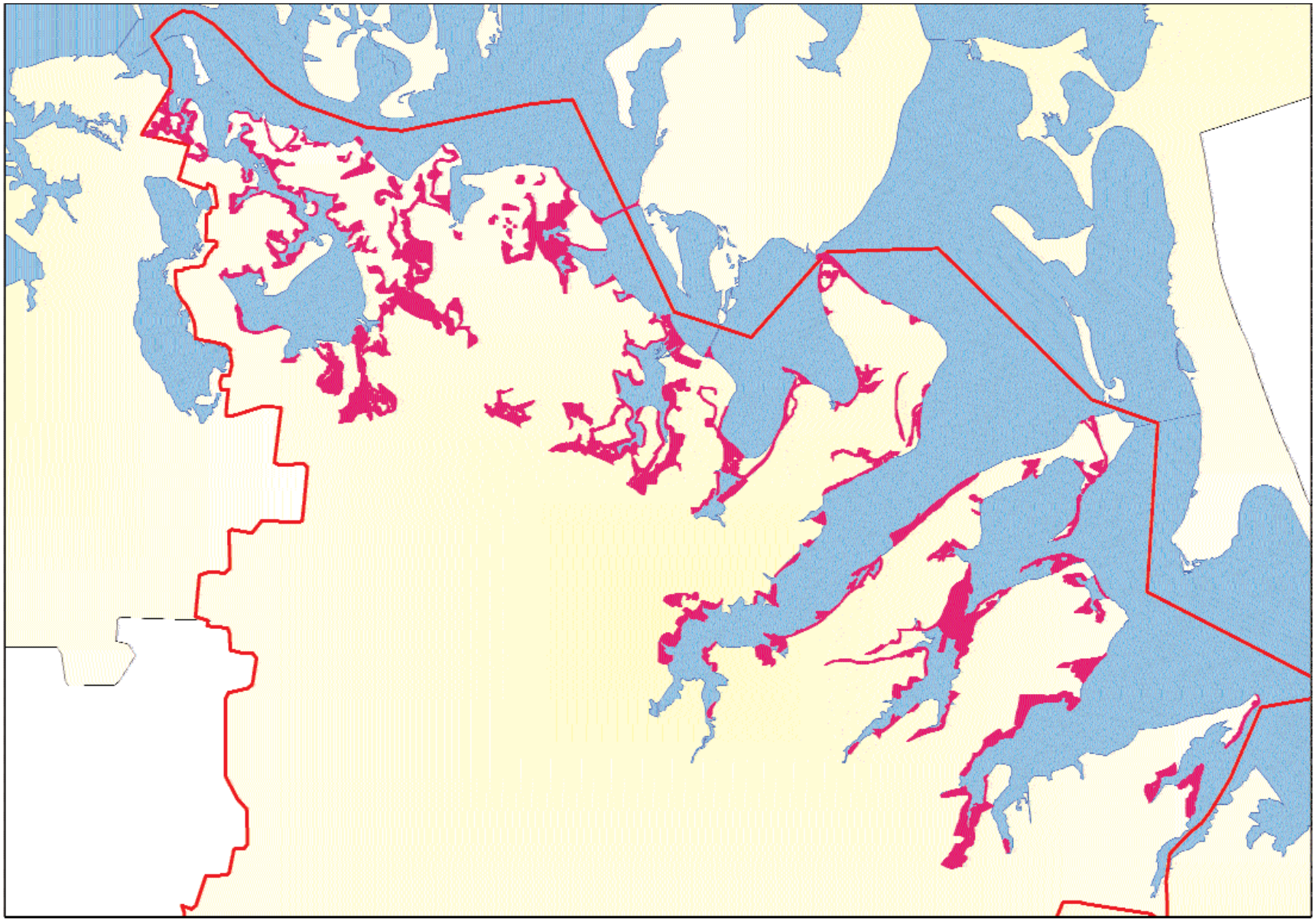

Figure 5. Distribution of saline vegetation communities in the coastal zone of Dzhankoi District.

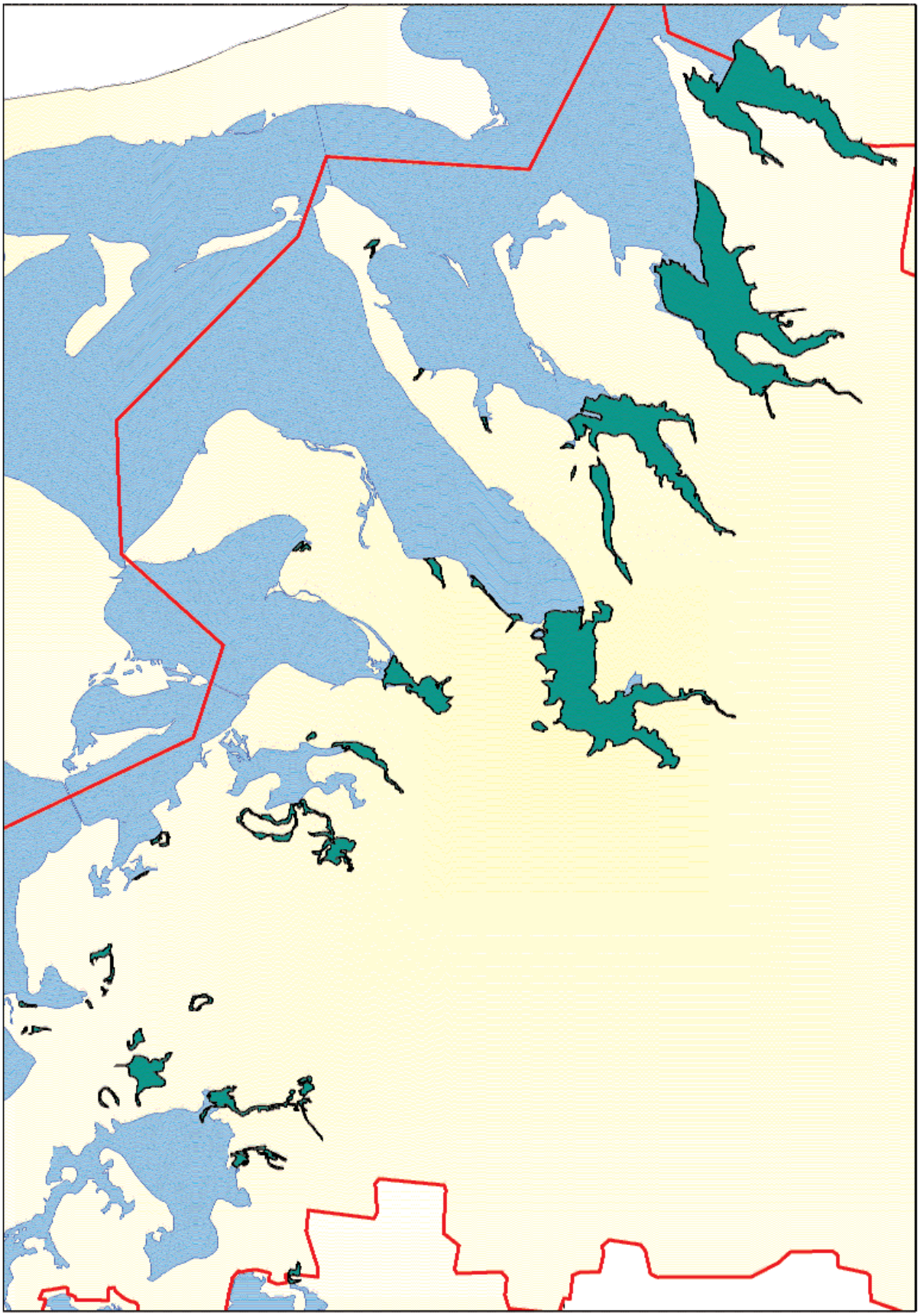

Figure 6. Distribution of wetland vegetation communities in Dzhankoi District.

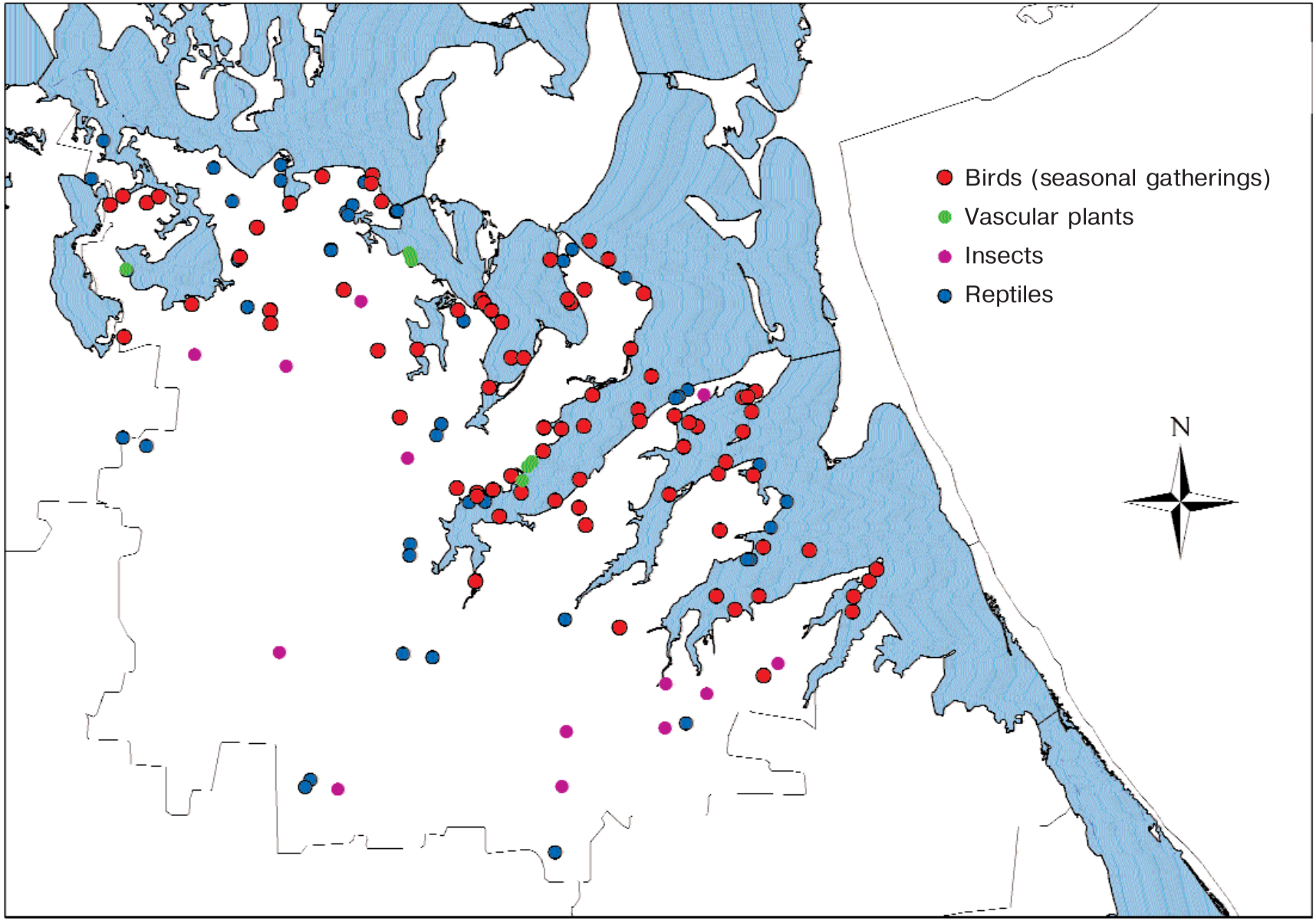

Figure 7. Localities where species listed in the Red Data Book of Ukraine have been recorded.

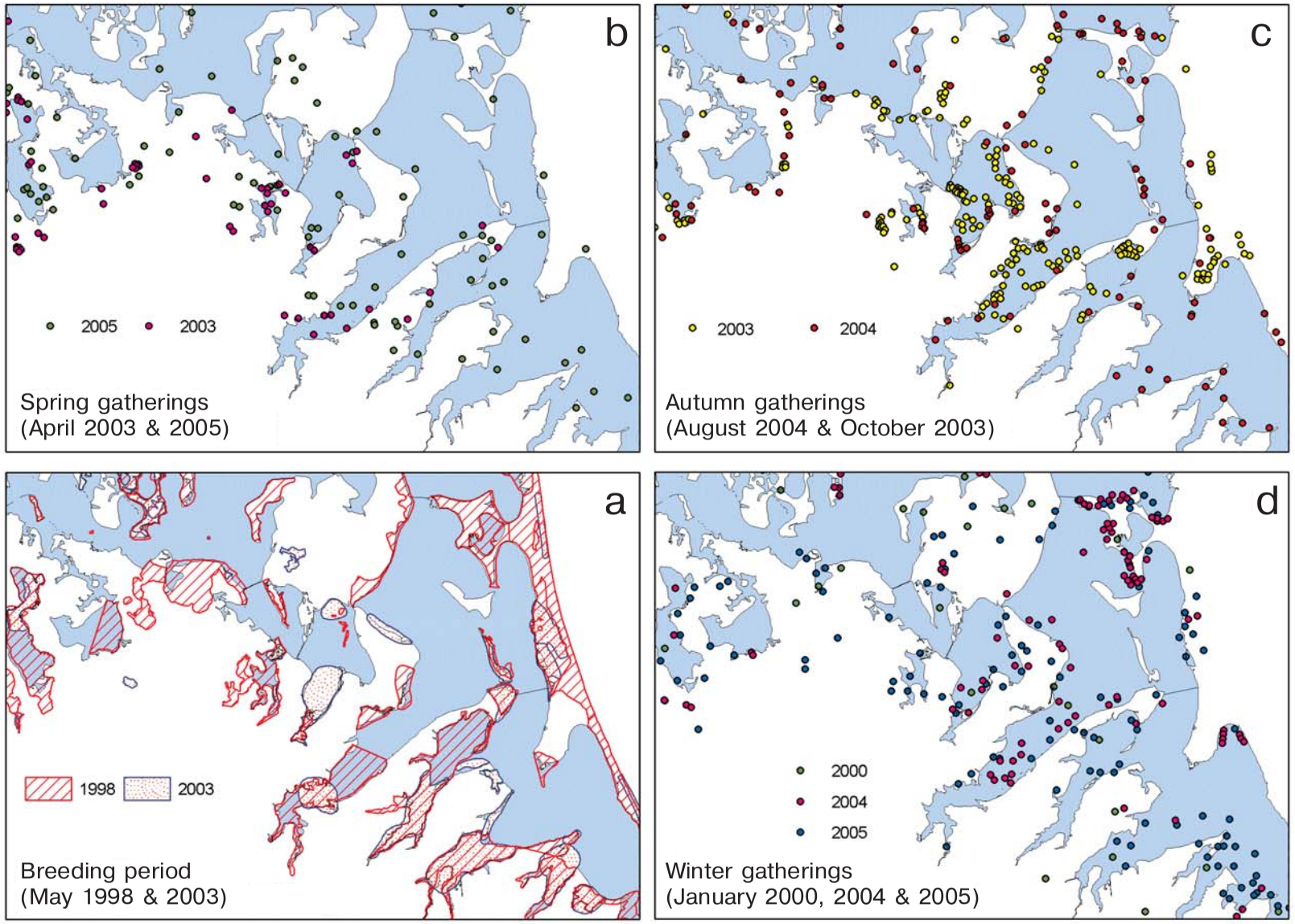

Figure 8. Areas where waterbird concentrations were counted during the breeding period (a); spring (b) and autumn (c) migration periods; and in winter (d).

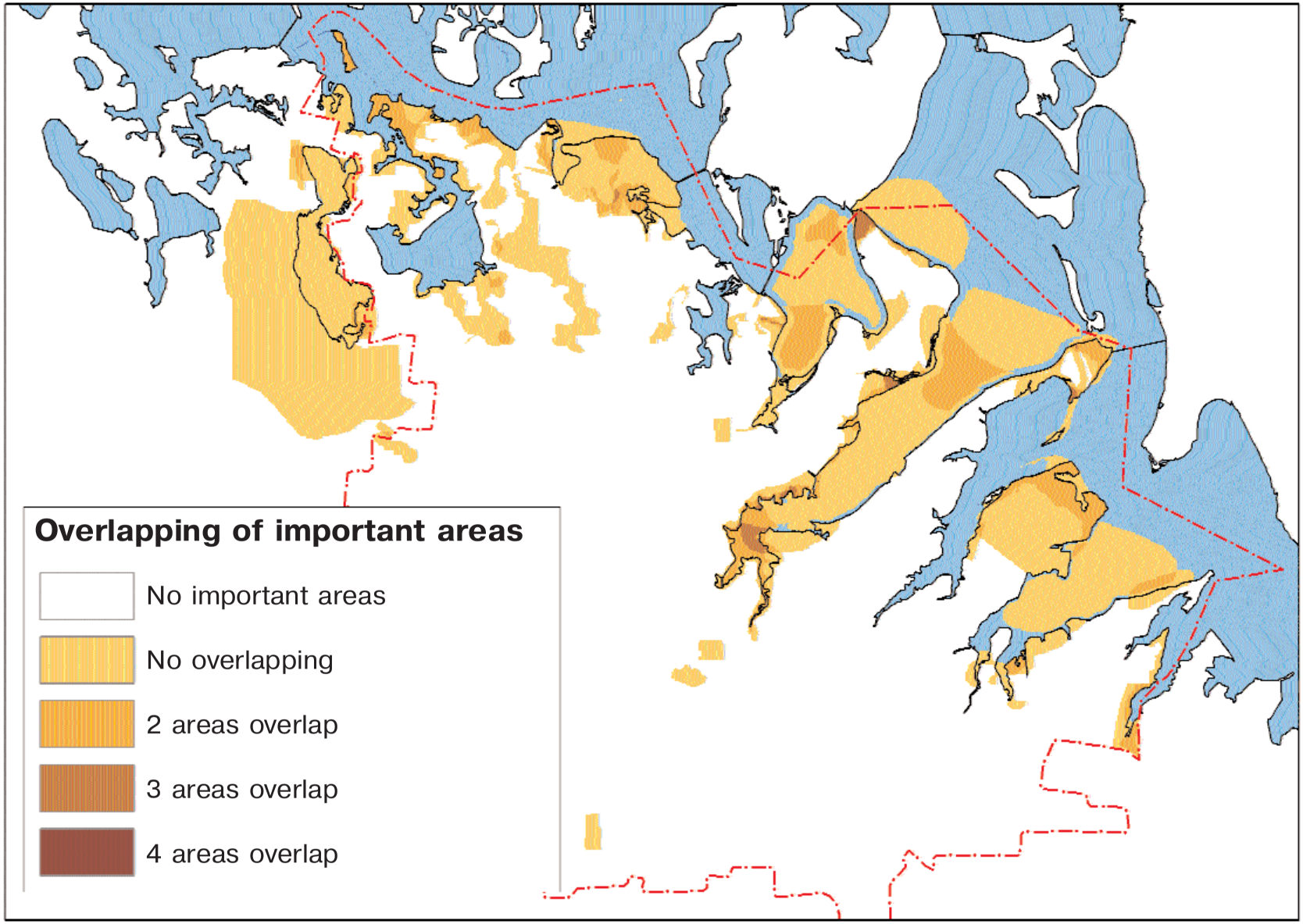

Figure 9. Areas important for conservation of biodiversity (flora and vegetation, fish, reptiles, birds): overlapping zones.

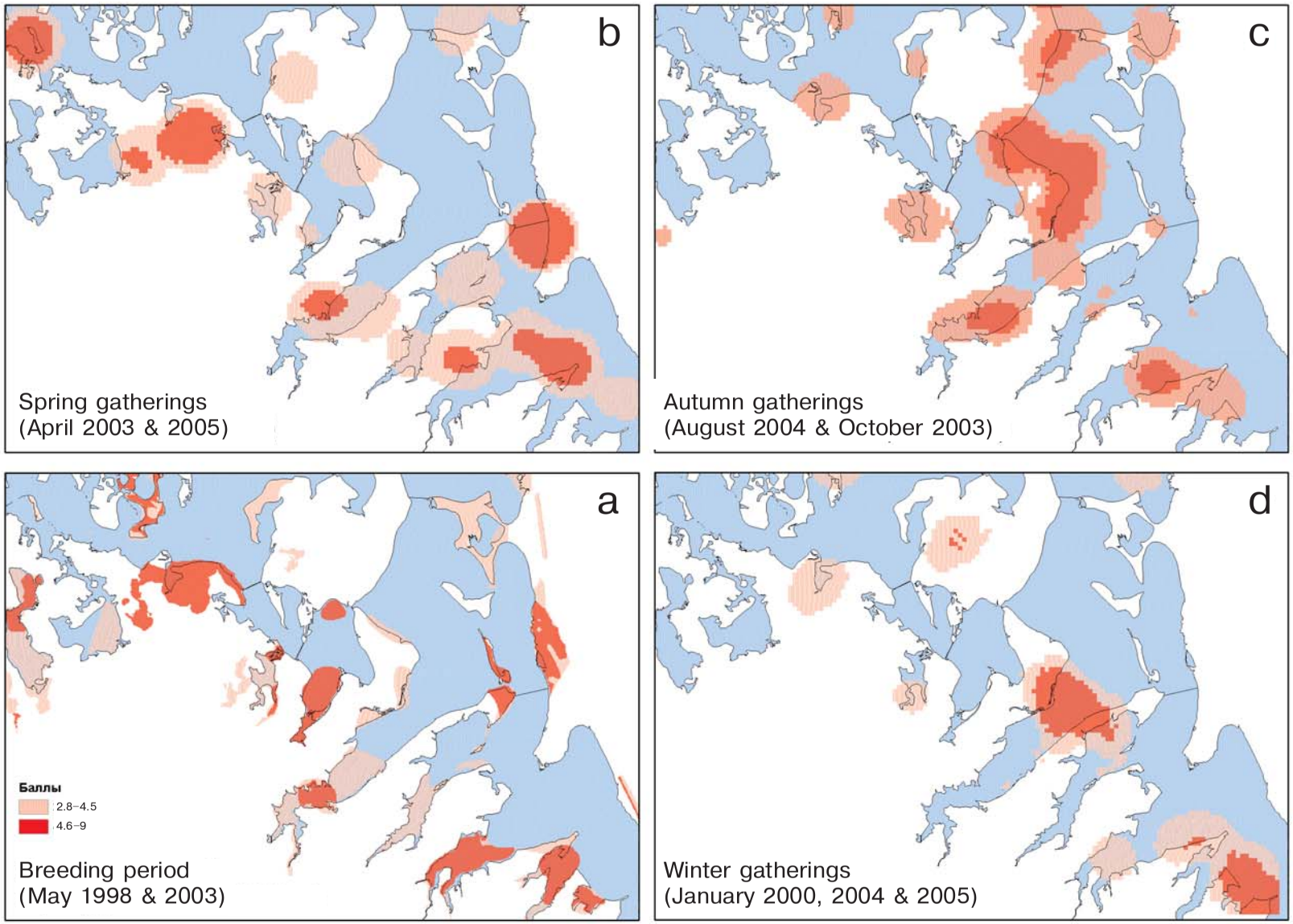

Figure 10. Areas with high concentrations of waterbirds calculated by size and frequency of assemblages (or breeding density) during: a) the breeding period; b) spring migration period; c) autumn migration period; d) wintering period.

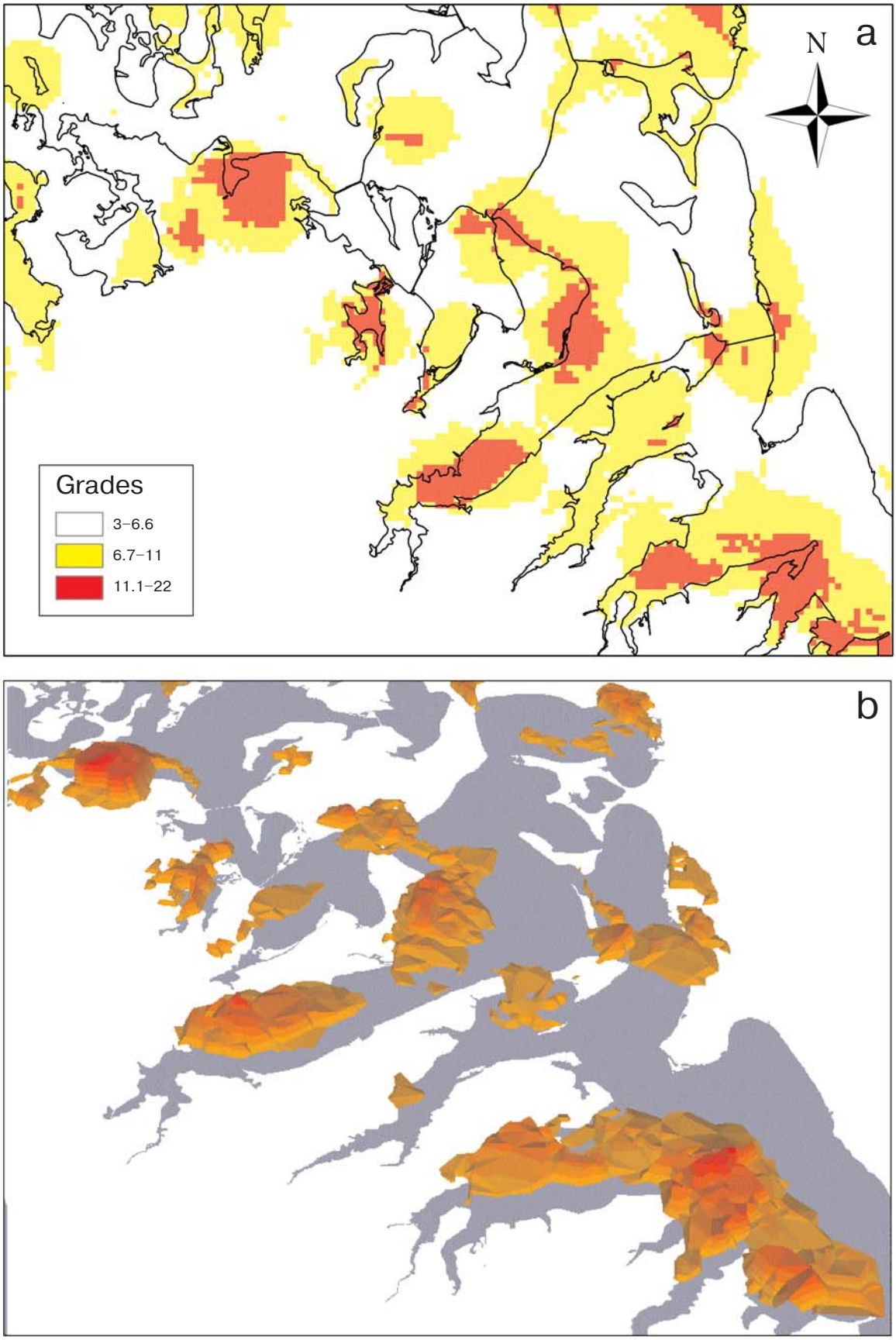

Figure 11. Areas with high concentrations of waterbirds calculated by integrating data on their seasonal distribution (breeding, spring and autumn migration, and wintering periods) (a — 2D image, b — 3D image).

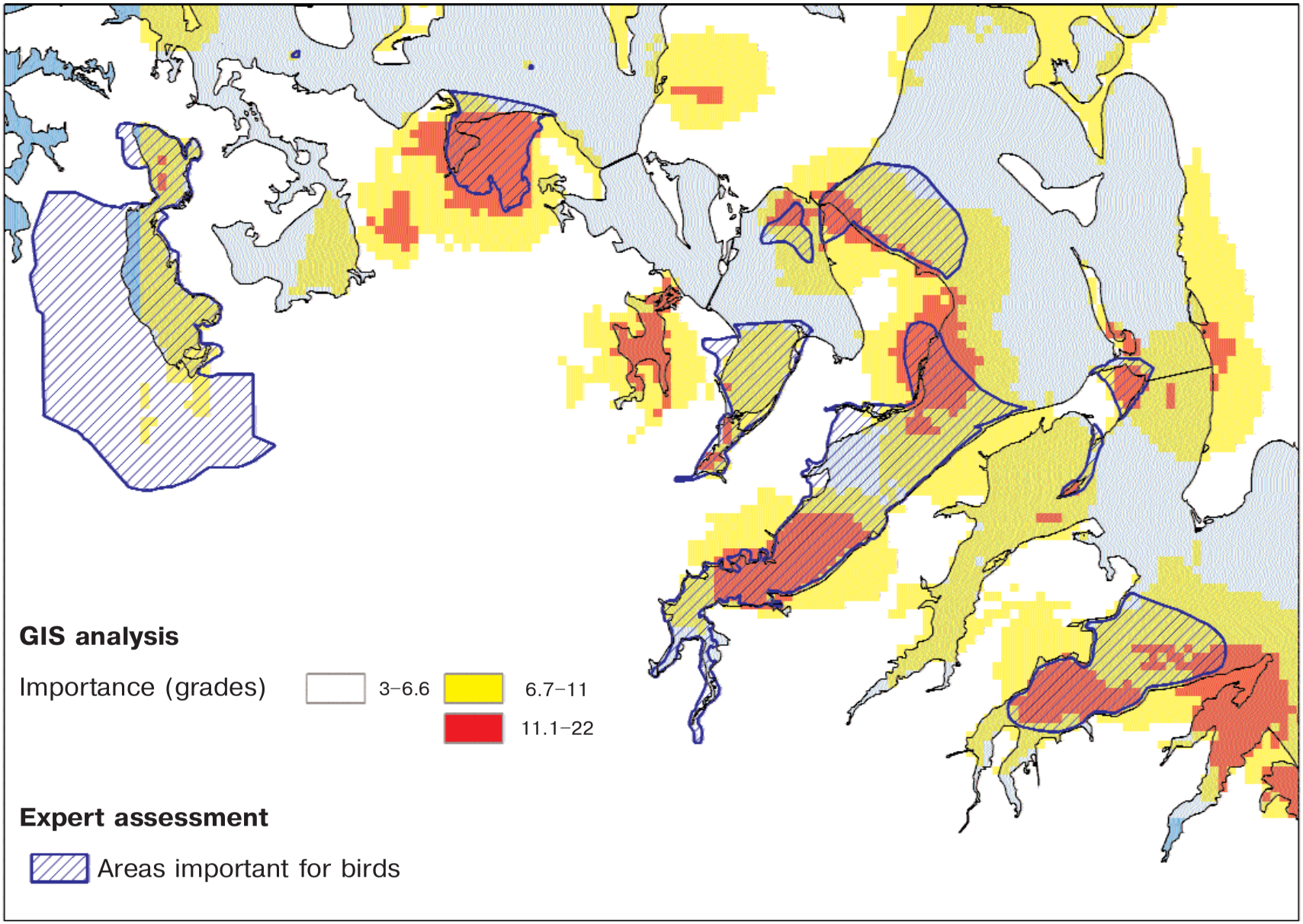

Figure 12. Areas important for bird conservation based on expert assessment and GIS-based identification.

Annex II

Table 1
Plant species recorded in Dzhankoi District

Species*	Ecotopes in which species occur	Records available for periods			Conservation status
		Late 19 th – early 20 th centuries	1946–1979	1980–2004	
1	2	3	4	5	6
Alisma plantago -aquatica	Hyg	+		+	
Sagittaria sð.	Hyg			+	
Allium ampeloprasum	Sin	+			
A. paniculatum	Stp/Arc	+			
A. paczoskianum	Prt/Stp	+	+		
A. rotundum	Stp	+		+	
Amaranthus albus	Sin	+		+	
A. blitoides	Sin			+	
A. retroflexus	Sin		+	+	
Cotinus coggygria	Sin			+	
Bifora radians	Sin	+		+	
Bupleurum tenuissimum	Sol		+		
Caucali s platycarpos	Sin	+			
Conium maculatum	Sin	+		+	
Daucus carota	Prt, Sin			+	
Eryngium campestre	Arc, Stp, Slg	+		+	
E. maritimum	Arc	+			
Falcaria vulgaris	Stp, Sin	+		+	
Torilis arvensis	Stp, Sin			+	
Trinia hispida	Stp		+		
Aristolochia cl ematitis	Stp, Sin		+		
Cynanchum acutum	Stp, Arc, Sin	+	+	+	
Asparagus litoralis	Stp	+			RDB – II, ERL – I
Achillea micrantha	Stp			+	
A. nobilis	Stp	+		+	
A. pannonica	Stp	+		+	
A. setacea	Stp, Sin	+	+	+	
Acroptilon repens	Stp, Sin	+	+	+	
Ambrosia artemisifolia	Sin			+	
Anthemis austriaca	Stp, Sin			+	
A. ruthenica	Stp, Sin	+	+	+	
Arctium lappa	Sin			+	
Artemisia absinthium	Stp, Sin			+	
A. austriaca	Stp, Stp/Prt, Arc	+	+		
A santonica	Prt, Sol, Slg	+	+	+	
A. scoparia	Stp	+		+	
A. taurica	Slg, Stp	+	+	+	
A. vulgaris	Sin			+	
Carduus acanthoides	Stp, Sin		+		
C. arabicus	Sin			+	
C. crispus	Sin, Stp		+		
C. thoermeri	Stp		+		
C. uncinatus	Stp, Prt, Sin	+	+	+	
Centaurea adpressa	Stp		+		
C. diffusa	Stp, Sin	+	+	+	
C. phrygia	Stp		+		
C. salonitana	Stp	+			
C. scabiosa	Stp		+		
C. solstitialis	Stp		+		

1	2	3	4	5	6
Matricaria recutita	Stp, Slg, Sol, Sin	+		+	
M. tzvelevii	Sol		+		
Chondrilla juncea	Stp, Arc	+	+	+	
Cichorium intybus	Stp, Sin	+		+	
Cirsium arvense	Sin			+	
C. incanum	Prt, Stp, Sin	+		+	
C. vulgare	Sin			+	
Crepis pulchra	Sin			+	
C. rhoaedifolia	Stp/Arc, Sin			+	
C. tectorum	Stp		+		
Galatella villosa	Stp, Slg	+	+	+	
Iva xanthiifolia	Sin			+	
Conyza canadensis	Sin		+	+	
Filago arvensis	Stp, Sin	+	+	+	
Galinsoga parviflora	Sin			+	
Helianthus annuus	Sin			+	
Inula br itannica	Prt		+	+	
Jurinea multiflora	Stp	+	+	+	
Lactuca serriola	Stp, Sin, Arc	+		+	
L. tatarica	Slg, Stp, Sin		+	+	
Tripleurospermum inodorum	Sin			+	
Onopordum acanthium	Sin, Stp	+		+	
Pulicaria vulgaris	Prt		+		
Saussurea salsa	Sol		+	+	
Scariola viminea	Arc, Sin			+	
Scorzonera laciniata	Stp, Slg, Prt, Sol	+		+	
S. parviflora	Stp			+	
Senecio grandidentatus	Sin, Prt	+			
S. jacobaea	Prt/Stp, Sin		+		
S. vernalis	Stp, Slg, Sol, Sin	+	+	+	
Sonchus arvensis	Sin, Prt		+	+	
S. asper	Sin	+	+	+	
S. oleraceus	Sin	+		+	
Tanacetum millefolium	Stp, Slg		+	+	
Taraxacum bessarabicum	Sol, Prt		+	+	
T. erythrospermum	Stp, Sin	+		+	
T. officinale	Stp, Slg, Sin			+	
T. serotinum	Prt, Stp	+	+		
Tragopogon dubius	Stp, Prt, Slg, Sol, Arc	+		+	
Tripolium vulgare	Prt/Sol, Slg	+	+	+	
Xanthium californicum	Sin			+	
X. spinosum	Sin			+	
X. strumarium	Sin	+		+	
Xeranthemum annuum	Stp	+	+	+	
Anchusa azurea	Sin	+			
A. pusilla	Sin, Stp			+	
Argusia sibirica	Arc	+	+	+	
Buglosso ides arvensis	Sin, Slg	+		+	
Echium biebersteinii	Stp, Sin	+			
E. vulgare	Stp, Sin		+	+	
Heliotropium ellipticum	Arc, Sin, Stp	+			
H. europaeum	Arc, Sin, Stp	+		+	
Lappula patula	Sin, Stp	+		+	
L. squarrosa	Sin, Stp	+		+	
Lycopsis orientalis	Si n	+		+	

1	2	3	4	5	6
L. ramosissima	Prt/Stp	+	+		
Nonea pulla	Stp, Sin		+	+	
Onosma tinctoria	Stp		+		
O. visianii	Stp	+	+	+	
Alyssum hirsutum	Stp, Slg, Prt	+		+	
A. desertorum	Stp, Slg	+		+	
Brassica juncea	Stp, Sin	+			
Cakile euxina	Arc	+	+	+	
Cam elina rumelica	Stp	+			
C. sativa	Sin	+			
Capsella bursa -pastoris	Stp, Sin, Slg	+		+	
Cardaria draba	Sin, Stp	+	+	+	
Chorispora tenella	Stp, Sin	+		+	
Crambe aspera	Arc		+		ERL – R
Descurainia sophia	Stp, Sin	+	+	+	
Diplotaxis tenuifolia	Sin			+	
Eruca vesicaria	Sin	+			
Erucastrum armoracioides	Stp	+			
Erysimum repandum	Stp, Sin	+	+	+	
Lepidium crassifolium	Sol	+	+		
L. perfoliatum	Sin, Prt, Sol	+	+	+	
L. ruderale	Sin, Slg	+	+	+	
Meniocus linifolius	Stp	+		+	
Rapistrum rugosum	Stp, Sol, Sin	+		+	
Rorippa austriaca	Sin			+	
Sinapis arvensis	Stp, Sin	+	+	+	
Sisymbrium altissimum	Sin, Stp	+		+	
S. orientale	Sin, Stp			+	
S. polymorphum	Stp	+	+	+	
Thlaspi arvense	Sin	+		+	
Turritis glabra	Stp	+			
Gleditsia triacanthos	Sin			+	
Agrostemma githago	Sin	+			
Arenaria serpyllifolia	Stp, Prt/Str, Sin	+		+	
A. zozii	Stp	+			
Bufonia tenuifolia	Stp	+	+		
Cerastium atriusculum	Stp	+			
C. perfoliatum	Slg, Sol, Sin	+			
C. ucrainicum	Stp		+		
Dianthus campestris	Stp, Slg	+	+	+	
D. lanceolatus	Stp		+		IUCN – R, ERL – I
D. bessarabicus	Stp	+			RDB – II, ERL – R
Dichodon viscidum	Sol	+		+	
Gypsophila perfoliata	Stp, Prt, Arc	+	+		
Herniaria glabra	Slg		+		
Holosteum umbellatum	Stp, Slg	+			
Kohlrauschia prol ifera	Stp	+	+	+	
Pleconax subconica	Stp	+		+	
Psammophiliella muralis	Stp		+		
Otites densiflorus	Stp, Slg	+		+	
O. wolgensis	Stp, Prt	+	+	+	
Elisanthe viscosa	Stp, Prt	+		+	
Spergullaria media	Slg, Prt/Sol, Sol	+	+	+	
S. salina	Slg, Prt, Sol , Arc	+			
Atriplex patula	Slg, Sin			+	

1	2	3	4	5	6
A. prostrata	Slg, Arc	+			
A. rosea	Slg,Arc	+			
A. tatarica	Slg, Prt/Sol, Arc, Sin	+		+	
Bassia hirsuta	Sol, Arc	+		+	
B. sedoides	Slg, Sol, Stp	+	+	+	
Camphorosma monspeliaca	Sol, Stp	+		+	
Caroxylon laricinum	Sol, Stp	+	+		
Chenop odium album	Sin	+		+	
Ch . glaucum	Prt(Sol)	+		+	
Ch . opulifolium	Prt, Sin	+			
Ch. pedunculare	Sin			+	
Ch. vulvaria	Sin	+		+	
Halimione pedunculata	Sol, Arc, Prt, Slg	+	+	+	
H. verrucifera	Sol, Prt, Slg	+		+	
Halocneum strobilaceum	Sol, Slg	+	+	+	
Kochia laniflora	Arc, Slg, Sin			+	
K. prostrata	Slg, Stp	+	+	+	
Ofaiston monandrum	Sol	+	+	+	
Petrosimonia brachiata	Sol, Arc, Prt	+	+		
P. oppositifolia	Sol, Slg, Prt	+	+	+	
P. triandra	Sol, Arc, Prt	+	+	+	
Polycneum majus	Sin		+		
Sali cornia prostrata	Sol, Slg	+	+	+	
Salsola tragus	Arc, Sin, Prt/Sol	+		+	
S. soda	Sol, Prt/Sol	+	+		
Suaeda altissima	Sol	+	+	+	
S. acuminata	Sol	+			
S. prostrata	Sol, Arc	+	+	+	
S. salsa	Sol, Prt	+	+	+	
Convolvulus arvensis	Stp, Prt, Sin	+	+	+	
C. lineatus	Prt/Stp, Slg		+	+	
Cuscuta sp.	Sin			+	
Bolboschoenus maritimus	Hyg, Pal, Prt/Sol	+	+	+	
B. maritimus var. compactus	Hyg, Pal, Prt/Sol	+		+	
Carex melanostachya	Prt	+	+		
C. praecox	Prt	+			
C. stenophylla	Stp, Prt, Slg		+	+	
Eleochari s palustris	Hyg	+	+	+	
E. uniglumis	Prt/Pal, Hyg	+		+	
Scirpoides holoschoenusk	Prt/Sol , Pal, Hyg	+			
Scirpus lacustris	Pal	+			
S. tabernaemontani	Hyg, Pal, Sin	+		+	
Elaeagnus angustifoli a	Sin			+	
Ephedra distachya	Stp/Arc		+		
Euphorbia al eppica	Sin	+			
E. chamaesyce	Stp		+	+	
E. humifusa	Sin	+			
E. peplis	Stp/Arc, Sol	+		+	
E. seguierana	Stp, Sin	+	+	+	
E. virgata	Stp, Sin	+		+	
Astragalus asper	Stp		+		
A. borysthenicus	Stp/Arc	+	+		RDB – II, ERL – R
Caragana scythica	Stp			+	

1	2	3	4	5	6
Lathyrus aphaca	Sin			+	
L. tuberosus	Sin, Stp	+	+		
Lotus corniculatus	Prt, Prt/Stp, Slg	+	+	+	
Medicago agrestis	Stp	+		+	
M. falcata	Stp/Prt, Sin	+	+	+	
M. lupulina	Str, Prt	+			
M. minima	Stp	+			
M . romanica	Str, Prt	+	+		
Melilotus albus	Sin, Stp, Arc	+		+	
M . officinalis	Sin, Arc, Stp, Slg	+	+	+	
Ononis arvensis	Prt/Stp	+			
Oxytropis pilosa	Stp	+			
Robinia pseudoacacia	Sin			+	
Securigera varia	Stp, Sin, Arc	+	+	+	
Sophora japonica	Sin			+	
Trifolium arvense	Stp		+	+	
T. bonannii	Prt		+		
T. campestre	Stp, Prt	+	+	+	
T. diffusum	Stp	+	+	+	
T. fragiferum	Prt, Slg	+	+		
T. aureum	Sin	+			
Trigonella monspeliaca	Sin, Stp		+	+	
T. procumbens	Stp, Prt		+		
Vicia hirsuta	Stp	+			
V. villosa	Stp, Sin		+		
Fra nkenia hirsuta	Sol, Prt, Slg, Arc	+	+	+	
F. pulverulenta	Sol	+	+	+	
Fumaria schleicheri	Sin, Stp	+	+	+	
Centaurium meyeri	Sol		+		
C. pulchellum	Slg		+		
Erodium cicutarium	Stp, Sin, Prt	+	+	+	
Geranium pusillum	Stp, Sin	+		+	
Hypericum perforatum	Prt, Stp, Sin	+		+	
Iris pumila	Prt/Stp	+	+		
Juncus articulatus	Prt		+		
J. gerardii	Prt/Sol, Arc		+	+	
J. tyraicus	Prt			+	
Triglochin maritimum	Prt, Pal	+	+		
Acinos arvensis	Stp	+			
A. villosus	Stp	+			
A. rotundifolius	Stp		+		
Ajuga chi a	Stp/Prt		+	+	
Dracocephalum thymiflorum	Sin	+			
Lamium amplexicaule	Stp, Prt, Sin	+		+	
Lycopus europaeus	Prt	+			
Marrubium perregrinum	Stp, Sin	+	+	+	
M. praecox	Stp	+			
M. vulgare	Stp			+	
Mentha pulegium	Prt, Pal/Sol		+		
Phlomis pungens	Stp, Sin, Prt/Stp	+		+	
Ph. taurica	Stp			+	
Salvia aethiopis	Stp, Prt, Sin	+		+	
S. nemorosa	Stp	+	+		
Sideritis montana	Stp/Arc, Sin	+		+	
Stachys annua	Sin			+	
Teucrium polium	Stp	+		+	

1	2	3	4	5	6
Thymus roegneri	Stp	+			
Muscari neglectum	Stp	+			
Ornithogalum arquatum	Stp, Prt	+			
O. kochii	Stp	+			
Gagea bulbifera	Stp, Slg	+			
G . pusilla	Stp	+			
Tulipa schrenkii	Stp	+		+	
Goniolimon bess eranum	Stp			+	
G. tataricum	Stp, Stp/Prt, Slg	+	+	+	
Limonium caspium	Sol, Slg, Prt	+	+	+	
L . gmelinii	Stp, Sol, Slg	+	+	+	
L . meyeri	Slg, Prt, Sol	+	+	+	
L . sareptanum	Stp	+	+	+	
L . suffruticosum	Slg	+	+	+	
L . tschurjukiense	Sol, Slg	+			
Linum austriacum	Stp, Prt	+	+	+	
Lyth rum salicaria	Prt	+			
Alcea pallida	Stp	+			
Althaea hirsuta	Stp, Sin	+		+	
A. officinalis	Prt		+		
Hibiscus trionum	Sin		+	+	
Lavatera thuringiaca	Stp	+			
Malva neglecta	Prt, Stp, Sin			+	
Morus alba	Sin			+	
Epilobium parviflorum	Hyg		+		
E. tetragonum	Sin, Prt			+	
Orobanche cumana	Stp	+		+	
Glaucium corniculatum	Stp			+	
Papaver dubium	Stp	+		+	
P. laevigatum	Stp	+			
P. rhoeas	Sin, Stp			+	
Peganum harmala	Stp, Sin	+		+	
Plantago cornuti	Prt/Sol		+		
P. lanceolata	Stp/Prt, Sin	+		+	
P. major	Prt, Sin	+		+	
P. salsa	Prt, Prt/Sol	+	+	+	
P. arenaria	Stp/Arc	+			
P. tenuiflora	Slg	+		+	
Aegilops cylindrica	Stp, Prt, Sin	+		+	
Aeluropus li toralis	Slg, Prt, Arc	+	+	+	
Agropyron cimmericum	Stp			+	IUCN – I
A. pectinatum	Stp/Prt, Sl g	+	+	+	
Alopecurus myosuroides	Prt, Sin	+	+		
Anisantha sterilis	Stp, Sin			+	
A. tectorum	Stp, Arc, Sin	+	+	+	
Apera interrupta	Stp, Prt, Slg		+		
A. maritima	Arc		+	+	
Botriochloa ischaemum	Stp	+			
Bromopsis inermis	Stp, Prt	+	+		
Bromus com mutatus	Sin			+	
B. japonicus	Stp, Prt, Sin	+	+	+	
B. hordeaceus	Sol, Slg, Sin, Stp	+		+	
B. secalinus	Sin		+		
B. squarrosus	Stp/Prt, Stp, Sin	+	+	+	
Calamagrostis arundinacea	Prt	+			
C. epigeios	Prt			+	

1	2	3	4	5	6
Catabrosa aquatica	Hyg		+		
Crypsis aculeata	Prt/Sol	+	+	+	
Cynodon dactylon	Prt, Arc, Stp, Sin	+	+	+	
Digitaria sanquinalis	Sin		+	+	
Echinochloa crusgalli	Prt , Sin			+	
E. oryzoides	Sin			+	
Elytrigia elongata	Prt, Prt/Sol	+	+	+	
E. maeotica	Stp	+			
E. repens	Prt/Stp, Prt, Sin, Slg	+	+	+	
Eragrostis minor	Stp, Sin			+	
Eremopyrum triticeum	Stp, Sol	+		+	
Festuca regeliana	Stp, Prt	+			
F. rupicola	Stp	+	+	+	
Glyceria fluitans	Prt, Hyg	+			
Hordeum leporinum	Stp, Sin	+		+	
H. murinum	Stp, Sin			+	
Koeleria cristata	Stp	+	+	+	
Leymus racemosus	Arc	+		+	
L. ramosus	Arc	+	+		
Melica taurica	Stp	+			
Phragmites australis	Hyg	+		+	
Poa angustifolia	Stp, Prt			+	
P. bulbosa	Stp, Prt, Sol, Slg	+	+	+	
P. compress a	Arc/ Stp		+		
P. pratensis	Prt, Stp, Arc	+	+		
Puccinellia distans	Sol, Prt, Slg	+	+	+	
P. fominii	Sol, Arc, Prt, Slg	+	+	+	
P. gigantea	Prt, Sol, Arc, Slg	+	+	+	
Sclerochloa dura	Stp,Sin			+	
Setaria glauca	Sin			+	
S. verticillata	Sin			+	
S. virid is	Sin	+		+	
Stipa capillata	Stp, Slg	+	+	+	RDB – III
S. lessingiana	Stp	+	+	+	RDB – II
S. ucrainica	Stp	+	+	+	RDB – II
Tragus racemosus	Arc, Stp	+		+	
Fallopia convolvulus	Sin	+		+	
Persicaria amphibia	Hyg, Pal, Sin			+	
P. hydropiper	Prt, Pal	+			
P. lapathifolia	Sin			+	
Polygonum aviculare	Stp, Prt, Arc, Sin	+	+	+	
P. bellardii	Slg		+		
P. patulum	Arc, Sin	+	+		
P. pseudoarenarium	Arc			+	
Rumex crispus	Sin	+		+	
R. pulcher	Sin			+	
R. stenophyllus	Prt, Sin	+	+	+	
Portulaca oleracea	Sin	+		+	
Potamogeton pectinatus	Hyg, Pal	+		+	
P. perfoliatus	Hyg, Pal	+			
Anagallis foemina	Stp, Sin	+			
Androsace elongata	Stp	+	+		
A. maxima ssp . *turczaninovii*	Stp	+			
Adonis flammea	Stp	+	+		
Batrachium rion ii	Hyg	+			

1	2	3	4	5	6
B. trichophyllum	Hyg	+			
Ceratocephala testiculata	Stp	+			
Consolida orientalis	Sin, Stp		+	+	
C. paniculata	Sin, Stp	+	+	+	
Nigella arvensis	Sin, Stp	+		+	
Ranunculus oxyspermus	Stp	+			
R. sceleratus	Pal	+	+	+	
R. trachycarpus	Prt	+		+	
Reseda lutea	Stp, Sin			+	
Potentilla callieri	Stp		+		
P. orientalis	Stp		+		
P. supina	Prt	+			
Poterium polygamum	Stp, Prt	+		+	
Cruciata taurica	Stp, Sin, Arc			+	
Galium aparine	Stp, Sin	+		+	
G. humifusum	Arc, Stp, Sol, Slg	+		+	
G. mollugo	Stp			+	
G. tenuissimum	Stp	+	+	+	
Ruppia cirrhosa	Hyg	+		+	
R. maritime	Hyg	+			
Thesium arvense	Stp	+			
Linaria biebersteinii	Stp	+		+	IUCN – I
L. genistifolia	Stp	+			
L. macroura	Stp	+			
L. ruthenica	Stp, Arc			+	
Verbascum blattaria	Stp			+	
V. ovalifolium	Stp	+		+	
V. phlomoides	Stp			+	
V. thapsus	Sin, Stp			+	
Verbascum sp.	Sin		+		
Veronica triphyllos	Stp	+		+	
V. verna	Stp			+	
Ailanthus altissima	Sin			+	
Hyoscyamus niger	Sin, Stp	+		+	
Lycium barbatum	Sin			+	
Solanum nigrum	Sin			+	
Typha angustifolia	Hyg, Pal		+	+	
T. laxmannii	Hyg, Pal		+		
Ulmus sp.	S³n			+	
Valerianella carinata	Stp, Prt	+			
V. pumila	Stp	+	+		
Viola kitaibeliana	Stp, Prt	+			
Zannichelia palustris ssp. *pedicellata*	Hyg			+	
Zostera noltii	Hyg	+	+	+	
Tribulus terrestris	Stp/Arc, Sin	+		+	
Zygophyllum fabago	Sol	+			

Notes: * — species are listed in order according to Vascular Plants of the USSR (Cherepanov, 1981). Ecotopes: Hyg — coastal areas with high humidity, Sin — anthropogenically disturbed areas including fields, forest belts and fallow land, Stp — steppe, Stp/Arc — psammophytic steppe; Arc — accumulative formations including islands, bars and spits, Prt — halophytic meadows, Slg — saline land, Sol — saline deserts and semi-deserts, Pal — bogs, combination of signs separated by '/'- transitional habitats. IUCN — 1997 IUCN Red List of Threatened Plants (1998); ERL — European Red List (1991); RDB — Red Data Book of Ukraine. Plants (1996); Conservation status in IUCN Red List and ERL: R — rare, I — unidentified (data deficient); in RDB: I — disappearing, II — vulnerable, III — rare.

Table 2
Species composition and conservation status of birds in Dzhankoi District according to count data, 1980—2004

Species*	Seasonal status						Conservation status						
	B	M	W	Wa	Vt	SPEC	ETS	IUCN	BERN	BONN	AEWA	CITES	RDB
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Gavia arctica		+	+			III	V		II	II	+		
Podiceps ruficollis	+	+	+				S		II				
P. nigricollis	+	+	+				S		II				
P. griseg ena	+	+	?										
P. cristatus	+	+	+				S		III				
Puffinus puffinus				+		II	L		II				
*Pelecanus onocrotalus***				+		III	R		II	I	+		+
Phalacrocorax carbo	+	+	+				S		III				
Ph. pygmaeus	+		+										+
Botaurus stellaris	+	+	+			III	V		II	II	+		
Ixobrychus minutus	+	+				III	V		II	II	+		
Nycticorax nycticoraõ	+	+				III	D		II				
Ardeola ralloides	+	+				III	V		II				+
Egretta alba	+	+	+				S		II		+		
E. garzetta	+	+					S		II			+	
Ardea cinerea	+	+	+				S		III				
A. purpurea	+	+				III	V		II	II	+		
Platalea leucorodia	+	+				II	E		II	II	+	+	+
Plegadis falcinellus	+	+				III	D		II	II	+		+
Ciconia ciconia		+				II	V		II	II	+		
Phoenicopterus roseus					+	III	L		II	II	+	+	
Rufibrenta ruficollis		+	+			I	L	VU	II	II	+		+
Anser anser	+	+	+				S		III	II	+		
A. albifrons		+	+				S		III	II	+		
A. erythropus		+	+			I	V	VU	II	II	+		
A. fabalis		+					S		III	II	+		
Cygnus olor	+	+	+				S		III	II	+		
C. cygnus		+	+			IV	S		II	II	+		
Tadorna ferruginea	+		+			III	V		II	II	+		+
T. tadorna	+	+	+				S		II	II	+		
Anas platyrhynchos	+	+	+				S		III	II	+		
A. strepera	+	+				III	V		III	II	+		
A. quårquedula		+				III	V		III	II	+	+	
A. crecca		+					S		III	II	+	+	
A. penelope		+	+				S		III	II	+	+	
A. acuta		+	+			III	V		III	II	+	+	
A. clypea ta	+	+					S		III	II	+	+	
Netta rufina	+	+	+			III	D		III	II	+		
Aythya ferina	+	+	+			IV	S		III	II	+		
A. fuligula		+	+				S		III	II	+		
A. marila		+	+			III	L		III	II	+		
A. nóroca		+				I	V	LR	III	II	+		+
Bucephala clangula		+	+				S		III	II	+		+
Mergus albellus		+	+			III	V		II	II	+		
M. serrator	+	+	+				S		III	II	+		+
M. merganser		+	+				S		III	II	+		
Pandion haliaetus		+				III	R			B		+	+
Pernis apivorus		+				IV	S		II	II		+	
Milvus migrans		+				III	V		II	II		+	
Circus cyaneus		+	+			III	V		II	II		+	+
C. macrourus		+				III	E	LR	II	II		+	+

1	2	3	4	5	6	7	8	9	10	11	12	13	14
C. pógargus		+				IV	S		II	II		+	
C. aeruginosus	+	+	+				S		II	II		+	
Accipiter gentilis		+	+				S		II	II		+	
A. nisus		+	+				S		II	II		+	
Buteo làgopus		+	+				S		II	II		+	
B. rufinus		+	+			III	E		II	II		+	+
B. b uteo		+	+				S		II	II		+	
Circaetus gallicus		+				III	R		II	II		+	+
Haliaeetus albicilla		+	+			III	R	LR	II	I			+
Falco cherrug	+	+	+			III	E		II	II		+	+
F. peregrinus		+	+			III	R		II	II		+	+
F. subbuteo		+					S		II	II		+	
F. columbarius		+	+				S		II	II		+	
F. vespertinus	+	+				III	V		II	II		+	
F. tinnunculus	+	+	+			III	D		II	II		+	
Perdix perdix	+		+			III	V		III				
Coturnix coturnix	+	+				III	V		III	II			
Phasianus colchicus	+		+				S		III				
Grus grus		+	+			III	V		II	II	+	+	+
Anthr opoides virgo	+	+					S		II	II	+	+	+
Rallus aquaticus	+	+	+				S		III				
Porzana porzana	+	+				IV	S		II	II	+		
P. parva	+	+				IV	S		II	II	+		
Crex crex		+				I	V	VU	II				
Gallinula chloropus	+	+	+				S		III				
Fulica atra	+	+	+				S		III		+		
O tis tarda		+	+			I	D	VU	II	I		+	+
Burhinus oedicnemus	+	+				III	V		II	II			+
Pluvialis apricaria		+				IV	S		III	II	+		
P. squatarola		+	+				S		III	II	+		
Charadrius hiaticula		+					S		II	II	+		
Ch. dubius	+	+					S		II	II	+		
Ch. alexandrinus	+	+				III	D		II	II	+		+
Eudromias morinellus		+					S			II			
Vanellus vanellus	+	+					S		III	II	+		
Vanellochettusia leucura					+								
Arenaria interpres		+					S		II		+		
Himantopus himantopus	+	+					S		II	II	+		+
Recurvirostra avosetta	+	+				IV	L		II	II	+		
Haematopus ostralegus	+	+					S		III	II			+
Tringa ochropus		+	+				S		II	II	+		
T. glareola		+				III	D		II	II	+		
T. nebularia		+					S		III	II	+		
T. totanus	+	+				II	D		III	II	+		
T. erythropus		+					S		III	II	+		
T. stagnatili s		+					S		II	II	+		+
Actitis hypoleucos		+					S			B			
Xenus cinereus		+					S		II	II	+		
Phalaropus lobatus		+					S		III	II	+		
Philomachus pugnax		+	+			IV	S		III	II	+		
Calidris canutus		+				III	L		III		+		
C. minuta		+											
C. ferrugi nea		+							II		+		
C. alpina		+				III	V		II		+		
C. alba		+					S		II		+		
C. temminckii		+											
Limicola falcinellus		+				III	V		II	II	+		

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Lymnocryptes minimus		+	+			III	V		III		+		
Gallinago gallinago		+	+				S		III				
G. media		+				II	V	LR	II	II	+		
Scolopax rusticola		+				III	V		III				
Numenius arquata	+	+	+			III	D		III	II	+		+
N. phaeopus		+				IV	S		III	II	+		+
N. tenuirostris		?			+	I	NE		II	II	+	+	+
Limosa limosa		+				II	V		III	II	+		
L. lapponica		+				III	L		III	II	+		
Glareola nordmanni	+	+				III	R	DD	II	II	+		+
G. pratincola	+	+				III	E		II	II	+		+
Stercorarius parasiticus		+					S		III				
Larus ichthyaetus	+	+					S		III		+		+
L. melanocephalus	+	+				IV	S		II	II	+		
L. canus		+	+			II	D		III				
L. minutus		+				III	D		II				
L. ridibundus		+					S		III				
L. genei	+	+					S		II		+		
L. fuscus		+				IV	S		III				
L. ca chinnans	+	+	+				S		III				
Chlidonias leucopterus	+	+											
Ch. hybrida	+	+				III	D		II				
Ch. nigår		+											
Gelochelidon nilotica	+	+				III	E		II		+		
Hydroprogne caspia	+	+				III	E		II	II	+		+
Thalasseus sandvicensis	+	+											
Sterna hirundo	+	+					S		II		+		
S. albifrons	+	+				III	D		II	II	+		
Columba palumbus	+	+	+			IV	S		III				
C. oenas		+	+			IV	S		III				
Streptopelia decaocto	+		+				S		III				
S. turtur	+	+				III	D		III				
Cuculus canorus	+	+					S		III				
Asio otus	+	+	+				S		II			+	
A. flammeus	+	+	+			III	V		II			+	
Otus scops	+	+	+			II	D		II			+	
Athene noctua	+		+			III	D		II			+	
Caprimulgus europaeus	+	+				II	D		II				
Apus apus	+	+					S		III				
Coracias garrulus	+	+				II	D		II	II			
Alcedo atthis	+	+	+			III	D		II				
Merops apiaster	+	+				III	D		II	II			
Upupa epops	+	+					S		II				
Jynx torquilla		+				III	D		II				
Dendrocopos syriacus	+		+										
Riparia riparia	+	+				III	D		II				
Hirundo rustica	+	+				III	D		II				
Delichon urbica	+	+					S		II				
Galerida cristata	+	+	+			III	D		III				
Calandrella cinerea	+	+				III	V						
C. rufescens	+	+	+			III	V		II				
Melanocorypha calandra	+	+	+			III	D		II				
Eremophila alpestris			+			II	S		II				
Lullula arborea	+	+				III	V		III				
Alauda arvensis	+	+	+			III	V		III				
Anthus campestris	+	+				III	V		II				
A. trivialis		+					S		II				

1	2	3	4	5	6	7	8	9	10	11	12	13	14
A. pratensis		+	+			IV	S		II				
A. cervinus		+					S		II				
Motacilla flava		+					S		II				
M. feldegg	+	+											
M. alba	+	+					S		II				
M. citreola		+					S		II				
Lanius collurio	+	+				III	D						
L. m inor	+	+				II	D						
Oriolus oriolus	+	+					S		II				
Sturnus vulgaris	+	+	+				S		III				
S. roseus	+	+					S		II				+
Garrulus glandarius	+		+				S		III				
Pica pica	+		+				S		III				
Corvus monedula	+		+			IV	S						
C. frugilegus	+	+	+				S		III				
C. cornix	+		+										
C. corax	+		+				S		III				
Troglodytes troglodytes		+					S		III				
Prunella modularis		+				IV	S		II				
Locustella luscinioides	+	+				IV	S		II	II			
L. fluviatilis		+				IV	S		II	II			
L. naevia		+				IV	S		II	II			
Acrocephalus schoenî bàenus	+	+				IV	S		II	II			
A. agricola	+	+					S		II	II			
A. scirpaceus	+	+				IV	S		II	II			
A. palustris		+				IV	S		II	II			
A. arundinaceus	+	+					S		II	II			
Sylvia nisoria	+	+				IV	S		II	II			
S. atricapilla		+				IV	S		II	II			
S. communis	+	+				IV	S		II	II			
S. borin	+	+				IV	S		II	II			
S. curruca		+					S		II	II			
Phylloscopus trochilus		+					S		II	II			
Ph. collybità		+					S		II	II			
Ph. sibilatrix		+				IV	S		II	II			
Regulus regulus		+				IV	S		II	II			
Ficedula hypoleuca		+				IV	S		II	II			
F. parva		+					S		II	II			
F. albicollis		+				IV	S		II	II			
Muscicapa striata	+	+				III	D		II	II			
Saxicola rubetra		+				IV	S		II	II			
S. torquata		+				III	D		II	II			
Oenanthe oenanthe	+	+					S		II	II			
O. pleschanka	+	+					S		II	II			
O. isabellina	+	+					S		II	II			
Phoånicurus phoenicurus		+				II	V		II	II			
Ph. ochruros		+					S		II	II			
Erithacus rubecula		+				IV	S		II	II			
Luscinia luscinia		+				IV	S		II	II			
L. megarhynchos		+				IV	S		II	II			
L. svecica		+					S		II	II			
Turdus pilaris		+	+			IV	S		III	II			
T. merula	+	+	+			IV	S		III	II			
T. philomelos	+	+				IV	S		III	II			
T. viscivorus		+	+			IV	S		III	II			
Panurus biarmicus	+		+				S		II				

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Remiz pendulinus	+	+					S		III				
Parus caeruleus	+	+	+			IV	S		II				
P. major	+	+	+				S		II				
Passer domesticus	+		+				S		III				
P. montanus	+		+				S		III				
Fringilla coelebs	+	+	+			IV	S		III				
F. mont ifringilla		+	+				S		III				
Chloris chloris	+		+			IV	S		II				
Spinus spinus		+				IV	S		II				
Acanthis cannabina	+		+			IV	S		II				
Carduelis carduelis	+		+				S		II				
Coccothraustes coccothraustes	+		+				S		II				
Emberiza calandra	+		+			IV	S		III				
E. hortulana	+	+				IV	V		I	II			
E melanocephala	+												+
E. citrinella	+	+	+			IV	S		II				
E. schoeniclus	+		+				S		II				

Note: * — species are listed according to Stepanjan (2003); ** — this species was common in the Sivash at the beginning of the last century; its extinction was probably related to the development of irrigation. Seasonal status: B — breeding, M — migratory, W — wintering, Wa — wandering, Vt — vagrant. Conservation status: SPEC — Species of European Conservation Concern (categories); ETS — European Threat Status (categories); IUCN — IUCN Red List of Threatened Species (categories); BERN — Annexes I or II of the Bern Convention; BONN — Annexes I or II of the Bonn Convention; AEWA — Listed under the African-Eurasian Waterbird Agreement; CITES — listed by the Convention on International Trade in Endangered Species of Wild Flora and Fauna; RDB — Listed in the Red Data Book of Ukraine. Animals (1994).

Table 3
Changes in numbers or occurrence of some migratory species* over the period since the onset of irrigation in 1975

Species**	Change in occurrence		Change in numbers	
	Now occurs	No longer occurs	Increasing	Decreasing
1	2	3	4	5
Podiceps nigricollis			+	
P. grisegena			+	
P. cristatus			+	
Phalacrocorax carbo			+	
Botaurus stellaris			+	
Ixobrychus minitus			+	
Nycticorax nycticorax			+	
Ardeola ralloides	+			
Egretta alba	+			
E. garzetta			+	
Ardea cinerea			+	
A. purpurea			+	
Platalea leucorodia	+			
Plegadis falcinellus	+			
Ciconia ciconia			+	
C. nigra			+	
Rufibrenta ruficollis			+	
Anser anser			+	
A. albifrons			+	
A. erythropus			+	
Cygnus olor			+	
C. cygnus			+	
Anas plathyrhynchos			+	
A. crecca			+	
A. strepera			+	
A. penelope			+	
A. acuta			+	
A. querquedula			+	
A. clypeata			+	
Netta rufina	+			
Aythya ferina			+	
Buceph ala clangula			+	
Mergus albellus			+	
M. serrator			+	
M. merganser			+	
Pandion haliaetus			+	
Circus aeruginosus			+	
Buteo rufinus				+
Aquila rapax		+		
Haliaeetus albicilla			+	
Falco cherrug				+
F. peregrinus				+
F. tinnunculus			+	
F. naumanni		+		
Grus grus			+	
Anthropoides virgo			+	
Rallus aquaticus			+	
Porzana porzana			+	
P. parva			+	
Crex crex			+	
Gallinula chloropus			+	

1	2	3	4	5
Fulica atra			+	
Otis tarda				+
Tetrax tetrax				+
Burhinus oedicnemus				+
Pluvialis squatarola			+	
P. apricaria				+
Charadrius alexandrinus				+
Chettusia gregaria		+		
Vanellus vanellus			+	
Himantopus himantopus			+	
Tringa och ropus			+	
T. glareola			+	
T. nebularia			+	
T. totanus			+	
T. erythropus			+	
T. stagnatilis				+
Philomachus pugnax			+	
Calidris minuta			+	
C. temminkii			+	
C. ferruginea			+	
C. alpina			+	
Gallinago gallinago			+	
Scolopax rusticola			+	
Numenius arquata				+
N. phaeopus				+
N. tenuirostris		+		
Glareola nordmanni		+		
Larus cachinnans			+	
L. genei				+
Chlidonias hybrida	+			
Ch. leucopterus			+	
Columba palumbus			+	
Cuculus canorus			+	
Otus scops			+	
Alcedo atthis			+	
Jynx torquilla			+	
Galerida cristata				+
Calandrella cinerea				+
C. rufescens				+
Melanocorypha calandra			+	
Lullula arborea			+	
Alauda arvensis			+	
Anthus campestris			+	
A. pratensis			+	
Motacilla alba			+	
Lanius minor			+	
Oriolus oriolus			+	
Corvus frugilegus			+	
Troglodytes troglodytes			+	
Prunella modularis	+			
Locustella luscinioides			+	
Acrocephalus schoenobaenus				+
A. agricola			+	
A. palustris			+	
A. arundinaceus			+	
Hippolais icterina	+			
Sylvia nisoria			+	

1	2	3	4	5
S. borin			+	
S. atricapilla			+	
S. communis			+	
S. curruca			+	
Phylloscopus trochilus			+	
Ph. collybita			+	
Ph. sibilatrix			+	
Ficedula hypoleuca			+	
F. albicollis			+	
F. parva			+	
Muscicapa striata			+	
Saxicola rubetra			+	
S. torquata	+			
Oenanthe oenanthe				+
O. isabellina				+
Phoenicurus phoenicurus			+	
Ph. ochruros	+			
Erithacus rubecula			+	
Luscinia luscinia	+			
L. svecica	+			
Turdus merula			+	
T. pilaris			+	
T. philomelos			+	
Remiz pendulinus			+	
Parus major			+	
P. caeruleus			+	
Fringilla coelebs			+	
F. montifringilla			+	
Chloris chloris			+	
Spinus spinus			+	
Emberiza calandra				+
E. citrinella			+	
E. hortulana				+
E. schoeniclus			+	
Total species	12	5	105	20

Note: * — Migratory species not recorded since 1980 have been excluded from Table 2 in Annex II, but included in this table; ** — Species are listed according to Stepanian (2003).

Наукове видання

Іригаційне землеробство і проблеми збереження біологічного різноманіття Джанкойського району Автономної Республіки Крим

Під загальною редакцією Василя Анатолійовича Костюшина
та Геннадія Васильовича Фесенка

Монографія

(англійською мовою)

Публікація є результатом виконання однієї з частин українсько-голандського проекту "Towards Improved Water Management in Ukraine" (Watermuk), метою якого було вивчення сучасного стану та перспектив іригаційного землеробства в Україні на прикладі Джанкойского району АР Крим. Вона цілком присвячена біорізноманіттю вказаного району. Наведено дані по основним таксономічним групам тварин і рослин, обговорюються зміни в їх складі та чисельності під впливом іригації, вказуються території, найцінніші для збереження біоти, а також необхідні заходи охорони. Враховуючи, що умови існування цінних видів тварин і рослин в Джанкойському районі нерозривно пов'язані зі станом Сивашу в цілому, багато уваги приділяється проблемам збереження збалансованого екологічного стану цієї унікальної водойми.

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