MINISTRY OF ENVIRONMENT AND WATER

ENDORSED:

DOLORES ARSENOVA
MINISTER OF ENVIRONMENT AND WATER

MANAGEMENT PLAN FOR THE SREBARNA MANAGED NATURE RESERVE

Central Laboratory of General Ecology

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The Convention on Wetlands of International Importance, especially as Waterfowl Habitat, signed at Ramsar, Iran, on 2 February 1971, is an intergovernmental treaty which provides the framework for cooperation in the conservation and wise use of wetlands and their resources. There are presently 121 Contracting Parties to the Convention, with 1,027 wetland sites, totalling 78.1 million hectares, designated for inclusion in the Ramsar List of Wetlands of International Importance.

Bulgaria joined the Ramsar Convention in 1975, designating two wetlands: Arkutino and Srebarna. The Atanassovo Lake, the Durankulak Lake and Lake Shabla were added later on. A Ramsar National Committee has been established with the Ministry of Environment and Water. The Central Laboratory of General Ecology has two representatives on this Committee.

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Contributors

This Management Plan for the Srebarna Biosphere Reserve has been prepared by a team of the Central Laboratory of General Ecology:
Senior Research Associate Dr Georgi Hiebaum, Team Leader
Senior Research Associate Tanyu Michev
Research Associate Dr Vassil Vassilev
Senior Research Associate Dr Yordan Ouzounov

The materials for Part 1: "Description" is based on the reports prepared by:
1.14.1. Geology, geomorphology and hydrogeology
A. Benderev, Geological Institute, Bulgarian Academy of Sciences

1.14.3. Hydrology (incl. seasonal water balance, water level, outflow and inflow)
I. Dyadovski, Central Laboratory of General Ecology, Bulgarian Academy of Sciences

1.14.4. Soil types and soil features
T. Shishkov, Nikola Poushkarov Soil Science and Agroecology Research Institute

1.14.5. Nitrogen and phosphorus levels in soils and lake sediments
V. Koutev, Nikola Poushkarov Soil Science and Agroecology Research Institute

1.14.6. Water quality
G. Hiebaum, V. Tsavkova, V. Vassilev, R. Hristova, Central Laboratory of General Ecology, Bulgarian Academy of Sciences

1.14.7. Climate
A. Tsenkova, E. Koleva, Yu. Ivancheva, L. Krustev, National Institute of Meteorology and Hydrology, Bulgarian Academy of Sciences

1.16.1. Principal habitats and vegetation types
Vl. Velev, Central Laboratory of General Ecology, Bulgarian Academy of Sciences

1.16.2.1. Phytoplankton
M. Stoineva, Faculty of Biology of St. Kliment Ohridski University of Sofia

1.16.2.2. Zooplankton
V. Naidenov, V. Tsvakova, Institute of Zoology, Bulgarian Academy of Sciences; *Central Laboratory of General Ecology, Bulgarian Academy of Sciences*

1.16.2.3. Fish
L. Pehlivanov, Institute of Zoology, Bulgarian Academy of Sciences

1.16.2.4. Macrozoobenthos
Y. Ouzounov, V. Tsavkova, I. Todorov, E. Varadinova, Central Laboratory of General Ecology, Bulgarian Academy of Sciences

1.16.2.5. Production and destruction of organic matter

V. Vassilev, G. Hiebaum, V. Tsavkova, Central Laboratory of General Ecology, Bulgarian Academy of Sciences

1.17.1. Algae and fungi (incl. lichens)
After Stoyneva (1998), Denchev, Stoyneva (1998), Ivanov (1998)

1.17.2. Vascular plants
Vl. Velev, G. Baeva, Sv. Bratanova, Central Laboratory of General Ecology, Bulgarian Academy of Sciences; *Teacher Training Institute, Silistra*

1.17.3. Forests and arboreal plant species
Sv. Bratanova, Central Laboratory of General Ecology, Bulgarian Academy of Sciences

1.18.1. Invertebrates (excluding helminths and insects)
B. Georgiev, Central Laboratory of General Ecology, Bulgarian Academy of Sciences

1.18.2. Helminth parasites
T. Genov, V. Bisserkov, B. Georgiev, Central Laboratory of General Ecology, Bulgarian Academy of Sciences

1.18.3. Insects
N. Kodjabashev, University of Forestry, Sofia

1.18.4. Amphibians
V. Bisserkov, Central Laboratory of General Ecology, Bulgarian Academy of Sciences

1.18.5. Reptiles
V. Bisserkov, Central Laboratory of General Ecology, Bulgarian Academy of Sciences

1.18.6. Birds
T. Michev, N. Mihov, L. Profirov, Central Laboratory of General Ecology, Bulgarian Academy of Sciences; *Bulgarian-Swiss Biodiversity Conservation Programme (BSBCP)*

1.18.7. Mammals
Sv. Gerassimov, University of Forestry, Sofia

1.19. Socio-economic and cultural values
Y. Koutsarov, Srebarna Biosphere Reserve

1.26. Conservation education
E. Matveeva, Ministry of Environment and Water

Maps and GIS:
Maps Nos. 2, 5, 7, 9 and 15
V. Dimitrov, A. Stoimenov, Space Research Institute, Bulgarian Academy of Sciences

Maps Nos. 6 and 8
K. Danailov - Danailov (2000)

Maps Nos. 10, 11, 12, 13 and 14
T. Michev, I. Yanchev, A. Lebedevski, Central Laboratory of General Ecology, Bulgarian Academy of Sciences

All other parts of the Management Plan have been written by the leading team which assumes the responsibility for the overall development and final version of the Plan.
Technical staff:
I. Yanchev: maps, aerial photography, graphic design
Vl. Pomakov: translation into English
N. Mihov: sampling and water level control

PART 0. INTRODUCTION

For decades, Bulgaria's wetlands have been subjected to drastic change in general and, in particular, to drainage for the purpose of land reclamation. Owing to this shortsighted policy, the aggregate area of wetlands in Bulgaria is now just one-twentieth of the area that existed in the early 20th c., as described by Bonchev (1929). Decision-makers started to realize the importance of these lakes and marshes for biological diversity in the 1970s, when parts of Atanassovo Lake and the Vaya Lake were designated protected areas, two wetlands were included in the Ramsar List, etc. Substantial progress in this aspect was achieved in the 1980s and especially in the 1990s, when almost all wetlands already enjoyed some conservation status.

Bulgarian nature conservation, including the protection of wetlands, has been developing in a favourable legislative environment. According to the Constitution of the Republic of Bulgaria, "any international treaty, which has been ratified according to a procedure established by the Constitution, which has been promulgated, and which has entered into force for the Republic of Bulgaria, shall be part of the domestic law of the land. Any such treaty shall take priority over any conflicting standards of domestic legislation" (Paragraph (4) of Article 5). This constitutional clause has very tangible implications, in so far as Bulgaria is a party to a number of international conventions and treaties relevant to biodiversity and habitat conservation, such as the Convention on Wetlands of International Importance, especially as Waterfowl Habitat (Ramsar, 1971), the Convention concerning the Protection of the World Cultural and Natural Heritage (Paris, 1972), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington, 1973), the Convention on the Conservation of European Wildlife and Natural Habitats (Bern, 1979), the UN Convention on Biological Diversity (Rio de Janeiro, 1992), etc. By virtue of the obligations assumed as party to these and other international instruments, Bulgaria consistently develops its own legislation, institutions and practices. One of the substantial components of this process is the planning of activities related to nature conservation management with a view to achieving objectives and values ensuring sustainable existence and use of biodiversity. The stages in this development have been marked by the National Plan of Priority Actions in the Most Important Wetlands (1993), the National Biodiversity Conservation Strategy (1994), and the recently adopted National Action Plan for Biodiversity Conservation in Bulgaria (1999). The Protected Areas Act, passed in 1999, has transposed the best of the effective conservation legislation and practice of the European Union and is in full harmony with essential requirements and provisions of a number of international conventions and treaties to which Bulgaria is a party, including the Ramsar Convention. Thus, one of the requirements of the Protected Areas Act is that the management of protected areas, including wetlands, be based on Management Plans, adopted after a broad public discussions with the parties concerned, non-governmental organizations and the local community. The requirements and terms for development and endorsement of management plans are established in the recently promulgated Regulation on Elaboration of Protected Area Management Plans (*State Gazette* No. 13/2000). The format adopted for the management plan largely follows the EUROSITE format but is fully compatible with the RAMSAR format as well.

Responsibility for wetlands conservation and management is part of the policy of the Ministry of Environment and Water which, according to domestic legislation, is in charge of the conservation and management of national parks, strict nature reserves, protected sites and natural monuments. The Ministry's strategy and policy were first elaborated in the three-

volume National Strategy for Biodiversity Conservation in Bulgaria, published with the support of the US Agency for International Development (Sakalyan & Meini, eds., 1993).
With the support of the French Government and the Ramsar Convention Bureau, the Ministry of Environment and Water has developed a National Action Plan for the Conservation of the Most Important Wetlands in Bulgaria (Michev, ed., 1993). The wetlands included in this Plan are grouped into several categories depending on their importance for biodiversity conservation on a global, regional and national scale. Priority actions, methods of work and required resources are also described.
The following categories of wetlands and sites are included in the National Action Plan for the Conservation of the Most Important Wetlands in Bulgaria:

- Wetlands of global importance:

Srebarna Biosphere Reserve
Durankulak-Shabla Lake Complex
Bourgas lakes, including Atanassovo Lake

- Wetlands of European importance:

Ropotamo Nature Reserve, including Arkutino Marsh
Belene Nature Reserve
Kamchia Nature Reserve
Stariya Dub Protected Site

- Wetlands of national importance:

Pomorie Lake
The mouths of the rivers Veleka and Silistar
Maluk Preslavets Marsh
Garvan Marsh
(The underlined wetlands have been designated Ramsar sites)

Lake Srebarna occupies a remarkable place among Bulgarian wetlands. Its history reflects the changes in the attitude of Bulgarian society towards this valuable type of ecosystems during the different periods of development of the conservation movement in Bulgaria. This attitude has ranged from one extreme: unrestricted and year-round exploitation of its natural resources (until about 1948) to the other extreme: complete prohibition of all economic activities (since 1975). The philosophy of the present Plan rests on the wise use of the Reserve's natural resources, combined with guaranteed and long-term conservation of its biodiversity. In this way, the local people will get fresh opportunities to increase and improve their prosperity and, on the other hand, the lake's wildlife will be preserved for future generations.

The Ministry of Environment and Water has prepared yet another key document on conservation of biological diversity and the related wetlands: a National Plan for Conservation of Biological Diversity in Bulgaria. Implementation of this major programme, approved by the Government, is starting in 2000.

PART 1. DESCRIPTION

1.1. Date this Plan was completed:
February 2001

1.2. Name of wetland:
Lake Srebarna

1.3. Geographical coordinates:
44°07 N, 27°04 E; UTM grid NJ 08

1.4. Elevation:
10-13.2 m

1.5. Area:
902.1 ha (reserve proper), 600 ha (Ramsar Site)

1.6. Overview

Ramsar Site designation date: 24 September 1975.

Legal status: Established as a wildfowl refuge in 1942. Nature reserve since 1948. Designated Wetland of International Importance under the Ramsar Convention in 1975, and recognized as a Biosphere Reserve under UNESCO's Man and Biosphere Programme in 1977. Inscribed on the UNESCO World Heritage List of Natural Properties in 1985.

Access: Until 2000 only for scientific research on a research access permit issued by the Ministry of Environment and Water. All economic and tourist activities are prohibited according to the Nature Conservation Act. Included on the Montreux Record (1990) of priority sites for conservation action in 1993. Managed nature reserve since 1999.

Principal Physiographical Characteristics: A hyper-eutrophic lake, located on the Bulgarian (right) bank of the River Danube between km 391 and km 393. The Nature Reserve, on a total surface area of 902.1 ha, is exclusive state property, and the adjoining land tracts are private property or municipal property. Commercial fishing and mowing of Reed, Reedmace and Bulrush in the Reserve was discontinued in 1975. Since then, the natural resources have not been exploited.

The lake bowl lies in the Pliocene clays over a substratum of Barremian and Aptian limestones. In 1949 the lake was disconnected from the Danube by a dyke, and since then ground water sources and surface run-off from the neighbouring hills have remained the only source recharging the lake with fresh water. The connection with the Danube was partially re-established in 1978, but river waters do not flood the lake every year. The lack of an adequate connection with the Danube for long periods of time creates conditions for accretion of bottom sediments (organic and inorganic sludge), reducing the water depth to only 1 m (measured in 1993). A canal connecting the Danube with the lake, built in 1994 with the financial support of international organizations, has improved substantially the ecological conditions in the lake. The abundance and diversity of bird species typical of the region is increasing.

Flora and Fauna: The dominant plant association is that of the Reed (*Phragmites australis*), which occupies about two-thirds (400 ha) of the Reserve's total surface area. Gray Willow (*Salix cinerea*) and Purple Osier (*Salix purpurea*) bushes grow in some places. The second widest spread plant species after the Reed is the Lesser Reedmace (*Typha* *angustifolia*), and it is more abundant than the Great Reedmace (*Typha latifolia*). Of all 139 vascular plant species hosted by the Reserve, 11 are rare or endangered. Some 19 fish species occurred in the lake until 1948. There are 21 reptile and amphibian species, and 41 mammal species. The avifauna is the most diverse animal kingdom group found in and around the Srebarna Reserve: a total of 223 bird species. The nesting colony of Dalmatian Pelicans (*Pelecanus crispus*) is the pearl of the Reserve. The number of breeding pairs in the colony varied from 29 to 127 in the 1950-1980 period.

1.7. Wetland type

Wetland Type (applicable codes are marked)

Marine/coastal:	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Inland:	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**Sp**	**Ss**	**Tp**	**Ts**
	U	**Va**	**Vt**	**W**	**Xf**	**Xp**	**Y**	**Zg**	*Zk*		
Human-made:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**		

The following wetland types can be found in Srebarna:

O - Permanent freshwater lakes: the open-water surface of Srebarna.

M - Permanent rivers: the arm of the Danube streambed between the right bank and the Island of Devnya.

P - Seasonal marshes/pools: the excavation pits between the Vetren-Silistra Dyke and the right bank of the River Danube.

Xf - Freshwater, tree-dominated wetlands; seasonally flooded forests: the entire area of the Island of Devnya and part of the riverside between the Vetren-Silistra Dyke and the right bank of the River Danube.

Zk - Subterranean karst and cavern hydrological systems: the Kanarichkata Spring in the southern section of Srebarna.

1.8. Ramsar Criteria

1c - Particularly good representative example of a wetland playing a substantial hydrological, biological and ecological role for the nature functioning of a major river basin or coastal system, especially when located in a border area.

Located on the right bank of the River Danube, which is coextensive with the international border between Bulgaria and Romania, Lake Srebarna plays a substantial hydrological, biological and ecological role in the region. This role may be enhanced dramatically by the designation of a bilateral protected area between Bulgaria and Romania.

2a - Supports a remarkable community of rare, vulnerable or endangered species as follows:

- According to the European List of Globally Threatened Animals and Plants:

Plants	2
Animals	
Leeches	1
Snails	1
Bivalves	1
Dragonflies	1
Beetles	1
Birds	9
Mammals	4

- According to the Red Data Book of Bulgaria:

Plants	13
Animals	68
Fish	1
Amphibians	1
Reptiles	1
Birds	59
Mammals	6
Total	149

Total 22

3b - Regularly supports individuals in specific groups of waterfowl indicative of the wetlands' values, productivity or diversity; the Srebarna Biosphere Reserve supports a substantial number of individuals of the following groups of waterfowl:
Pelicans *(Pelecanidae)*
Cormorants *(Phalacrocoracidae)*
Herons, Spoonbills and Ibises *(Ciconiiformes)*
Ducks and Geese *(Anseriformes)*
Terns *(Sternidae)*

3c - Supports 1% of the individuals in populations of one and the same species or subspecies (when quantitative population data are available):

Species	**Region**	**1% level**		**Srebarna**	
		Breeding	Wintering	Breeding	Wintering
Great Cormorant *(Phalacrocorax carbo*)	Black Sea and Mediterranean	100	1,000	300	
Pygmy Cormorant *(Phalacrocorax pygmaeus*)*	Black Sea and Mediterranean	50		100-plus	
Dalmatian Pelican *(Pelecanus crispus*)*	All countries	All	25	80	
White-fronted Goose *(Anser albifrons*)	Black Sea (winter)		6,500		7,600
Ferruginous Duck *(Aythya nyroca*)*		?	300	60	

* Globally threatened species.

1.9. Location:
The Srebarna Biosphere Reserve is situated in the northeastern part of Bulgaria, on the right-hand bank of the Danube, District of Silistra, South Dobrouja.

1.10. Physical Characteristics:
1.10.1. Geology, geomorpholgy and hydrology

Historical Data Review
Geological structure and hydrogeological conditions in the region of Lake Srebarna are characterised on the basis of previous information, as well as the recent report of Shopova (1999). Results from all geological surveys and mappings carried out in the area have been summarized in the Explanatory Note to the geological map of 1: 100 000 scale, for the region of Tutrakan and Silistra. Main archive sources on subterranean waters in the region were the reports on hydrogeological mappings conducted on a 1:250 000 scale carried out by Yotov (1968) and Danchev, Manolov (1972).
Lower Cretaceous, Neogenic and Quaternary sediments are present in the inspected region. ***(App. 1, Map 3).***

The Lower Cretaceous is represented by the Rousse suite, exposed to the surface in small tracts south of lake Srebarna. It is composed of strong, massive, light brown to white, porcelain and porcelain-like limestones; oolythic limestones; chalky and thick-layered organogenic limestones. These limestones are often fissured and karstified.

Three suites represent Neogenic materials. The Sarpov's suite lies as a transgression over the Rouse suite. It is composed of grey, grey-bluish to light brown, calciferous, thin-layered and at places arenaceous clays. This suite makes up the basis of Lake Srebarna, and at some places, in its southern end; the limestones of the Rouse suite tear it up from below. In the stand of the Aidemir formation lying upon the Sarpov's suite participate fine- to medium-grained, grey, yellowish to light-brown, quartz sands, lying in slanting layers at places. It is exposed on the slopes facing the lake and in the gullies that feed the lake with water. The third suite – the one of Srebarna – is exposed at the higher levels of the terrain, over the Aidemir suite. It is composed of grey-bluish, strong argillaceous limestones in the base with calcareous clays over them. In the uppermost part lay light grey to white, compact and strong limestones, more argillaceous in places. The Quaternary is represented by Eolithic formations (loess), covering a large part of the inter-fluvial beds. It represents a beige-yellowish, light, porous, fine-grained, loose, clayey-silt rock, enriched with calcium carbonate in the form of single grains, coatings and concretions. The flooded terrace of the Danube is made up of alluvial materials abutting the lake to the north. Fine-grained, grey-black sands, fine- to medium-grained sands mixed with medium-size rubble and grey arenaceous clays can be traced from bottom to top. Overall thickness is 20 m. It is necessary to mention contemporary marsh silt and sludge, covering the bottom of the lake ***(App. 2, Geological profile).***

With regard to structure the considered territory is located within the Mysian platform. The region is characterised by a platform development regime and almost horizontally laid out layers. The main structures are fault disruptions that delimit varying in size and levelling blocks, and the considered territory belongs to the Tutrakan grabenlike depression of northeast-southeast orientation.

The geologic conditions in the area of the site predetermine the presence of the following hydrogeological sections:

- Lower Cretaceous (Apt) Aquifer. The subterranean water forms within the unevenly karstified limestones of the Rousse suite. The aquifer here is 50-60 m thick and is slightly inclined to the north-northwest. The Hotrivian marl impoundment lies beneath, covered by the Pliocene aquifer complex. The Apt horizon is exposed only to the south of Lake Srebarna. Part of its water drains though hydrogeologic fenestrae into the lake. Another part drains into the Quaternary aquifer. Feeding is accomplished to the south of the considered site, mainly through precipitation. The aquifer is characterized by a relatively high abundance of water.

- Pliocene Aquifer Complex. This complex is composed of 3 basic litho-stratigraphic units, each with different hydrogeologic properties. The lowest one – The Sarpov's suite is built up of calcareous clays and represents a water impoundment (filtration coefficient of 0,8x10-6 m/d.). The bowl of the lake is situated in this water impermeable clay. The Aidemir suite that lies on top of it is the most water permeable – it is composed of 2 to 16 m thick layers of sands. It is exposed on the surface above the erosion basis determined by the Srebarna Lake water level. The Pliocene aquifer complex is covered by the clayey-limestone Srebarna suite, which also appears to be poorly water-abundant to water impermeable. The Pliocene complex is almost horizontal and is covered by the Quaternary loess aquifer complex.

- Quaternary Aquifer. According to the type of deposits there are two main Quaternary aquifers:

Alluvial aquifer. It corresponds to the terrace sediments of the Danube, building up the Aidemir lowland. It represents a two-layer aquifer with a more water-permeable lower part (built-up of sands and gravel) and a less water-permeable upper part (argillaceous-arenaceous). Total thickness of this aquifer reaches 29 m and that of its lower part is up to 14 m. Water formed within is semi-confined and non-confined. It is characterized with highest water-abundance in the whole region. Lake Srebarna (its northern shore) abuts to this aquifer.

Loess aquifer. This is the uppermost aquifer in the geologic section which is distributed almost everywhere in the inter-fluvial beds. The existing information allows for making up only regional characteristics of the area under examination. The number of springs, boreholes and wells is rather small. Most of them are of unclear geology and structure. There is no systematic information on the qualitative and quantitative characteristics of the surface and underground waters. Available data do not allow for making an analysis and interpretation of individual elements of the water balance and for determining how the lake is fed and drained underground. From the analysis of the geologic and hydrogeologic conditions one can assume that Srebarna Lake water, apart from the surface run-off, comes also as Karst water from the Lower Cretaceous (Apt) aquifer through hydrogeologic windows while the draining goes into the alluvial aquifer. It follows from this fact that the role of the underground water is of great importance for the water exchange of the lake. Colmatage of the outcomes of the water from the Apt aquifer disturbs the underwater feeding of the lake with underground water. It is possible that this feeding of the lake with underground water has also decreased because of the pumping out of underground water thus disturbing the water balance.

1.10.2. Origin

Lake Srebarna is of natural origin (see 1.14.1.). It represents a typical freshwater Danube lake of the river flood terrace. At the beginning of the Holocene, about 11 000 years B.C., right after the so called Flandrian transgression the riverbed underwent significant changes, (Popov, 1986). According to a palinological research, Lake Srebarna has been formed about 8 000 years ago following the inundation of the riverside terrace by the Danube (Bozilova, Lazarova, Strashevska, 1989; Lazarova, 1990, 1994, 1995). In the past its water drained into the Danube through a natural channel in the localities of Dragaika and Tarlitsa. This is now accomplished through an artificial canal.

1.10.3. Hydrology

Historical review

The development of the Lake Srebarna ecosystems can be divided into several stages depending on the anthropogenic modifications: natural state (before 1948); disturbed state (from 1949 to 1978); Stage One recovery (from 1979 to 1994); Stage Two recovery (since 1994). In 1978, after a partial removal of the dyke, the periodic inflow of spring flood water from the Danube was restored, affecting substantially the water balance and the hydrologic characteristics of the lake. A persistent drought between 1988 and 1994 had an adverse impact on the morphometric parameters of the lake, diminishing the water surface area and the actual water volume of the lake. The commissioning of a hydraulic system connecting the

Danube to Lake Srebarna by a canal in 1994 created conditions for control of the water level, the size of the inundated areas and the actual water volume of the lake. Hydrological studies of Lake Srebarna were conducted between 1991 and 1993 in connection with the planned construction of a hydraulic connection of the lake with the Danube at high water levels in the river (Radev, 1993). These studies showed the adverse impact of the drought on the hydrologic and morphometric parameters of the lake.

Current state

The catchment area of the lake (402 km^2) is drained by the rivers Srebarnenska and Kulnezha, whose hydraulic regime varies widely and they run almost dry in summer and autumn ***(App. 1, Map 4)***. In its morphometric parameters, Lake Srebarna can be categorized as one of the smallest water bodies, with a surface area not exceeding 10 km^2.

The water level fluctuations resulting from a complex of factors, like the morphometric properties of the lake itself, the inflow and the outflow, and the internal dynamics of the water masses, provide an integrated indicator of the changes in the volume of the lake. Systematic monitoring of the lake water levels dynamics has been conducted since August 1990 at the Ecological Field Research Station of the Central Laboratory of General Ecology with the Bulgarian Academy of Sciences (Nikola Mikhov, personal communication).

The present state of the lake can be characterized by the following hydrologic and morphometric parameters for the 1998-1999 period:

For 1998, the water level mark varied between 11.91 m and 12.78 m and reached a mark of 13.73 m in November, after Danube waters overflowed the dyke:

- The water column height varied from 1.10 to 2.90 m, measured at a prescribed measuring point;
- Areas inundated at these water levels varied between 2.334 km^2 and over 7.15 km^2;
- The water volume impounded in the lake varied from 2.82 million m^3 to 10.9 million m^3;
- The thickness of bottom sediments was about 1.5-1.7 m (Radev *et al*., 1993).
- For 1999, the water level mark varied between 13.68 m and 14.06 m;
- The water column height varied from 2.2 m to 3 m;
- Areas inundated at these water levels varied between 7.137 km^2 to 7.218 km^2;
- The water volume impounded in the lake varied from 10.67 million m^3 to 14.35 million m^3.

In order to determine the basic trends in the lake water level fluctuations for the 1990-1999 period, a statistical model has been constructed according to the method of seasonal time series analysis. The trend function is shown as a polynomial of the fifth power, expressed as follows:

$\mathbf{h(t)=a_0+a_1.t+ a_2.t^2+a_3.t^3+ a_4.t^4+ a_5.t^5}$, where **t** represents time.

This model characterizes adequately the trends in the lake water level dynamics.

The trend function shows variable progress within narrow amplitude when the level increases to 11.8 m for the 1990-1991 period and when it falls to 11-11.5 m in the 1991-1994 period. After the canal providing a hydraulic connection of the lake with the Danube went into operation in May 1994, a trend emerged towards water level increase for the 1994-1996 period, followed by stabilization of the level between 12 and 12.4 m over the last two years.

The results of the commissioning of the hydraulic connection canal prove the possibility to regulate the water level as a key component of the biosphere reserve management.

These changes in the water level, the size of inundated areas and of the impounded water quantities are all functionally related, which should be borne in mind when regulating the inflow of Danube water.

Models have been developed to describe the dynamics of the size of inundated areas and the water quantities impounded depending on the fluctuations in the lake water level. The models are polynomials of the following type:

$\mathbf{F(t)=a_1+a_2.h+ a_2.h+a_3.h^2+ a_4.h^3}$

$\mathbf{V(t)=a_1+a_2.h+ a_3.h^2}$**,** where h represents the water level mark in metres.

Modelling the dynamics of these hydrologic and morphometric parameters is of substantial importance for managing the hydrologic, hydrochemical and hydrobiological processes in the functioning of the lake ecosystems.

The lake water balance for a given time interval has also been reduced to an equation. This balance equation expresses the changes in the lake water level depending on the inflow

The basic trends in water quality evolution have been identified on the basis of a retrospective analysis of the pollution of Danube waters at the Silistra monitoring point for the 1986-1993 period according to data of the National Eco-monitoring System. It was established that pollution is tending down in terms of the parameters BOD5.

1.10.4. Soil Types And Soil Characteristics

Historical Data Review

In 1931 when N. Pushkarov drew up the first Soil Map of Bulgaria, the Region of Silistra was not within the boundaries of the State, and due to that no data on soils in that region is available. As a result of the research carried out by the 1948 Bulgarian-Soviet expedition (Antipov- Karataev, Gerasimov, 1948) a soil map in a 1:1 000 000 scale has been drawn up, showing the distribution of Haplic Chernozems (Haplic Chernozem – after the FAO Classification - 1990) within the Danube adjacent part. The medium-scale Soil Map of Bulgaria in a 1:200 000 scale provides a more detailed presentation of the distribution of these soils, as well as of Meadow. Geographical distribution of soils is presented more precisely on the Soil Map in a 1:400 000 scale, showing also Calcic Chernozems (Carbonate or Calcic Chernozem – FAO) – Angelov et al., 1975. The results of large-scale research with the Institute of Pedology and Agrarian Ecology were included in agrochemical articles, accompanied by a Soil Map in a 1:25 000 and 1:10 000 scale.

Actual Sate

Soil Formation Conditions: For the purpose of this project a detailed map in scale 1:5 000 has been drawn up ***(App. 1, Map 5)***. The Srebarna Biosphere Reserve is situated in the northeastern part of the Danube adjacent part of the Danube Hilly Plane, within the region of the Aidemir Alluvial Lowland. The territory relief is both undulating and flat, showing alternations between deep ravines and flat inter-plane spaces, thus creating conditions for soil erosion processes. The average annual precipitation is 500 mm; the average annual soil temperature is 12,4°C, with the lowest value in January (-0,1°C) within 2-5 cm from the surface. According to the Soil Taxonomy the temperature regime is mesic, and the moisture regime is ustic (Boyadjiev, 1989).

The main soil forming materials are Quaternary loess sediments, as well as Pliocenic clays, marls and calcareous sandstones. The elevations along the Danube originate from Miocenic sediments – argillaceous marls and calcareous sandstones. The soil forming materials within the alluvial lowlands are river deposits and loess formations, and within dry vallies such are diluvial and alluvial-diluvial deposits.

The following units of soil varieties characterize the area of the Srebarna Reserve:

- On the southern and western sides and adjacent territories: Haplic Chernozems (Haplic Chernozems, FAO), of medium depth, slightly eroded, of medium-arenaceous argillic texture; moderate to severe erosion develops on the steep slopes;
- Thickness of the upper Molic A horizon of areas not subjected to erosion is 40 to 50 cm, and that of slightly eroded areas is up to 20-30 cm. The plough layer is powdery to slightly compact, due to prolonged cultivation. Humus content is 1,7-2,8%. Lower Mollic horizons show coarse-grained-crumb-like to fine-nodular texture, with humus concentration gradually decreasing along the depth of the profile. Metamorphic B-Horizon is lighter than the previous one, 30 to 40 cm thick, slightly compact with firm sub-angular blocky structure. Carbonates appear at the lower part of horizon as a mycelium-like accumulation. In the Ck horizon at the depth of 80 to 90 cm carbonates accumulate as small soft concretions. $CaCO_3$ content is about 15% to 20%.
- In lowlands and along ravines soil types are represented by Meadows Chernozems, accumulated, of medium arenaceous argillic texture. Depending on the material deposited they can also be Calcic; Meadows Chernozems cover the lowlands and blind creeks. Typically they have a well-pronounced thick Mollic A horizon. In some areas covering with soil material, deposited from adjacent hills, partially contributes to this. Overlapping stratum is of different depth and is subjected to meadow processes. Average thickness of the profile exceeds 100 cm. Humus content is around 2,0-2,9% and is slowly changing along the depth of the profile. In some areas carbonates are present within the superficial horizon. pH is neutral to alkalescent (pH H_2O – 6,6-7,9). Texture is coarse, showing arenaceous-argillic characteristics. These soils have no deposits of salts.
- In the northern part of the region – in the lowland between the lake and the Danube, soils are represented in a complex of: Calcic Meadow-Chernozem-like, alluvial and alluvial-meadow, slightly swamped soils;
- Meadow marshy soils occupy part of the coastal strip; lacustrine marsh soils are in their greater part covered by the water of the lake.

Agricultural activities played a significant role, especially in the past, when a considerable area had been deforested for the purpose of increasing the arable land. Forests have disappeared in many areas, and often only locality denominations remind of the forests, that had once existed. Meanwhile reforestation activities on adjacent areas were implemented within the territory of the Reserve.

Other significant ameliorative activities were carried out – a dike on the Danube was constructed, adjacent lowlands were drained and cultivated, considerable areas on the hills surrounding the shores were terraced against erosion. Along with great changes in connection to the cultivation of soils, as a result of tillage, fertilization and so on there is a number of examples indicating negative impact from agricultural activities. The first one is acceleration of erosion processes. Denudation is the most common contemporary morphogenetic process, manifesting through sheet erosion (at a rise lower than 2,5°) and gully erosion (at a rise higher than 5-8°). Instances of limestones from below the loess appearing on the surface are not rare. This necessitates good knowledge of soil characteristics with regard to their most rational use and planning of activities on their improving.

1.10.5. Nitrogen And Phosphorus Concentration IN Soils and Lake Sediments

Historical Data Review

Soils in cultivated land are the main source of N and P pollution of lakes and rivers due to soil erosion. Available forms of N and P are important part of the total amount of these elements in the soil. They have accumulated during the years of applying fertilizers and have very favourable effect on crop growing. Furrow crops near lakes and rivers increase erosion and pollution of waters. Soil particles and dissolved soil P in water run-off from agricultural fields are the most important source of lake and river pollution with phosphorus (Austin et al., 1996). No earlier data on nutrient dynamics, either in soils or in sediments is available.

Actual State

Haplic Chernozem is the main soil type within the lake region. Carbonates were found at a depth of 60 to 70 cm in non-eroded soils. Humus content varies between 1.7% and 2.8%. Average clay content is about 42.4%.

The following regions in the vicinity of Lake Srebarna were studied: the locality of Gabritsa on the eastern shore; the maize fields on the southern lakeshore and the heavily eroded western shore of the lake. The northern shore of the lake is low and densely covered with reed, so it cannot be a source of pollution, caused by soil erosion. Soil samples from 0-15 cm and 15-30 cm below surface were taken. Water samples were taken from the Danube; the Kalnezha river; the canal, connecting the Danube and the lake, and at three points within the lake proper ***(App. 1;Map 15).*** Sediment samples for analysis were also taken at the same points within the lake. The upper layer of the sediments is viscous and rich in organic matter. The second layer consists of well-metamorphosed, viscous, gray and mainly mineral sediment. The third layer represents grayish-white argillic sediment. The total nitrogen concentration was determined by the Kjeldahl method and the concentration of mineral nitrogen was determined by the method of Bremner-Keeney. Total nitrogen concentration was determined through digestion in perchloric acid; available phosphorus concentration was determined through the Ivanov method, performed in lactate extract. Organic carbon concentration was determined through the Tjurin and Anstett methods. Isotopic-exchange phosphorus and its distribution to pools of different availability were determined through the isotopic exchange kinetic method, as described by Fardeau et al. (1979).

Nitrogen mineralization of the organic part of sediments was analysed in a laboratory incubation test. In this experiment 4 g of wet sediment were added to 20 g of soil and the mixture was incubated at 25°C for 28 days.

Soils **(App. 3, Tables 1,2 and 3)** Highest nitrogen concentration in the analysed soils was found in the forest soil from the eastern shore of the lake. Cultivation of soils in connection to their agricultural use has lead to an almost two-fold decrease of the total soil nitrogen in the soils from the southern and western lakeshores. Lowest nitrogen concentration was found in the samples taken from the eroded slopes on the western lakeshore.

Inorganic nitrogen concentration in the analysed soils varies between 3,5 to 20 mg $N.kg^{-1}$. These levels are relatively low and impose no direct risk for pollution of the lake water. Only nitrate nitrogen can be leached if favourable conditions are present. Available phosphorus concentration is nearly the same in all non-disturbed soils: from 7.3 to 7.9 mg P_2O_{5}ч kg^{-1}. The evaluation scale of the method for the determination of available phosphorus used shows that concentrations exceeding 25 mg P_2O_5. kg^{-1} lead to depression in the development of agricultural plants. These conditions are present in the eroded material from the western shore and in the soils from the southern shore of the lake. Surface erosion from these fields has loaded Srebarna Lake with huge amounts of available phosphorous. A study for the phosphorus bioavailability through isotopic exchange kinetics reveals that readily available P contained in the soils of the southern lakeshore is several times higher than that in the soils from the western shore. High concentrations of bio-available phosphorus in forest soil are not a hazard for the lake water, because of the low erosion rate in this soil. In view of erosion as a way of polluting the lake, the peculiarities in the location of the western lakeshore (closest to the waterplane) make it more hazardous. The transfer of available phosphorus through erosion contributes to the increase of eutrophication in the lake.

Sediments ***(App. 3, Tables 4 and 5).*** The net nitrogen mineralization is possible in the presence of organic matter with C: N ratio below 25, while the net phosphorus mineralization – at a C: P ratio of less than 200. In all sediments analysed these ratios were less than the marginal. This is to show that at ratios below the ones mentioned above inorganic forms of nitrogen and phosphorus will be released in the water in the process of mineralization of organic matter. Argillic sediments from the lake have lower C: N and C: P ratios than organic ones, but overlaying sediments (rich in organic matter) isolate them and the rate of input of the ammonium and phosphate in the lake water will depend on the rate of the organic matter mineralization.

Sediments from Ribarnika have the highest total nitrogen and phosphorus concentrations. The material eroded from the soils covering the adjacent highly eroded shore of the lake is rich in available phosphorus. This represents the link between phosphorus concentration in soils and high phosphorus concentration in the sediments, which is a direct consequence of the transfer of soil particles from the shore into the lake. Increased soil erosion in this case is perhaps the result of uprooting vineyards several years ago. The most important pools of readily available phosphorus (isotopic exchange phosphorus) were observed in the upper layer of the sediments from Ribarnika. High P content in the sediments from Kamaka is also indicative of the pollution from the Kalnezha river, disgorging near this place.

High content of organic matter in the lake sediments (abound 30 cm in 1 to 1.2 m of water depth) is favourable to the denitrification of incoming flow-off nitrates and the mineralization of organic matter in the lake. According to Obenhuber & Lowrance (1991), adding 10 mg C L^{-1} reduced nitrate concentration in a water body from 12 to 6 mg L^{-1} for 35 days. Denitrification is thus preventing nitrate accumulation in the lake water.

E*valuation of the fertilizing capacity of sediments.* The comparison between N and P concentration in sediments and farmyard bovine manure allows for the evaluation of the qualities of sediments as an organic fertiliser. In well-composted farmyard bovine manure the average N content is 0,5% and the average content of P is 0,25%. Results for the total concentration of N and P in sediments are shown in ***Table 4, App. 3***. Total nitrogen concentration of sediments is higher than the average nitrogen concentration in farmyard bovine manure, and the one of phosphorus is lower. Such a concentration of nitrogen and phosphorus in sediments allows for their use as fertilisers of soils with high available phosphorus concentration – that is the case with soils within the maize field on the southern shore of the lake.

Results from the incubation test on sediments and soil reveal that mineralised nitrogen is 50% more after the 28 days incubation period following the addition of 20 g of sediments to 1 kg of soil (calculated as dry matter) in comparison to the soil incubated without the addition of sediments ***(App. 3, Table 6)***. This test reveals that nitrogen mineralization following the addition of high quantities of sediments is possible and will improve the nitrogen regime of soils around the lake. The application of large quantities of organic matter into soils will improve soil structure and will contribute to the decrease of soil erosion.

Influence of the Kalnezha river. The highest mineral nitrogen concentration (as nitrites) was found in the water of the Kalnezha river - 1,84 mg. L^{-1}. This river flows through agricultural lands and near a pig farm, so pollution of its water with inorganic and organic fertilizers increases its nitrogen concentration. However, as the water inflow from Kalnezha is negligible it could only temporary affect the nitrogen concentrations in the part of the lake called 'Kamaka'.

Reed analysis. Total nitrogen concentration in reed is similar to that of sediments from Ribarnika and Kamaka (sample taking points are close to the reed covered shores). The total nitrogen concentration in the centre of the lake is twice as low as that of reed. This is due to the spatial remoteness of the reed. It means that conditions within the lake are favourable for the maintenance of low inorganic nitrogen concentrations of the lake water ***(App. 3, Table 7).***

1.10.6. Water quality

Historical review

Judging from indirect information on the lake (Petkov, 1911), at the turn of the 20th century the lake was presumably mesotrophic to slightly eutrophic (Stoyneva and Michev, 1998). Information dating from the 1960s, after the natural connection with the Danube was disrupted in 1948, shows transition of the lake water to eutrophic state (Rozhdestvensky, 1964). The concentration of phosphates and other nutrients increased nearly ten-fold between 1960 and 1985 (Tzankov, 1993). After that period, the hydrochemical state of the lake underwent substantial changes as a result of a 1982-1984 drought. In 1964 the water was rated as bicarbonate-chloride type (Rozhdestvensky, 1964), while in 1985 it was described as bicarbonate (Radev, 1993). Drastic changes in the lake - the partial drying and shallowing in 1990-1993 - dramatically altered the mineral composition of its water, with the mineral content almost doubling and the water type changing from bicarbonate to sulphate with a 13-fold increase in the sulphate concentration (from 38.1 to 487.3 mg/l (Ibid.). In anaerobic conditions, sulphate was reduced to hydrogen sulphide. The nutrient concentration also surged (Tzankov, 1993).

Current state

The concentrations of inorganic nitrogen and phosphorus (NH4+, NO2-, NO3-, PO43+) and of silicon (Si) in water have been measured with the help of standard analytical methods (Merck) and an Ultrospec1000 spectrophotometer of LKB/Pharmacia-Biotech. The temperature, conductivity and oxygen concentration have been measured with the help of a MultiLine P4 field apparatus of WTW. Average samples have been collected for the entire water column down to the interface between water and sapropel from 5 points in the lake ***(App. 1, Map 15)***.

Srebarna is currently in an initial phase of a classic-type succession from lake to marsh to wet meadow. The periodic inflow of river water and the partial drying in summer is the principal factor that affects water quality in the first place. The primary production of reed and plankton is the second principal factor that depends on water quality and, at the same time, largely determines it.

More comprehensive data on the pollution of the lake with petroleum products are not available in this section.

The **mineral composition** of the lake undergoes seasonal fluctuations corresponding to the processes of flooding and partial drying. The hydrocarbonate, chlorine, sulphate, sodium, calcium and magnesium ions account for the bulk of the minerals in the water. Results of lake water analyses made in the summer and autumn of 1998 showed again a decrease in mineral content and restoration of the bicarbonate type of the water. ***(App. 1, Fig. 1)***.

When succession to a flow-through-type lake takes place, the water type changes from bicarbonate to sulphate in the final phases of turning of the lake into a bog (Wetzel, 1983). In the 1990-1993 period, the Lake Srebarna water started to change in this way but following the re-establishment of the connection with the Danube, it has reverted to the bicarbonate type ***(App. 4, Fig. 1)***. Electric conductivity reflects the mineral composition of water. For the period under study, this conductivity was within the normal limits (420-520 μS/m), close to the electric conductivity of the Danube water (300-540 μS/m).

The **nutrient concentration** depends, on the one hand, on the inflow from the River Danube and the surface and ground run-off from the water catchment area and, on the other hand, on the phytoplankton production and the processes of nutrient recycling. For their part, the nitrogen and phosphorus flows control the hydrobiological processes in the Reserve.

A disturbance of the lake hydraulic regime in the 1990-1993 period thinned the water layer and accelerated eutrophication - two processes that were at the root of most of the negative changes. Nutrient concentration increased significantly between 1985 and 1993: nitrates (5- to 10-fold); ammonia (up to 6-fold for the minimum values); phosphate (5- to 4-fold) ***(App. 4, Fig. 2.1. to 2.3)***. This in turn led to a high production of organic matter and, respectively, to hypoxia in water. As a result, food chains were disrupted, leading to a disturbance in the food resources for waterfowl.

As evident from the same figures, after 1994 nutrient concentration dropped dramatically and in 1998 it was already within its perfectly normal range for a eutrophic environment: NH_4^+ (0.7 to 1 mg/l), NO_3^- (0.9 to 7.8 mg/l), PO_4^{3+} (0.1 to 0.55 mg/l) ***(App. 4, Fig. 3)***. The nutrient composition of the lake water underwent an abrupt change due to an influx of Danube water in November 1998. Large quantities of nitrogen compounds entered the lake after rushing water stirred the bottom sediments in the canal connecting the Danube to Srebarna and in the canal inlet in the area of Dragaika. The biogeochemical processes in the lake initially led to the re-mineralization of nitrogen and phosphorus compounds and, then, to their absorption by the primary producers and, probably, upon denitrification (see Section 1.10.5). The result was a decrease of nitrates and phosphates in the water to nearly a fifth of their previous level **(App. 4, Fig. 3)**.

Between January and July 1999, some 30% to 60% of the reed died off as a result of high water levels. The annual production of reed air-dry mass (assuming that one-third of the mass is in the roots) has been estimated at over 11,600 tonnes (see Section 1.12.2.5.). With a nitrogen content of 1.16% and a phosphorus content of 0.0655% (Section 1.14.5), the biodegradation and re-mineralization of this mass may liberate about 40 to 80 tonnes of nitrogen and 2.3 to 4.5 tonnes of phosphorus into the water (see also **Sludge Removal** Project). These huge amounts could cause extremely powerful plankton blooms and, of course, a surge in the nutrient concentration. No such phenomena were observed in 1999: on the contrary, the nitrate, ammonia and phosphate concentrations remained extremely low and the primary productivity remained within normal limits (see Section 1.12.2.5). Obviously, the biochemical processes in the lake effectively block the nutrients in a form inaccessible to the primary producers.

The silicon concentrations, identified as SiO_2, exceed 3 mg/l and are not a limiting factor of phytoplankton growth and development.

Oxygen concentration in the water column is one of the principal elements of water quality. Normally, the gradient in water starts with high oxygen concentration (5 to 22 mg/l or 60 to 320% saturation) near the surface, diminishing steeply to near zero close to the water-sapropel interface. The 24-hour dynamics show that the greatest fluctuations in oxygen concentration occur during the summer maximum in plankton growth (August - September). In conclusion, it can be noted that a depletion of oxygen concentration attributable to eutrophication, which could endanger aquatic life, have not been observed in the water column proper.

Analyses of the content of **heavy metals** (Cu, Pb, Zn, Cd, Mn, Co, Ni and Fe) in the 1-metre thick layer of bottom silt show normal concentrations and give no ground to suspect pollution of the lake. Similar results have been obtained regarding chlorine-containing organic compounds, including chlorine-containing pesticides and PCBs.

Changes in **water quality and their relation to the trophic state** of the lake in the 1990-1999 period can be interpreted with the help of the **OECD classification system** (Vollenweider, R. & J. Kerekes, 1982). Chlorophyll concentrations and the Secchi disc readings show that the lake is within the range of the eutrophic state, tending to normalize.

1.10.7. Depth

Hypsometry of Lake Srebarna has been drawn up by Danailov (2000) and is shown on ***Map 6, App. 1***.

Provided that the southern lock remains closed, maximum depth of Lake Srebarna is determined by the point where its water flows in or out of the Danube (at present this is the area of the destroyed part of the dike at the south-western end of the Reserve). The altitude of this part is 13,2 m. At this water level maximum water is 3,3 m and can be observed at the mouth of the Dragaika canal which is the point where water flowed out in the past, and the average water depth is 2,1 m.

1.10.8. Climate

Individual environmental components, such as climatic conditions, surface and subterranean water regime, air and water quality, etc. form the living milieu of the Reserve. Closely interrelated biotic and abiotic factors require the Management Plan that has been developed for the Reserve area to pay serious attention to abiotic conditions.

Historical Data and Actual Sate

The continental climate is well pronounced, in cold winters and hot summers. In winter weather is formed mainly under the influence of continental atmospheric masses. Summer is hot due to the predomination of subtropical atmospheric masses from southern latitudes or either – they formed there under the influence of the strong summer solar radiation under conditions of a slow-moving anti-cyclone.

Brief Seasonal Description Of The Climate:

WINTER – Biological winter is a period when the ambient temperature remains below 5°C, the onset is around the 26th of November and the end – around the 13th of March, and the total duration is of about 110-120 days. The thermal characteristics of January are: average temperature – within -1,5 and –2,5°C; the minimum at snow cover and anticyclonic weather may vary between -20°C and -25°C; in extreme situations minimum temperatures may drop down to -30 to -35°C; the microclimate variability is 5 to 6°C. The number of days with minimal temperature below: 0°C(days of frost) is 26; 10°C is around 8. The average daily temperature is higher than 5°C in 12 % of the winter days. Winter precipitation totals

105 mm. The snow cover onset is 13 November until the mid-December or an average of 48 days.

SPRING – The onset of spring is the 12th of March and the end is around the 2nd of May. The frequency of early and late springs is 27-28%. Spring frosts are common at the end of March and the beginning of April. In spring on the average 1 or 2 days are with mean diurnal temperature below 5^{o}C, but only in 4 to 5 days of the month the minimum temperature falls below 2^{o}C. Total precipitation for the astronomical spring is around 122-128 mm, and for the biological one it is only 70 mm. There are periods of rainless weather exceeding 10 days every 2 out of 10 years.

SUMMER – Average diurnal temperature steadily increases and exceeds 15^{o}C about 2 May and keeps these values until 2 October. Average temperature for July is 23°C with maximums of up to 39-41°C. 80-85% of the days in this period are with average daily temperatures higher than 25°C, while around 40-45% have maximal temperatures exceeding 30°C. Total precipitation is 159 mm. All in all in summer and autumn there are 4 to 5 rainless periods lasting on the average between 16 and 20 days each.

AUTUMN – It sets in with the air temperature steadily passing below 15^{o}C point and the season end comes when it drops down below 5^{o}C: from 2 October till about 26 November. Precipitation total of climatic autumn is 113 mm and that of the biological – 66 mm. The mean circadian air temperature falls below 10^{o}C by 20 or 25 October and below 5^{o}C - between 15 and 20 November. The first autumn frosts set in as early as by the end of October or in the beginning of November.

Morphographic specifics of the region: the altitude of the flat-top heights surrounding the lake from west and east; the varying in area and depth water bodies as well as the type and thickness of the marshy vegetation thoroughly disturb the structure of the meteorological fields. The average monthly minimum temperature there in summer differs by about 1.5^{o}C from that measured on flat and open places and by 1.5^{o}C to 2.5^{o}C from that measured on the surrounding hilltops. Under conditions of night radiation cooling at no advection in clear and calm nights the above differences can reach 5^{o}C to 6^{o}C. Daily temperature amplitude at the feet of the surrounding hills is by 2^{o}C to 3^{o}C greater than on the hilltops. In winter this difference decreases by about 0.5^{o}C to 1^{o}C but is still significant. The duration of the frost-free weather in the region of the lake and the adjacent low shore is expected to differ by 7 to 12 days from that in the surrounding heights and from there the accumulated heat decreases with about 500^{o}C. With advection present the coefficient of wind deviation reaches 2 to 2.5 and the percentage of calm periods increases several-fold. The differences in the rate of evaporation in the lake and on the shore during the warm half-year is of the order of 100 mm per month and more. These differences are not the same throughout the Reserve area but have a rather mosaic distribution. Thus for example if in the foot of the western surrounding hill the minimum temperature is 6^{o}C less than that on the top of the hill, in the eastern part this difference is still less, which is determined by the different air catchment.

One of the main characteristics is potential evapotranspiration, which serves as an index for the possible evaporation from the natural underlying ground surface of a certain region (including the vegetation) under the existing climatic conditions. The average multiannual evapotranspiration is calculated in mm using the Thornthwaite method. For the region of Srebarna it is between 112,6 and 134,5 mm in the summer, as computed on the basis of data from the Silistra station. During the driest part of the year for this region (December - February) it falls to 0 mm. The annual evapotranspiration for the region is around 691 mm.

Another complex index, based on temperature and precipitation is the so-called dry or aridity index I, formulated by De Martone. The annual course of the aridity index I for the period 1931 through 1973 is shown graphically on ***Fig.1, App. 5***.

The annual value of I is 23,2, hence the region is described as moderately arid according to the Kirov, Kyutchukova (1995) classification with I values under 20 during 4 months of the year (July to September).

The Ped index was also used for the evaluation of aridity of the area under examination. The average value of the Ped index for the area is below 1, which means that the region is not a very arid one.

Another important specific feature of the climate of the region, having a direct influence on the state of the Reserve are the processes of ice formation on the Danube. Ice formation phenomena in the Bulgarian part become more and more rare since 1986. The physical characteristics of their manifestation reveal that they are in close connection with meteorological conditions. A joint presentation of the time series of the average winter temperature and the number of days with ice formation was made. It was established that 1953 was the coldest winter with the largest number of days with ice formation. It deserves noting that in some comparatively cold winters there was no ice formation while in other winters with positive average temperature there was ice formation.

The climatic characteristics described above undergo changes and fluctuations down the years. The multiannual trend of the alteration of temperature, precipitation and aridity indices dynamics for the period from 1941 through 1997 was studied. The trend of the annual temperature characteristics, precipitation and the De Marton and Ped indexes is shown in ***App. 3***. No tendency towards alterations of the average annual temperatures is observed. The same refers to the Ped aridity index, which fluctuations are negligible. Only in the annual precipitation totals and indexes of De Martone there was a slightly expressed tendency towards decrease of the humidity degree since the beginning of the 1970-s till 1994 after that there has been a tendency towards its increase. For a greater clarity the analysis was performed separately for winter and summer seasons. (***App. 5, Fig. 2,3 and 4)***

There are almost no multiannual alterations of the average winter temperatures and the total winter precipitation. However, the situation was not the same as regards the summer characteristics. From 1984 till 1996 there has been a well-expressed tendency towards an increase of the summer temperatures. To the contrary, the total summer precipitation shows a slight tendency towards reduction since the late seventies.

Since the end of the 1970-s there has been a marked trend towards drier summers. Thus for the period 1972 through 1995 the I values have been under 20 in more than 50 % of the summers, which indicates an increased aridity of the region.

In contrast to other regions of the country, there are low or no tendencies towards aridification and warming of the climate of this region, such as the observed in the larger part of the country.

The climatic characteristics as described above undergo significant changes within the Reserve boundaries commensurable with a change of the climatic region. These changes may not be negative with respect to the climate proper, but may prove fatal for the Reserve biota. Thus for example the decrease of the open water areas and their overall depth due to the accumulation of silt has had as a consequence a change in the thermal conditions of the individual water bodies. In the case of Srebarna in particular this may lead to the increase of the water temperature during the warm half-year, which in turn may cause the increase of the evaporation while during the cold half-year the decease of temperatures and to the freezing of the lake in shallower areas. This problem can be solved by undertaking measures for cleaning up the lake bottom, as well as the vegetation of the floating dry reed islets provided this will not harm the birds colonies.

1.11. Hydrological Characteristics

Groundwater recharge: The analysis of geological and hydrogeological characteristics allows for the assumption that besides surface water and Danube water, water of Lake Srebarna is also replenished by karst water from the Low Cretaceous (Apt) aquifer passing through hydrogeological fenestrae and draining into the alluvial aquifer. Therefore subterranean water has a significant role in lake water exchange. Colmatage of water outcomes from the Apt aquifer disturbs underwater feeding of the lake with ground water. That is why lake feeding with ground water may have possibly decreased through pumping out underground water, disturbing in turn the water balance.

Flood control: Protection of the Reserve adjacent territories is based on a system of dikes along the Danube riverside in the northern part of the Reserve and to the east of it (***App. 1, Map 2***). When the Danube water level is very high the river enters the Reserve from the northeastern part, which is outside the system of dikes. In this case the watershed region is not protected against flooding. The watershed is thus not additionally protected from flooding. If that happens after the level of the Danube water has dropped, the water would run off through the same spot where it entered the Reserve and along the canal connecting the lake with the Danube when sluices are opened.

Sediment trapping: The Lake is a sediment trap for material eroded from the watershed. In fact eroded soil may enter the lake from the elevated western bank of the lake (see also parts 1.14.4 and 1.14.5).

Shoreline stabilization: There are no pre-conditions of significance to advance soil erosion or cause changes to the shoreline of the Reserve.

1.12. Ecological Characteristics

1.12.1. Main Habitats And Vegetation Types

The Srebarna Biosphere Reserve vegetation, presented mainly by rooted hydrophytic, hygrophilic, hygromesophilic, mesophilic and mesoxerophilic communities (cenoses) plays a significant role in maintaining an optimum ecological balance of the aquatic and land ecosystems in the lake area. Basically, its importance is expressed in the following:

- A key role for the stability of the Reserve's ecosystems
- Specific character of the cenotic combinations within the plant associations
- Main contribution for the ecological balance
- High scientific and cognitive value of a substantial part of the Reserve's higher flora

The main types of habitats were classified in accordance with the KORINE Programme Nomenclature. The following types are present within the territory of the Srebarna Biosphere Reserve (part of the term have no Bulgarian translation):

22. Standing fresh water
22.2. Temporary fresh water
22.411. Duckweed covers *(Lemna, Spirodela, Wolfia, Azola)*
22.412. Frogbit rafts *(Hydroharis morsus-ranae)*
22.413. Water-soldier rafts *(Stratiotes aloides)*
22.415. Salvinia covers *(Salvinia natans)*
22.42. Rooted submerged vegetation *(Potamogeton)*
22.422. Small pondweed communities *(Ceratophyllum)*
22.43112. Northern Nymphaea beds *(Nymphaea alba)*

53.1111. Freshwater Reed Beds *(Fragmites australis)*
53.131.Broad-leaved Cattail Beds *(Thypha latifolia)*
53.132. Narrow-leaved Cattail Beds *(Thypha angustifolia)*
38.251. Ponto-Panonia mesophyll hay meadows *(Leucojum aestivum)*
83.3212. Other poplar Stands *(Populetum)*

The habitats 22.412 - Frogbit Rafts, 22.413 - Water-soldier rafts, 22.415 - Salvinia covers и 38.251 - Ponto-Panonia mesophyll hay meadows habitats are included in the Bern Convention List of habitats in need of special conservation measures at European level. They are also listed in Annex I of the EU Habitat Directive.

The vegetation cover of the Srebarna Biosphere Reserve water catchment area consists of the following types of vegetation:

1.Marsh And Bog Hygrophytic Vegetation (at places also hydrophytic) with the predomination of common reed *(Phragmites australis*), cattails (*Typha angustifolia* u *Typha latipholia*), bulrush (*Schoenoplectus lacustris, Sch. triquetra, Sch. tabernemontana)* etc.

2. Mesoxerothermal Grassy Vegetation with the predomination of Bulbous Bluegrass (*Poa bulbosa*), Perennial Ryegrass (*Lolium perenne*), Bermuda Grass (*Cynodon dactilon*), at places also by Beard Grass (*Dichantium ischaemum*) and more rarely Scented Grass (*Chrysopogon gryllus*) mostly on the village pastures.

3. Mixed woodlands of Turkey Oak (*Quercus cerris*), Downy Oak (*Quercus pubescens*) and Virgilian Oak (*Quercus virgiliana).*

4. Secondary Mixed woodlands of Italian Oak (*Quercus frainetto*) and Oriental Hornbeam (*Carpinus orientalis*) with Mediterranean characteristics at places.

5. Silver Lime (*Tilia argentea*) woodlands at places being a secondary growth.

6 Arable land where oak forests used to stand in the past consisting of Turkey Oak (*Quercus cerris*) and Virgilian Oak (*Quercus virgiliana*) often mixed with Long-Thorned Oak (*Quercus pedunculiflora*).

Transpirational functions of vegetation have a direct bearing on the hydrological regime of the wetland. This necessitated specialized research of the transpired quantities of water by phytocenoses, consuming great amounts of water and spread widely within the territory of the Reserve and its buffer zone.

The result of the research carried out for determining the intensity of transpiration of Common Reed (*Phragmites australis*), Grey Willow (*Salix cinerea*) within the reed bed and poplar stands within the buffer zone, revealed an average of 1,79 gr/dm2/h for poplars during a two-season monitoring, and a daily water expenditure of 1,81 g per 1 g of leaves. Using the average values obtained, it may be calculated that the water transpired by a single poplar tree per vegetation period is, on the average, of 3 000 l (varies from 2 500 to 3 000 l). The intensity of transpiration of *Salix cynerea* is 0,575 g/dm2/h and the daily water expenditure is 1,24 g per 1 g of leaves. The intensity of transpiration of *Phragmites australis* is of 0,478 gr/dm2/h, and the water evaporated by 1 g of leaves -- 1,35 g.

On the basis of the above results and taking into account the areas, over which the considered cenoces are spread, it is determined that poplar stands, situated within the buffer zone of the Reserve having a total area of 18,1 ha, transpire 70 200 t of water per season. Poplar stands within the boundaries of the Reserve designated as a protective forest strip along the Danube with a total area of 56 ha transpire 218 400 T of water per season. Since the Grey Willow (*Salix cinerea*) is scattered in small patches within the reed bed, the quantity of water transpired by it is added to that of the reed. The surface area covered by the reed bed amounts to 402 ha and transpires approximately 1 413 000 of water per season.

1.12.2. Lymnological Characteristics

The main lymnological characteristics of Lake Srebarna are as follows:

Characteristics	*Source*	*Source*
Altitude (m)	Danailov (2000)	10,0 - 13,2
Water catchments area (km^2)	Part 1.10.3 of the MP	402
Total shoreline (km), 1993 г.	Map 1:5000, 1993	18,5
Area of the Reserve (ha)	State Gazette, No 97/ 1999	902,1
Area of the lake mirror (ha), 1993	Map 1:5000, 1993	120
Volume (km^3), 1998 (low level)	Part 1.10.3 of the MP	2,81
Volume (km^3), 1999 г. (high water levels)	Part 1.10.3 of the MP	14,35
Maximum depth (m),	Danailov (2000)	3,3
Annual inflow (m^3), 1998 г.	Part 1.10.3 of the MP	12,48
Retention period (months), 1998 г.	Part 1.10.3 of the MP	2,67

1.12.2.1. Phytoplankton

Historical Data Review

There is little data on phytoplankton as an association, analysed in the context of the overall development of the Srebarna Biosphere Reserve in a small number of works (Stoyneva & Michev, 1998). The publications of Stoyneva (1994; 1998b) contain the most detailed data on the alterations within the phytoplankton association and the trophic state of the water body for the period 1982 through 1995.

The largest number of taxa was found in samples from the period 1987/ 1988 (up to 98 taxa per sample). In the extremely dry 1993 the depth of the lake shrunk to its most critical value - an average of 20 cm (Michev et al., 1993) and the number of species dropped drastically down to 7 species per sample. Heterocytic blue-green algae were not present in phytoplankton associations, while the number of chlorococcal cyanophytes and pyrophytes increased, terratologic forms had also evolved within some chlorococcal species. A repeated increase in the total number of species (up to 43 per sample) with an increase in the number of algal groups was observed in 1994 when the connection with the Danube was re-established and phytoplankton had been introduced by inflowing water.

The total number of phytoplankton cells in Srebarna varies between 1,9 x 10^8 cells l^{-1} up to 18,5 x 10^9 cells l^{-1} per year. For the period 1987 through 1988 the average total number has been 2,6 x 10^8 cells l^{-1}, while for the period 1989 through 1993 it has been 4,8 x 10^9 cells l^{-1}. Following the inflow of Danube water in may 1994 and April-may 1995 the total number of algae showed a tendency towards increase to the average of 3,9 x 10^9 cells l^{-1}. The character of the lake changed progressively from eu-, eu-polytrophic and hypertrophic till 1993 when the reverse process began, reaching again eupolytrophic conditions after 1994. For the period 1982 through 1993 the average value of the biomass has tended to increase but in the next two years - 1994 and 1995 it began to decrease. Average values over given periods of time were as follows: 38,5 mg l^{-1} in 1987-1988, 67,9 mg l^{-1} in 1990-1993, and 40,8 mg l^{-1} in 1994– 1995.

Actual State

The present elaboration was made on the basis of the analysis of 35 plankton samples, collected nearly every month on eleven dates from May 1998 till April 1999. Sample taking points are shown on ***Map 15, App. 1***. Samples were processed using the standard methods, described in detail by Stoyneva (1998b). Phytoplankton is among the most examined groups within the Reserve, but because of its dynamic character it should be studied periodically.

A total of 145 taxa (species, varieties and forms) of algae from 9 divisions and subdivisions were found in the materials collected. Cyanoprokaryota - 52, Euglenophyta - 3, Pyrrhophyta - 4, Chrysophyta - 15 (Chrysophytina - 5, Xanthophytina - 1, Bacillariophytina - 9), Cryptophyta - 3 and Chlorophyta - 74 (Euchlorophytina - 70, Zygnemophytina - 4). A total of 123 taxa were found in the central part of the lake, and 94 taxa in the locality of Kamaka. The two main groups forming the qualitative pattern of phytoplankton during almost all periods of research were blue-green and green algae (***App. 6, Fig. 1***). The number of taxa in the samples taken at the different points and during the separate periods is different. The curve in the diagram showing the total number of species in the central part of the lake has a spring-summer peak while the curve showing the total number of species in the separate pool of Kamaka had two peaks, a summer and an autumn one. It may be affirmed that there is an increase of the total number of species while comparing 1990, 1991 and 1993 to the 1990-1994 period. On the other hand, the number of species found in the period 1998 through 1999 has been 4 times as less compared to their number for the period immediately after the canal connecting the lake with the Danube had been set into operation (Kovachev et al., 1995). The largest number of species per sample (53) found during the period of study was considerably lower compared to the period of 1987 through 1988 when this number was 97 (Stoyneva, 1998b) ***(App. 6, Fig. 2).***

The abundance of phytoplankton in the largest (central) open water area (the lake mirror) showed a peak in the summer and autumn and a minimum in the spring and winter, while the number and biomass dynamics were approximately constant ***(App. 6, Fig. 3 and 4)***. In the Kamaka pool number of cells had its peak in the autumn, while the biomass had a summer-autumn peak. The number of cells in the central part of the lake varied between 1,2 x 10^7 cells l^{-1} (April 1999) and 7,1 x 10^{10} cells l^{-1} (September 1998) and in the Kamaka pool-between 2 x 10^5 cells l^{-1} (January 1999) and 1,17 x 10^{10} cells l^{-1} (October 1999). The values of the biomass in the central part of the lake varied between 2,45 mg l^{-1} (March 1999) and 153,73 mg l^{-1} (September 1998) and in the Kamaka pool– between 3,31 mg l^{-1} (January 1999) and 141,07 mg l^{-1} (September 1998). The peak/average abundance of numbers had the following values: 3,86 and 3 in the central part and 5,1 и 3,3 in the locality of Kamaka. This ratio is higher compared to the one for the period 1994 through 1995, but lower than the one found from 1994 till 1995 (Stoyneva, 1998b).

The outlined peaks in the abundance of phytoplankton were due mainly to the development of cyanoprokariots – a phenomenon characteristic of eu- and mostly of hypertrophic water bodies.

The winter-spring minimums in phytoplankton abundance with the prevalence of golden, diatom, cryptophyte and fusiform coccal green algae is quite normal when the low winter and spring temperatures in 1999 are taken into account combined with the sharp increase of the water level after the Danube water entered the lake. In spite of the fact that diatoms were the main group forming the composition of the Danube phytoplankton during the cold part of the year (Kusel-Fetzmann, 1998; Stoyneva, 1998c), their quantities found in Lake Srebarna after the Danube water entered in 1998/1999 period were notably lower compared to the quantities typical for the river.

Phytoplankton associations in the central part of the lake were more frequently monodominated, while these in the Kamaka pool were more frequently oligo- or polydominated with bigger differences between dominants depending on the method they had been calculated - by numbers or by biomass. This data corresponds to the results obtained through evaluation using the Margalef index. Only three of the dominants registered from 1988 till 1999: have also been found as dominants within Srebarna *Scenedesmus acuminatus* (once during the period 1980-1988, Stoyneva, in litt.), *Leptolyngbya foveolarum* (several times during the 1989-1993 period, Stoyneva, in litt) и *Planktolyngbya* sp. (once during the period 1994-1995, Stoyneva, in litt).

Dominant species in the central part of the lake (b - calculated by biomass, n - by numbers): May 1998 - *Limnothrix planctonica* (n, b); June 1998 - *Scenedesmus acuminatus* (b); *Planktolyngbya subtilis* (n); July 1998 - *Cylindrospermopsis raciborskii* (b); cf. *Achroonema angustatum* (b); August 1998 - *Cylindrospermopsis raciborskii* (b); cf. *Achroonema angustatum* (n); September 1998 - cf. *Achroonema angustatum* (n, b); October 1998 - cf. *Achroonema angustatum* (n, b); November 1998 - *Limnothrix planctonica* (n, b); January 1999 - *Leptolyngbya foveolarum* (n, b); March 1999 - *Nitzschia acicularis* (n, b); April 1999 - *Synedra* sp. (n, b).

Dominant species in the Kamaka pool are: May 1998 - *Actinastrum hantzschii* (b); cf. *Achroonema angustatum* + *Planktolyngbya subtilis* (n); July 1998 - *Planktolyngbya subtilis* + *Euglena* sp. (b); *Phormidium circumcretum* + *Planktolyngbya subtilis* (n); August 1998 - *Cylindrospermopsis raciborskii* (n, b) + *Phormidium circumcretum* (n); September 1998 - cf. *Achroonema angustatum* (n, b) + *Anabaena* cf. *variabilis* (b) + *Planktolyngbya subtilis* (n, b); October 1998 - cf. *Achroonema angustatum* (n, b) + *Anabaena* cf. *attenuata* (b); November 1998 - *Leptolyngbya foveolarum* (b); *Planktolyngbya* sp. (n); April 1999 - *Cryptomonas erosa* (b); *Scenedesmus ecornis* (n); March 1999 - *Uroglena* sp. (n, b).

Generally, the indices of diversity (H) and of evenness (E) had lower values within the central part of the lake compared to those in the Kamaka pool. The values of the index of dominance (c) were evidence of the development mostly of monodominant phytoplankton complexes in the central part and mainly of polydominant complexes within the Kamaka pool. Data analysis of structural parameters showed that phytoplankton both within the large water mirror and in the Kamaka pool is in a quite instable state and is far from optimum. The values of H and E are lower that those of the Danube (Stoyneva & Draganov, 1994b; Stoyneva, 1998c) and Srebarna (Kovatchev et al., 1995; Stoyneva, 1998b) before 1995.

According to the Niegard trophicity index the water of Srebarna could be referred to the highest, indicated by Niegard category – the polytrophic one. Apart from the species composition a criterion for the trophic condition is the annual average value of the phytoplankton abundance and according to this criterion the marsh pertains to the highest category, set by the OECD terminology – the hypertrophic one. This is valid for the central area of open water of the lake where the annual average number of algae was 18,4 x 10^9 cells/l and the average annual biomass amounted to 51,18 mg/l as well as for the 'Kamaka' pool where these values were 2,28 x 10^9 cells/l and 42,76 mg/l respectively. Although the low abundance levels in the spring-winter period show a temporary mesotrophic state, according to the OECD criteria these levels cannot be accepted as indicative in determining the trophic conditions of the lake.

The comparison of values obtained in this study with those from previous studies has shown that the average number of cells is significantly higher in all the periods after 1987, while the average of the biomass is lower than it has been in the most critical period of the existence of Srebarna Lake - between 1990 and 1993 when it was 67.9 mg/l - but higher than it was in the period 1994 through 1995 (40,8 mg/l) after the Danube water entered for the first time via the newly built connecting canal (Stoyneva, 1998b)

As expected, there was a considerable improvement of the ecological situation within Srebarna following the first inflow of Danube water in 1994 (Kovachev et al., 1995; Stoyneva, 1998b; Stoyneva & Michev, 1998). As far as this first life-saving measure was not followed by any other restoration activities, the recently observed positive tendency may be described as instable. All data on the phytoplankton show that the limnic system not only remains in a hypertrophic state, but that this condition has worsened compared to that in the period 1994-1995. Phytoplankton species, which caused massive blooms are not edible for the zooplankton and fish and the great amounts of the produced and accumulated biomass cannot move along the food chains.

Nutrients accumulated in bottom sediments are the main cause for the mass growth of phytoplankton and algal blooms. A supporting factor was the extremely high temperatures of the lake water in the summer-autumn period of 1998. Resting stages of many species of algae have accumulated in the bottom sediments, which had already caused algal blooms in the past (Michev et al., 1993; Stoyneva & Michev, 1998; Stoyneva, 1994, 1998 a, b)and, as this study also showed, could still cause them. This is an extremely negative and dangerous factor for the future development of the Srebarna Biosphere Reserve. Most of these species have developed toxic strains. The limnic system is in an extremely fragile state and if restoration activities are not carried out continuously, the best prognosis will be that the limnic system will continue to be in the same as before hypertrophic state.

1.12.2.2. Zooplankton

Historical Data Review

The first information on zooplanktonic Rotatoria from Srebarna Lake was in the works of Konsulov (1912). Under the conditions of a dike-protected right-hand riverside Naidenov (1965) reported 21 species of Branchiopoda and Copepoda. Later on the same author (Naidenov, 1984) found some Rotatoria species. In 1992 Kraeva determined the species composition and seasonal dynamics of the zooplankton in the Reserve and found 9 species of Rotatoria and 8 species of Crustacea. She also gave, for the first time, quantitative data on the community.

Actual State

Qualitative and quantitative samples for determining structural characteristics of the metazoan plankton were collected monthly from May through November 1998 and from January through May 1999, from 5 stations in the lake. Collection stations (sampling points) were both on the open water area of the lake and amidst the lake vegetation ***(App. 1, Map 15).*** Because of the little depth samples were taken by directly drawing in 50 l water from beneath the surface and filtering it through a flour sieve with size of openings 100 µm. The residue was then fixed, then brought to 100 ml by adding water, then from this volume the zooplankton content in 1 ml was counted. Then the value thus obtained was computed for 1 m^3 by a coefficient of 2000 for the numbers. The biomass was determined by the standard individual weights (dependent on the average body length of the plankters multiplied) by the number of individuals per m^3.

During the present studies 40 taxa, including species and genera, of Rotatoria, 12 of Cladocera and 12 of Copepoda were found in the lake. In 1998 the most widely spread perennial species in the Reserve were: *Brachionus diversicornis, Brachionus calyciflorus, Bosmina longirostris, Acanthocyclops robustus* и *Thermocyclops crassus* (excluding the undefinable subadult stages of Cyclopoida). In 1990 they were joined by *Asplanchna sieboldi, Keratella quadrata* and *Filinia terminalis*. What impressed the authors in 1998 was the complete lack of some very common and widely spread in Bulgaria species, genera and even families, which in the past studies were always well presented in the pelagic parts of the lake. This statement refers most of all to families and genera of the suborder Calanoida found almost in every marsh on the Bulgarian riverside or on islands in the Danube (Naidenov, 1965; Naidenow, 1968, 1979, 1998a). In 1999 some of the taxa (Sididae, Daphniidae, Calanoida and Polyarthra), mentioned above as absent, began to reappear, sometimes with high frequency. In general during the second year of the study 23 taxa of Rotatoria, 8 of Cladocera and 10 of Copepoda were found, i.e. significantly less than in 1998.

The year-round surveys show more or less clearly the seasonal dynamics of the zooplankton composition. In winter months of January and February the zooplankton is dominated by representatives of Rotatoria like *Keratella quadrata* (over 50% of the total numbers), *Brachionus calyciflorus* and *Polyarthra dolichoptera*. In March diversity of the zooplankton components increases sharply with Rotatoria still dominating (57.2% of the total numbers and 25.7% of the biomass), later into the spring there is noticeable increase in the quantitative indices for Crustaceans, the numbers of which reaches 63.16% of the total with subadults of Copepods prevailing. The biomass of Cladocerans is particularly high and in May it averages 65.5% of the total biomass mainly due to the high population density of *Daphnia galeata* and *Bosmina longirostris* ***(App. 7, Fig. 1, 2)***.

With regard to horizontal distribution, perennating components are more frequent everywhere, as well as the temporally limited, such as *Asplanchna sieboldi*, *Brachionus forficula, Alona rectangula, Chydorus sphaericus, Daphnia galeata, Brachionus diversicornis*.

In 1998 the situation at individual stations for collecting samples showed rather close values regarding species abundance. The least number of species was found at stations 1 and 5 (a total of 27), the greatest one was found at station 4 (a total of 39) but the numbers and biomass of any single species found there were rather low. In 1999 the number of participating species remained almost the same but the highest numbers of species was found at station 5 (a total of 38) while at the rest of the sample stations (points for collecting samples) the total number of the species found varied between 25 and 28.

The average annual values of the total numbers and biomasses found in samples from the separate stations in 1998 ***(App. 7, Table 1)*** allow for the separation into two groups. While density at stations 1,2 and 3 varied between 826 000 and 1 706 000 ind./m^3, and biomass was between 3,2 и 6,7 g/ m^3, stations 4 and 5 showed a density of approximately 500 000 ind./ m^3 and a biomass of 2,3-2,5 g/ m^3. The horizontal distribution of zooplankton varied considerably during the different months. In May for instance station 3 showed the highest parameters (1 900 000 ind./ m^3, 6,7 g/ m^3), and station 5 – the lowest (276 00 ind./m3, 1,1 g/ m^3). In June there was a considerable reduction of this difference, and in July and August station 1 showed the highest quantitative indices, and station 4 – the lowest. From September till November station 3 took again the leading position with the highest values and stations 4 or 5, with the lowest ones.

In 1999 the horizontal distribution of the quantitative indices was traced out in March, April and May. The average summary values of the population numbers and biomass at any individual station were considerably more equalized compared to the previous year (119,200 to 184,300 ind./m^3 and 600 to 1169 mg/m^3). The highest values of these parameters were found in samples from stations 2 and 4. During different months in which studies were carried out there were noticeably greater fluctuations. The extreme values for numbers were found in samples from station 1 in March (42,680 ind./m^3) and at station 5 in April (372,000 ind./m^3) The lowest biomass for the period was found at station 2 in March (210 mg/m^3) while the highest one was found at station 4 in April (2092 mg/m^3).

The big difference between quantitative indices for 1998 and 1999 is obvious, even without taking into account the results obtained during the period when the lake was under ice cover. Available data indicate that the best conditions for the appearance of the secondary production in the pelagic parts of the lake exist both in the open water areas and in areas overgrown with macrophytes. The antagonism between the higher aquatic vegetation (vascular plants) and the phytoplankton is a scientific fact known for a long time (Sirenko, 1975). Indirectly, through the food chains, this antagonism also affects the phytophagous and detritophagous zooplankton as more of the dominant species in the lake are. Contrariwise, the massifs of higher standing aquatic vegetation and particularly its submerged and emerged components favourably affect the development of the phytophilic zooplankters among which a number of benthic plankton species occur.

For the period May through November 1998 summary seasonal curves of numbers and biomass were characterized by a well-expressed peak in August ***(App. 7, Fig. 1)***, which was typical of polymictic water bodies in our country and was due to the restoration of soluble inorganic phosphorus and nitrogen compounds, released as a result of decomposition of organisms from the supposed post-ice peak in April. The peak values of 10,2 g/m^3 were among the highest ever observed in our country (Sirenko, 1975), and they also remained very high throughout the rest of the months, similar to other water bodies of the same type. For instance, maximum biomasses of Shabla-Ezerets and Durankulak, which are similar in morphometry and trophicity, are 10,4 и 10,2 g/ m^3 respectively (Sirenko, 1975; Naidenow, 1981; 1998b).

The situation becomes clearer when the main zooplankton groups are analysed separately. In 1998 the numbers and biomass of zooplankton in the Srebarna Biosphere Reserve were built up only of Rotatoria and Copepoda, which is a typical property of the potamoplankton but not of the zooplankton of stagnant water bodies. Cladocerans are in very small quantities or they simply are not present (their average relative participation is 0.23% for the numbers and 0.1% for the biomass).

The absolute values are lower than those typical for the eutrophic water bodies. This substantial difference may be explained with the presence of a multitude of newly hatched fishes in the period of March through May that later turn to feeding on benthic animals or become predators. This opinion of ours was supported by the trend in increasing of the percentage of the big crustaceans in May and their secondary increase in October and November. The Rotatoria preserve their high numbers almost throughout the year, as the fish-press is of much lesser importance to them than to larger crustaceans.

The retrospective analysis, made using the data of Kraeva (1992) and from our studies in the 1998/1999 period allowed for the conclusion that the species composition of Rotatoria and Copepoda in recent times was significantly richer and the dominating species from order Cladocera, with the exception of *Bosmina longirostris,* previously belonged mainly to the *Daphnidae* family, which in 1998 was absent and was again well presented in 1999, mainly by *Daphnia galeata* and *Bosmina longirostris*. In March and April the Copepods were 70 to 90% of the summary biomass.

In quantitative aspect during the period of 1990 through 1992 there was a winter-spring and a summer (in August) peaks having absolute values of 6.8 mln ind./m^3 and 10.17 mln ind./m^3 for the numbers and 90 and 102 g/m^3 for the biomass respectively, while the average annual ones for the two amounted to 4.3 mln ind./m^3 and 47.6 g/m^3. It was a curious fact that both peaks owed their existence to the Cladoceran *Bosmina longirostris*. Cyclopoida prevailed only in April and Rotatoria (*Brachyonus diversicornis*), in June. Considerable reduction both of total numbers and zooplankton biomass is obvious and may be explained only with the inflow of large quantities of water from the Danube, leading to a change of the dominant species, consisting at present mainly of components with lower specific weight.

The lack of information for the last several years since the connection with the Danube was restored does not allow for the evaluation of the actual changes within the qualitative and quantitative composition of zooplankton. As a blank spot in our information on this group of aquatic animals remains the almost complete lack of information on the protozoan component in the zooplankton structure and composition.

The dominant complex, as well as a number of indicator species allows referring Srebarna to the category of eutrophied β-mesosaprobic stagnant water bodies in Southeast Europe. High total numbers and biomasses for the period from May till October are indicative of the relatively smaller relative share of predatory plankters and the weak pressure exerted by zooplanktonophagic fish. A strong influence of carnivorous fishes and fish-eating birds is also quite possible, an indirect evidence of which are the considerably lesser quantities of zooplankton for the period November through April.

The rather big differences found for the qualitative and dominating species composition in 1998 and 1999 are indicative for unstable, mainly trophic relations within the ecosystem, which affect negatively its homeostasis.

1.12.2.4. Macrozoobenthos

Historical Data Review

Till recently macrozoobenthos within Lake Srebarna was not subject to regular benthological research. Available data summarised in “Biodiversity of the Srebarna Biosphere Reserve. Checklist and Bibliography” (Michev et al., 1998) concerned the record of species from various taxonomic groups, some of them being a component of bottom associations, thus increasing the knowledge of the diversity of species within the Reserve.

Most of the available data were findings during episodic visits to the lake and/or additional samplings for faunal research, obtained mainly from phytophilic cenoses along the lakeshore. In general, one may assume that there are 136 species registered in the faunistic inventory of the Reserve, which are or could be a component of bottom communities (Michev et al., 1998).

Kovachev et al. (1995) conducted a more regular cenological research in 1994 and 1995, looking for the primary results of the construction of the canal connecting Dragaika with the Danube. Unfortunately, at that time results were entirely negative: there was no macrozoobenthos at all. According to Assistant Professor, dr S. Kovachev’s personal opinion the situation of that period characterises the state of the lake as an ecological regress, leading to (with regard to bottom associations) a passive state, in which the ecosystem cannot effectively utilize inflowing organic matter, which is decomposed under microanaerobic and even anaerobic conditions near the bottom.

The prediction about future restoration of the macrozoobenthos under the conditions of regular inflow of fresh water from the Danube and maintenance of relatively high water levels in Lake Srebarna was ascertained by this research, carried out in the period of 1997 through 1999.

Actual State

Within the framework of the Project Monitoring Programme quantitative bottom samples were collected monthly with the help of an Eckmann drag of 225 cm^2. Single preliminary quantitative observations were performed in August-September 1997, but samples were collected mainly from May through November 1998 and from March through July 1999 at 5 permanent sampling points in the central part of the lake (a total of 60 samples ***(App. 1, Map 15)***. In parallel with collecting quantitative samples, qualitative ones were also taken on three occasions (in August, September and October 1998) along the lakeshore and at the connecting canal with the Danube ***(App. 1 Map 15)*** - a total of 16 qualitative samples.

The data received from the benthological reseash allows for the statement that the prediction for the restoration of the macrozoobenthos was confirmed. Diversity of species was enriched from 136 species recorded so far (according to generalized data from “Biodiversity of the Srebarna...”) with another 34, new to the lake fauna, while findings of another 40 were confirmed. It is a fact however, that with regard to the number of recorded species diversity within coastal areas (a total of 53 taxa) is considerably higher than that observed at the examined stations within the open water area of the lake (a total of 45 taxa).

During the present research findings only of *Segmentina nitida* (Gastropoda) as a globally endangered species part of European limnofauna, according to the E/ECE/1249/1991 list and Appendices II and III to the Bern Convention on the conservation of European wildlife and natural habitats (1991) were confirmed. *Hirudo medicinalis (Hirudinea)* and larvae of *Gomphus flavipes* (Odonata*)* were not found, and *Brachytron pratense* (Muller) и *Leucorrhinia pectoralis* (Charpentier) (Odontata) included in the same list have not been found since the late sixties (Beshovski, Marinov, 1993).

Particular attention should be paid to the fact that though poor in species, macrozoobenthos is present throughout the whole biological season. This suggests a certain stability of the conditions within the habitat, established in the last years, in comparison to the period before 1995. The presence of secondary aquatic insects, *Chaoborus crystallinus* being an absolute dominant, together with the larvae of some species of the Chiromonidae family and other Diptera is an important characteristic of the restoration process. The participation of primary aquatic species (oligochaets, molluscs, crustaceans in the composition of bottom associations still lacks density. Trivial limnobionts like *A. lacustris, B. tentaculata, V. piscinalis, P. corneus, D. polymorpha*, and the Oligochaeta - *L. claparedeanus, L. hoffmeisteri, and P. bavaricus* etc. are represented among the recorded Molusca only by single specimens.

Therefore the conclusion may be drawn that following the construction of the Danube connecting canal (1994) the diversity of species of bottom invertebrates is gradually restoring and that macrozoobenthos was permanently registered during the examined vegetative season.

Data on the density and biomass of the bottom community are distinguished by low values – an average of 190 ind/m^2 with a maximum value at station V in June 1999 (1 188 ind/m^2). As it was mentioned above, the benthos there is composed of permanently present, but single larvae of *Chaoborus crystallinus*, some chironomid and other insect larvae and single molluscs. The” soft” biomass is also built up of the larvae of *Ch. crystallinus*, as well as those of *Chironomus plumosus* and other chironomids, single individuals of Odontata, Ephemera and Water Bugs. Maximum values were recorded at station V in May 1999 (14,7 g/m^2), while the average value for the zoobenthos is fixed at 0.903 g/m^2, which is considerably lower compared to other, already studied, wetlands (Kovachev & Uzunov, 1981) ***(App. 8, Fig. 1 and 2)***.

A preliminary evaluation of the annual production of macrozoobenthos estimated to 5,148 g/m^2 (at an average biomass of 0.903 g/m^2 for the period) or to 8.125 t/year at 150 ha of open water area of the lake was made on the basis of soft biomass. If one third of this production (2,7 t/year) is utilized by ichtyofauna, the expected growth of ichtyomass is estimated to hardly 387 t/year or to 4,8% of the total annual production of macrozoobenthos. These tentative values may be interpreted as reduced, if the share of molluscs in the ration and the opportunities for fish for feeding on zoobenthos are considered, as phytophyllic associations within the dense vegetation along the shore presuppose.

1.12.2.5. Production And Destruction Of Organic Matter

Historical Overview

Research on the functional structure, i.e. the basic biological processes of production and biodegradation within the ecosystems of Srebarna, was carried out by Baeva (1994) and Vassilev et al. (manuscript). Baeva determined the primary biological production of dominant species of *Phragmites australis* (Cav.) Trin ex Stend. и *Thypha angustifolia* (L.) within the “reed belt” for the period from 1986 through 1987 on the basis of the annual accumulation of vegetable biomass. In 1990 and 1991 Vassilev et al. (manuscript) carried out a research on the production of phytoplankton and the processes of degradation within the water column of Lake Srebarna, using the oxygen modification of the dark-and-light-bottles method.

Three main groups of producers are responsible for the synthesis of the primary organic production in the Srebarna ecosystems. The basic share is held by the so called “reed belt”, where the dominant associations are composed of *Phragmites australis* (Cav.) Trin ex Stend. and *Thypha angustifolia* (L.). According to data supplied by Baeva (1994) net production by the *Phragmites australis* association, covering 402 ha of the area of the Reserve, amounts to 1926 g of absolute dry biomass per 1 m^2 per year. Following the termination of the activity of Kamashit- Silistra in 1977 harvesting of this production is practically reduced to a zero. A considerable part of this organic matter sinks to the bottom of the lake and is accumulated there.

Another group of producers playing a significant part in the formation of the total net primary production within the Srebarna ecosystems are the phytoplankton organisms. According to Vassilev et al. (manuscript) net primary production per square meter of the water column (∑GPP) for the period from 1990 through 1991 varies between 1 and 4 g of organic carbon. m^{-2} .day^{-1} (an average of 2,33 g of organic carbon. m^{-2} .day^{-1}) or 850 g of organic carbon per square meter per year. For the same period the destruction of organic matter for the whole water column (∑R) was 10% less on the average. The metabolism of bottom sediments was not evaluated. If we assume that the average surface area of the lake water mirror is 1,5 km^2 (150 ha), then the total net primary production by phytoplankton for the whole area of the lake will amount to 1 275 t of organic carbon (to 2 560 t of organic matter) annually, and the net one – to 256 t of organic matter.

In other words 7 742 t of organic matter are accumulated within the reed belt of Lake Srebarna each year. If we assume, that the biomass from the 20 m wide reed ring surrounding the waterplane is accumulated in the lake, then around 85 t tons will sink to the bottom of the lake, in case the reed is not cut down and burned away, and around 256 t of organic matter synthesised by phytoplankton will also be deposited on the bottom. As a result, for the past 30 to 40 years a layer of sapropel and sludge over 1 m thick has been deposited on the lake bottom. As a whole the submerged macrophytes played a subordinate role as producers for the period of 1990 through 1991.

Actual State

The primary production of phytoplankton and degradation within the water column were evaluated monthly at four depths using the oxygen modification of the dark-and-light-bottles method ***(App. 1, Map 15).*** In contrast to the research carried out in 1990 and 1991 using the Winkler method, in 1998 and 1999 oxygen concentration was measured using the WTW-Multiline P4 apparatus. The daily cycle of oxygen within the water column was also measured. Concentration of Chlorophyll A was measured through the spectrophotometric method. Samples were taken monthly from the whole water column at points 1,3 and 5. Integrated assessment of light conditions in the water body was made on the basis of maximum depth of macrophyte colonisation. Transparency by the Sechi method is measured monthly at the five monitoring points.

The monitoring research carried out in 1998 and 1999 on the processes of production and destruction, concentration of assimilative pigments and photic conditions in the water of the lake reveals a considerably modified state. The Total (gross) primary production of phytoplankton per square unit during that period has been 3.3 times less compared to that production for the same months in the period of 1990/1991. The reduction of maximum net primary production per square unit is even more drastic – the decrease being by an order of magnitude. There is also a trend towards restoration of the balance between the processes of production and destruction. The production-degradation ratio ($\sum GPP/\sum R$) = 1.05. (between 0.56 and 1.63). All data synonymously reveal a reduction of the productivity of the water body ***(App. 9, Fig. 1)***.

Decrease of trophicity has been confirmed by data on the concentration of Chlorophyll A. For the period 1990 through 1991 the total concentration of Chlorophyll A was without any exception over 100-140 $mg.m^{-3}$, i.e. the water body was indisputably classified as hypertrophic. In 1998 concentration of chlorophyll (110-116 $mg.m^{-3}$) was typical of the dividing line between hyper- and eutrophy, while in individual occasions (September and October) it has been higher. The large-scale rush of the Danube water in the autumn of 1998 led to a reduction in the concentration of Chlorophyll A by another order and in a number of cases it was getting within the limits typical of mesotrophic water bodies ***(App. 9, Fig. 2)***. There is a steady tendency towards reduction of trophicity from hypertrophic to eu- and even mesotrophic. This tendency has been confirmed by the data for the transparency (the Sechi method), which was two to ten times higher (an average of 4-5 times) from 1990 till 1991.

In 1998 through 1999 *Ceratophylum* colonies were also observed in the main part of the lake at depths of up to 3 m, which indicates that despite the higher water level the photic zone occupies the whole water column ***(App. 9, Fig. 3)***. Alterations of maximum depth of colonisation as a long-term integral index, characterising the photic conditions of the lake, confirm the registered positive tendencies.

Monitoring studies on the intensity of the processes of production and destruction within the lake shall most likely continue in this way even after the project is over. Collection of bigger series of data shall allow for the more accurate evaluation whether the balance between production and destruction processes has been restored and, on the other hand, will reflect in due time the possible alarming trends as for instance an increase in the trophicity towards hypertrophy or significant disturbance of the balance between the basic biological processes.

A blank spot in our information currently remains the production of bottom macrophytes, although we can reasonably assume for the time being that it is negligibly small (especially in the main open water area). The exchange between water and sediments has not been measured directly.

1.13. Noteworthy Flora

1.13.1. Algae And Fungi (Incl. Lichens)

The information referred to below has been taken from the Synopsis on the Srebarna Biosphere Reserve (1998).

Algae

Stoyneva (1998a) found 1 123 taxa of algae (1 010 species, 75 varieties and 38 forms) within the territory of the Srebarna Biosphere Reserve. The best-studied ecological group is that of the phytoplankton (see Part 1.16.2.1) while the neuston, edaphyton and aerophyton are hardly ever studied.

Fungi

The checklist of this group, compiled by Denchev & Stoyneva (1998) includes 17 species of 16 genera, 10 families, 7 orders of 5 classes and 3 phyla. The species found represent different ecological groups from various habitats and hosts in the lake proper and in the Reserve buffer zone. However, it is obvious that further mycological investigations would reveal much greater species abundance. Special attention has also to be given to the fungi on the Danube island of Devnya, which belongs to the Reserve total area and has never been studied for this group.

Lichens

The lichens of the Biosphere Reserve Srebarna have never been studied thoroughly. Data presented were taken from Ivanov (1998), who has reported 15 species belonging to 5 families.

1.13.2. Vascular Plants

Historical Data Review

There are publications on the species composition of vascular plants within the lake by Petkov (1911) describing 31 species, Bonchev (1929) – 33 species, Yordanov (1946-1947) – 47 species, Ganchev (1957) – 40 species, Ivanov et al. (1964) – 34 species, Kochev and Yordanov (1984) – 72 species, Kochev (1987a,b) – 82 species, Baeva (1987, 1988a,b, 1992) – 139 species.

The 139 taxa of higher plants within Srebarna found so far belong to 45 families and 97 genera. According to Stoianov, Stefanov, Kitanov (1966 – 1967) the lake's floristic composition makes up 4.5% of Bulgarian flora, or 3.9% according to the Guide to the Vascular Plants (Andreev et al., 1992).
Srebarna gives home to 53% of the species, 75% of the genera and 78% of all plant families comprising the floral gene pool of the Bulgarian wetlands.

Actual State

For the purpose of this project the method of observation was used. The research was carried out through direct observation on previously appointed transsections. A map of scale 1: 5 000 was used. The pattern of floristic and phytocenological state of the Srebarna Biosphere Reserve ***(App. 1, Map 7)*** with a complete record of the diversity of species, together with the floristic, ecological, ecophysiological and seasonal analyses is the basis for the following conclusions:

- The Biosphere Reserve of Srebarna vegetation is composed of 139 species of vascular aquatic and hydrophilic plants.
- There is information on 18 other species in some sources that has not been confirmed yet.
- The species *Ranunculus lingua* found within the Reserve in 1975, has not been confirmed again since 1980.
- 9 of the total number of species are protected under the Environment Act.
- 13 species of the Srebarna Biosphere Reserve flora are included in the Red Book of Bulgaria.
- Three of the species included in the Red Book of Bulgaria have not been confirmed again since 1975.

- Two of the species typical of the flora of Srebarna are included in the European List of Threatened, Rare and Endemic Plants in Europe.
- Relic and endemic (Bulgarian and Balkan) species of higher plants are not present within Lake Srebarna (the Tertiary relic *Trapa natans* has not been confirmed for the flora of the Reserve. Petkov, 1911 and Ivanov et al., 1964 mentioned its presence within Srebarna).
- No mass growth of *Telipteris palustris* on the floating reed islands was observed since 1996 under the new parameters of the hydrological regime.
- The association of *Nymphaea alba* is degrading. At present it is represented by groups consisting of separate individuals in the western and southeastern part of the lake. Annual observations reveal no fatal deviations in its seasonal dynamics. At the time of its peak growth a slight reduction in the number and frequency of some the concomitant species is observed.
- *Najas marina, Najas minor, Sagittaria sagittifolia* forma *valisneriifolia, Caltha palustris subsp. cornuta, Aldrovanda vesiculosa* have not been observed since 1989.
- More and more seldom and in alarmingly reduced numbers one can find the populations of the following species *Utricularia vulgaris, Utricularia australis, Sonchus palustris, Bidens cernua, Bidens tripartita, Stachis palustris, Teucrium scardium, Galium palustre, Lysimachia vulgare, Calistegia sepium, Oenanthe aquatica, Sium latifolium, Epilobium hirsutum, Lithrum salicaria, Rorippa amphibia, Persicaria hydropiper, P. minor, P. Lapatifolia.*
- Changes in the abundance and frequency of some of the species, participating in the reed cenoses are due to different seasonal levels of the water of the lake. This is the most likely reason for the absence of some species not only during the spring sinusium, but also during the peak months of the vegetation season, and especially of those species, inhabiting the former floating dry reed islands (the so called "kochki").
- The *Phragmites australis - Telipteris palustris* association, considered rare, shows no significant seasonal fluctuations under the conditions of a disbalanced hydrological regime.
- There is degradation of the cenoses of *Azola filiculoides* and also a sharp reduction in the numbers and density of its populations within other associations in which it forms a part.
- Stabilization of the numbers of the Narrow-Leaved Rush within the *Typha angustifolia - Schoenoplectus lacustris* association is observed, but not of Reed, Bulrush and Wide-Leaved Rush that also take part in forming the above association.
- The increase of the ruderal element in the peripheral areas of the Reserve and their having penetrated deeply into the Reserve territory comes as a result of the antropophytic overloading of the peripheral areas. There are no Bulgarian and Balkan endemic and relict species within the territory of the lake.
- A map showing the distribution of the main phytocenoses within the area of the lake and signifying the localities of the most rare and endangered species was drawn up.

1.13.3. Forests And Arboreal Plants

Historical Data Review

According to the “Geobotanical division of Bulgaria” (Bondev, 1997) the territory of the Srebarna Reserve is located in the region of Silistra and represents a part of the Eurasian Steppe and Forest-Steppe Area, the Lower Danube Province, District of Dobrouja.

The Srebarna Reserve and its buffer zone lie within the area run by the Silistra Forestry. The last Forest Management Plan (FMP) has been worked out in 1989; the next and new one is due in 2001.

According to the current forest management plan the Reserve and the Danube protective strip encompass the forestry sections 13 and 14 with a total surface area of 74.0 ha ***(App. 1, Map 3)***. The buffer zone encompasses the forestry sections 49, 50, 51, 52 with a total area of 202.5 ha. In the Reserve's immediate vicinity there are woods that belong to the Agricultural Land Fund and are designated for commercial use. However, it is our opinion that they have direct bearing to the Reserve and its hydrologic conditions. These are forest section 1, part of section 5 (subsections a, b, c, d) and section 6 with a total area of 115.7 ha ***(App. 10, Table 1)***.

Actual State

For the purposes of this study the method of observation was applied. Observations were made by walking along routes of preliminary laid down transsections. We have also used information from forest management plans worked out in 1979 and in 1989 (App. 9) together with the maps attached to them.

The River Danube And The Reserve Protective Strip:

Forest stands that belong to the Reserve and to the Danube protective strip are in forestry sections 13 and 14 and are of economic class Special Purpose Poplar Stand. The type of habitat is M-I-1, D-2,3 (flooded, fresh to humid, on alluvial soils – the typical poplar one). The afforestation with hybrid poplar saplings of type 'u 214' was done according to the schedule 5X4. The spacing index of the plantations (measured as the proportion of the total surface area of the cross-sections of all the trees and the unit area on which they grow, in square meters) varies from 0.7 to 1.0 with the exception of forest section 13 which is a low-density plantation. The state of the plantations is good. According to the forest management plan these plantations were intended for intensive use and turning into pure poplar ones.

Reserve Buffer Zone:

The species composition within the Reserve is diverse and includes both local and introduced, alien for this region, species like the Austrian pine, the Black Locust, and the Honeylocust. Black Locust forestation activities carried out several years ago have completely altered the appearance of the forests surrounding the Reserve. At present more than 30 % of the area of the buffer zone is occupied by this species. It should be noted that this is quite an aggressive species, spreading very easy and fast. According to the guidelines laid down in the Forest Management Plan all forestry sections with Black Locust rated 10 (stands consisting entirely of Black Locust) have been planned for a clear felling and a follow-up reconstruction with Raywood Ash (*Fraxinus oxycarpa*), Silver Lime (*Tilia argentifolia*), Turkey oak (*Quercus cerris*), Durmast Oak (*Quercus sessiliflora*). From the on-site survey we carried out we have found such sites of clear felling and consequent planting with Durmast Oak in several forestry sections.

Section 49

This section includes plantations and sucker forests (the area is 85.8 ha) belonging to economic classes: Deciduous low-stemmed, Deciduous high-stemmed, Coniferous (in two subsections), and Special Function Forests – those in the Reserve buffer zone. The Austrian Pine is planted by man and occurs in two subsections, "b" and "d". Afforestation was carried out 30 years ago to strengthen the slopes. In those times it was a quick effect that was sought by creating an Austrian Pine plantation. According to the forest management plan the only management activity accomplished in these pure Austrian pine plantations has been the thinning-out, which is believed to have brought local species to settle as undergrowth. The pure Black Locust stands cover a total area of 40.1 ha which makes up almost half the area of this forestry section. These subsections have also been intended for a clear felling with consecutive reconstruction with Silver Lime, Raywood Ash, Turkey Oak And Durmast Oak by mixing in groups. Dominating spacing index of the stand is 0.9. Types of habitats are M-I-2, D-2 (flat and on slopes, fresh on carbonate Haplic Chernozems) rarely D-1 (dry on Haplic Chernozems). The state of plantations is from good to average, from 1st to 4th class of productivity.

Section 50

The area of this section is 41.3 ha. It includes forest plantations and sucker forests of economic (commercial) classes Deciduous low-stemmed, Deciduous high-stemmed, as well as Coniferous (subsection 50-c). The state of plantations may be determined as good to average. Austrian Pine occurs only in one subsection mixed with Silver Lime, Sycamore, Ash and Durmast Oak on an area of about 7.1 ha. Here the forestry measure undertaken was landscape felling to thin out and lighten the forest. Pure Black Locust plantations predominate on a total area of 28.8 ha and are intended for reconstructing with local tree and shrub species following a clear felling. The spacing index is predominantly 0.9 with the exception of subsection 50-g – a thinned-out plantation (0.3) in a poor state. Types of habitats are M-I-2, D-1 and 2 – flat and on slopes, dry and fresh on carbonate Haplic Chernozems.

Types of habitats are M-I-2, D-1 and 2 – flat and on slopes, dry and fresh on carbonate Haplic Chernozems.

Section 51

Here again in this section with a total area of 47.4 ha the stands are plantations and sucker forests of economic classes Deciduous high-stemmed and Deciduous low-stemmed forests. Here again the pure Black Locust plantations predominate covering a total of 33.4 ha, and are also intended for a full reconstruction, not yet accomplished. At present their state may be determined as of 3rd and 4th class of productivity. Planned measures for the remaining stands of mixed high-stemmed broad-leafed plantations are landscape and sanitary felling. Their state is good. Predominating spacing index is 0.9 (between 0.5 and 0.9). Types of habitat are M-I-2, D-1 – flat and on slopes, dry, on carbonate Haplic Chernozems.

Types of habitat are M-I-2, D-1 – flat and on slopes, dry, on carbonate Haplic Chernozems.

Section 52

The total area of this section is 28.0 ha. Pure and mixed plantations of Austrian Pine with some participation of Sycamore, Silver Lime And Raywood Ash dominate over 21.2 ha. Only sanitary felling was planned for this plantation. The rest of this section area, totalling 4.6 ha, is covered by Black Locust sucker forest that has occupied the area after a non-reconstructed (or maybe not well reconstructed) clear felling. It has been planned to completely reconstruct these plantations by the end of the period (i.e. the year 2000). Predominant spacing index is 0.9.

Types of habitats are M-I-2, D-1 – on the plain and on slopes, dry, on carbonate Haplic Chernozems.

Forests Within The Agricultural Lands**:**

According to the forest management plan of 1989 those forests do not belong to the Reserve buffer zone and are not forests of special function but for commercial use only. These are mostly man-made plantations – of hybrid poplar, pure black locust stands, mixed Black Locust and Silver Lime plantations. They are located immediately by the Reserve boundaries and it is our opinion that they influence in a direct way the Reserve hydrological conditions. Immediately by the bridge over the rivulet Srebarnenska along the riverbed in the southwest direction our survey found a poplar plantation in a good state, which was not shown on the management plan maps. This plantation, at an age of about 15 years covers an area of about 12 ha. Here we are going to comment on forest sections 1, 5 (subsections a, b, c, d) and 6, which have some relation to the Reserve. The state of plantation is good except section 1, subsection 'g' which was in poor condition. Predominant spacing index is 0.8 (between 0.5 to 1.0). Most of the Black Locust stands are planned for clear felling. Types of habitats are M-I-1, D-2, 3.

1.14. Noteworthy Fauna

1.14.1. Invertebrates (Helminths And Insects Excluded)

Historical Data Review

Data on the non-insect invertebrate animal's diversity in the Biosphere Reserve Srebarna are available in 74 papers, mostly by Bulgarian authors. The first two articles were by Chichkoff (1909) on free-living Copepod crustaceans and by Consuloff (1912) on Rotifers.

Research on invertebrate fauna of the Reserve was urged mainly by two factors. The first was that the relatively extensive hydrobiological investigations into the lake ecosystems have revealed the importance of several groups of animals for the species composition of the zooplankton (crustaceans, rotifers), the phytoplankton (mastigophoran protozoans) and the zoobenthos (oligochaetes, nematodes, aquatic molluscs and crustaceans). The latter was the fact that in 1962 a natural focus of the 'rabbit fever' (Tularemia) and some other diseases of importance to humans and animals were discovered within the boundaries of the Reserve. This provoked extensive epizootological and parasitological studies resulting in abundance of data on helminths, parasitic protozoans and arthropods. Parasitological studies have also supplied data on several invertebrate groups, which were intermediate hosts for parasites (e.g. terrestrial oligochaetes and molluscs).

The only attempt to summariz

e data on the species diversity (including non-insect invertebrate groups) of the Srebarna Biosphere Reserve is the checklist by Michev et al. (1998). The relevant parts of the chapter on invertebrates (edited by this author) were written by leading Bulgarian experts on each group.

Actual State

Most of the data given below are based on parts of the above-mentioned chapter on invertebrates from the work of M i c h e v et al. (1998). A report, especially prepared for the purposes of this management plan by T. Genov, V. Y. Biserkov and B. B. Georgiev entitled *Helminth parasites as a biotic factor affecting the vertebrate animal populations in the Biosphere Reserve Srebarna* was also incorporated (see 1.18.2).

Assessment of the knowledge on any given group of invertebrates from the Srebarna Biosphere Reserve was based on the approximate estimate of the expected number of species. Generally, it was either taken in a ready-made form from the relevant publications, or was arrived at after consultations with an expert on the relevant groups. The 20 invertebrate phyla given below either have been already recorded or may occur in the Srebarna Biosphere Reserve. They are: Sarcomastigophora, Apicomplexa (=Sporozoa), Microspora, Ascetyospora, Myxozoa, Ciliophora, Spongia, Coelenterata, Platyhelminthes, Rotifera, Gastrotricha, Nematoda, Nematomorpha, Acanthocephala, Mollusca, Annelida, Arthropoda, Tardigrada, Pentastomida and Ectoprocta. The number of species recorded in the Reserve and the number of species expected to be found there are shown in ***App. 11***. It is apparent from it that data are available only on 10 of all the 20 phyla that may be found in the Reserve.

Here below are the comments on the species diversity and the degree of our knowledge on some of the groups.

Phylum Sarcomastigophora. Autotrophic species of the subphylum Mastigophora are a well-studied group for the Reserve as they are considered algae and make up a substantial part of the lake phytoplankton (see Stoyneva, 1998). Species known as flagellate sarcomastigophorans all belong to the algal divisions Euglenophyta with 154 species recorded from the Reserve, and Cryptophyta with 19 species along with some taxa belonging to the algal divisions Chrysophyta (49 species), Pyrrhophyta (16 species) and Chlorophyta (55 species). The total number of the species pertaining to this group and found in the Reserve is 293. Though species diversity of the plankton flagellates has been thoroughly studied, it is quite possible to find new species when dealing with some of the so far unstudied ecological groups like neuston, edaphophyton, aerophyton, etc. (Michev et al., 1998). There are no information on parasitic and commensal flagellates occurring in vertebrate and invertebrate hosts in the Reserve. There are no data on another two phyla, Opalinata (parasites of cold-blooded vertebrates, 1 to 10 expected species) and Sarcodina (free-living and parasitic, 100 to 500 expected species).

Phylum Apicomplexa (= Sporozoa*)* includes parasitic protozoans only. The species diversity of the coccidian parasitic in small mammals (rodents and insectivores) has been studied almost in full (14 species, see Golemansky, 1998). The following 3 species were originally described on specimens collected in Srebarna Biosphere Reserve: *Eimeria arkutinae* Golemansky, 1978, *Eimeria micromydis* Golemansky, 1978 and *Isospora talpae* Golemansky, 1978. Srebarna Biosphere Reserve is the only known locality for *Eimeria micromydis* in the world. There are no data on sporozoan parasites in other vertebrate and invertebrate groups occurring in the Reserve or its vicinity.

Phylum Myxozoa. A single species was recorded for the Reserve (Margaritov, 1959; Golemansky, 1998). The abundant fish fauna of Srebarna Lake is a pre-requisite for a relatively diverse species list of myxozoan parasites in fishes (up to 20 expected species).

Phylum Ciliophora (Cilian protozoans). There are no records of cilian protozoans in Srebarna. Numerous free-living species (both aquatic and soil) and parasitic or commensal on/in fishes, mammals and invertebrates are expected (up to 200 species).

Phyla Spongia, Coelenterata, Gastrotricha, Tardigrada and Ectoprocta. No research was ever conducted on these groups in Srebarna Reserve. Members of these groups are frequent components of temperate freshwater ecosystems. Further hydrofaunistic studies may reveal their presence in the lake. Gastrotricha and Tardigrada are generally poorly known in Bulgaria as there are no experts on these groups in the research institutions of the country.

Phylum Platyhelminthes includes free-living, mostly benthic (Class Turbellaria) and parasitic organisms (Classes Monogenea, Trematoda and Cestoda). There are no records on turbellarians from Srebarna; between 5 and 10 species may occur in the lake ecosystem. The parasitic flatworms are represented by 117 species: 49 cestodes and 68 trematodes. The trematode *Troglotrema srebarni* Genov, 1964 and the cestodes *Paranoplocephala aquatica* Genov, Vasileva & Georgiev, 1996, *Catenotaenia matovi* Genov, 1971 and *Hilmylepis prokopici* Genov, 1970 were originally described from Srebarna Biosphere Reserve. The number of expected platyhelminth species might exceed 300 to 500.

Phylum Rotifera. Only 18 species of planktonic rotifers have been studied so far (see Naidenow, 1998). No data are available on the soil representatives of this group.

Phylum Nematoda (Nematodes, Roundworms). Represented by 106 species-group taxa in Srebarna Reserve. These include three major ecological groups: benhtic (9 species, see Stoychev, 1998), soil (16 species, see Peneva, 1998) and zooparasitic nematodes (81 species, see the survey by Genov & Georgiev, 1998). Each of these groups should be further investigated. The number of the expected species may be 5 to 10 times higher. The zooparasitic nematode *Paracrenosoma kontrimavichusi* Genov, 1978 was originally described from Srebarna Reserve. For further comments on parasitic nematodes see 1.18.2.

Phylum Molusca (Moluscs). Two ecological groups occur in the Reserve. The freshwater moluscs numbering 29 snails and 12 bivalve species are well studied and no new species are expected (Angelov, 1998). Information on the diversity of terrestrial snails is limited (see Dedov, 1998). Two freshwater species occurring in the Reserve, the snail *Segmentina nitida* and the bivalve *Unio crassus,* are included in the European red List of Globally Threatened with Extinction Animals and Plants (1991).

Phylum Annelida. As a whole, the group is poorly known from the Reserve. There are data on 26 oligochaete species (Uzunov, 1998) and 3 leeches (Vidinova, 1998). The leech *Hirudo medicinalis* is included in the *European Red List of Globally Threatened with Extinction Animals and Plants (1991)*. The expected total number of annelids in the Reserve is probably not less than 50 species.

Phylum Arthropoda (for insects see 1.14.3.). There are 171 species known from the Reserve. The species diversity of the planktonic branchiopod and copepod, and the benthic ostracod crustaceans is relatively well studied (see Nadenow, 1998). Information on higher crustaceans has been gathered sporadically (Andreev, 1998). Terrestrial non-insect arthropod species are presented by 2 opiliones (Mitov, 1998), 57 spiders (Deltschev and Blagoev, 1998) and 65 mites and ticks (Dobrev, 1998). It is expected to find many new species belonging to all these groups. Data on myriapods and terrestrial isopods are not available. The expected total number of this group is between 500 and 1000 species.

On the basis of data specified above the following conclusions may be drawn:

1. The knowledge on the non-insect invertebrate fauna of Srebarna Biosphere Reserve should be considered as insufficient and a preliminary one. The known number of species (803 species) appears to be only 15% to 30% of their expected number in the Reserve ecosystem. Some major invertebrate groups have never been studied or, at least, have not been sufficiently studied. These are: the free-living protozoans; the parasitic protozoans of fishes, birds and invertebrates; hydrozoans; free-living flatworms; helminth parasites of fishes and many birds; soil nematodes; terrestrial gastropods; terrestrial oligochaetes; myriapods; terrestrial isopods.

2. The major gaps in knowledge are due to the scarcity of faunistic data on the groups mentioned above and to the lack of quantitative assessment of invertebrate populations. Extensive studies on the fauna and ecology of invertebrate animals in the Reserve should be carried out.

3. The value of Srebarna Biosphere Reserve for the biodiversity conservation both on a national and a global scale is mainly related to its importance for the protection of ecosystems, typical for the Lower Danube freshwater wetlands. It is further enhanced by the considerable species diversity of the non-insect invertebrates, the fact of three species of them (2 molluscs and 1 annelid) being included in the *European Red List of Globally Threatened with Extinction Animals & Plants (1991)* and by the fact that 8 species (3 protozoans, 3 cestodes, 1 trematode and 1 nematode) were originally described on specimens from the Reserve and for one sporozoan species the Reserve is the only known locality in the world. The above species were found in Srebarna in the period of 1964 through 1966. This is

an indication that more new members of the global species diversity may exist in the Reserve among the poorly studied groups.

1.14.2. Helminths

Historical Data Review

Results from helminthological studies carried out in the Srebarna Biosphere Reserve are reported in 33 publications. The first reports were on helminth parasites of Pelicans and White Storks (Yanchev, 1958). Detailed helminthological investigations were carried out on small mammals only. Two monographs (Procopic & Genov, 1974 and Genov, 1984) were based on the results from these. The host groups listed below have been studied sporadically: fishes (Margaritov, 1959), frogs (Boschkow, 1965), reptiles (Biserkov, 1989), birds (Kornyushin et al., 1984), artiodactyls (Genov, 1971b) and carnivores (Genov, 1971c). Data from literature have been summarized by Michev et al. (1998). A total of 204 helminth species have so far been recorded from Srebarna: 49 cestodes, 68 trematodes, 81 nematodes and 6 acanthocephalans. As a whole, the group has not been adequately studied and further investigations may significantly lengthen the list of species. It might be expected that the longest list of new species will be the one of trematode and cestode parasites of birds and fishes. Probably the overall number of helminth species found in vertebrates from the Reserve may exceed 300.

Actual State

The present evaluation is based mainly on the summary of all available publications. Two on-site helminthological studies were carried out in 1998 and 1999.

Helminths represent a major biotic factor within the ecosystems of the Reserve. In cases of massive infestations, they cause severe health problems in both wild and domestic animals and in humans. Their diversity is very great in wetlands and freshwater basins. The helminth parasites are substantial biotic factor in all ecosystems of the Reserve. In a number of cases they are agents of parasitic diseases, and at times parasitic infestations may prove fatal. Besides, infested animals are very vulnerable to the negative combined effects of the parasitic worms and other pathogenic agents. Some parasitic larvae are very dangerous because their life strategies are directed to changing the host behaviour in such a way as to render it an easy prey for carnivores. This is usually caused by larvae inflicting damages to the nervous system, eyes, muscles, swim bladder of fishes, etc. From the point of view of human medicine the hydatid tapeworm (*Echinococcus granulosus*) represents a hazard. It causes one of the most significant helminthoses.

Helminth parasites indisputably affect all vertebrate animals in wetlands like Srebarna. Means available for reducing the influence of parasites through this Management Plan are limited but their implementation is realistic. Regarding this control it should be noted that the relation between biodiversity and the helminth influence on populations of the final hosts is of utmost importance. Two of the aspects of this relation are of a great significance: (1) It is a known fact that the increase in the biodiversity leads to the stabilization of infestation parameters thus limiting the cases of extremely high infestation levels. (2) The high degree of system biodiversity is a pre-requisite for a high helminth diversity, which results in competitive interactions at the level of the intermediate hosts, rarely at the level of the final hosts. These competitive interactions also limit the helminth infestation to a certain degree.

Another important relation is the ratio between the degree of the eutrophication of the water body and the parameters of helminth infestation in it. In the course of successions as the one now observed in the Reserve, the rule is that the high level of eutrophication results into suitable conditions for the helminth circulation, respectively into a stronger impact on the host populations.

The impact of the helminth parasites is often combined with the impact of other biotic and abiotic factors. The food resources available to the hosts are very important. Among starving animals the negative effects are more pronounced in those infested by helminth parasites.

1.14.3. Insects

Historical Data Review

Studies carried out so far on the insect fauna of the Reserve (with the exception of two groups of insects) are partial and insufficient. This was the main difficulty in making an overall assessment of the species abundance, biodiversity and the extent of human impact. The most complete faunal synopsis was made in the species checklist (Michev et al., 1998). According to this work the total number of insects found so far is about 560 species belonging to 9 orders and nearly 80 families:

Ephemeroptera –	1 species (Vidinova, 1998)
Odonata –	35 species (Beshovski &Marinov, 1998)
Mallophaga –	7 species (Georgiev, 1998)
Anoplura –	3 species (Georgiev, 1998)
Coleoptera-	298 species (Kodzhabashev & Penev, 1998)
Hymenoptera –	8 species (Stoyanov, 1998)
Siphonaptera –	18 species (Vasileva & Georgiev, 1998)
Diptera –	13 species (Michailova, 1998)
Lepidoptera –	105 species (Beshkov, 1998)

Actual State

The only group of terrestrial insect that is well studied and can be used as a model for typifying the strato- and epigeobiotic habitats of invertebrate land animals are the Carabid, or Ground Beetles (family Carabidae). Representatives of this group have been successfully used as bioindicators and for monitoring of the animal communities in a work of recording the extent of human impact and of finding and predicting ecological trends and changes in the succession.

The study of the contemporary state of the epigeo- and stratobiotic invertebrate fauna as well as its assessment from community point of view has been performed by the method of pitfall traps with monitoring group the family Carabidae (Carabid, or Ground Beetles). During the study 150 traps were set in 6 different land habitats for a period of 24 months. Each month (winter period excepted) we collected biological material from the traps. The software used for processing and analysing results from the terrastic monitoring were BIODIV, CANOCO and TWINSPAN.

The two-year Carabids-community monitoring carried out in the area of the Reserve gave us the opportunity to find a number of ecological regularities and to predict trends in the succession of the land ecosystems in the Reserve and its buffer zone. The habitat- and ecosystem typifying of the epigeo- and stratobiotic insect fauna has been made with the help of cluster- and structure- multidimensional analysis while the extent of human impact has been measured with the help of a system of ecological indicators and coefficients in reading various biotic parameters of alpha and beta diversity.

The main types of terrestrial habitats found in the region may be classified into 6 categories of habitats.

- Insects inhabiting the mixed deciduous forest ecosystems;
- Insects inhabiting the dry steppe grassy plant communities;
- Insects inhabiting the meadow- and hygrophilic plant communities;
- Insects inhabiting hygrophilic tree communities;
- Insects inhabiting hydrophilic plant communities;
- Insects inhabiting open areas around water bodies.

The lack of thorough field studies and the limited available information on most of the insect groups do not allow us to make a full assessment of the Reserve role with regard to conservation of rare and endangered species of insects as well as of the importance of the taxonomic group (Class) for maintaining the biological equilibrium.

1.14.4. Fish

Historical Data Review

Indirect information on the fish populations inhabiting Srebarna Lake till the beginning of the 1950-s can be found in research publications concerning the lake ichthyofauna and fisheries in the river and adjacent basins (Antipa, 1909; Ivanov, 1910; Kovachev, 1922; Morov, 1931; Bacescu, 1942, Drensky, 1951). Bulgurkov (1958) carried out the first more extensive ichthyological study of Srebarna Lake in 1952 through 1953. According to his data and the information from official fishing statistics (Statistical information of the town of Rouse Inspectorate of Fishing – quoted after Bulgurkov, 1958), the lake was extremely rich in fish and fishing was an important means of livelihood for the local people. For the years that follow Bulgurkov's work there are data only on the species composition of fishes from occasional observations related mainly to the fish-eating birds' feeding habits (Michev, 1968; Michev, 1981; Michev et al., 1993; Karapetkova, 1998) ***(App. 12, Table 1).***

Actual State

Ichtyological material collected in the spring, summer, autumn and winter of 1998 and 1999 collected with the help of net instruments and fishing rods was analysed. Information was supplied by officers and workers with the Reserve Administration, by local people and by associates with Central Laboratory of General Ecology Field Research Station.

In the lake proper 18 species of fish belonging to 6 families were found ***(App. 12).*** All of them are representatives of the Danube fish fauna. On the first place by the number of species is the family Cyprinidae. The most numerous species are the Goldfish (*Carassius auratus gibelio*), the Roach (*Rutilus rutilus*), the Rudd (*Scardinius erythrophthalmus*) of the family *Cyprinidae* and the Redfin Perch *(Perca fluviatilis)* of the family Percidae. As was in the past so at present the numbers of the Northern Pike (*Esox lucius*) of the family Esocidae remained comparatively high. Potential inhabitants of Srebarna Lake are two species of Gobies – *Neogobius fluviatilis* and *Neogobius melanostomus* (family Gobiidae) – caught in the canal outside the lake proper. Occasionally single Silver Carps (*Hypophthalmichthys molitrix*) and Rapacious Carps (*Aspius aspius*) have been observed.

Six of the observed species are protected under the Bern Convention: *Aspius aspius, Chalcalburnus chalcoides, Leucaspius delineatus, Rhodeus sericeus amarus, Misgurnus fossilis and Pungitius platygaster*, listed in App. III thereof. In the National Strategy for Biodiversity Conservation the Danube bleak *Chalcalburnus chalcoides* is classified as a species rare for Bulgaria, the Belica *Leucaspius delineatus* as medium rare, and the Southern

Ninespine Stickleback *Pungitius platygaster* as extremely rare. Those same species were listed in the Red Book of Bulgaria as "endangered". No special measures for preserving these species have been taken so far.

Thirteen out of the 18 species found in the lake are potentially subject to commercial or sporting fishing. They are: *E. lucius, St. lucioperca, C. carpio, A. brama, T. tinca, C. a. gibelio, H. molitrix* и *A. aspius, P. fluviatilis, A. alburnus, R. rutilus, Sc. erythrophthalmus* and *N. melanostomus.*

Srebarna ichthyofauna is composed mainly of I and II order consumers which are the main intermediary link in the trophic structure of the ecosystem. Their staple diet are the macrophytes consumed directly or in the form of detritus and the zoobenthos. Final consumers in the ichthyofauna are represented by the Northern Pike, mature Redfin Perches and the Pike Perch, though the latter is a rather scarce species. For the ecosystem as a whole final consumers are various species of fish-eating birds, otter and man. Main resource for all groups of final consumers are most of all the abundant species of Cyprinids and Percids and for man also the Pike.

Fish are an important link in the energy-transfer along the detritus food chain. Their participation in the grazing one is comparatively weak. They obviously can limit the abundance of certain groups of bottom-dwelling and phytophyllic invertebrate animals (insect larvae, oligochaet worms, cladocerans of the family Chydoridae) but they are not crucial for the development of pelagic plankton in the parts of the lake with open water.

The relatively numerous small-sized fish provide a good feeding grounds for the Pike and the other fish-eating fishes being at the same time easily available food resource for the fish-eating birds.

Populations of all valuable as a natural resource species (i.e. from commercial point of view) in Srebarna, with the exception of the Pike, are relatively sparse and unstable. With most of them the low numbers are due to the intensive illegal fishing with nets and with cyprinid fishes in particular, a destabilizing factor of importance is the insufficiency of adequate nourishing food. Populations of less valuable species like the Roach, Rudd, Goldfish and Redfin Perch are numerous but the size of individual fishes is small. With the exception of the Rapacious Carp the populations of rare and endangered species, though not numerous are stable and probably they have not undergone any significant fluctuations in recent years. Most of the found species also reproduce in the lake. The Silver Carp and the Rapacious Carp definitely do not spawn here while for the Carp, Bream and the Pikeperch the question of reproduction has not been answered yet.

Species occurring in Srebarna in very big numbers like the Pumpkinseed and the Bleak inhabit both the main body of the lake and the peripheral pools. The greater part of the fishes school together mainly in the shallower and close to the shore parts of the lake, overgrown with submerged aquatic vegetation (*Ceratophyllum sp.*). Open water areas of the main water body are scarcely populated by fish.

1.14.5. Amphibians

Historical Data Review

Amphibians in Srebarna Reserve have not been a subject of special research. Data published so far have been summarized in the checklist by Michev et al. (1998). They were in 7 publications on various topics containing also some information on the amphibians in Srebarna (Beshkov, 1965, 1972; Beshkov & Beron, 1964; Bozhkov, 1965; Ivanov et al. 1964; Michev et al., 1993; Paspaleva-Antonova, 1961).

Actual State

Twelve species of amphibians have so far been recorded for the Reserve (Michev et al., 1998), of them the Syrian Spadefoot Toad *(Pelobates syriacus)* was reported by Michev et al. (1998) for the first time.

The importance of this group for Srebarna Biosphere Reserve is determined by the fact that there is one species, the Syrian Spadefoot Toad (*Pelobates syriacus*), included in the Red Book of Bulgaria and eight more species protected by the Bulgarian Law. These latter are: the Danube Crested Newt (*Triturus dobrogicus*), the Common Newt (*Triturus vulgaris vulgaris*), the European Fire-bellied Toad (*Bombina bombina*), the Yellow-bellied Toad (*Bombina variegata*), the Common Spadefoot (*Pelobates fuscus*) the Common Spadefoot Toad (*Bufo bufo bufo*), the Green Toad (*Bufo viridis viridis*) and the Common Tree Frog (*Hyla arborea arborea*).

The most abundant and most significant are the water frogs *Rana ridibunda* and *Rana esculenta*. They are a food source for many predatory fishes, Grass Snakes, birds, insectivore and carnivore mammals. The proportion of these species of frogs in the diet of the above mentioned predators increases by the end of their period of metamorphosis when they shift from aquatic to a terrestrial way of life. Amphibian larvae on their part are a food source for a considerable range of aquatic birds. At the same time frogs and toads themselves consume large amounts of arthropods, mainly insects. The tadpoles are exclusively herbivorous, eating algae and vascular aquatic plants.

1.14.6. Reptiles

Historical Data Review

There are no special publications on reptiles of Srebarna Reserve. Data published so far have been summarized in the checklist by Michev et al. (1998). These are contained in ten previously published works on other aspects of Srebarna (Beshkov, 1984, 1986; Beshkov & Beron, 1964; Biserkov, 1987, 1989; Genov, 1969; Ivanov et al., 1964; Michev et al., 1993; Paspaleva-Antonova, 1961).

Actual State

Two expeditions for field observations and data collection were carried out. Fifteen species of reptiles have been recorded for the Reserve. Five of them are mentioned by Michev et al. (1998) for the first time. In addition in 1999 a new species for the Reserve area, the Slow Worm (*Anguis fragilis),* was found in the forest along the Danube riverside.

The importance of the group for the Reserve is determined by the fact that it includes a species listed in the UICN Red Data Book and in the Red Book of Bulgaria - the Aesculapian Snake *(Elaphe longissima).* Another six species are protected by the Law: Spur-thighed Tortoise *(Testudo graeca),* European Pond Terrapin *(Emys orbicularis*), Green Lizard *(Lacerta viridis),* Large Whip Snake *(Coluber jugularis),* Smooth Snake *(Coronella austriaca*), Bulgarian Ratsnake *(Elaphe quatuorlineata sauromates).*

There are only 3 reptile species, which are widespread in the Reserve: the Grass Snake (*Natrix natrix*), the Dice Snake (*Natrix tesselata*) and the European Pond Terrapin (*Emys orbicularis*). The remaining species occur mainly in the Reserve periphery of the Reserve. **As a whole, the reptiles do not play a role of any significance in the Reserve ecosystem functioning.**

Observations of new species of reptiles in the fauna of the Reserve are most unlikely under the present conditions. The only species, which might be found there is the Sand Lizard (*Lacerta agilis*).

The knowledge on reptiles of the Srebarna Reserve can be defined as incomplete and initial. It is necessary to carry out further investigations on the population dynamics of each species.

The main deficiency in the knowledge on the group is the lack of quantitative data on reptile populations.

1.14.7. Birds

Historical Data Review

Srebarna Lake drew the attention of a number of European and Bulgarian ornithologists as early as in the middle of the last century. The most exhaustive scientific work on the Reserve avifauna was published by Paspaleva-Antonova (1961). The list of research and scientific literature on Srebarna avifauna comprises 77 titles (Michev et al., 1998).

Birds are by far the most significant biological group in Srebarna Reserve. Thanks mostly to them, and to Dalmatian Pelicans, in particular the Reserve earned its present worldwide fame. The rare and threatened by extinction species on a local, national, regional and global scale increase considerably the value of Srebarna as an important place for preserving Earth’s biodiversity. Other species of birds on their part are valuable nature resource or are valuable as subject of the cognitive tourism.

The Reserve bird species composition is determined to a large extend by its bio-geographic location. The number of bird species found in the Reserve and its vicinities is 223, or 55% of the total of 400 species found so far for Bulgaria. Fifty-four of them are breeding and 2 of these – the Dalmatian Pelican and the Great White Egret breed only in Srebarna. Another two species, the Pygmy Cormorant and the Ferruginous Duck have one of their most important breeding grounds there, while the Red-breasted Goose has in Srebarna one of its most important wintering grounds.

Srebarna avifauna conservation status is as follows: the number of protected species is 195; species listed in The Red Book of Bulgaria are 57; globally threatened species are 12.

Actual State

The changes in the Reserve avifauna for the past 20 years have been reviewed for three major periods:

- 1980 through 1990 – a period of relatively normal state of the Reserve ecosystem, Danube waters have entered the lake several times in spring periods;
- 1991 through 1994 – a period of reduced water volume of the lake, high eutrophication and complete isolation from the Danube;
- 1995 through 1998 – a period of restoring the Reserve normal state; entering of Danube waters via an artificial canal constructed in 1994.

In all three above periods the species composition of the breeding birds in the Reserve has been studied in May-June using one and the same technique – by visual observations from the west and south banks of the lake. An overview of the results is given in *Fig. 1, App. 14.* As may be seen on that figure, during the second one of the above periods, when ecological conditions in the Reserve were extremely unfavourable, the number of the observed bird species was very low. During the third period, when the connection of the lake with the Danube was restored and negative factors removed, the usual number of bird species has recovered to a great extends too. The numbers of the Dalmatian Pelican *(Pelecanus* *crispus)* varies greatly during all three periods but recently it showed a tendency for increasing *(App. 14, Fig. 2).*

Another important change in the Reserve avifauna for the past 20 years has been related to the species composition of Cormorants, Herons & Egrets, Glossy Ibis and Spoonbill. According to M i c h e v & S t o y n e v a (1994) these species and most of all the Glossy Ibis can be used as biological indicators for the overall state of wetlands in general and Srebarna in particular. During the first of the above periods both species bred in the two large reed-beds (north and south ones) in the Reserve. During the second period Cormorants and Herons/Egrets (with the exception of Glossy Ibis and Spoonbill) moved to the nearby Danube island of 'Komlouka' (recently added to the Reserve area proper). Two species have not yet returned to their traditional breeding sites (the north and south reed-beds). The first species, the Cormorant, breeds still in the colony on Komlouka Island, while the second one, the Glossy Ibis, visits the Reserve only during migrations. In the year 2000, however, it also returned and bred in the big colony to the north of the Pelican Pool.

There are still some blank spots in the information on the birds of Srebarna for quite a long period of time – from 1894 till 1947. Data on places where Dalmatian Pelicans, Herons/Egrets, Glossy Ibises and Spoonbills used to feed in Romanian marshes, fishponds and reservoirs are insufficient. It is not very clear where are the places of greatest importance in this respect and what are the negative factors affecting birds when they happen to be there.

1.14.8. Mammals

Historical Data Review

Mammals of the Srebarna Biosphere Reserve were studied by Christov (1961), Racheva (1963), Peshev and Angelova (1985). Mammals in that region had been subjected to much more intensive studies in connection with their parasitological status and as vectors of naturally transmitted infectious diseases. There are over 20 scientific publications in this respect (Michev et al., 1998).

In studying rodents and other small mammals researchers have applied standard methods of catching and preserving material. For 14 species there is habitat clustering based on data on the relative quantitative records for prolonged periods of time Information on big mammals has been supplied by the Union of hunters and fishermen in Bulgaria.

Actual State

As a result of these studies as well as on the basis of not published field studies carried out by the biologists T. Genov, B. Georgiev, N. Kodzhabashev and S. Gerasimov 41 species of mammals have been found in the region of Srebarna Reserve at present. However, in a more detailed examination of collected specimens and their identification it was found that there might be three duplicate species – *Apodemus sp., Mus sp.* and *Microtus sp*. Then the overall number of species may grow to a total of 45. In this way practically half of the Bulgaria's mammal fauna was found in the Reserve and in its buffer zone ***(App. 15, Table 1).***

Mammal species found for Srebarna, systematically are grouped in the following way: 7species of insectivorous mammals; 2 species of bats; 17 species of carnivores; 3 species of ungulates, 18 (21) species of rodents and 1 species of hare. **Three of those did not occur in this region in the past. They are:**

- The Jackal (*Canis aureus*) following the expansion of its range in 1960-ies settled permanently in the area of the lake and has been in very high numbers since;

- The Muskrat (*Ondatra zibethica*) was introduced in the lake in 1950-ies and suffers considerable fluctuations in its numbers through the years;
- The Raccoon Dog (*Nyctereutes procyonoides*) is a newcomer to the Reserve and has come here from the Danube Delta in recent years.

Rating on the population density of all mammals reported in Srebarna was carried out with regard to zones (1 -waterplane, 2 – wet reedy, 3 – pastures and agrocenoses, 4 – woodland). Data is shown in a separate table ***(App. 15, Table 1)***.

From ecological viewpoint we have found the following grouping of mammals: in the lake proper and immediately around it the aquatic and hydrophilic mammals (12 species) predominate while in the lake periphery and in the buffer zone occur steppe and forest-steppe species. These are most of the rodent species, the carnivores and ungulates. Typically steppe mammals (*Erinaceus concolor*, *Martes foina*, *Mustella eversmanni*, *Spermophilus citellus*, *Spalax leucodon*, *Mus spicilegus*, *Mesocricetus newtoni* and *Sicista subtilis*) occur in dry places and in agricultural communities in the buffer zone. As species of isolated distribution for Dobrouja (resp. for Srebarna) are the populations of the two species of Shrews – (*Sorex araneus* and *Sorex minutus*) which at present are typical for mountain forest ecosystems in Bulgaria

1.15. Socio-economic and cultural values

The Srebarna Reserve borders on the land-use areas of three villages in Silistra Municipality, Region of Silistra. Since ancient times, this has been a predominantly farming and fishing area.

The three villages, though very similar, have some substantial distinctions as well, both in social status and economy. A description follows.

The **Village of Aidemir** has a population of over 10,000 and is the largest village in Bulgaria. When Southern Dobroudja was liberated from Romanian occupation in 1940, Aidemir had just 3,000 residents. It grew and developed its economy and infrastructure ahead of the rest largely because of its proximity to Silistra, as well as because for some time it used to be a neighbourhood of the town. The village is divided into three neighbourhoods: Delenkite, Aidemir, and Tataritsa. The bulk of the population is ethnic Bulgarians. Tataritsa is inhabited by Old Believers who left Russia several hundred years ago and settled there to escape religious persecution and preserve their traditional beliefs. A small number of Roma live in Delenkite.

Aidemir's economy consists of the Kapitan Mamarchev Rubber Products Plant, and of Faserles and Lesilhart (privatized parts of a former Timber Processing Works), which used to provide most of the jobs in the village. At present Aidemir's industrial workers are largely employed in the enterprises of Silistra. Farming is the principal local means of livelihood. Apart from the numerous private farms, there are one cooperative and three farmer associations. The Baltata Locality, a natural appendage of Lake Srebarna, was the site of the Aidemir Marsh with a surface area of 1,700 ha. It was drained and the land was reclaimed for cultivation in 1949 with the construction of the Vetren-Silistra Dyke. At present Baltata is farmed by the Zelen Pazar [Green Market] joint-stock company. The principal crops are cereals (barley, wheat, maize, and sunflower), vegetables (tomatoes, cucumbers), and beans. Apricots and vines occupy the largest area under perennials, and there are smaller plantations of peaches, cherries and morello cherries.

Stockbreeding is practised on a very small scale in Aidemir, for the most part by petty farmers. The registered livestock population consists of 200 head of cattle, 2,000 sheep and goats, 130 horses, 1,980 pigs, 3,000 fowl and 350 dogs. The only commercial pig-breeding farm, which used to discharge its wastewaters into the Kulnezha rivulet (which empties into Lake Srebarna), has been privatized and now raises about 200 pigs.

About 100 people are engaged in the Danube fisheries operating from the fishing village of Ivanovo (on the Danube bank). It has electricity and running water. There are a couple of other fishing villages downstream. The local authority has excluded 4.6 ha of municipal-owned land from the land distribution plan, allocating it for construction of a new and modern fishing village. Historically, the residents of Tataritsa have been fishing in Lake Srebarna. Now only a few of them engage in traditional commercial fishing in the Danube.

Wickerwork manufacture used to be a traditional handicraft in Aidemir, as well as in the two other villages, but is now moribund. On the whole, the village has a ramified network of retail outlets and public services. There are two schools, a kindergarten, and a secondary school of agriculture with a 100 ha farmstead of its own.

Just as everywhere else in Bulgaria, unemployment is the main problem. At present over 180 families subsist on social welfare. The authorities estimate the actual jobless level, including hidden unemployment, at over 20% of the total population.

The **Village of Srebarna** is located 18 km west of Silistra, right on the western bank of the Srebarna Reserve. The population is approximately 1,100, all ethnic Bulgarians. Part of them were resettled to these parts from Northern Dobroudja in 1942 under the Treaty of Craiova. They are concentrated in the Presseltsi [Settlers] Neighbourhood in the northwestern end of the village. Until 1962, Srebarna had some 2,500 residents. After Silistra became a district capital, quite a few villagers were almost forced to move from Srebarna to the town to provide labour force for the newly built factories.

The village has never had any industry. Quite a number of the residents commute to Silistra.

Agriculture is the main source of livelihood in Srebarna, too, where some 3,800 ha of land is cropped. The two cooperatives are the largest agricultural producers in the village, farming two-thirds of the arable land. There are also three tenant farmers, each leasing some 200 ha of land. Here, too, cereals are the main crops: wheat, maize and sunflower. Vegetables are grown in negligible quantities, mainly for the farmers' own needs.

Stockbreeding has shrunk to subsistence levels. There are 44 cows, 855 sheep and goats, 242 horses, 640 pigs, 6,657 fowl, and 215 dogs.

Consumer services are provided by one carpenter, one ironsmith and one tailor. The village has six retail outlets, one bakery and seven mass-catering establishments. Local residents work at the Natural History Museum, the Reserve Administration and the Ecological Field Research Station of the Central Laboratory of General Ecology with the Bulgarian Academy of Sciences. There are also some wicker workers, but demand for their products is slack for the time being.

The village has a school with a dormitory, but it is disused. The few local children, 36 in all, attend school in Aidemir. The kindergarten now has an enrolment of 22, but it is expected to be closed down soon for lack of pre-school children. About half of the local residents (540 people) are pensioners, and 40 are registered unemployed. The actual unemployment rate is greater. It diminishes in summer, when quite a few people are hired on a day-rate basis by the larger farmers.

The **Village of Vetren** is the smallest of the three nucleated settlements in the immediate vicinity to the Reserve. It is located 3 km from the northwestern end of the Reserve, on an elevated Danube riverside terrace, and reaches the riverbank in the north. The resident population approximates 500, but in summer up to 1,500 live here. Quite a few of the residential properties are used as country houses or part-time farmsteads, mostly by people living in Silistra. Vetren's economic structure is similar to that of Srebarna. The villagers' livelihood largely depends on crop farming, followed by commercial fishing.

Vetren's agriculture is structured in much the same way as that of Srebarna: one large cooperative farming 90% of the cultivable land (1,750 ha in aggregate), one small and three larger private farmers. Unlike Srebarna, Vetren has large perennial plantations: 140 ha of vineyards, 30 ha under apricots, and smaller areas under walnut and hazelnut trees. The main annual crops are wheat, maize and sunflower. After 1992, when the area of the Reserve was expanded northward into the land-use area of the village, state-owned land tracks in Baltata across the northeastern boundary of the Reserve were provided in compensation. When the canal connecting the lake with the river is full, farmers have to take a detour via Tataritsa to reach their farmland tracts. Stockbreeding is practised mainly on a subsistence basis. There are about 500 sheep, 150 goats, several cows, etc.

The riverside village of Vetren has always been renown for its fisheries. About 50 fishing boats are kept at two jetties. The larger jetty is very close to the village, while the other one is in the Tanassovo Holiday Village, next to the northwestern corner of the Srebarna Biosphere Reserve. The fish is usually sold on the spot, being kept alive in big wicker-baskets or enclosures inside the river itself, or in freezers. Consumer services are provided by one bakery, three retail outlets and three pubs in the village. There are also some rather good recreation facilities in Vetren, both company-owned and public. The Water Supply and Sewerage company and the Electricity Supply company have their own holiday homes here. A former government residence is now managed by Silistra Municipality as a hotel. The Bulgarian Hikers Union also keeps a recreation facility in Vetren. The Kalimanitsa Hotel Restaurant is built in the traditional Dobroudja architectural style but is far from the riverbank. The largest and most convenient of these facilities is a chalet formerly belonging to the trade unions and now leased to a private tour operator of Silistra.

The village of Vetren has a long history. Twenty-seven Thracian burial mounds dot its land-use area. Historical sites from Roman times have been excavated in the area.

The climate here is unique for the region and is very similar in its parameters to the climate of the Vurshets spa in the Northwestern Balkan Range.

The **Tanassovo Holiday Village** is in the land-use area of Vetren, right on the Danube bank and next to the northwestern corner of the Reserve. It consists of about a dozen huts and has one permanent resident. It was started in 1963 as an unlicensed construction project by fishermen from the Village of Srebarna, on the side of a single fisherman's cabin used by two parties of fishermen of the local collective farm. One can still see the ruins of three-ice cellars, dug deep underground to keep ice extracted from the river or from the lake in summer. Initially, owners were fined annually for illegal construction, and the structures remain unlegalized to date. They are built on a tract of the forestland stock.

In summer, part of the boats are moved from one of the Vetren's jetties to Tanassovo and then, particularly on weekends, its population increases to some 20 people. Electricity supply is not available, and drinking water is drawn from wells.

Local stockbreeding and its impact on the Reserve

Some 25 cows from the Village of Srebarna graze regularly in the western part of the Reserve's buffer zone, and about 50 sheep and goats from the Village of Vetren graze occasionally in the northeastern part of this buffer zone. Both herds pool animals owned by different households and are tended by hired shepherds. A small herd of 10 sheep also graze south of the Reserve, tended by their sole owner. This place was unsuitable for grazing in 1999 because of the high water level in the lake. Most of the livestock in the Village of Srebarna graze along the valley of the Srebarnenska rivulet south-west of the village. The watering site is Dyakova Cheshma in the Papratta Locality. There are no pastures east of the Reserve.

Sedges *(Carex sp.)*, Great Bulrush *(Scirpus lacustris)* and other graminoids are mown for hay in the drier northwestern section of the Reserve (below Kodja Bair). The mowed patches rarely exceed 200 square metres. Grass for hay is also harvested in the ravines down the western bank of the lake.

Just below the village itself, along the buffer zone boundary, there is a place where a large number of fowl (hens, turkeys, domestic ducks and geese) stay unattended, feeding on the grass or in the lake shallows close to the bank. Occasionally, one or two horses also graze there.

The privately owned pig farm in the village of Aidemir is located in immediate proximity to the Kulnezha rivulet, which is part of the drainage basin of the Reserve. The other pig farm, in the village of Sitovo, is also private, but there are no pigs in it now.
A dive of animal produce purchase prices in 1999 has led to a steep decline in livestock population, especially pigs. The milk produced is mostly fed back to the domestic animals.

Another sustained trend in recent years has been an increase in the number of goats, directly as a result of mass-scale impoverishment. Goats are the cheapest to breed, but also have the most degrading effect on the environment. For the time being, the Reserve has not suffered from the goats which are few in number and graze only occasionally in its buffer zone.

In conclusion, it should be noted that stockbreeding around the Srebarna Reserve is extensive and underdeveloped ***(App. 2, Table 1)***. There are no indications of its abrupt growth or dramatic restructuring. The only obvious trend is the increase in the goat population. On the whole, stockbreeding does not affect the Reserve and its buffer zone.
Around the Reserve, there are five comparatively larger apiaries with a total of some 350 beehives. Two of these apiaries are within the buffer zone, in the Kamuka Locality, and one is just above the fishing village of Tanassovo.

The Union of Hunters and Anglers of Bulgaria keeps a pheasant-breeding farm in the Kamuka Locality. In recent years, the farm has been raising 150-200 pheasants.

Hunting and fishing in the area of the Reserve

Evidence of fishing as a key source of livelihood for the population of lower reaches of the Danube valley dates from as far ago as the New Stone Age (5000 to 3800 BC). Fish was also a means of exchange with settlements in the hinterland. Fishing developed along with the development of statehood. The Thracians were the earliest known expert fishermen in the area. Until recently, people in the Village of Srebarna still employed an ancient Thracian technique of catching fish under the ice. An archeological expedition excavating a site not far from the Village of Vetren (the Roman Tegulitium) has found clay tablets depicting Hecate, the patron goddess of river and sea travellers and of hunters. Such tablets have been unearthed mostly in and around settlements where fishing was well developed. Under the First and the Second Bulgarian Empire, fishing was an important part of the economy of local boyars. According to extant royal charters (*chrysobulla*), fisheries were donated by the Tsar to the boyars or to monasteries. Under the Ottoman domination, the main fisheries (*sinal* in Turkish) in the Danube, in the riverside marshes incl. Srebarna and in narrow channels (*bogaz*) connecting the marshes, were conceded by the local Turkish authorities by public auction (*mezap*) at an initial fee (*resim*) for a term of four years. According to a document dated 1814, the fish exported from the Turkish Empire to Austria and Wallachia was transported by the fishermen from the Toutrakan and Silistra areas. The document specifies that the entire population of the villages of Srebarna, Vetren, Tataritsa, Garvan and some others was engaged in fishing. After the liberation from Ottoman rule, the situation did not change appreciably. Many fishermen from Toutrakan, harassed by the Romanian occupation authorities, moved to this area in 1922. Another wave of settlers arrived in 1940, after the liberation of Southern Dobroudja from Romanian presence, when a large colony of Russian Old Ritualist fishermen came to the present-day Tataritsa from the village of Dikilitash (Stulpishte near Rousse). The commercial fishing importance of the area between Toutrakan and Silistra is also evident from the fact that 1,650 tonnes of fish were caught until 1878 while the catch increased to 2,400 t even in 1879. The first fishermen cooperatives were established in Silistra and in Srebarna in 1941. They merged in 1945 into the 65-member Sharan [Carp] Cooperative. In the following 50 years, the number of cooperative members declined steadily. This cooperative fished in the Reserve until 1965, but only in autumn and winter. The maximum daily catch on record was 3 tonnes of fish. The communist regime aspired to develop the Silistra region as a major centre of industry and agriculture, and all people of working age were employed in industrial enterprises and collective farms. Besides, the large Aidemir Marsh was drained, as were almost all of the remaining riverside marshes except Srebarna, which was designated a game bird reserve and was isolated from the Danube.

As a result of the disruption of the connection between the Danube and the riverside marshes and their reclamation, cyprinoid species now account for a negligible proportion of commercial fishing, while the share of pelagic species has increased dramatically. Now the number of people engaged in commercial fishing is growing again and has already reached the levels of the early 20th century. The main reason is the particularly high unemployment rate in this area, along with the large spans of spare time enjoyed by farmers. The fishing villages are in Vetren, Tanassovo, Ivanovo and two or three smaller ones, located further downstream in the direction of Silistra, just after a group of Danube islands called Chaika. There are 50 to 60 fishing boats, as fishermen from other parts of the region, such as Silistra, also fish there. Unemployment is also the main cause for poaching in the Reserve, which is also motivated by the unavailability of water bodies suitable for angling to members of the Union of Hunters and Anglers of Bulgaria (for more information on poaching, see Section 1.22).

As a means of livelihood, hunting is as old as fishing. The tighter control under which the authorities have kept hunting throughout mankind's history has made it less commonly practised until it has turned into a sport. On the other hand, hunting, being out of reach to the larger part of the public, has led to mass-scale poaching. Now hunting is regulated by the Hunting and Gamekeeping Act and its practise is limited to card-holding members of the Union of Hunters and Anglers of Bulgaria (UHAB) who must pass a written examination in game biology, hunting and hunting law and a practical trap-shooting test. A specific hunting ground is allocated within the land-use area of each village, and it is managed by a local UHAB chapter. The number of hunters within a land-use area may not exceed one per 110 ha. The principal big-game species in the area is the Wild Boar (*Sus scrofa*), of which between 20 and 25 are killed annually. Wild boars are also the main target of poachers. Roe Deer (*Capreolus capreolus*) and Red Deer (*Cervus elaphus*), whose population has declined dramatically, are no longer huntable. The number of red deer in the area is estimated at 30, and the number of roe deer at 20. Until 1989, hunting the so-called "pernicious game" was generously paid by the government and was even set as a state plan target, in terms of bag per species. Now such hunting is practised on rare occasions. Only 20 Jackals (*Canis aureus*) and ten Foxes (*Vulpes vulpes*) were killed in Srebarna in 1999. The jackal population has boomed during the last 30 years or so, having become almost extinct in this area. The Hare (*Lepus europaeus*), another nearly exterminated species, has been increasing its population over the last couple of years. Hare hunting is also suspended for the time being. Of the game fowl, the commonest target is the Ring-necked Pheasant (*Phaisanus colchicus*). This non-native species is breeding in large numbers in the area, and young birds are released from the pheasant farm every year. Each village hunting club takes between 30 and 50 pheasants per hunting season, varying by the year. The River Danube, the Reserve proper, as well as the numerous fields under winter wheat attract tens of thousands of wintering Greylag Geese (*Anser anser*) to the area. They are, however, difficult to hunt even for skilled marksmen, and a village hunting club rarely bags more than 50 geese per hunting season. Goose- and duck-hunting parties often shoot from a launch or a boat on the Danube, which is illegal. This duck-hunting practice has been adopted only by the village hunting clubs of Vetren and Aidemir. The hunting season opens with hunting of Quail (*Coturnix coturnix*), Turtle Dove (*Streptopelia turtur*) and Wood-pigeon (*Columba palumbus*), but later in the season hunters rarely target these particular game species.

Handicrafts

Fishing and farming, as described above, have always been and still are the principal occupations in the area. Another noteworthy craft, that has already disappeared, is the manufacture of articles from marsh vegetation. This handicraft dates from early antiquity, and in 1954 it grew to an industrial scale with the commissioning of the Kamaschit Factory in Silistra. The factory used reed harvested from all riverside marshes. Initially, Kamaschit produced crude mats woven of Reed (*Phragmites australis*), used for ceiling surfacing. Later on, the factory branched out into "pressed mats," used for heat and sound proofing of roof spaces. Floor mats were made of Reedmace (*Typha latifolia* and *Typha angustifolia*) and of Great Bulrush (*Scirpus lacustris*). Sheaths of mowed reed or bulrush were tied with ropes made of Sedge (*Carex sp.*).

Later on, in a bid to cut transport costs, the Kamaschit Factory opened a mat workshop in the Village of Srebarna. However, vegetation mowing in the Reserve was banned in 1975. The factory remained in operation for several more years, using reed, reedmace and bulrush harvested mainly from the Kalimok Marsh. Then mats were no longer in demand, and the factory switched to articles made of Purple Osier (*Salix purpurea*). Some people in the area are still skilled in manufacturing reed and bulrush mats, but the demand is mainly for decoration and for fencing off the open-air gardens of drinking establishments.

1.16. Land tenure/ownership

The reserve is an exclusive state property and is managed by the Ministry of Environment and Water (MoEW). The surrounding land plots are variously owned:

Land Tract Areas around the Reserve by Ownership Type (ha)

OWNERSHIP	*Aidemir*	*Srebarna*	*Vetren*	*Total*
Church-owned land tracts	25.0	1.0	0	26.0
Privately-owned land tracts	354.0	406.1	331.9	1,092.0
Municipal-owned land tracts	153.6	352.1	150.6	656.4
State-owned land tracts	232.0	694.8	652.8	1,579.6
Total	764.7	1,454.0	1,135.3	3,354.0

*Applicable to areas shown on ***Map 9, App. 1.***

1.17. Current land use

Natural resources are not exploited within the boundaries of the Reserve. The surroundings of the Reserve contain over 10,000 ha of crop-fields under wheat, maize, sunflower and vines in the land-use areas of the villages of Srebarna, Vetren and Aidemir. Large quantities of chemical fertilizer were applied when these land tracts were tilled before 1989. At present almost no fertilizers are used.

The reserve is also surrounded by 392 ha of forests, mostly homogeneous stand plantations of Black Pine (*Pinus nigra*), Black Locust (*Robinia pseudoacacia*) and Hybrid Poplar (*Populus sp. X Populus sp.*) (see Section 1.17.3).

1.18. Adverse factors affecting the ecological characteristics of Lake Srebarna

The factors are classified as 'existing' (ex), 'potential' (pt), 'internal' (int), 'external' (ext):

The most important factor that has substantially affected the change of the ecological characteristics of the Srebarna Lake and the areas that surround it was the building of dikes parallel to the riverbank in order to protect arable land from flooding as well as to reclaim new land for agriculture. The dike Vetren – Silistra was erected in 1948 and has served since to really protect several thousand ha of arable land and riverside marshes from flooding. Erection of dikes has caused the following adverse factors to affect the Reserve natural character (ex; ext):

- The Danube water stopped entering the lake thus causing significant disturbance of this wetland's hydrologic conditions.
- Precluding the seasonal wash-out of the lake's bowl at high level of the Danube water when the water rushes in the lake from the north-west corner of the Reserve and leaves it through the Aidemir marsh in the north-east. In this way the accumulated sludge, nutrients and floating reed islands were naturally partly washed away from the lake.
- Acceleration of the ecological succession "lake-to-marsh-to-wet meadow" due to:
- Reduction of the lake water level because of insufficient water inflow and silting up of the lake bowl;
- The lake becoming overgrown with reed because of the low water level and the impossibility of at least part of the reed floating islands to be washed away into the Danube;
- Acceleration of the lake eutrophication because of the accumulation of nutrients;
- Reclamation of thousand ha of natural bogs and marshes for cultivation.

The increased eutrophication leads to hypoxia, anoxia, and changes in the living communities of the lake and destruction of the food web. Changes to the latter are responsible for a large part of the aquatic birds to abandon the Reserve (ex; int).

The lake siltation is an outcome of the west bank soil erosion as well as of the increased productivity of the reed beds and the phytoplankton (ex; int).

The change of the Danube water conditions with the dam Zhelezni Vrata (Iron Gates) getting under construction and the natural process of lowering the river erosion basis have diminished the opportunities of the river water to enter the Reserve at high water levels in the Danube (ex; ext).

The changes of the global climate leading to Europe's climate becoming drier (the last drought was in the period 1982 through 1994) which in turn has led to worsening of the water conditions and to lower water levels (ex; ext).

Polluting the Reserve with nutrients and pesticides from diffuse sources within its water catchment area (ex, pt; ext), with nutrients and raw organic matter from a pig-fattening farm near the rivulet Kalnezha (ex; ext), with nutrients - NO_x, SO_2, NH_3, etc. - through precipitation from the atmosphere (ex, pt; ext), with nutrients, heavy metals, pesticides, PCB, hydrocarbons with water flowing in from the Danube. Changes in the ecology of the Srebarna Lake in the past were also due to the extensive use of fertilizer and pesticides in the crop fields around the Reserve. At present almost no agricultural chemicals are in use (ex; pt; ext).

There also exists the danger of accidental discharge in the Danube of persistent compounds like heavy metals, chlorinated compounds, PCB, oil derivatives, etc. The same follows accidental releases in the atmosphere of H_2S, SO_2, chlorine derivatives, dioxine, etc. all of which may enter the water catchment area through precipitation (pt, ex; ext).

Another cause for changes in the ecological characteristics of the Reserve surroundings was the afforestation of extensive areas using tree species that were either not native for the region like the Austrian (European Black) Pine *(Pinus nigra),* or were altogether alien species like the Hybrid Poplar *(Populus sp. x Populus sp.*), Black Locust *(Robinia pseudacacia),* Common Gloxinia *(Gleditschia triacanthos),* Oleaster *(Eleagnus angustifolia).*

Exotic or allochthonous species for the Reserve Srebarna and its vicinities are:

A. Plant species:

- Azola - *Azola fuliculoides*. Found in Srebarna for the first time in 1960-s. It is supposed that the species had come by the Danube where it was found years ago. Occurs predominantly in the peripheral water bodies of the Reserve.
- Common Gloxinia - *Gleditschia triacanthos*. This species had been introduced in the area by the Silistra Forestry Department in the 1950-s when some tracts of the riverside at km 393 were planted with it.
- Black Locust - *Robinia pseudacacia*. There are some tracts on the east bank of the Reserve - the slope of the hill Kara Bouroun - planted with Black Locust as early as in the 1950-s. After vine growing on the terraces of the eastern slopes of the hill Kodzha Bair was forcibly eliminated in the 1980-s the abandoned plots were planted with this species.
- Hybrid poplar - *Populus sp. x Populus sp.* There are plantations of these poplars in the northern and southern parts of the Reserve.
- Oleaster - *Eleagnus angustifolia*. This species has invaded the area all of its own and at present grows on the slopes of Kodzha Bair.
- Tree-of-heaven - *Ailanthus altissima*. The species has pervaded the region at some obscure time in the past and has spread along the west bank of the Reserve.
- Amorpha - *Amorpha fruticosa*. The species has invaded the whole of the Danube basin in the first half of the 20^{th} century. In the Reserve it can be found predominantly in its northern part nowadays.

B. Animal species:

- Pumpkinseed Sunfish (*Lepomis gibbosus*). Spread spontaneously along the River Danube, now occurs in the northern parts of the Reserve.
- Muskrat (*Ondatra zibethica*). This species was introduced into the reserve by the former Administration of Forests and Forestry Industry in 1956, when 24 specimens were released. The population peaked in the mid-1960s, then it started to decline steadily until it reached its present-day level of between 10 and 100 individuals.

Illegal fishing and taking of considerable quantities of fish from the lake has the effect of a pre-eminent predator in respect of the trophic network (TN) in the lake, with all consequences for the trophic structure and aquatic birds trophic resources.

Illegal fishing is practised primarily by residents of the Village of Srebarna and of the Tataritsa neighbourhood of the Village of Aidemir. Presumably, there are about 20 'professional' poachers there, who fish every night using fishing nets. Some of the nets are 150 to 200 m long, which is evidence that the catch is not for family needs. Over 250 kg of nets of an aggregate length exceeding 4 km were confiscated in a single crackdown in October 1999 alone. Some of the illegal fishermen occasionally use fykes as well. Experts estimate the illegal catch at around 1 tonne per day (20 poachers catching an average 50 kg each). The most commonly caught species is the Crucian Carp (*Carassius carassius*), followed by the Pike (*Esox lucius*) and other fish species. On weekends and holidays, illegal fishing increases, first because the Reserve guards are off duty and secondly because people from Silistra and other settlements in the region arrive for angling. In winter, catching pikes through holes in the ice cover of the lake is a very popular method of illegal fishing. During high water levels, when the lake is connected to the Danube, poachers stretch their nets across about 500 m of the water stream flowing into the lake and thus prevent a large quantity of fish from entering the Reserve.

In recent years, the overall anthropogenic pressure on the surroundings of the Reserve, and especially on the area between the Village of Srebarna and the River Danube, has eased tangibly. This can be attributed to a decrease of the population of the villages of Srebarna and Vetren to almost a third of its previous level. Illegal fishing, however, has increased, most probably due to the steady impoverishment of the local population and to a significant increase in the unemployment rate in the surrounding villages and in Silistra.

1.19. Conservation measures taken

Thanks to studies conducted by Bulgarian and foreign researchers back at the turn of last century, the general public and decision-makers realized the need to conserve the extraordinary biodiversity of Lake Srebarna back in the 1940s. Since then, a number of biodiversity conservation measures have been taken in respect of the lake. They can be divided in two principal groups: measures involving conservation legislation, and measures involving the re-establishment of the hydraulic connection between the lake and the Danube.

A. Conservation legislation:

- In 1942, at the suggestion of Mr Aleksi Petrov (a prominent Bulgarian conservationist) the lake was designated a "breeding ground for waterfowl game," entailing certain restrictions and bans on hunting in it.
- In 1948, again at the suggestion of Mr Aleksi Petrov, Lake Srebarna was designated a nature reserve (Council of Ministers Decree No. ZP/2-11-931 dated 20 September 1948).
- In 1960, the former General Administration of Forests gazetted an Ordinance on Management and Administration of the Srebarna Reserve. The Ordinance established a procedure and timeframe for fishing and harvesting reed, reedmace and grass mowing within the Reserve.
- In 1975, acting on the initiative of the former Nature Protection Commission with the Bulgarian Academy of Sciences, Lake Srebarna was designated a Ramsar Site within the then boundaries of the Reserve.
- In 1977, acting on a proposal of the same Commission, Srebarna was named a UNESCO Man and Biosphere Reserve, which was certified by a special diploma.

- In 1983, on a proposal made by the former Research and Co-ordination Centre for Ecology and Environmental Protection with the Bulgarian Academy of Sciences, Srebarna was inscribed on the World Heritage List of cultural and natural sites.
- In 1989, on a proposal by the Institute of Ecology with the Bulgarian Academy of Sciences, Srebarna was designated an Important Bird Area (IBA).
- In 1983, the former Committee for Environmental Protection established a buffer zone around the Reserve by Order No. 1, promulgated in the *State Gazette* No. 5 of 1983. In 1992, the Institute of Ecology and the Ministry of Environment sent letters to the Ramsar Convention Bureau, reporting a deterioration of the ecological character of Srebarna and requesting the initiation of a Ramsar Management Guidance Procedure.
- In 1993, a group of experts inspected the Reserve and submitted a report to the Ramsar Convention Bureau. As a result, Srebarna was included on the Montreux Record of priority sites for conservation action.
- In 1993, the Ministry of Environment incorporated former arable land tracts into the Reserve, expanding its total surface area to 902.1 ha, by Order No. 581 dated 28 June 1993.
- In 1999, a joint mission of the World Heritage Committee and the Ramsar Convention Bureau visited Srebarna and surveyed and assessed the measures taken for improvement of the Reserve's ecological state. As a result, Srebarna was retained on the List of World Heritage Sites in Danger but was not removed from the World Heritage List.

B. Attempts to re-establish the hydraulic connection of the lake with the River Danube:

- In 1963, a canal was dug and a sluice was constructed on the Vetren-Silistra Dyke. Because of frequent flooding of the arable land crossed by the canal, the sluice was almost never opened and was removed altogether later on.
- In 1979, a long curved dyke was built to protect the then arable land tracts in the northern part of Srebarna (now incorporated into the Reserve). After that dyke was completed, a 500 m section of the Vetren-Silistra Dyke was removed to allow the Danube water to flow into the Reserve in spring. The Danube water last entered the lake in 1988.
- In 1994, a new canal was built with two sluices at both ends with financial support from the World Heritage Committee and the Ramsar Convention Bureau. Even in the same year, the Danube water rushed into the lake and raised its water level significantly.

1.20. Conservation measures proposed but not yet implemented

In 1994, it was proposed to construct a second canal connecting the Danube and the lake so as to ensure circulation of the lake water at high water levels in the Danube. However, the probability of such circulation taking place is extremely low.

1.21. Current scientific research and facilities

A comparatively comprehensive and up-to-date database exists on the biodiversity, hydrochemistry, hydrobiology and other parameters of the Reserve, even though most of the information is scattered among various entities engaged in the collection of research information and in the management of Srebarna (Central Laboratory of General Ecology, other research institutes of the Bulgarian Academy of Sciences, the Natural History Museum at Srebarna, the Ministry of Environment and Water, and some conservationist NGOs). This Management Plan has drawn on practically all available information.

The earliest written reports on Lake Srebarna were published by Austrian naturalist Eduard Hodek in 1882 (Hodek, E., 1882. Der Wanderer Heim (Beschreibung des Besuches 1880 am Srebarna See). Mitteilungen des Ornithologishe Vereines in Wien, 6, 3: 25-26, 4: 31-34, 5: 58-59). After him, Lake Srebarna has also been described in the works of Kalbermatten (1891), Lorenz-Liburnau (1893), Reiser (1894). The first Bulgarian biologist to take notice of the lake was Prof. St. Petkov, who published information on certain Srebarna plants in 1911. Between 1919 and August 1940, Srebarna was under Romanian control, and no data on the lake whatsoever are available from the period, with the exception of some oral information provided by elderly residents of the villages of Srebarna and Tataritsa.

Scientific research of the Reserve was resumed in the 1950s. It was then that Srebarna's bird life (Paspaleva-Antonova, 1961 a, b) and mammalian fauna (Christov, 1961) were studied in detail.

The Dalmatian Pelican population in the nesting colony ***(App. 13, Fig. 2)*** has been monitored annually since 1955, and the same monitoring procedures have been applied to the Cormorants, Spoonbills and Herons, also breeding in colonies, since 1958. Two institutions: the Higher Institute of Military Medicine and the National Centre for Epidemic Research and Control, started studying Srebarna as a focus of rabbit fever.

On the initiative of Prof. Georgi Paspalev, a Biological Research Station was set up in Srebarna in 1961. It functioned under the then Institute of Zoology with the Bulgarian Academy of Sciences and was closed down in 1968. In 1983, its functions were taken over by an Ecological Field Research Station of the Research and Co-ordination Centre for Ecology and Environmental Protection (now Central Laboratory of General Ecology).

An International Symposium on "The Role of Wetlands in Preserving the Genetic Material" was held in Srebarna in 1984. All papers presented at that symposium were published in a separate collection (Nedialkov *et al*., 1987).

The water level of the lake has been regularly monitored since 1994. Readings are taken once a week and are averaged on a monthly basis. Hydrological and hydrobiological monitoring has been regularly performed since 1998. Monitoring procedures include taking monthly measurements of the hydrochemical conditions, phytoplankton, zooplankton, zoobenthos, production and reduction of organic matter.

Dr Gergina Baeva defended her doctoral thesis on the ecology of the Reserve vegetation (Baeva, 1988a)

A total of 273 research papers, reports, reviews, ecological assessments etc. on Srebarna were published until 1998.

An Ecological Field Research Station has been established with the Reserve. It is located on the western bank of the lake and is a division of the Central Laboratory of General Ecology with the Bulgarian Academy of Sciences. The Station consists of a chemical laboratory, a multi-purpose laboratory, a dormitory for two, a kitchen and a storage room on an aggregate area of 60 m^2. Research instruments comprise an UV-VIS spectrophotometer, a field multiline pH, conductivity, oxygen and temperature-meter, microscopes and other basic laboratory equipment. Hydrochemists, hydrobiologists, biodiversity experts and scientists in other fields of ecology can do their research at the Station.

The following **research projects** are being implemented in the Reserve:

- The water level of the lake, its hydrochemical parameters, the phytoplankton, zooplankton, zoobenthos, the production and destruction of organic matter, and the trophic and functional structure of the aquatic ecosystem have been monitored since 1998.

- Ecology and migrations of the Dalmatian Pelican. A special observation hide was built close to the pelican colony in the autumn of 1999, along with about a 40 m long tunnel, covered with reed mats. Thanks to this facility, researchers now have a unique opportunity to conduct detailed observations of the nesting biology of the species without disturbing the birds;
- Average winter numbers of aquatic birds. The project is part of the annual average winter monitoring of Bulgaria's aquatic bird population. Counts have been regularly taken since 1977.

1.22. Current conservation education and public awareness

Attracting the public to the Srebarna Reserve and the objectives of conservation education have several aspects:

- promoting the natural heritage of the Srebarna Reserve as a designee of the highest international conservation status, promoting the scientific value of biodiversity and its importance for ecological stability; maintaining a dialogue on the state of natural resources, especially of the Dalmatian Pelican, Pygmy Cormorant and the other rare bird populations, and on the conservation priorities according to the analysis of the data base and the monitoring results;
- identifying target groups among the public, identifying interests and starting partnerships at local, national and international level for conservation activities in the Reserve;
- producing up-to-date demonstration materials, news reports and educational items; setting up bird watching sites and 'know the buffer zone' paths in the buffer zone; preparing and displaying explanatory panels; associating the natural heritage with the cultural and historical heritage within a broader area around the Reserve; developing the interpreting skills of the personnel of the Reserve.

A number of Bulgarian and foreign **non-governmental organizations** (the Ramsar Convention Bureau, EUROSITE, the Bulgarian Society for the Protection of Birds/BirdLife Bulgaria, Le Balkan-Bulgaria, the Green Balkans Society, etc.) have helped to implement projects intended to broaden public relations by providing funding for several workshops (1994, 1998 and 1999); by updating the data base; by organizing volunteers to clean up the area of the Reserve; by arranging photo and drawings exhibitions and competitions, quiz games, young scientists meetings, etc. The National Environmental Protection Fund has partly financed the publication of folders, posters, bibliographical references on the Reserve, etc.

A Natural History Museum opened in the Village of Srebarna in 1973. Initially, the Museum was accommodated in a house in the centre of the village, and a special building for it was constructed in 1983. While the Reserve was managed by the Municipality of Silistra, the Natural History Museum was also in charge of physical security and management of the Reserve. After the Reserve passed under the jurisdiction of the Ministry of Environment and Water, the Museum no longer performs these functions and, according to the effective regulatory acts, the Natural History Museum is formally unrelated to the Reserve.

The Museum has a video projection room, large panoramic windows and a Reserve observation deck. The standard display consists of stuffed birds exhibited in glass show cases. The display is rather outdated and cannot provide an adequate idea of the present state of the Reserve. The Museum records approximately 15,000 admissions annually. Thirty-five per cent of the visitors are schoolchildren arriving on tours organized by their schools at the beginning and the end of the school year. They spend about an hour at the Museum, viewing the display. The film projection room in the Museum building is not used adequately for conservation education and public awareness. A remote video observation system of the pelican colony, installed in the 1980s, has been inoperative for years.

A workshop on "Sustainable Land Use and Water Management in the Drainage Area of the Srebarna Biosphere Reserve" was held in the autumn of 1994, with the participation of the local public. The educational programme was intended to familiarize the local people with the need to protect ground and surface waters against pollution, to adopt organic farming, to develop eco-tourism, etc. The meetings have encouraged the local public to join the continuous campaigns for improvement of the surroundings of the Reserve and to provide services to the increased flow of tourists. The national and local mass media have been especially active in this field by covering the successes achieved and difficulties experienced by the Srebarna Biosphere Reserve.

A training workshop for the local public was held in the autumn of 1999. The subject of the workshop was "The Srebarna Biosphere Reserve as a Key Site in the European Ecological Network." Representatives of the Ministry of Environment and Water, the Central Laboratory of General Ecology, the local NGOs, BirdLife International, journalists, etc. discussed questions concerning NATURA 2000, the need to establish transboundary protected areas along the Lower Danube, and the important place of the Srebarna Reserve in the new European initiatives.

1.23. Current recreation and tourism

The Srebarna Nature Reserve is probably one of the best suited places for sight-seeing tourism in the Region of Silistra. It provides opportunities for conventional, special-interest and rural tourism. Being one of the best known Bulgarian nature reserves both at home and abroad, Srebarna attracts a lot of ordinary people without any special interests. The Natural History Museum is an added attraction.

Unfortunately, hoteliery in the area is underdeveloped. The riverside holiday home in Vetren has 70 beds, half of them in rooms with a private bathroom, and three suites. Hotel Kalimanitsa has seven two-bed rooms, and the facility of the Bulgarian Hikers Union has 40 beds but the conditions are substandard. This is the reason why most of the visitors usually prefer sleeping accommodation in Silistra, where there are four hotels.

At present, there are two recreation sites in the surroundings of the Srebarna Reserve:

- The Village of Vetren. Over the last couple of years, the village (after a decline due to a loss of population and a stagnant economy) has been transformed into a country-house zone by enterprising residents of Silistra, the regional capital.
- The Village of Tanassovo, located right on the Danube bank opposite the western end of the Island of Vetren. This settlement consists of some 20 small ramshackle sheds, probably all of them built without obtaining the requisite permits. In summer, when the Danube water level drops significantly, large sand bars form by the Danube islands of Devnya and Vetren opposite Tanassovo. Local people, including visitors from Silistra, use these sand bars as a beach since they provide the best sun-bathing conditions regionwide.

1.24. Jurisdiction

Government authorities with functional jurisdiction over the wetland:

Region of Silistra, Municipality of Silistra. The Reserve, being exclusive state property, is under the jurisdiction of the Ministry of Environment and Water.

Authority with functional jurisdiction for conservation purposes:

National Nature Protection Service with the Ministry of Environment and Water, Sofia
Rousse Regional Inspectorate of Environment and Water

Srebarna Managed Nature Reserve Administration

1.25. Management authority

Since its designation in 1948, the Srebarna Reserve has been managed by several authorities varying in character and competence:

- The Sofia Zoo, 1948-1960, with a staff of one guard.
- The Committee of Forests and Forestry Industry, 1960-1979, with a staff of one guard.
- The Municipality of Silistra, 1980-1991, with a staff of two guards.
- The Silistra Departmental Police Force, 1991-1993.

Since 1993 the Reserve has been managed by the Ministry of Environment and Water, which has appointed a Reserve Manager and two guards. A new modern building was constructed in 1997 for the Reserve Administration, which reports to the Rousse Regional Inspectorate of Environment and Water. Here are their addresses:

Regional Inspectorate of Environment and Water: 20 Pridounavski Blvd., 7000 Rousse. Srebarna Biosphere Reserve Administration: Village of Srebarna, Region of Silistra.

PART 2. EVALUATION AND OBJECTIVES

2.1. Evaluation

2.1.1. Position in the ecological complex

Srebarna is an important component of an ecological complex comprising ***(App.1, Map 1)***:

- The entire aquatic and terrestrial area of the Reserve.
- The drainage area of Lake Srebarna.
- The Kanarata, Kodja Bair, Polyanata and Kara Bouroun hills surrounding the lake.
- The Garvan Marsh and the micro-dam lakes near the villages of Srebarna, Lambrinovo and Sitovo.
- The Danube stream bed with the adjacent islands of Vetren and Devnya.
- Part of the Danube left bank with its wetlands (currently converted into dam lakes, fish ponds and fish farms).
- Lake Garlita (located to the east of Silistra).

Of all sites listed above, only Lake Srebarna and the Garvan Marsh have a conservation status. The last two groups of wetlands are located on Romanian territory.

2.1.2. Biological diversity

The Srebarna Reserve hosts a sizable diversity of species

According to Michev *et al*. (1998) the recorded species diversity of Srebarna consists of 1,116 genera with 2,748 taxa (species, subspecies, varieties and forms). They belong to 47 classes, 24 divisions and phyla:

Cyanophyta	231
Prochlorophyta	1
Glaucophyta	1
Euglenophyta	154
Pyrrhophyta	17
Chrysophyta	140
Cryptophyta	19
Chlorophyta	555
Rhodophyta	1
Basidiomycota	9
Ustomycota	1
Deuteromycota	6
Lichenophyta	15
Bryophyta	1
Polypodiophyta	4
Magnoliophyta	275
Sporozoa	14
Myxozoa	1
Platyhelminthes	117
Nemathelminthes	125
Acanthocephala	6
Mollusca	48
Annelida	29
Arthropoda	669

Pisces	23
Amphibia	12
Reptilia	15
Aves	221
Mammalia	41

The diversity of communities within the Reserve and in its vicinities has been determined according to the CORINE Biotopes Project. According to it, 13 types of habitats exist in Srebarna (they are described in Section 1.16.1). The Reserve itself is part of nearly 150 sites of substantial importance for conserving Bulgaria's biodiversity.

Under the Ramsar Convention, the ecosystem diversity in the Srebarna Reserve has been determined according to the following wetland types within the Reserve proper and in its buffer zone:

M - Permanent rivers (an arm of the Danube stream bed between the right bank and the Island of Devnya).

O - Permanent freshwater lakes (the open-water surface of Lake Srebarna).

P - Seasonal marshes/pools (excavation pits between the Vetren-Silistra Dyke and the left bank of the River Danube).

Xf - Freshwater, tree dominated wetlands; seasonally flooded forests (the entire area of the Island of Devnya and part of the riverside between the Vetren - Silistra Dyke and the right bank of the River Danube).

Zk - Subterranean karst and cave hydrological systems (the Kanarichkata Spring in the southern section of Srebarna).

The diversity of biogeographical provinces (after Udvardy, 1975) has been determined on the basis of the presence of three biogeographical provinces, *viz.*:

Middle European Forest
Pontic Steppe
Balkan Highland.

2.1.3. Naturalness

Srebarna has a remarkably good naturalness, which could have been even better without the homogeneous stand plantations of Black Locust (*Robinia pseudoacacia*), Black Pine (*Pinus nigra*), Common Gloxinia (*Gleditschia triacanthos*) and Hybrid Poplar (*Populus sp. X Populus sp.*) on Kara Bouroun, Polyanata and Kodja Bair and without the large dyke in the northern section. The two reed-beds in the northern and southern sections of the lake are among the largest ones in Bulgaria.

2.1.4. Rarity

The following characteristics of the Srebarna Reserve substantially increase the values of this indicator:

- A nesting colony of Dalmatian pelicans that is unique for Bulgaria and rare for the Balkan Peninsula and for Europe, easily observable at a relatively short distance from the surrounding hills;
- Bulgaria's only traditional nesting occurrence of the Great Egret (*Egretta alba*);
- One of Europe's few nesting occurrences of globally threatened bird species like the Pygmy Cormorant (*Phalacrocorax pygmaeus*) and the Ferruginous Duck (*Aythya nyroca*);

- One of the few wintering grounds of globally threatened bird species like the Lesser White-fronted Goose (*Anser erythropus*) and the Red-breasted Goose (*Branta ruficollis*);
- One of Bulgaria's and Europe's few age-old nesting colonies of Little Egrets (*Egretta garzetta*), Squacco Herons (*Ardeola ralloides*), Night Herons (*Nycticorax nycticorax*), Grey Herons (*Ardea cinerea*), Purple Herons (*Ardea purpurea*), Glossy Ibises (*Plegadis falcinellus*) and White Spoonbills (*Platalea leucorodia*);
- Bulgaria's only occurrence of *Aldrovandra vesiculosa*.
- Bulgaria's only place with floating reed-beds;
- One of Bulgaria's few places with expansive reed-beds.
- The only well preserved marsh along the Bulgarian sector of the Danube riverside.

2.1.5. Fragility

The Srebarna Reserve is a relatively very fragile ecosystem for several reasons:

- The lake is closely connected to the River Danube and is strongly dependent on it;
- The lake is at the lowest elevation of a 402 km^2 catchment area, and all substances used in farm land treatment find their way to the lake;
- The Village of Srebarna, located next to the western lake shore, has a certain adverse impact on the Reserve;
- The processes of active erosion of the surrounding hills (Kutev, 1999) have a strong impact on the water quality of the lake;
- a large part of the piscivorous birds that breed in the Reserve feed outside the boundaries of the Reserve, mainly in Romania (fish ponds and fish farms, dam lakes) and to a lesser extent in Bulgaria (micro-dams and overflows) which do not enjoy any conservation status.

2.1.6. Typicality

The Srebarna Reserve is a typical inland wetland of the Lower Danube with typical plant and animal biota. Some bird species like the Bee-eater (*Merops apiaster*), the Kingfisher (*Alcedo atthis*), the Roller (*Coracias garrulus*) and the Hoopoe (*Upupa epops*) are typical of the loess walls in Dobroudja. The Danube Island of Devnya hosts vegetation and features mud-banks and sand bars typical of the Lower Danube.

2.1.7. Potential improvement

Possibilities to improve the state of the Reserve are available through:

- increase of the water volume of the lake through deepening, which will also contribute substantially to an improvement of the ecological conditions;
- amelioration of the landscape around the Reserve through replacement of the non-indigenous tree and shrub vegetation by native vegetation;
- tangible increase of sight-seeing tourism;
- upgrading communication, education and public awareness (CEPA); enlistment of the local people in the work to protect and promote the Reserve.

2.1.8. Aesthetic, cultural and religious values

The Reserve has a great aesthetic value as an unexplored, exotic and unusual environment. The floating reed-beds (reed islands), the channels crossing the reed-beds, the island-shaped mats of White Water-lilies (*Nymphaea alba*), as well as the large concentrations of rare and endangered aquatic birds are little known to the general public and excite their curiosity.

An abundance of natural resources like fish, ducks, geese, reed, reedmace, etc. have attracted people to this area since ancient times. The ruins of an ancient settlement have been discovered in the Opashkata Locality.

The village of Tataritsa, now a neighbourhood of the village of Aidemir, is located near the Reserve. The residents of Tataritsa are Russians, known as Lipovani or Old Believers. They settled there some 200 years ago. Until recently the Lipovani did not intermarry with local Bulgarians and have thus preserved a number of peculiarities in their costumes, lifestyle and working habits. Men were professional fishermen, while women mainly worked in the vineyards. The lifestyle and customs of this village is of definite interest for sight-seeing tourism.

The residents of the three villages around the Reserve are adherents to Eastern Orthodox Christianity. There are well-preserved churches in all three villages. A small part of the population in the neighbouring villages have joined the Church of Seventh-day Adventists.

Ethnographically, the villages around the Reserve have largely preserved their traditional costumes, customs and festivals. The Koukeri carnival-like folk custom and the Lazarouvane maidens' initiation rite are of substantial interest for sight-seeing tourism.

2.1.9. Social and economic value

The principal means of livelihood in the villages around the Reserve are crop farming (some 10,000 ha of cultivable land in aggregate), stock-breeding (60 cows, 1,500 sheep and 550 goats graze around the Reserve), fishing (in the Danube), and bee-keeping (there are five apiaries with a total of 350 bee-hives). The Union of Hunters and Anglers of Bulgaria keeps a pheasant-breeding farm in the Kamuka Locality. Not more than 150-200 pheasants have been raised there in recent years.

The only industrial enterprises are in the village of Aidemir, but they do not affect the Reserve. Recently, however, there has been evidence of air pollution in the area of the Reserve. This pollution presumably originates from the iron and steel works at Calarasi, across the river in Romania.

Unemployment is a major concern for the villages around the Reserve. Thus, over 180 families in the Village of Aidemir subsist on welfare benefits, and unemployment (including hidden unemployment) is expected to affect over 20% of the population. The increased unemployment contributes to an invigoration of poaching of fish, Red Deer, Roe Deer, Wild Boars, Hares, etc.

The three villages have a lot in common, but there are also some substantial distinctions in social status and economy.

The tourism industry is underdeveloped for the time being. Despite the lack of essential conveniences, Srebarna welcomes some 15,000 visitors annually. Thirty-five per cent of them are schoolchildren arriving on tours organized by their schools at the beginning and the end of the school year. They spend about an hour here, viewing the display. Fifty per cent of all visitors are foreigners, mostly holidaymakers from the Bulgarian Black Sea resorts. Srebarna is the last stop of their one-day tour to the Lower Danube riverside.

Some 50 people of Srebarna and Vetren regularly go hunting. In winter, hunters from other parts of the country come as well to shoot wild geese roosting in the Reserve.

Many local residents angle as a pastime. The Danube river bank, part of which is within the boundaries of the Reserve, is a favourite location for anglers.

2.1.10. Communication, education and public awareness

The Natural History Museum is an asset for the Reserve. For better attainment of its assigned purpose, however, it should be transformed into an Information & Visitor Service Centre.

While a lot has been achieved for conservation education and public awareness (see Section 1.27), the following obstacles and limiting factors remain:

- Insufficient funding for conservation and environmental communication, education and public awareness programmes, the first one being replacement of the outdated information panels and sign posts.
- Conflicts with local people, who find it hard to accept the strict protection regime of the Reserve.
- Lack of information exchange with similar reserves abroad and with international conservation organizations like the World Conservation Union (IUCN), WETLANDS INTERNATIONAL, EUROPARK, EUROSITE etc.
- Lack of e-mail and other modern communications means.
- Lack of a Consultative Board with the Reserve Administration.
- Lack of systematic fund-raising activities for the Reserve.
- Outdated display of the Natural History Museum which does not meet modern requirements and trends; lack of programmes to attract visitors (who are mostly schoolchildren, students and ordinary tourists); lack of expert guides familiar with the Reserve and its biota.
- Lack of essential facilities for the visitors of the Reserve (eco-paths, bird-watching hides, information signs and brochures).
- The Reserve Administration and Natural History Museum buildings are not equipped to host CEPA events for visitors.
- Lack of a system to recruit volunteers for work at the Reserve, at the Ecological Field Research Station or at the Natural History Museum.
- Lack of a programme to observe national and international wildlife or environmental conservation days.
- Estrangement of the local people from the problems of the Reserve; lack of contacts with the surrounding settlements and especially with Silistra.

Programmes and projects for improvement of conservation education and public awareness are covered in Part 3.

Public awareness of the problems of the Srebarna Reserve is assessed as good. Stories, films and reports frequently appear in the press and on radio and TV, but this activity still leaves much to be desired.

2.1.11. Recreation

At present, there are two recreation sites in the surroundings of the Srebarna Reserve:

The Village of Vetren. In recent years, the declining village has been transformed into a country-house zone by enterprising residents of Silistra. Just outside the village, there is a holiday home formerly run by the Trade Unions which is now operated as a hotel by a private company.

The Village of Tanassovo, a holiday village located right on the Danube bank opposite the western end of the Island of Vetren. This settlement consists of some 20 small ramshackle sheds, none of which have been legalized.

In summer, the reserve attracts several categories of visitors:

Schoolchildren from all over the country, touring Bulgaria's natural and cultural sites. These are the most numerous visitors (35% of the total), who view the museum display, listen to an explanation by the guide, take a quick look at the Reserve through a telescope and binoculars, and leave Srebarna after an hour's stay.

Foreign tourists without special interests, arriving from the seaside resorts of Albena and Golden Sands (50% of the total). They visit Srebarna on package tours. Their stay follows the same schedule as the schoolchildren's visits.

Foreign bird-watchers. Their visits are arranged by specialized Bulgarian and foreign tour operators (Pandion D, Neophron, Explorer, etc.) These groups are usually led by an expert bird guide who accompanies them to the crest of the neighbouring Kodja Bair Hill, which commands an excellent view of the Dalmatian Pelican colony. These groups are the least numerous category of visitors to Srebarna.

2.1.12. Research/study

The Reserve provides ample opportunities for scientific research thanks to the extraordinary biological diversity of species, ecosystems and biogeographical provinces. Several research programmes are being currently implemented at Srebarna. These opportunities will be enhanced even more with an augmentation of the experimental facilities and research equipment at the Ecological Field Research Station of the Central Laboratory of General Ecology with the Bulgarian Academy of Sciences. The Reserve can also serve as an International Experimental Station for the study of typical Lower Danube wetlands subject to strong anthropogenic pressure.

The research work done in Srebarna has always attracted great interest. The steady augmentation of the databases, analyses, monitoring of endangered species and habitats could become standing research objectives. They can be pursued with the active assistance of the Reserve Administration and other institutions in charge of the implementation of the Management Plan.

One of the principal tasks of the Reserve Administration is to organize a standardized system for data collection and storage. The MedWet programme software could be used to this end.

Evidently, scientific research is conducted at the Srebarna Reserve at a relatively adequate level. In this respect, Srebarna is a front ranker among the other protected sites in Bulgaria.

2.2. Ideal (long-term) management objectives

The ideal (long-term) objectives express an aspiration to restore fully the natural state of the Reserve, provided there are no legal, political, financial and natural impediments to the attainment of these objectives. These objectives comprise:

- Complete restoration of the natural ecosystems and biological diversity.
  Sustainable management of ecosystems, habitats and species.
- Restoration of the natural hydrological regime.
- Turning the Reserve into a considerably larger transboundary ecological complex with sustainable self-controlling and self-recovering functions.

2.3. Factors influencing achievement of ideal (long-term) management objectives (constraints and modifiers):

2.3.1. Internal natural factors:

- Accelerated processes of succession, giving terrestrial predators and poachers easy access to the Reserve, as a result of which the nesting colonies are disturbed.

2.3.2. Internal human-induced factors:

- Large-scale poaching, using commercial fishing gear, electricity and other devices.

2.3.3. External natural factors:

- Prolonged drought that has prevented the Danube water from flushing the lake since 1988;
- Invasion of non-native (predominantly American) plant and animal species along the Lower Danube like False Indigo (*Amorpha fruticosa*), Tree-of-Heaven (*Ailanthus sp.*), Muskrat (*Ondatra zibethica*), Pumpkinseed Sunfish (*Lepomis gibbosus*), etc. (see also Section 1.22).
- The function of Lake Srebarna as a natural capture (end receiving waters) for nutrients and pollutants from the Danube and the drainage area.

2.3.4. External human-induced factors:

- Interference with the natural hydraulic regime of the River Danube by the construction of large-scale dams in the Yugoslav sector of the river.
- Interference with the natural hydraulic regime of Lake Srebarna as a result of the construction of the Vetren-Silistra Dyke in 1948.
- Grubbing-up of the vines on the western bank above the Village of Srebarna and conversion of the tracts into crop fields susceptible to intensive land erosion.
- Pollution of the River Danube with petroleum products, heavy metals and other noxious substances.

2.3.5. Factors arising from legislation or tradition:

- Traditional use of the lake's natural resources, such as reed, bulrush, fish, waterfowl, etc. by the local people of the villages of Vetren, Srebarna and Tataritsa.

2.3.6. Available resources:

Limited financial resources from the Ministry of Environment and Water are available for implementation of the Management Plan. Funds and donations have been provided by international organizations for construction of the canal connecting the lake with the Danube in 1994, for construction of a building to house the Reserve Administration, for establishment of a monitoring system, for purchase of a new boat, etc.

2.3.7. Summary of factors influencing the achievement of long-term objectives

Most of the adverse factors described above are irreversible. Thus, it is impossible to restore entirely the previous natural hydrological regime of the River Danube and, hence, of the Srebarna Reserve as well. Even if this happened, the Danube stream bed erosion base is steadily sinking, which makes the influx of the Danube water into the Reserve ever more difficult.

The principal factor that would impede the achievement of the long-term ideal objectives is the lack of sufficient financial resources to implement a series of conservation measures in the Reserve. The State allocates resources from the budget and from the National

Environmental Protection Fund. Efficient use has to be made of NGO initiatives and funding available from international organizations and programmes.

The second most important factor is the resistance, indifference and lack of initiative on the part of the local people. They still do not appreciate and use adequately the significant opportunities offered by the Reserve for tangible improvement of their circumstances with the development of tourism.

2.4. Identification of realistic (operational) objectives

2.4.1. Introduction and maintenance of a specific hydraulic regime

This regime should be the nearest approximation to the previous natural regime and should be optimal for the ecosystems in the Reserve. A subsidiary objective is to restore the previous water volume in the open-water surface of the lake and the Baboushkoto Marsh to the volume that existed before 1948 through scooping (suction pumping) of a certain layer of bottom sediments.

2.4.2. Containment of succession and reduction of the eutrophication level in the Reserve so as to maintain optimal conditions for the existing ecosystems and globally threatened species.

2.4.3. Reduction of the influx of pollutants into the Reserve.

2.4.4. Conservation and restoration of biological diversity in the Reserve, with the subsidiary objectives:

- To conserve and restore globally threatened species.
- To conserve and restore species included in the Bulgarian Red Data Book and local tree and shrub species.

2.4.5. Enlistment of local people in the development, discussion and implementation of the Management Plan of the Reserve.

2.4.6. Communication, education and public awareness regarding nature and biodiversity conservation and addressing the problems of protected areas.

2.4.7. Accumulation of specialized scientific data concerning the Reserve and wetlands in general.

2.4.8. Improvement of the work of the Reserve Administration.

- The principal strategies for achievement of the realistic (operational) objectives and, hence, of sustainability of the ecosystems in the Srebarna Reserve are:
- Periodic (at an interval of 30 to 50 years) scooping (suction pumping) of sediments accumulated in the lake instead of mowing or burning of the reed, which has a proven adverse impact on the ecosystems and biodiversity.
- Removal of part of the primary production into the River Danube; another part to be absorbed by herbivorous fish like Silver Carp (*Hypophthalmichthys molitrix*) etc.
- Enlisting local people in the active management and stewardship of the Reserve and providing them with a profit motive for its preservation and protection.
- Monitoring the principal components of the ecosystems in the Reserve.
- The principal strategies for enhancement of sight-seeing, rural and eco-tourism are:
- Establishing modern accommodation facilities in the villages of Srebarna and Vetren by persuading interested local people to convert their own houses to this end.

- Providing opportunities for visits to parts of the Reserve by rowboats along a designated route.
- Identifying and sign-posting ecological routes and eco-paths around the Reserve for treks of various duration (an hour, half a day, all day, etc.).
- Organizing outings to the Danube bank and the surroundings of the Reserve on horseback, donkey or Dobroudja cart.
- Conducting promotional campaigns.
- The principal strategies for improvement of communication, education and public awareness are:
- Transformation of the existing Natural History Museum into a modern Information & Visitor Service Centre and making more efficient use of the premises of the Museum, as well as of the auditorium of the *Chitalishte* community centre.
- Enlisting non-governmental organizations.

PART 3. ACTION PLAN

3.1. Introduction

From a conservation point of view, the Srebarna Biosphere Reserve occupies an insufficiently large surface area, as a result of which it is in an unstable transitional state leading to processes of degradation. These processes are caused by natural succession and by the global and local anthropogenic impact.

The character of the Action Plan with the **Management Plan of the Srebarna Biosphere Reserve** is determined by the **Protected Areas Act** (promulgated in the *State Gazette* No. 133 of 1999). This Act categorizes Srebarna as a "**managed nature reserve**." According to Article 27 (1) of the Act, any activities in managed nature reserves are prohibited with the exception of:

1. Physical security.
2. Visits for the purpose of scientific research.
3. Pedestrian traffic movement on marked hiking trails, including such traffic for educational purposes.
4. Collection of seeds, wild plants and animals for the purpose of scientific research or for repopulating other sites.
5. Conduct of maintaining, steering, controlling or restorative measures.

In compliance with the conservation status of this category of protected area, it is possible to take active measures to mitigate and/or discontinue the adverse anthropogenic or natural impact (including the impact of the global changes of the environment) on the Reserve ecosystems *not only by managing processes in the surrounding areas* but also *by exerting direct influence on the habitats and populations of plant and animal species.* In general, the working programmes and projects under this Management Plan are intended to result in effective conservation and restoration: biological diversity, naturalness and rarity, as well as to diminution of ecosystems' vulnerability. At the same time, the social, cultural and economic values of the Reserve should be preserved and augmented, using it for the purposes of education, recreation and scientific research. Achieving these objectives should lead to raising of the environmental and conservation awareness and education of the local people, cultivating respect not only for this particular protected area but for wildlife in general. The Reserve offers a great but still underutilized potential for in-depth scientific research, which would improve management and increase human knowledge of the structure and functioning of wetlands.

Upon its entry into effect, the Management Plan of the Reserve supersedes the part of Ministry of Environment and Water Order No. RD 367 dated 15 October 1999 (promulgated in the *State Gazette* No. 97 of 1999) determining the protection regimes and the standards of the Reserve.

3.2. Zoning, regimes and standards

For the purpose of its more efficient management and physical security, the area of the Reserve is divided into the following zones with different regime and character of maintaining, steering, and controlling or restorative measures.

3.2.1. Zone A (core of the Reserve)

Assigned function: conservation in their natural state of the hosted plant and animal habitats, ensuring normal conditions for birds to breed, feed and stage during the period of breeding, migration and wintering.

The boundaries of this zone are plotted on ***Map 14, App. 1.*** It incorporates the open-water surface of the lake, the northern and southern reed-beds, as well as the areas connecting them. The Island of Devnya is also included in this zone.

The following activities are prohibited in Zone A:

- Visits for the purpose of education and tourism.

The following activities are permissible in Zone A:

- Entering for the purpose of protection, scientific research, sampling and monitoring according to the procedure established by Article 17 (3) and Article 28 of the Protected Areas Act. The only point of entry is the Pristana Locality on the western bank, which is designated an official entrance to the Reserve. The Reserve Administration records each entry in the zone in a Log of Visits to Zones A and C.
- Conduct of the following maintaining, steering, controlling or restorative measures according to Article 27 (2) of the Protected Areas Act and this Plan (Section 3.3. Working programmes and projects).

3.2.1.1. Maintaining activities

(A) Maintaining the water level in a state closest to the maximum level. The regime for opening and closing of the sluices is specified in a manual endorsed by the Director of the Rousse Regional Inspectorate of Environment and Water ***(Project 1.1.1.)***.

(B) Preventing accidental pollution of the Reserve according to an Emergency Plan endorsed by the Director of the Rousse Regional Inspectorate of Environment and Water.

3.2.1.2. Steering activities

Encouragement and increase of the populations of:

(A) Globally threatened and rare bird species: Dalmatian Pelican (*Pelecanus crispus*), Pygmy Cormorant (*Phalacrocorax pygmaeus*), Great Egret (*Egretta alba*), White Spoonbill (*Platalea leucorodia*), Glossy Ibis (*Plegadis falcinellus*), Ruddy Shelduck (*Tadorna ferruginea*), Ferruginous Duck (*Aythya nyroca*), White-tailed Sea Eagle (*Haliaeetus albicilla*) by building artificial nests in appropriate places etc. ***(Projects 4.3.1. and 4.3.2.)***.

(B) Rare fish species: Asp (*Aspius aspius*), Blue Bream (*Abramis balerus*), White-eye Bream (*Abramis sapa*), Striped Ruff (*Gymnocephalus schraetzer*) ***(Project 4.2.2.)***.

(C) Globally threatened and rare mammal species: European Otter *(Lutra lutra)* ***(Project 4.1.3.)***.

3.2.1.3. Controlling activities

(A) Controlling the populations of Wild Boars and terrestrial predators (Jackal, Fox and Raccoon-like Dog) when they can cross the frozen aquatic area of the Reserve in packs ***(Project 4.2.1.)***.

(B) Control of the Gray Willow (*Salix cinerea*).

(C) Replacement of the homogeneous stand plantations of Hybrid Poplar (*Populus sp. X Populus sp.*) ***(Project 1.2.2.)***.

(D) Control of certain fish populations ***(Project 4.4.3.)***.

(E) Mowing and removal of Reed and Reedmace to an extent and in quantities fixed by the Reserve Administration ***(Project 5.2.2.)***.

3.2.1.4. Restorative activities

(A) Restoration of the stable bottom and natural depth through removal of sediments accumulated in the open-water area of the lake outside the breeding period ***(Project 2.2.1.)***.

(B) Restoration of part of the open-water surface of the lake and the natural links between the pools populated by reed-beds as a result of succession. Restoration is implemented by removal of part of the reed together with its floating islet ***(Project 2.2.2.)***.

(C) Restoration of the communities of White Water-lily (*Nymphaea alba*) and Water Soldier (*Stratiotes aloides*).

(D) Restoration of the fish stocks in the Reserve. Breeding sustainable populations of rare and endangered fish species ***(Project 4.2.4.)***.

(E) Restoration of the basic trophic structure in the lake ***(Project 4.2.3.)***.

The controlling and restorative activities are carried out outside the breeding period (February-August).

3.2.2. Zone B

Assigned function: conservation in their natural state of the hosted plant and animal habitats, ensuring normal conditions for birds to breed, feed and stage during the period of breeding, migration and wintering. Subsidiary function: protection of the core of the Reserve, mitigation and containment of the adverse impact on the core. Conduct of educational activities in the zone is permissible along expressly designated routes and according to a procedure established by the Director of the Rousse Regional Inspectorate of Environment and Water.

The boundaries of this zone are plotted on ***Map 14, App. 1.*** It incorporates all or parts of the slopes of the hills surrounding the lake bowl on the west, south and east, as well as the area located to the north of the northern reed-bed (the aquatic area between the Island of Devnya and the bank, the area enclosed by dykes, and the aquatic areas around the Pristana Locality).

The following activities are permissible in Zone B:

(A) Entering for the purpose of physical security, scientific research, sampling and monitoring according to the procedure established by Article 17 (3) and Article 28 of the Protected Areas Act.

(B) Placing of apiaries according to a procedure established by the Reserve Administration.

(C) Pedestrian, bicycle, cart, tractor, motorcycle, passenger-car and under-3 t truck traffic movement on the following roads ***(Map 14, App. 1)***:

- Village of Srebarna - Kanarichkata - Todoranka - Tanassovo Holiday Village;
- Village of Vetren - site of former 1948 dyke - Baltata Locality;
- Silistra-Rousse road - Pheasant-Breeding Farm in Kara Bouroun Locality.

(D) The following pedestrian trails and boat routes are designated for the purposes of education and tourism:

- Boat route: jetty - aquatic area in front of jetty - western end of open-water surface of lake and back. This route can be used by rowboats (without engines and sails) according to a procedure established in a manual endorsed by the Director of the Rousse Regional Inspectorate of Environment and Water.
- Pedestrian trail from the Reserve Administration, along the Kodja Bair Hill to the northeastern most sections of the Reserve. This route can be used by pedestrians, carts and horses.
- Boat route along the arm of the River Danube between the bank and the Island of Devnya. This route can be used only by fishing boats.

All roads and trails described above are marked with sign posts, information panels etc. ***(Project 6.1.1.)***.

- Conduct of the following maintaining, steering, controlling or restorative measures according to Article 27 (2) of the Protected Areas Act and this Plan (Section 3.3. Working programmes and projects).

3.2.2.1. Maintaining activities

(A) Repair of the defects and leaks of the northern sluice so as to retain longer the water volume within the area enclosed by dykes in the northern section of the Reserve ***(Project 1.2.1.)***.

(B) Arrangement of round-the-year, round-the-clock physical security of the northern sluice ***(Project 8.2.1.)***.

3.2.2.2. Steering activities

Increase in the populations of:

(A) Globally threatened and rare bird species: Pygmy Cormorant (*Phalacrocorax pygmaeus*), Great Egret (*Egretta alba*), White Spoonbill (*Platalea leucorodia*), Glossy Ibis (*Plegadis falcinellus*), Greylag Goose (*Anser anser*), Ruddy Shelduck (*Tadorna ferruginea*), Ferruginous Duck (*Aythya nyroca*), White-tailed Sea Eagle (*Haliaeetus albicilla*), Black Tern (*Chlidonias nigra*), Whiskered Tern (*Chlidonias hybrida*), Roller (*Coracias garrulus*), Bee-eater (*Merops apiaster*), Kingfisher (*Alcedo atthis*) and Hoopoe (*Upupa epops*) ***(Project 4.3.2.)***.

(B) Endangered and rare mammal species: European Otter *(Lutra lutra)*, Russian Polecat (*Mustela eversmanni*), Marbled Polecat (*Vormela peregusna*), Common (Black-bellied) Hamster (*Cricetus cricetus*).

3.2.2.3. Controlling activities

(A) Control of vegetation in the western hilly sections of the Reserve so as to preserve the steppe character through round-the-year grazing of sheep, goats, cows, horses and donkeys (but not pigs) within traditional proportions. Fees are collected for the performance of this activity according to the procedure established by Item 5 of Article 50 of the Protected Areas Act ***(Map 13, App. 1)***.

(B) Replacement of the plantations of Hybrid Poplar (*Populus sp. X Populus sp.*), Oleaster (*Elaeagnus angustifolia*), Common Gloxinia (*Gleditschia triacanthos*) and Black Locust (*Robinia pseudoacacia*) within the zone by autochthonous tree and shrub vegetation ***(Project 4.2.6.)***.

(C) Control of the fish flock through rod fishing from the bank and at places shown on ***Map 13, App. 1*** and in compliance with the relevant regulatory acts on angling and according to a procedure established by the Director of the Rousse Regional Inspectorate of Environment and Water ***(Project 5.2.1.)***.

3.2.2.4. Restorative activities

(A) Restoration of the steppe character of the areas previously planted with Black Locust (*Robinia pseudoacacia*) in the northwestern hilly section of the Reserve.

(B) Restoration of the natural tree and shrub vegetation through gradual replacement of allochthonous, non-native species (Common Gloxinia (*Gleditschia triacanthos*), Oleaster (*Elaeagnus angustifolia*), Hybrid Poplar (*Populus sp. X Populus sp.*), Tree-of-Heaven (*Ailanthus sp.*), Black Locust (*Robinia pseudoacacia*), Black Pine (*Pinus nigra*) by indigenous species like Lime Tree (*Tilia*), Common Elm (*Ulmus minor*), Oak (*Quercus*) ***(Project 4.2.6.)***.

3.2.3. Zone C

Assigned function: ensuring and guaranteeing the conservation of the permanent nesting colony of Dalmatian Pelicans, Great Cormorants and Bee-eaters, as well as of the annually relocating nesting places of Herons, Glossy Ibises, White Spoonbills and Terns.

Zone C consists of several permanent and temporary patches of various surface area, plotted on ***Map 14, App. 1***.

Annually, on or before 15 May, the Reserve Manager designates the location of the temporary nesting colonies and plots them on a map, which is endorsed by the Director of the Rousse Regional Inspectorate of Environment and Water.

The following activities are prohibited in Zone C:

(A) Entering for the purpose of education.

(B) Entering during the breeding period, with the exception of visits:

- For the purpose of scientific research (sampling, monitoring and offspring tagging according to the procedure established by Article (3) and Article 28 of the Protected Areas Act) once or twice per season, with the stay not exceeding one hour in sunny weather at noon. Tagging is conducted only under the guidance of a professional ornithologist with an experience of over three years. The type and number of research materials collected and the data on the tagged birds are recorded in a Log of Visits to Zones A and C.
- After natural disasters and calamities, after exceedingly cold spells, after mass poisonings, after gross breaches of the protection regime of this zone and in other emergencies. The activities and observations conducted, as well as the damage detected, are recorded in a memorandum of ascertainment.

The following activities are permissible in Zone C:

Conduct of the following maintaining, steering, controlling or restorative measures according to Article 27 (2) of the Protected Areas Act and this Plan (Section 3.3. Working programmes and projects).

(A) Building artificial nesting platforms to protect the nesting places against flooding and to expand the nesting space ***(Project 4.3.1.)***.

(B) Fencing the nesting places if under a proven threat from terrestrial predators ***(Project 4.3.1.)***.

(C) Piling of additional nesting material on the nesting places ***(Project 4.3.1.)***.

(D) Monitoring species composition and population size ***(Project 4.3.1.)***.

(D) Installation of equipment for remote transmission of audiovisual information (Project 8.2.6).

(F) Restoration of the stable bottom and natural depth in the Pelican Pool and the Baboushkoto Marsh through removal of accumulated sediments ***(Project 2.2.1.)***.

All activities listed above are carried out outside the breeding period (February-August).

3.3. Working programmes

The Action Plan as part of the Srebarna Reserve Management Plan has been developed in compliance with the pre-set structure. After identifying the realistic (operational) management objectives for the Reserve, one or several working programmes have been elaborated for achievement of each objective. These programmes conform to specific management strategies and, in turn, comprise a group of projects geared to the implementation of a specific strategy. Each project is a specific task subsumed under an identified operational objective.

3.3.1. Priorities

The following scheme of priorities has been applied:

- Elimination of the risk of impact of disastrous natural and anthropogenic phenomena and factors;
- Elimination of factors threatening the state of ecosystems and/or populations of rare and endangered species;
- Elimination/mitigation of the effect of factors threatening individual habitats or populations of rare and endangered species;
- Re-introduction of protected species;
- Restoration of the natural character of the Reserve, or elimination of existing pollution, or mitigation of the adverse impact of a factor on the Reserve.

This system of priorities is weighed against a balance of costs and benefits. Another operative approach is used as well, bringing up projects of a high cost/benefit ratio and implementable within a short period of time and at a low absolute price. The most urgent projects, ranked according to this system, are presented below after the Working Programme.

3.3.2. Management Plan implementation evaluation and monitoring system

This Management Plan has been developed in the Ramsar Convention management-planning format, according to which implementation is evaluated and plans are partially updated on an annual basis. According to the Protected Areas Act and the Regulation on Elaboration of Protected Area Management Plans, however, their evaluation and periodic adjustment takes place once every ten years. The Srebarna Reserve is a rather unstable and dynamic environment, which requires annual arrangements for evaluation, monitoring of implementation and partial updating.

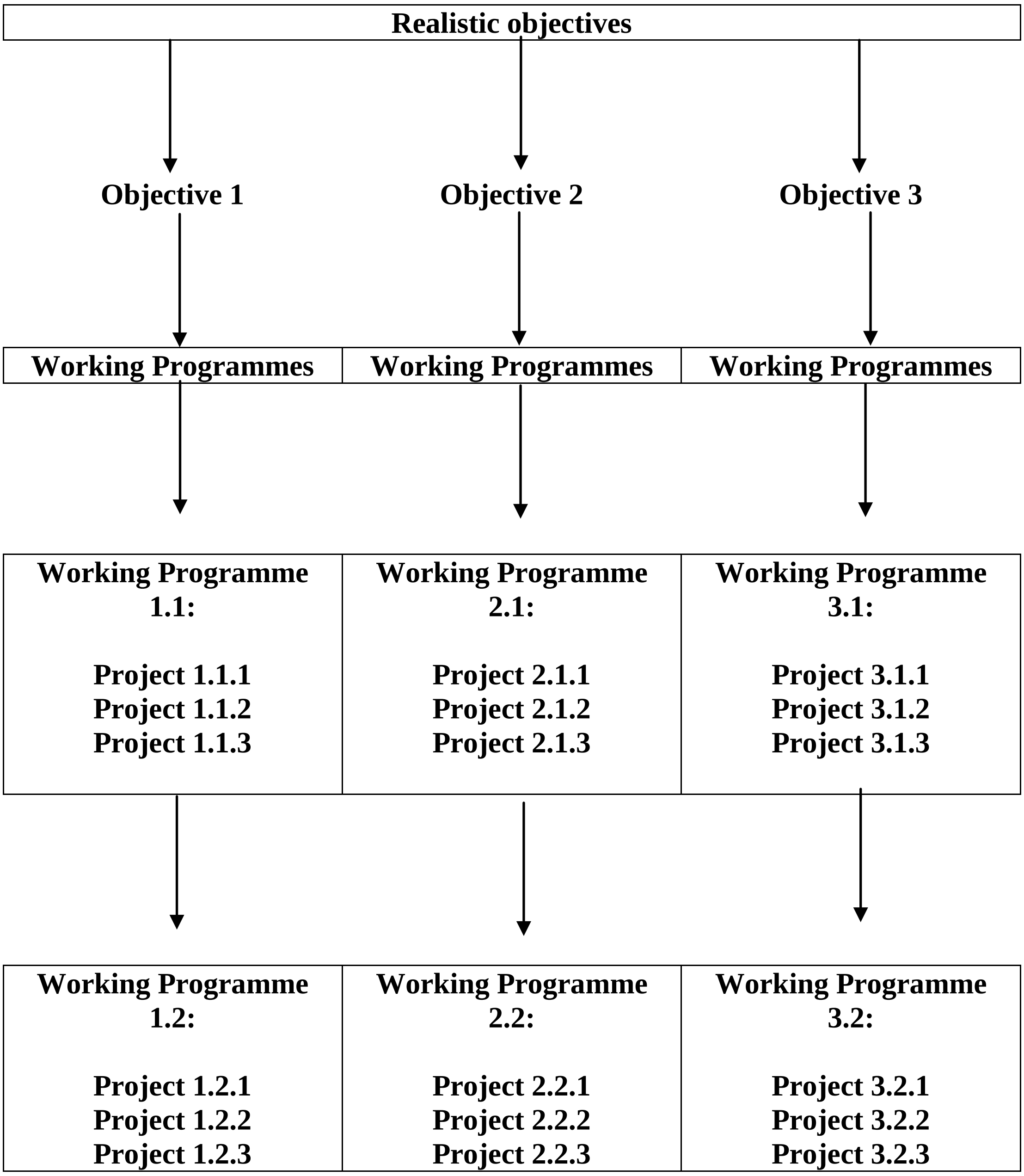
Within its annual report, according to the Rules for Assignment of Activities within Protected Areas Constituting Exclusive State Property, the Reserve Administration is required to report the state of the Reserve including:

1. Overall assessment of the state of the Reserve and the trends of its development.
2. List of projects in preparation.
3. Assessment of the impact of projects under implementation on the populations, habitats and environment parameters in conformity with the objectives set.
4. Assessment of any adverse changes in the state of the Reserve and the new management priorities arising in this connection.
5. Proposals for updating of the Management Plan, if necessary.

Data of the most significant parameters describing the state of the Reserve during the year are attached to the report in a standard form.

A diagram of the Working Programmes is presented by way of illustration.

Realistic objective ⌖ achieved through **Working Programmes,** designed by specific strategies ⌖ consisting of a system of **Projects**


Realistic objectives
Objective 1
Objective 2
Objective 3
Working Programmes
Working Programmes
Working Programmes
Working Programme 1.1:
Project 1.1.1
Project 1.1.2
Project 1.1.3
Working Programme 2.1:
Project 2.1.1
Project 2.1.2
Project 2.1.3
Working Programme 3.1:
Project 3.1.1
Project 3.1.2
Project 3.1.3
Working Programme 1.2:
Project 1.2.1
Project 1.2.2
Project 1.2.3
Working Programme 2.2:
Project 2.2.1
Project 2.2.2
Project 2.2.3
Working Programme 3.2:
Project 3.2.1
Project 3.2.2
Project 3.2.3

3.3.3. Description of individual programmes and projects

1. Realistic objective: Introduction and maintenance of a hydraulic regime that should be the nearest approximation to the previous natural regime and should be optimal for the ecosystems in the Reserve.

1.1. Working Programme: Increase of the inflow of water into the Reserve

1.1.1. +++ Project: Compilation of a temporary manual for control of the sluices built in 1994. **Objective:** To make the best use of the medium and high Danube water level until development of an expert information system.

1.1.2. ++ Project: Development of an expert information system connected to the Danube water level to regulate the hydraulic regime through control of the two sluices built on the connecting canal in 1994. Stage II: computerized expert system. **Objective:** To maximize the use of medium-high Danube water level in the long term.

1.1.3. + Project: Development of research-information and expert system for assessment of hydrologic processes in the lake and its drainage area so as to determine the water balance and hydraulic regime of the Reserve and their influence on its ecosystems. **Objective:** To determine an optimum hydraulic regime of the Reserve.

1.1.4. + Project: Introduction of a system for use of existing pumping facilities so as to regulate the hydraulic regime of the Reserve through pumping water from the River Danube. **Objective:** To achieve an optimum water level in the event of persistent drought.

1.2. Working Programme: Reduction of water consumption

*1.2.1.+++ **Project:** Remodelling and repair of the two sluices built on the connecting canal in 1994. **Objective:** To retain for as long as possible the aquatic areas (enclosed by dykes in the northern section of the Reserve), which a number of rare and threatened bird species use for feeding and nesting.*

*1.2.2. ++ **Project:** Replacement of Hybrid Poplar plantations within the Reserve. **Objective:** To reduce the consumption of water through evapotranspiration and to increase the water volume of the lake.*

*1.2.3. + **Project:** Blocking the outlet of the drainage system in the northern section of the Reserve. Objective: To discontinue the outflow of water through this outlet.*

2. Realistic objective: Containment of succession and reduction of the eutrophication level in the Reserve so as to maintain optimal conditions for the existing ecosystems and globally threatened species.

2.1. Working Programme: Reduction of the influx of nitrogen and phosphorus compounds

***2.1.1. + Project:** Optimization of the nutrient influx at the time of flushing of the lake by Danube water through incorporation of a special module into the information system under Project 1.1.2. **Objective:** To reduce the nutrient influx and the accretion of nitrogen and phosphorus contained in the Danube water entering the Reserve.*

2.2. Working Programme: Reduction of nitrogen and phosphorus pools in the Reserve

***2.2.1. +++ Project:** Removal of lake bottom sediments. **Objective:** To deplete the biologically available nitrogen and phosphorus pools in the lake, thus reducing the phytoplankton production and, partially, the growth of the reed-bed. Deepening of the lake bottom is also intended to contain the succession **(Map 12, App. 1)**.*

***2.2.2. +++ Project:** Periodic removal of part of the reed growth along the rim of the open-water surface of the lake. **Objective:** To offset the accretion of reed biomass in the lake and, hence to lower the rate of eutrophication and decelerate the succession which results in reed overgrowing the aquatic areas. Implemented simultaneously with Project 2.2.1.*

3. Realistic objective: Reduction of the influx of pollutants and eroded soil into the Reserve

3.1. Working Programme: Reduction of the influx of pollutants into the Reserve

3.1.1. **+++** ***Project:*** *Development of an emergency action plan in the event of natural calamities or man-induced environmental disasters affecting the Reserve and its catchment area, including the River Danube and air emissions. Elaboration of a programme in combination with Projects 1.1.1. and 1.1.3., for prevention and reduction of pollution of the Reserve upon flushing by Danube water.* ***Objective:*** *To protect the Reserve from accidental pollution by devising a specific time schedule and an action plan, and assigning personal responsibilities for their implementation.*

3.2. Working Programme: Reduction of the transport of suspended particulate matter into the lake

3.2.1. **++** ***Project:*** *Erosion control measures on the steep slopes of the western and southern lake shores.* ***Objective:*** *To reduce the inflow of particulate matter into the lake so as to halt siltation. To preserve the area's natural character.*

3.2.2. **+** ***Project:*** *Construction of hydraulic engineering facilities at the inlet of the Danube-Lake Canal for reduction of the inflow of suspended matter into the lake upon entry of Danube water through the canal.* ***Objective:*** *To reduce the inflow of particulate matter into the lake so as to halt siltation.*

4. Realistic objective: Conservation and restoration of biological diversity in the Reserve

4.1. Working Programme: Conservation and restoration of habitats

4.1.1. +++ Project: *Expansion and deepening of the existing artificial water body built in the northern section of the Reserve; creating conditions for retention of a high water level after flushing by Danube water. To be implemented together with Projects 2.2.1 and 2.2.2.* ***Objective:*** *To create feeding biotopes for various aquatic birds (Waders, Herons and Egrets, Geese, Marsh Terns, Gulls, etc.).*

4.1.2. + Project: *Maintenance and restoration of areas of shrubs and small forest groups of native species along the periphery of the lake.* ***Objective:*** *To restore the natural biodiversity of autochthonous flora. To improve the amphibians habitat.*

4.1.3. + Project: *Cutting one or two canals (making pools) in the tree groups growing on the steep eastern shore of the lake. To the extent practicable, to be implemented together with Projects 2.2.1 and 2.2.2.* ***Objective:*** *To create suitable habitats for the European Otter (Lutra lutra).*

4.1.4. + Project: *Partial demolition of small sections of the southern part of the dyke built in 1978.* ***Objective:*** *To enhance the landscape value of the area and to increase the "non-disturbance" factor in the northern section of the Reserve by blocking access for passage.*

4.2. Working Programme: Re-introduction of native and endangered species and restoration of natural biodiversity. Control of the population size of predators and Wild Boars

4.2.1. ++ Project: *Control, should the need of it be proven (after a count), of the population size of the Jackal, Fox, Raccoon-like Dog and Wild Boar in the Reserve by winter culling.* ***Objective:*** *To protect ground-nesting birds.*

4.2.2. ++ Project: *Stocking the lake with fish species from the Danube, as well as re-introduction of extinct native species like the Asp (Aspius aspius), the Blue Bream (Abramis balerus), the White-eye Bream (Abramis sapa) and the Striped Ruff (Gymnocephalus schraetzer).* ***Objective:*** *To enhance species diversity of the fish community and to stabilize the trophic resources for piscivorous birds.*

4.2.3. **+ *Project:*** *Should the need be proven, creation of conditions for population booms of the Water Fleas (Daphnia sp.) and of Tubifex sp. and other plankton and benthos organisms.* ***Objective:*** *To restore the normal trophic network and natural biodiversity. To create stable trophic resources for plankton-feeding and predator fish species.*

4.2.4. **+ *Project:*** *Re-introduction of endangered and rare piscivorous fish species like the European Wels, (Silurus glanis), the Volga Pikeperch (Stizostedion volgensis) and the Czech Ruff (Gymnocephalus balonii).* ***Objective:*** *To establish sustainable populations of endangered, rare and indigenous fish species in the lake. To increase the biodiversity of the lake biota and the sustainability of the trophic resources for piscivorous birds. To create a sustainable grazing trophic chain for the purposes of water quality management.*

4.2.5. **++ *Project:*** *Restoration of the population of the Ruddy Shelduck (Tadorna ferruginea) through release into the wild of young birds reared in captivity at the Kalimok Biological Station.* ***Objective:*** *To restore the population of this endangered species in the Srebarna Reserve.*

4.3. Working Programme: Conservation and restoration of the habitats of rare and threatened species in the Reserve

4.3.1. +++ ***Project:*** *Conservation activities for the protection of the Dalmatian Pelican.* ***Objective:*** *To improve nesting conditions, to protect the colony against terrestrial predators, to prevent flooding and fires in the colony.*

4.3.2. +++ ***Project:*** *Conservation activities for the protection of globally threatened and rare species of aquatic birds.* ***Objective:*** *To conserve, re-introduce and increase the population of the five globally threatened species included in the project (three of them breeding), as well as of seven bird species included in the Red Data Book of Bulgaria.*

4.3.3. **+ *Project:*** *Creation of reptile wintering chambers along the periphery of the Reserve.* ***Objective:*** *To improve reptile breeding conditions as a prerequisite for conservation of reptile populations in and around the Reserve.*

4.3.4. + Project: *Control of the species composition of the fish community in the lake.* ***Objective:*** *To optimize the trophic network and trophic resources for piscivorous birds.*

5. Realistic objective: Enlistment of local people in the development, discussion and implementation of the Management Plant of the Reserve. Providing a profit motive.

5.1. Working Programme: Building infrastructure for sight-seeing tourism. Attracting young people to new occupations and businesses related to the Reserve

5.1.1. ++ ***Project:*** *Building a sand- and gravel-surfaced panorama path along the western edge of the Reserve.* ***Objective:*** *To create convenient conditions for visitors to tour the Reserve on foot, by cart or on horseback.*

5.2. Working Programme: Revival of traditional handicrafts and occupations

5.2.1. +++ ***Project:*** *Allocation of sites for licensed angling according to a procedure established by the Rousse Regional Inspectorate of Environment and Water.* ***Objective:*** *To control the size of the fish flock. To revive a traditional occupation of the local people. To create conditions for efficient control.*

5.2.2. **+ *Project:*** *Limited-scale mowing and removal of reed according to a procedure established by the Reserve Manager. Use of reed for traditional pursuits: manufacture of souvenirs, floor and wall mats.* ***Objective:*** *To create a mosaic structure in the periphery of the reed-beds, to remove biomass. To revive a traditional lifestyle and attitude towards the lake and to provide a profit motive.*

6. Realistic objective: Communication, education and public awareness regarding nature and biodiversity conservation and addressing the problems of protected areas.

6.1. Working Programme: Building infrastructure within the Reserve for support of education and training projects

6.1.1.+++ ***Project:*** *Spatial renewal of the area around the Pristana jetty (building a parking area, a drinking fountain, a lavatory) and of the Todoranka Fountain. Sign-posting of hiking trails around the Reserve, including an eco-path on the high western bank; designation of a boat route for visitors. Marking the entrance to the Reserve.* ***Objective:*** *To create conditions for development of eco-tourism, sight-seeing tourism and for educating younger generations.*

6.1.2. ++ ***Project:*** *Setting up of an adolescents education site.* ***Objective:*** *To cultivate sustained interest and proper attitude towards wildlife in children at the earliest age.*

6.2. Working Programme: Organizing communication, education and public awareness programmes

6.2.1. ++ ***Project:*** *Organizing educational courses, nature conservation camps and volunteer stints for university students and schoolchildren.* ***Objective:*** *To enhance knowledge of the environment and the role of nature reserves for wildlife conservation, to improve wildlife conservation and environmental education and awareness.*

6.2.2. ++ ***Project:*** *Conduct of courses for sight-seeing tourist guides, organizing bird-watching tours.* ***Objective:*** *To raise the environmental awareness of local people. To train personnel and provide prerequisites for eco-tourism.*

6.2.3. + Project: Organizing volunteer stints for children, schoolchildren and university students at a local, national and international level for cleaning the Reserve, building its infrastructure and implementing specific projects. Objective: To enlist public involvement and in particular younger generations in addressing nature conservation problems.

6.2.4. + ***Project:*** *Delivery of lectures before local hunters and fishermen on the Reserve's conservation status.* ***Objective:*** *To familiarize hunters and fishermen with the legally protected species and with hunting restrictions in the surroundings of the Reserve.*

6.3. Working Programme: Dissemination of knowledge on the Reserve by means of print publications, promotional items, souvenirs and other materials

6.3.1. +++ ***Project:*** *Production of a broad range of information materials to be posted on the Internet. Design of a Website.* ***Objective:*** *To disseminate knowledge and promote a positive attitude towards nature conservation.*

6.3.2. ++ ***Project:*** *Production of promotional and information print publications: brochures, folders, stickers, posters, etc.* ***Objective:*** *To disseminate knowledge and promote a positive attitude towards nature conservation.*

6.3.3. + ***Project:*** *Manufacture of souvenirs about the Reserve.* ***Objective:*** *To provide a profit motive to the local people. To promote the Reserve.*

6.3.4. + ***Project:*** *Making a popular science film about the Srebarna Reserve.* ***Objective:*** *To promote the Reserve and to attract tourists.*

6.3.5. + ***Project:*** *Making films and multimedia products about the Reserve.* ***Objective:*** *To disseminate knowledge and promote a positive attitude towards nature conservation.*

7. Realistic objective: Accumulation of specialized scientific data concerning the Reserve and wetlands in general.

7.1. Working Programme: Scientific research of the functioning of the ecosystems of the Reserve. Exploration of the biology, ethology and ecology of the protected and rare species

7.1.1. ++ ***Project:*** *Study of the inner mechanisms of the eutrophication processes in the lake.* ***Objective:*** *To provide science-based proposals for decision-making in connection with the Reserve.*

*7.1.2. ++ **Project:** Study of the ecology and ethology of globally threatened and rare species. **Objective:** To amass knowledge needed for their conservation and protection in the Reserve.*

*7.1.3. ++ **Project:** Study of the processes of siltation of the lake as a result of soil erosion and sedimentation. **Objective:** To amass knowledge needed for better management of the Reserve.*

*7.1.4. ++ **Project:** Assessment and behaviour of fish stocks in the reserve; study of production processes and trophic relations. **Objective:** To amass knowledge needed for better management of the Reserve.*

7.2. Working Programme: Monitoring

*7.2.1. +++ **Project:** Establishment of a system for long-term **surveillance** monitoring of ecosystems. Conduct of the monitoring. **Objective:** To gather information needed for **early warning** in the event of deterioration of the state of the Reserve.*

*7.2.2. ++ **Project:** Completion of the design and establishment of a system for automated monitoring of certain physical factors. **Objective:** To exercise operational control for the purposes of management of the Reserve.*

*7.2.3. ++ **Project:** Application of remote sensing methods for monitoring of the Reserve habitats. Information support for a Geographic Information System (GIS). **Objective:** To exercise operational control for the purposes of management of the Reserve and for scientific research.*

*7.2.4. + **Project:** Hydrological monitoring. See Projects 1.1.1. and 1.1.3. **Objective:** To exercise operational control for the purposes of management of the Reserve.*

8. Realistic objective: Improvement of the work of the Reserve Administration.

8.1. Working Programme: Improvement of the protection regime in the Reserve and the buffer zone, as well as of the transport infrastructure in the Reserve and in the area around its boundaries

*8.1.1. ++ **Project:** Improvement of the traffic regime in the periphery of the Reserve (from the Village of Vetren to the northern sluice; passage for angling along the Danube riverside). **Objective:** To lift restrictions on local people that have provoked a negative attitude toward nature conservation. To enlist local people in the implementation of the Management Plan.*

8.2. Working Programme: Improvement of the regime of control and use of the Reserve

*8.2.1. +++ **Project:** Making arrangements for effective round-the-clock control and physical security of the northern sluice. **Objective:** Securing the water volume of the lake against criminal or negligent opening/destruction of the sluice.*

*8.2.2. +++ **Project:** Urgent arrangement of effective control and physical security against large-scale poaching. **Objective:** To stabilize the fish stock of the Reserve. To improve the trophic resources for piscivorous birds.*

*8.2.3. ++ **Project:** Mapping of the boundaries of the Reserve and their marking by durable signs on site. **Objective:** To improve the administrative management of the Reserve.*

*8.2.4. ++ **Project:** Establishment of an automated physical security system. Use of remote video equipment for control, security surveillance and research observations. **Objective:** To improve the physical security of the Reserve.*

*8.2.5. ++ **Project:** Arrangements and fire protection of the Reserve. **Objective:** Securing the Reserve against fires.*

*8.2.6. + **Project:** Creation of a buffer zone around the Reserve, including the Garlita Marsh and a possibly larger part of the catchment area of the Srebarnenska and Kulnezha rivulets. **Objective:** To create conditions for sustainable development.*

Projects of Highest Priority for Urgent Implementation
(Number in brackets shows project number under Working Programmes)

- **Project:** Making arrangements for effective round-the-clock control and physical security of the northern sluice. **(8.2.1.)**
- **Project:** Urgent arrangement of effective control and physical security against large-scale poaching. Non-disturbance in the breeding period. **(8.2.2.)**
- **Project:** Compilation of a temporary manual for control of the sluices built in 1994. **(1.1.1.)**
- **Project:** Remodelling and repair of the two sluices built on the connecting canal in 1994. **(1.2.1.)**
- **Project:** Development of an emergency action plan in the event of natural calamities or man-induced environmental disasters affecting the Reserve and its catchment area, including the River Danube and air emissions. Elaboration of a programme in combination with Projects 1.1.1. and 1.1.3., for prevention and reduction of pollution of the Reserve upon flushing by Danube water. **(3.1.1.)**
- **Project:** Conservation activities for the protection of the Dalmatian Pelican. **(4.3.1.)**
- **Project:** Spatial renewal of the area around the Pristana jetty (building a parking area, a drinking fountain, a lavatory) and of the Todoranka Fountain. Sign-posting of hiking trails around the Reserve, including an eco-path on the high western bank; designation of a boat route for visitors. **(6.1.1.)**
- **Project:** Removal of lake bottom sediments. **Objective:** To deplete the biologically available nitrogen and phosphorus pools in the lake, thus reducing the phytoplankton production and, partially, the growth of the reed-bed. Deepening the lake bottom is also intended to contain the succession. **(2.2.1.)**

3.3. Recommended activities in the water catchment area of Lake Srebarna

Under Bulgarian legislation (the Protected Areas Act), the Management Plan does not cover actions and activities outside the territory of the Reserve. Each wetland, however, is significantly affected by the state of the ecosystems and processes in its catchment area. Inclusion of these activities is mandatory in the Ramsar Convention management-planning format. Therefore, the listing below represents recommended projects, which can be implemented by other authorities and organizations with the support of or jointly with the Ministry of Environment and Water, as well as by ecologist organizations interested in the maintenance of a World Cultural and Natural Heritage site. The projects are systematized in conformity with the adopted Working Programmes (management strategies).

1.1. Working Programme: Increase of the inflow of water into the Reserve

1.1.1.A. **+ Project:** Optimization of the use of water from the lake catchment area. **Objective:** To maximize the use of water from the lake water catchment area for increase of the water inflow, reckoning with the prevailing socio-economic conditions in the region.

2.1. Working Programme: Reduction of the influx of nitrogen and phosphorus compounds

2.1.1.A. ++ ***Project:*** *Development of a science-based programme for priority actions to reduce the number and intensity of nutrient sources in the lake catchment area.* ***Objective:*** *To assess the priority in launching the subsequent projects under the programme.*

*2.1.2.A. ++ **Project:** Introduction of organic farming within the catchment area of the Reserve. **Objective:** To reduce the import of chemical fertilizers into the catchment area of the Reserve and thus reduce the amount of nutrients leached from the soil.*

*2.1.3.A. ++ **Project:** Assessment of the impact of sewage water from the Village of Srebarna on the nutrient inflow into the lake. **Objective:** To assess the need of a sewerage system for the village, including a treatment plant.*

*2.1.4.A. + **Project:** Introduction of modern farming practices within the catchment area of Lake Srebarna. **Objective:** To optimize fertilizer application, to reduce leaching of the soil and thus decrease the nutrient inflow into the lake.*

3.2. Working Programme: Reduction of the transportation/import of suspended particulate matter into the lake

*3.2.1.A. + **Project:** Introduction of non-erosive farming practices within the framework of Projects 2.1.2.A. and 2.1.4.A. **Objective:** To reduce the inflow of particulate matter into the lake so as to halt siltation.*

4.1. Working Programme: Conservation and restoration of habitats

*4.1.1.A. +++ **Project:** Northward expansion of the Reserve to incorporate the Island of Vetren and establishment of a transboundary protected area with Romania. **Objective:** To establish a sufficiently large area including the breeding places of piscivorous bird species.*

*4.1.2.A. ++ **Project:** Establishment of an ecological corridor along the right bank of the River Danube from the marsh at the Village of Maluk Preslavets in Bulgaria to Lake Oltina in Romania. **Objective:** To make possible the exchange of genetic material and for the feeding migration of piscivorous birds. Stage One of the Project is establishment of an ecological corridor between the Garvan Marsh and Lake Srebarna.*

*4.1.3.A. ++ **Project:** Restoration of the Garvan Marsh. **Objective:** To enrich the food resources for piscivorous birds in the Srebarna Reserve by restoring a component of the natural ecological wetland complex that once existed on both banks of the Danube.*

4.2. Working Programme: Re-introduction of native and endangered species. Control of the population size of predators and Wild Boars

*4.2.1.A. ++ **Project:** Inclusion into a forthcoming forest-management design of the principles of gradual restoration of autochthonous vegetation in the area around the Reserve, including Willow (Salix sp.), White Poplar (Populus alba) etc., and elimination of non-native species (Oleaster (Elaeagnus angustifolia), Common Gloxinia (Gleditschia triacanthos), Black Locust (Robinia pseudoacacia), Black Pine (Pinus nigra) etc.). **Objective:** To restore natural biodiversity and habitats. **(Map 11. App. 1)**.*

*4.2.2.A. ++ **Project:** Inclusion into a forthcoming forest-management design of the principles of gradual restoration of autochthonous vegetation in the western hilly section of the Reserve, including Willow (Salix sp.), White Poplar (Populus alba) etc., and elimination of non-native species (Oleaster (Elaeagnus angustifolia), Common Gloxinia (Gleditschia triacanthos), Black Locust (Robinia pseudoacacia), Black Pine (Pinus nigra) etc.). **Objective:** To restore natural biodiversity and habitats.*

4.3. Working Programme: Conservation and restoration of the habitats of rare and threatened species in the Reserve

*4.3.1.A. ++ **Project:** Improvement of breeding conditions for the Corncrake (Crex crex) and Great Bustard (Otis tarda) and wintering conditions for the Lesser White-fronted Goose (Anser erythropus) and Red-breasted Goose (Branta ruficollis) through introduction of conservation-oriented approaches in farming practices. **Objective:** To create sustainable conditions for conservation of the populations of these globally and regionally threatened species.*

4.3.2.A. + ***Project:*** *Preservation of a large part of the hills surrounding the Reserve and their inclusion into a forthcoming forest-management design.* ***Objective:*** *To create breeding conditions for the Ruddy Shelduck (Tadorna ferruginea).*

5.1. Working Programme: Attracting young people to new occupations and businesses related to the Reserve. Building infrastructure for sightseeing tourism

5.1.1.A. +++ ***Project:*** *Making arrangements for eco-tourism and rural tourism in settlements around the Reserve.* ***Objective:*** *To provide the local people with a profit motive to maintain the Reserve and support the Management Plan.*

5.1.3.A. ++ ***Project:*** *Building infrastructure for eco-tourism and rural tourism. Creation of economic prerequisites for construction of family hotels through raising financial assistance and arranging soft loans from interested organizations.* ***Objective:*** *To assist local people in developing appropriate accommodation facilities, family hotels and restaurants, providing environmentally sound transport services: horses, donkeys, carts etc.).*

5.1.4.A. ++ ***Project:*** *Training suitable personnel to work as hotel managers, rural tourism service providers, Reserve guides, boatmen.* ***Objective:*** *To train skilled manpower for the new occupations.*

5.1.5.A. ++ ***Project:*** *Dredging and clearing of a man-made water body at the village limits of Srebarna on the Silistra-Rousse road* **(App. 1, Map 12)**. ***Objective:*** *To provide opportunities for angling and recreation.*

7.1. Working Programme: Scientific research of the functioning of the ecosystems of the Reserve. Exploration of the biology, ethology and ecology of the protected and rare species

7.1.5.A. + ***Project:*** *Exploration of ground water in the area and its role for recharge of Lake Srebarna.* ***Objective:*** *To amass knowledge needed for better management of the Reserve.*

7.1.6.A. + ***Project:*** *Identification of the comprehensive structure of the invertebrate fauna of the Reserve (including Helminths). Objective: To amass knowledge needed for management of fish stocks in the lake and detection of the risk of parasitic infestations.*

8.1. Working Programme

8.1.2.A. + ***Project:*** *Transfer (through indemnification, exchange or purchase) of the arable land tracts of the Village of Vetren located in the Baltata Locality to the land-use area of the Village of Aidemir.* ***Objective:*** *To avoid non-essential pedestrian and vehicular traffic across the Reserve and to facilitate local people by eliminating the excessive costs of farming in these land tracts. Project to be implemented solely if all stakeholders are mutually agreed.*

3.3 Projects

Project 4.3.1. CONSERVATION ACTIVITIES FOR THE PROTECTION OF THE DALMATIAN PELICAN (PELECANUS CRISPUS) – **THE PROJECT HAS BEEN IMPLEMENTED SINCE 1998**

Annotation: The nesting colony of the Dalmatian Pelican is the most valuable natural site in the Reserve. In Europe there are such colonies only on the Balkan peninsula (Romania, Greece, Albania and Bulgaria). The floating islands on which the colony lies does not always rise with the increase of the water level thus creating prerequisites for flooding the nests. Due to the great conservational significance of this colony, a special Work Programme that shall be implemented every year has been developed with regard to it. It includes the instructions for the monitoring and conservation activities that shall be carried out by the CLGE, BAS and the Le Balkan-Bulgaria foundation.

Objective: To create optimal conditions for the pelicans nesting in the colony. To increase the number of nesting pairs of this valuable and attractive species.

Cost (preliminary evaluation): 10 000 lv.

Activities

1. Annual monitoring of the colony (with the financial aid of the Tour de Valatte Biological Station-France.

January

- To make a final and last inspection of the nesting colony before the arrival of the pelicans.

February

- To record and trace the pelicans arriving at the colony.

March

- To determine the number of nesting pairs, of adult and young non-nesting birds, of nests and of eggs laid; determining the number of pairs that have abandoned their nests, the number of nests built that do not contain eggs; the number of eggs laid but not hatched; determining the scale of compromised nesting and the reasons for it.

- To read the numbers and colours of the rings found on the nesting birds.
- To carry out observations on the behaviour of pelicans.
- To prepare an Intermediary Report on the observations carried out in the colony.

April

- To determine the number of pairs that stared to nest later, of adult and young non-nesting birds, of nests and of eggs laid; determining the number of pairs that have abandoned their nests, the number of nests built that do not contain eggs; the number of eggs laid but not hatched; determining the scale of compromised nesting and the reasons for it.
- To read the numbers and colours of the rings found on the nesting birds.
- To carry out observations on the behaviour of pelicans.
- To prepare an Intermediary Report on the observations carried out in the colony.

May

- To determine the number and the age of newly hatched birds; of unhatched eggs, as well as the reasons for this.
- To read the numbers and colours of the rings found on the nesting birds.
- To carry out observations on the behaviour of pelicans.
- To visit the colony for ringing the newly hatched birds.

June-July

- To continue the inspections on the colony following the schedule from the previous months.
- To determine the number of young birds after they have left their nests; determining the dates and manner the young and adult birds leave their nests.
- To draft a Final Report, to analyse the results and to develop proposals for the more effective protection of this species.

2. Activities on maintenance (with the financial aid of Swarovski Optik Ltd.).

To implement the usual activities on maintenance in the colony (from August till September each year)

- To repair (move) the fence surrounding the colony;

- To mow a strip of reed on the external side of the fence;
- To pile up the mowed reed as sheaves on the breeding platforms of pelicans following the pattern used by the Le Balkan Foundation in the autumn of 1998 and 1999;
- To prepare the hide and the tunnel for the next breeding season;
- To repair the breeding sites and wooden pile platforms (October each year);
- To construct, transport and mount a floating platform (pontoon) in the nesting colony with a total surface area of 50 m^2 (from August till October 2000 and 2001);
- To carry out a survey on the opportunities for mounting a stationary video camera in the colony allowing visitors to make remote observations.
- To establish an office of the Le Balkan Foundation at the Reserve administrative building; to purchase a boat, equipment and facilities for monitoring.

Detailed information on the order and methods for visiting the pelican nesting colony is contained in the specially developed Manual.

Project 4.3.2: CONSERVATION ACTIVITIES FOR THE PROTECTION OF GLOBALLY ENDANGERED AND RARE SPECIES OF WATERFOWL

Annotation: Five globally endangered species of birds, 3 of them nesting in the reserve have been recorded for the Reserve. Except for these, there also 7 species included in the Red Book of Bulgaria. Specific conservation measures have been planned for each species included in this Project.

Objective: To preserve, restore and increase the populations of the species of birds included in this Project.

Cost (preliminary evaluation): 15 000 lv.

Activities:

Pygmy Cormorant *(Phalacrocorax pygmeus)*

- To secure preservation of its feeding grounds and the presence of adequate fish populations near the nesting colonies;
- To monitor its numbers in the breeding colonies;
- To monitor ecological changes in key places for the species;
- To carry out research on species ecology, especially on its feeding range in view of a possible conflict with fish-farming as well as in view of the species impact on fish populations;
- To organize public campaigns and training for hunters, fishermen and other representatives of the local communities in the vicinities of wetlands.

Great White Egret *(Egretta alba)*

For the returning of the great white egret in Srebarna, it will be necessary to develop a separate programme integrating the European experience in this respect.

Purple Heron *(Ardea purpurea)*

Whether the species will continue to be a breeding species for Srebarna or not depends on the lack of disturbance, improvement of the feeding grounds in the Reserve proper and the preservation of the reed-beds where herons normally build their nests.

Spoonbill *(Platalea leucorodia)*

- To investigate what are the negative factors affecting Srebarna breeding population;
- To plant single white poplar and white willow trees.

Glossy Ibis *(Plegadis falcinellus)*

- Not to mow or set to fire the reed-beds;
- To provide for the "no disturbance" factor.

Lesser White-fronted Goose *(Anser erythropus)*

- The measure for the ensuring of the quality of habitats shall take a bigger part in agricultural practices;
- To control the use of the feeding sites and to make research on the determination of the requirements of the geese towards habitats and the threats imposed to them in the corresponding area;
- To inform hunters with regard to the species importance, the problems with its conservation and the necessity to avoid hunting in the species key sites.

Graylag Goose *(Anser anser)*

- To secure there will be "no disturbance" factor during the breeding season;
- Not to mow or set to fire the reed-beds;
- To add to the Reserve the adjacent Danube islands where large flocks of this species stay during wandering, moulting, migration and wintering.

Red-breasted Goose *(Branta ruficollis)*

- To trace out and where possible to eliminate cases of disturbance and killing of the species caused by hunting practices;
- To provide for exerting strict control over the use of rodenticides and to secure its complete ban in the species main feeding grounds;
- To start ecologic and ethologic studies of the species in its wintering grounds.

Ruddy Shelduck *(Tadorna ferruginea)*

- Not to plant trees on parts of the bare hills around the Reserve, particularly where the Ruddy Shelducks nests are located. Such a mistake was made by the afforestation of Kodzha Bair where there used to be a nesting pair:
- To build up conservation awareness and cultivate nature-friendly attitude in local people where an old tradition of taking birds from the wild and keeping them as pets is still existing;
- To organize delivery and releasing of young birds from the ‘Kalimok’ Experimental Station, where they breed Shelducks especially to be released back in the wild.

White-eyed Pochard *(Aythya nyroca)*

- To secure there will be "no disturbance" factor during the breeding season;
- Not to mow or burn the reed-beds.

White-tailed Sea Eagle *(Haliaeetus albicilla)*

- To build up conservation and ecological awareness of the hunters and fishermen;
- To organize feeding up of the birds in winter;
- To build 4 to 5 artificial nests on old white poplars on the Danube islands.

Corncrake *(Crex crex)*

- To stimulate the working out of programmes for sustainable development of agricultural regions of importance to the Corncrake;
- To provide help for establishing of extensive farming practices including lesser use of fertilizer in areas where Corncrakes breed;
- To help introduce measures for stimulating farmers to apply as much as possible of Corncrake-friendly agricultural techniques.

Great Bustard *(Otis tarda)*

- To carry out conservation activities in the intensely cultivated areas surrounding the Reserve;
- To organize and carry out educational activities to build up conservation and ecological awareness of the local people particularly with respect to the cultural and scientific importance of the greater Bustard.

Project 1.2.1: Reconstruction and repair of the sluices constructed in 1994.

Annotation: The now existent Northern sluice has been constructed so, as to prevent the influx of high Danube water in the canal. At high water levels of the lake this sluice allows for drainage of water back to the river. As a result of this fault of the sluice, the area located to the Southwest and surrounded on all sides by dikes (*App. 1, Map 10,)* even though slowly, is drying up. Due to this fact the Reserve is annually bereft of 120 ha of shallow and nutrient rich water areas used by a number of waterfowl for feeding, reproduction, and rest. After a slight reconstruction and repair of the Northern sluice, it will be able to retain high water in the Northern part of the Reserve to a level of up to 13,2 m till the end of the reproduction period.

Objective: To preserve water areas in the Northern part of the Reserve till the end of the reproduction period. To create new habitats for rare and endangered species of waterfowl. To increase the abundance and diversity of birds.

Cost (preliminary evaluation): 2 500 lv.

Activities

1.1 Technical and economical evaluation

1.2 To carry out the reconstruction mentioned above

Project 2.2.1: Removal of silt from the bowl of the lake and other differentiated parts of it

Annotation: The negative impact of eutrophication is expressed by the acceleration of succession, increase of siltation and decrease of the depth of the lake, reduction of biodiversity and disturbance of the trophic web (see Sections1.14.6., 1.16.2.1. to 1.16.2.5.). Despite the positive trends in the last two years (1.14.6. and 1.16.2.5.) there is still a potential threat of the repeated increase of the level of eutrophication. Following the increase of the water level from 1988 through 2000 a large part of the reed together with its root system perished under the deep layers of water. Evidently a large part of the biogenic elements, namely nitrogen and phosphorus, remain blocked within the anaerobic mass of roots and sediments, but in the long run they may again return to the nutrient cycle of the ecosystem. On the other hand, a large quantity of nutrients remains in the viscous silt lying over the clay support (the Sarpovo suite – part 1.14.1. and 1.14.5.) of the lake bottom. Tentaive assessment of the quantities of nitrogen and phosphorus, based on the analyses described in Part 1.14.5., reveals the following:

Element	Sediment per 150 ha of the surface area of the lake [t]	Annual Reed Biomass per 402 ha (Baeva, 1994) [t]
Nitrogen	1834	135
Phosphorus	182	7,61

This considerable reserve of nutrients (biologically available in its largest part) will always maintain high levels of eutrophication. The hazard of plankton blooms leading to anaerobic conditions within the water column remains together with all ensuing negative consequences due to the disturbance of the trophic web and the dying out of organisms.

A considerable improvement of the nutrient regime might be expected after a large part of the liquid silt in the lake has been sucked off. As a result there will be a considerable reduction of the available nutrient reserve and an increase of the average depth of the lake with all positive prospects of reducing the levels of eutrophication and stopping/turning the course of succession.

Objective: To decrease the biologically available pools of nitrogen and phosphorus compounds in the lake, thus reducing the production of phytoplankton and partially that of the reed massif. Partial stopping of the succession through excavating the bottom.
Alternatives and conditions for the implementation:
According to the international practices (Bjorg, 1994) the following shall not be allowed while sucking off silt:

- Considerable resuspension (returning of large quantities of nutrients in the water column)
- Returning of the water with which the silt has been sucked off back to the lake, because it also contains high concentrations of nutrients.

The first condition requires the use of a suction-tube gredger with a system for the control of the suction process. The second condition may be satisfied if the silt is deposited at a suitable depot and re-pumping of Danube water back to the lake through the existing canal or through casting the whole of the dragged mass into the Danube. According to the first alternative the deposited silt might be used for the establishment of a rice-field or for soil fertilization, if the analyses show no presence of stable pollutants in the sediment (Section 1.14.6.). The site around the Reserve has only one spot suitable for depositing and/or the establishment of a rice-field: East of the Danube-Srebarna canal in the Aidemir plane on the site of the former marsh.

The areas, planned for dragging of the bottom are shown in **App. 1, Map 12.** If there is enough funding the Kamaka pool and the Tarlitza marsh may be added to the list.

Scope of operations:
Average area to be processed 150 ha
Average silt thickness 1 m
Average water content 85 % (75-95 %)
Average volume to be pumped off 1500 000 m^3
Dry matter approximately 225 000 m^3
Cost (preliminary evaluation)
Cost of the suction of 1 m^3 of dry matter and depositing 3 km away - 7.6 lv
Cost for 225000 m^3 – 1,71 mln lv
Cost of re-pumping of 1300 000 m^3 of water around 1 mln lv
Total cost (transport of machinery, electricity, etc.) - 1 mln lv
Drafting of the technical and economic documentation of this Project and preliminary evaluations 20 000 lv

Total Project Cost 3 730 000 lv.

Activities:

1. Preliminary evaluation
1.1. A preliminary evaluation of the geological profile of the lake
1.2. Preparation of the technical and economic documentation.
Alternative A – Casting silt into the Danube
Alternative B – Depositing silt for subsequent use for the purposes of soil improvement and fertilization
1.3. Economic justification
2. Preparatory activities
2.1. Transportation and mounting of facilities
2.2. Connection to the power supply network
2.3. Conducting the activities proper

PROJECT 2.2.2: REMOVING PART OF THE REED

Annotation: It is well known that succession within the lake ecosystem occurs mainly as reed spreads toward the open water area. In the past the front rows of reed used to become detached and some of the floating dry reed islets (known as “kochki”) were directed into the Danube at times of periodic influx and drainage of high waters from and into the Danube. At present, on account of disturbances in the water regime, the surface taken up by the reed is constantly increasing. About 15 % of the water surface has gradually become covered with reed since 1948, the better part growing on the “kochki” – detached floating islets. ***(Appendix 1, Map 8)*.** The main portion of “new reed” is located to the South of the lake and close to the extremities of the two pools, “Pristana” (to the West) and “Kamaka” (to the East).

During the implementation phase of the **Silt Removal Project** equipment will be mounted inside the lake that would be also capable of eliminating some of the reed therein growing. This operation would anyway prove necessary shoud equipment be introduced in the Pelican pool, through the reed, for bottom dragging operations. There are several requirements for the elimination of reed together with its root mass, namely:

- Preserve the ecological nature of the lake
- Eliminate reed from the periphery of the water plain only without destroying waterfowl habitats.

Objective: Regular elimination of biomass, preventing further accumulation inside the lake and the accompanying decrease of eutrophication and slow-down of succession, which would cause the spread of reed over the water area**.**

Cost (estimate)

Scope of operations:

Average perimeter of the lake - 6500 m

The average volume of mass removed at a 1-m thickness of removable stratum amounts to approximately 4200 m^3

Estimated cost 4200 x 12 lv = 50000 lv

Additional costs (equipment transportation, etc.) 50000 lv.

Total cost 100 000 lv.

APPENDICES

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XV. Mammals
XVI. Socio-economic Values
References

+++ High priority project
++ Medium priority project
+ Low priority project

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