

Lake Chudsko-Pskovskoe

Authors: S.Kondratiev, A.Izmaylova, E. Koroleva

Compilers, editors, translators: I. Plotnikov, N. Aladin

Lake Chudsko-Pskovskoe (or lacustrine complex) is the 4th by its area freshwater lake in Europe. It is the largest transboundary water body and it is located on the frontier between Russia and Estonia. The total lake area is 3555 km², 1985 km² of them belongs to Russia and 1570 km² belongs to Estonia. The lake has complicated configuration and is divided into three main parts: the northern largest (73%) Chudskoe Lake (Estonian *Peipsi järv*) having water area 2611 km², the southern (20%) Pskovskoe Lake (Estonian *Pihkva järv*) – 708 km² and connecting them Teploe Lake (7%) (Estonian *Lämmijärv*) – 236 km². The lake is relatively shallow; its maximal depth is 15.3 m.

Bottom deposits of Lake Chudsko-Pskovskoe in the central, relatively deep-water part, is composed from silts, in the open shallow coastal area from sands which is well observed at western, eastern and especially southern coast of Chudskoe Lake, and also at the eastern coast of Pskovskoe Lake.

The modern coastal line of Lake Chudsko-Pskovskoe is characterized by smooth cut-outs and is split weakly. The northern is without gulfs and bays and only in the southeast part of Chudskoe Lake there is Raskopelskaya Bay, in Teploe Lake there is Zhelchinskaya Bay, in the northwest part of Pskovskoe Lake there is Vyarskaya Bay. Shores of lake are mainly low formed by peat bogs; bottom is flat, covered by thick layer of grey silt. Southern and western shores are boggy, along the northern shore there are stretched enough high sandy dunes overgrown with pines. Islands are small and insignificant by area. In total on the lake there are 29 islands; the largest of them is Piirissaar (Porka).

Lake Chudsko-Pskovskoe is one of the most productive pools of the Baltic region with high level of reproduction of fish population. The trophic status of main lake parts is different: Pskovskoe Lake is considered as hypereutrophic, Teploe Lake is transitional to hypereutrophic, Chudskoe Lake is eutrophic. In the end of XX century, according to the majority of parameters, the trophic level of water body has increased.

1. Basic Information

1.1 Name(s)

1.1.1 In English (All official names, if called in more than one way.)

Lake Chudsko-Pskovskoe, Lake Peipsi

1.1.2 In local language(s)

Чудско-Псковское озеро (in Russian.), Peipsi (in Estonian)

1.2 Location

1.2.1 Latitude (range from West to East)

57°52' - 59°00' N

1.2.2 Longitude (range from South to North)

26°58' – 28°10' E

1.2.3 Elevation at water surface from sea level

30 m

1.2.4 Riparian countries and sub-national (state, province, etc.) jurisdictions

Russia, Pskov region; Estonia

1.2.5 Non-riparian basin (upstream) countries and sub-national jurisdictions

The catchment area of lake is about 44 000 km² (26% are in Estonia, 67% in Russia and 7% in Latvia).

1.3 Origin

1.3.1 In the case of natural lakes

- Origin of the lake (e.g., glacial, tectonic, volcanic, etc.)

The lake is a relict of the large glacial water body remained after recession of last Valdai glaciation. The modern lake occupies hollow of tectonic origin.

- Estimate of the age of the lake

Age of lake is about 12 thousand years.

1.4 Basin and/or Watershed, Map(s)

1.4.1 Major inflowing and out-flowing rivers

About 30 rivers inflow to Lake Chudsko-Pskovskoe, the largest are rivers Velikaya and Emajõgi. Basin of river Velikaya has area 25,200 km² (58% from the total area of catchment area), basin of river Emajõgi has area 9740 km² (22%). Among other rivers there are Piuza, Zhelcha. Gdovka. The river Narva belonging to the basin of Gulf of Finland outflows.

1.4.2 Main cities and other points of interest

The largest cities of basin are Pskov, 203000 inhabitants, and Tartu (Estonia), 98000 inhabitants. Among other large cities of the Russian part of catchment area are Ostrov, Opochna, Pechory. The large amount of the population lives in small villages (LBMI 2003).

1.4.3 National/sub-national jurisdictional boundaries

Russia, Estonia, Latvia

1.4.4 Etc.

1.5 Basin Demography, Map(s)

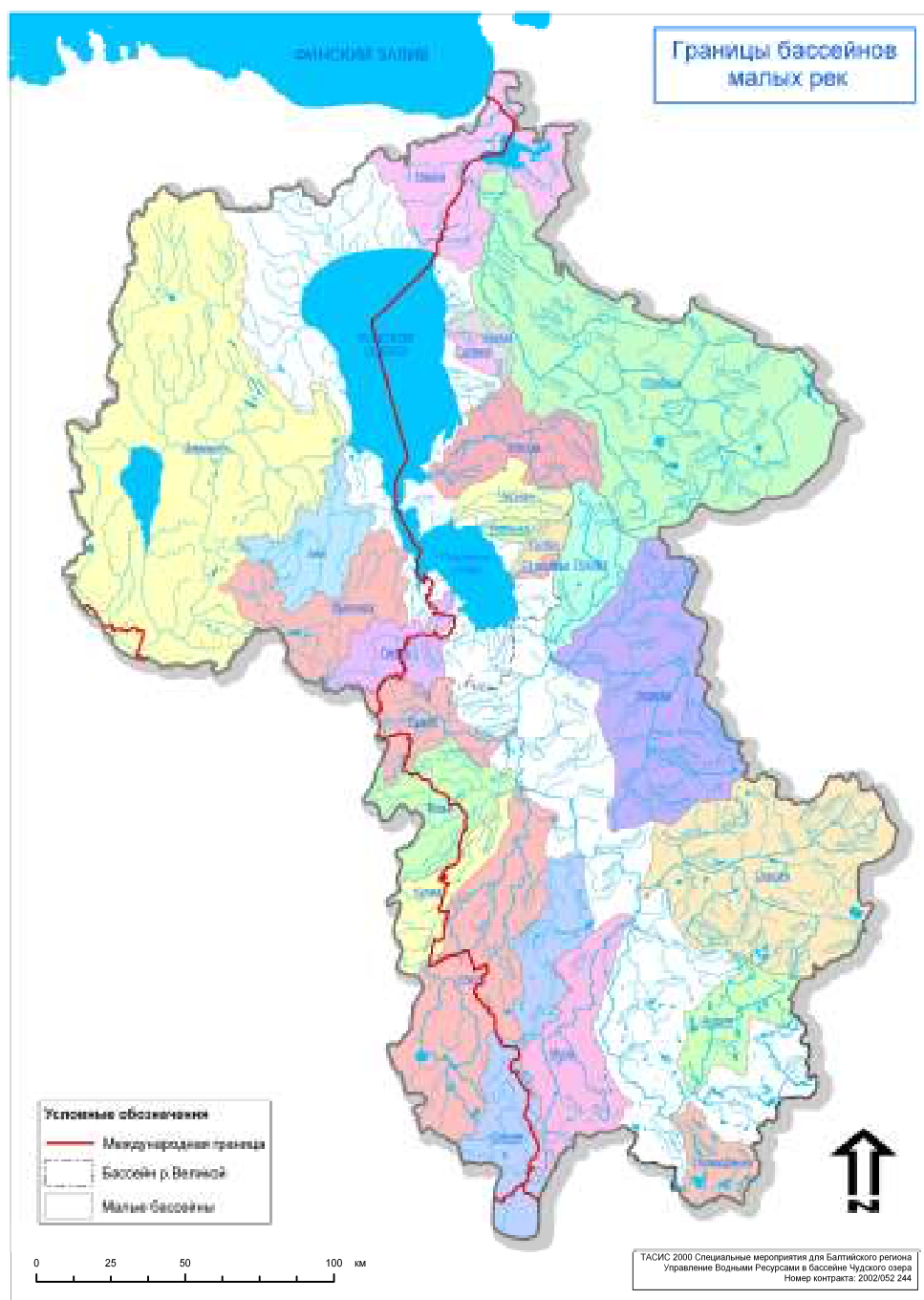
1.5.1 Population and density distribution

In the basin of lake live more than 1 million persons. On the present moment general population density in the Russian part of basin is about 16 person/km². Some areas have density of rural population less than 4 person/km²: Gdovskiy, Plyusskiy, Strugokrasnenskiy,

Krasnogorodskiy, Pushkinogorskiy, Bezhanitskiy and Pushtoskinskiy districts. Pskovskiy, Pechorskiy and Pytalovskiy districts have density of rural population more than 8 person/km². In the Estonian part of Chudsko-Pskovskoe Lake basin population density is equal to 31 person/km².

1.5.2 Etc.

(Maps and other resource materials containing geographical, demographical, land-use, geo-hydrological information for the lake and its basin and/or watershed.)



1.6 Landscape and waterscape

1.6.1 Visual features of the lake and its basin

(Photos of various kind including landscape, physical facilities, water quality problems, land and water uses in the riparian as well as upstream regions, biological and ecosystem conditions including unique fauna and flora, etc.)

2. Morphology

2.1 Bathymetric map, if available



2.2 Volume (in km³)

The water volume in Chudskoe Lake is 21.79 km³, in Pskovskoe Lake – 0.60 km³, in Teploe Lake – 2.68 km³. The total water volume in Lake Chudsko-Pskovskoe is 25.07 km³.

2.3 Surface Area (in km²)

The total lake area is 3555 km². The lake is divided into three main parts: Chudskoe Lake having water area 2611 km², Pskovskoe Lake – 708 km² and connecting them Teploe Lake – 236 km². The area water body is considerably changing at fluctuations of water level.

2.4 Length and width (in km)

Lake length is 150 km, maximal width is 50 km.

2.5 Length of shoreline (in km)

The total length of shore line of water body is 520 km: in Chudskoe Lake - 260 km, in Pskovskoe Lake - 177 km, in Teploe Lake - 83 km.

2.6 Maximum depth (in m)

15.3 m

2.7 Mean depth (in m)

The average depths are: Chudskoe Lake – 8.3 m, Pskovskoe Lake – 3.8 m and Teploe Lake – 2.5 m.

2.8 Note on intra- and inter-annual changes in water level and volume, if information is available (provide a note on water level changes due to flow regulations)

Agreed longtime average level of water in Chudskoe Lake is 200 cm on hydrometeorological station in Mustvee, i.e. +30.00 m a.s.l. Present data reveals cyclic character of water level in Chudskoe Lake:

- Longtime cycles: duration – 18-33 years, amplitude – about 80 cm;
- Annual cycles: amplitude from 50 up to 150 cm, from the beginning till the end of year: minimal - in the end of March (the end of water body icing period), maximal - in the middle of May (the end of snow melting period).

3. Water Balance

3.1 Inflow (Annual average in m³ per year)

3.1.1 Precipitation

Mid-annual income of atmospheric precipitations to the lake 2.3 km³ in a year or about 18% of income part of water balance.

3.1.2 Rivers (Note if they are controlled.)

Into Lake Chudsko-Pskovskoe about 30 rivers flow. The largest rivers are Velikaya with the mid-annual discharge 195 m³/sec and Emajõgi – 68 m³/sec providing 65% of inflow. Mid-annual surface runoff is 10.3 km³. The rivers are characterized by mixed feed, the portion of water from melted snow is about 50% of annual drain, portions of rain and underground waters are 25% each.

3.1.3 Groundwater

Underground waters in the basins Narva River and Lake Chudsko-Pskovskoe are everywhere in the upper layer of sedimentary covering (Quaternary and Paleozoic deposits). Underground waters are pressure waters as a rule. Feeding areas are confined to elevations (Sudomskaya, Bezhanitskaya, Haanja), and regional areas of underground waters unloading are lakes Chudskoe and Pskovskoe, local unloading is via riverine network. Thickness of fresh water zone in the feeding area is 200–400 m and in the unloading area is reduced up to 50–100 m.

3.2 Outflow (Annual average in m³ per year, if information is available.)

3.2.1 Evaporation

Evaporation from the lake surface is estimated as much as 1.8 km³/year.

3.2.2 Rivers (Controlled?)

From the lake the river Narva is flowing out into the Gulf of Finland runs. Its mid-annual

intensity of flow is 380 m³/sec or 10.4 km³/ year.

3.2.3 Groundwater

3.3 Retention time (In years, if information is available.)

3.3.1 Theoretical filling time (Lake volume/annual inflow)

2.5 years

3.3.2 Theoretical flushing time (Lake volume/annual outflow)

2.4 years

3.4 Notes on any long-term changes

4. Climate

Чудско-Псковское озеро расположено в регионе с умеренно-континентальным климатом. Продолжительность безморозного периода составляет 125-150 дней, в районе Чудского оз. несколько дольше, чем на востоке. Характер погоды неустойчивый во все сезоны года.

Climate in the region of Lake Chudsko-Pskovskoe is moderately continental. Duration of frost-free period is 115–150 days; near Chudskoe Lake it is longer than in the East. Character of weather is unstable in all seasons of year.

4.1 Average T, min monthly T, max monthly T (in centigrade)

Average annual temperature is 4.3–4.8°C. Average temperature in January is -8–10°C, in July – +17–18°C.

4.2 Average Precipitation, min monthly precipitation, max monthly precipitation (in mm)

Average annual precipitations amount is about 600 mm. On heights (windward slopes) their amount can raise up to 850 mm. At the coast of Chudskoe Lake and on plains – 640 mm/year.

4.3 Prevailing wind directions by season, strength

Catchment area is in the zone of raised cyclonic activity. For a year 130 cyclones (each three days) here pass. During year southern and southwest (16-21%) and also southeast and western (12-16%) winds prevail.

4.4 Seasonal and inter-annual variability (Describe.)

5. State of Ecosystem

5.1 Description on the state of ecological health including conservation of fauna and flora

The trophic status of Chudskoe Lake evaluated on concentration of nitrogen, phosphorus and chlorophyll "a", is different in each of its 3 parts: properly Chudskoe Lake is eutrophic,

Teploe Lake is close to and is it possible to consider Pskovsloe Lake as hypereutrophic. Concentration of nutrients in lake shows clear difference between these three its parts: their very high concentration in the southern part and rather low concentration in the northern part in the area of river Narva mouth.

During the second half of XX century ecological state of lake have considerably worsened. The majority of parameters testified about increase in the trophic level in 1980-1990 However a situation with income of pollution to the lake has changed after disintegration of Soviet Union. Worsening of economical situation in Estonia, Latvia and Russian Federation promoted significant reducing of pollution income from agriculture. Since the second half of 1990s other factor promoting decrease of pollution was improvement of sewage disposal plants on the majority of point sources of pollution. Nevertheless, the lake remains under strong anthropogenic press.

5.2 Description on the state of biodiversity conservation

6. Physical Data

6.1 Temperature of water

6.1.1 Versus time

6.1.2 Versus depth

6.2 Freezing period and extent of freezing

The lake ices in the end of November - beginning of December. From December till April the lake is ice-covered, but freezing-over is not always stable. Pskovskoe and Teploe lakes become free of ice earlier than Chudskoe Lake.

6.3 Mixing

6.3.1 Vertical

6.3.2 Horizontal (Note main bays, sub-basins of lake.)

Currents in Chudskoe Lake form 2 sections and only one in Pskovskoe Lake. Direction of currents depends on the direction of wind. Currents affect significant on the water quality at various stations of monitoring of lacustrine complex (on the margin of current water quality is better than in the centre). The exchange of water resources between Pskovskoe, Teploe and Chudskoe Lakes is studied insufficiently.

6.4 Stratification

6.4.1 Period and extent of stratification

During summer period water masses of are actively mixed by wind. With this it is connected water homothermy and good oxygen conditions in spring, summer and autumn.

7. Chemical Data

7.1 Concentrations: The state of chemical water quality in general including the states of eutrophication, i.e., oxygen demand, N and P concentration values (organic, inorganic, particulate, total, if available), salinity, organic and inorganic chemical pollution.

Average concentration of general phosphorus (P) and general nitrogen (N) for 1995-1998 in the surface waters of Estonian of part Chudskoe Lake were 42 and 768 mkg/l respectively (Income ...). Concentration of biogenes has even distribution in water column. The northern part of lake is much poorer by phosphorus and nitrogen than the southern, getting under influence of polluted waters of river Velikaya. Concentration of nutrients in Teploe Lake is by about 2 times higher than in Chudskoe Lake.

7.2 Loads (tons/yr.) of inputs from rivers, groundwater, and the atmosphere

According to the materials of scientific report on ecological monitoring of Lake Chudsko-Pskovskoe for 1998-99 (Income) with the drain of rivers and Emajõgi approximately 80% (16,500 tons/year) of total nitrogen and 84% (760 tons/year) of total phosphorus enter to the lake. River Velikaya provides about 65% from all quantity of nutrients coming with riverine flow. The highest specific income of nitrogen and phosphorus noted from one of tributaries of Emajõgi on which drainage area lands of agricultural purpose prevail.

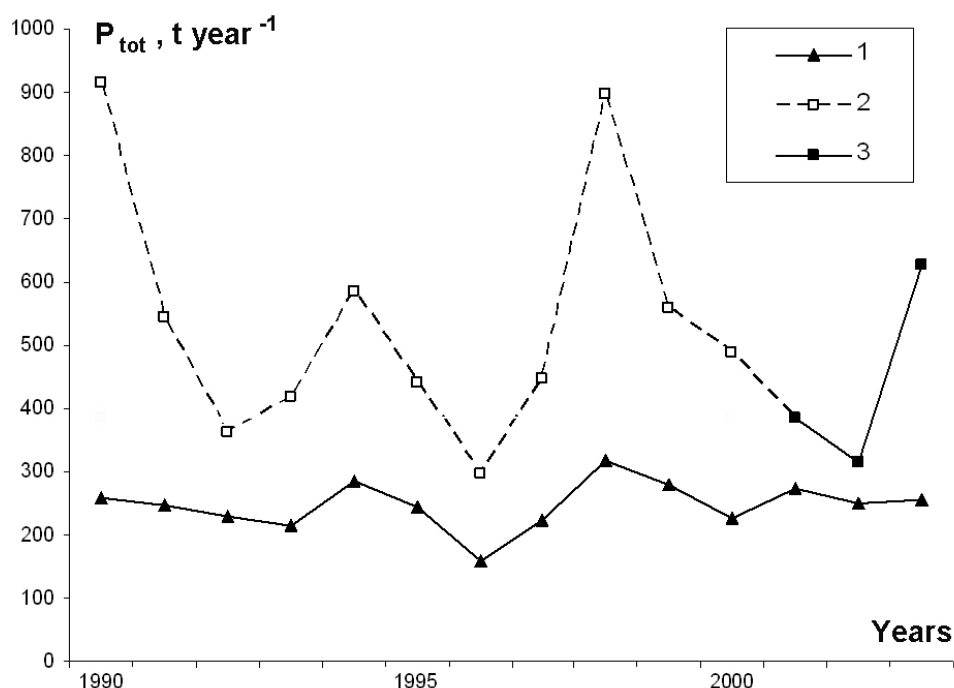


Fig. Assessment of total phosphorus load on Chudskoe and Pskovskoe Lakes from Estonia (1) and Russia (2 – re-calculated from PO_4 data, 3- based on direct measurements).

8. Biotic Data (Main species, exotics, productivity change through time)

8.1 The overall state of the lake ecosystem including its biodiversity

8.2 Phytoplankton, Zooplankton, Fish

In phytoplankton Lake Chudsko-Pskovskoe there are 475 species: Cyanophyta - 102 (21.5%), Chrysophyta - 12 (2.5%), Bacillariophyta - 153 (32.2%), Xanthophyta - 7 (1.5%), Cryptophyta - 4 (0.8%), Dinophyta - 3 (0.6%), Euglenophyta - 18 (3.8%), Chlorophyta - 176 (37.1%). Except for common species, characteristic for eutrophic and mesotrophic lakes, in Chudskoe Lake there are also Arctic, halophilous, galophobe, acidophilous and alcalophilous species. Species composition of predominant organisms during the most part of XX century did not undergo significant modifications (Laugaste et al., 1996). In the biomass of phytoplankton cyanobacteria have major importance, diatomic and green algae prevail by abundance. Among main predominating phytoplankton species in Pskovskoe Lake there are: *Aulacoseira granulata*, *A. italica* var. *valida*, *Stephanodiscus binderanus*, *Asterionella formosa* (diatoms); *Aphanizomenon flos-aquae*, *Anabaena flos-aquae*, *A. spiroides*, *Gloeotrichia echinulata* (cyanobacteria); in Chudskoe Lake – *Aulacoseira islandica*, *Stephanodiscus binderanus*, *Aulacoseira granulata* (diatoms), *Gloeotrichia echinulata*, *Microcystis pulvereae*, *Anabaena flos-aquae* (cyanobacteria).

By composition of predominating species phytoplankton is characterized as eutrophic diatomaceous-cyanobacterial (Melnik, Yastemskiy, 2003). In the annual cycle in different years there were noted 2 or 3 peaks of total biomass. Spring pick of biomass is caused by vegetation of diatoms, summer peak (maximal) by cyanobacteria and diatoms, autumn by diatoms (sometimes autumn peak is maximal). In Pskovskoe Lake role of cyanobacteria is significantly higher than in Chudskoe Lake where diatoms dominate in the biomass in all seasons and only in some years of little water cycle with many calm days, mainly in autumn, this group of algae gives palace to cyanobacteria. Every year in spring-summer time because of mass development of cyanobacteria in the lake it is observed water “blooming” of various intensity in the sequence of vegetation: *Anabaena flos-aquae*, *Gloeotrichia echinulata* u *Aphanizomenon flos-aquae*.

Average biomass of phytoplankton in one unit of volume on the average for the long-term period in Pskovskoe Lake (19.4 g/m^3) is higher than in Chudskoe Lake (12.9 g/m^3) by 1.5 times. In the middle of 1990s in spring it was (May-June) $5.6\text{-}16 \text{ g/m}^3$. Summer biomass (July-August) was $3.1\text{-}14.8 \text{ g/m}^3$ in Chudskoe Lake and $5.6\text{-}125$ (mainly $10\text{-}20$) g/m^3 in Pskovskoe Lake. In October phytoplankton biomass increased approximately up to 10 g/m^3 and again decreased

in November. In Chudskoe Lake the maximal biomass of phytoplankton is observed in July, in Teploe Lake is observed in autumn (Postuplenie).

Analysis long-term series of observations shows that stable increase of biomass in Pskovskoe Lake has begun since 1998 and in Chudskoe Lake since 1987. Increase of phytoplankton biomass was especially fast in less eutrophicated part of water body Chudskoe Lake. Since the same time in summer it was observed flash in development of two species of cyanobacteria before not being dominating forms – *Planktothrix agardhii* (Gom.) An. Rom and *Limnothrix redekei* (Var Goor) Maffert and visible increase in the biomass of cryptophytes (genus *Cryptomonas*). Since 1988 in Pskovskoe Lake it is observed the tendency to decrease in number of peaks of phytoplankton biomass during the vegetative period from two-three (spring and aestivo-autumnal or spring, summer and autumn) up to two (spring, aestivo-autumnal) and even up to one aestivo-autumnal. It is one of characteristic attributes of transition of water body into hypereutrophic stage. In Chudskoe Lake such tendency is not observed yet. Noted above change in the structure and parameters of quantitative phytoplankton development in Lake Chudsko-Pskovskoe testifies that since the second half of 1980s ecosystem of water body has passed to higher trophic step.

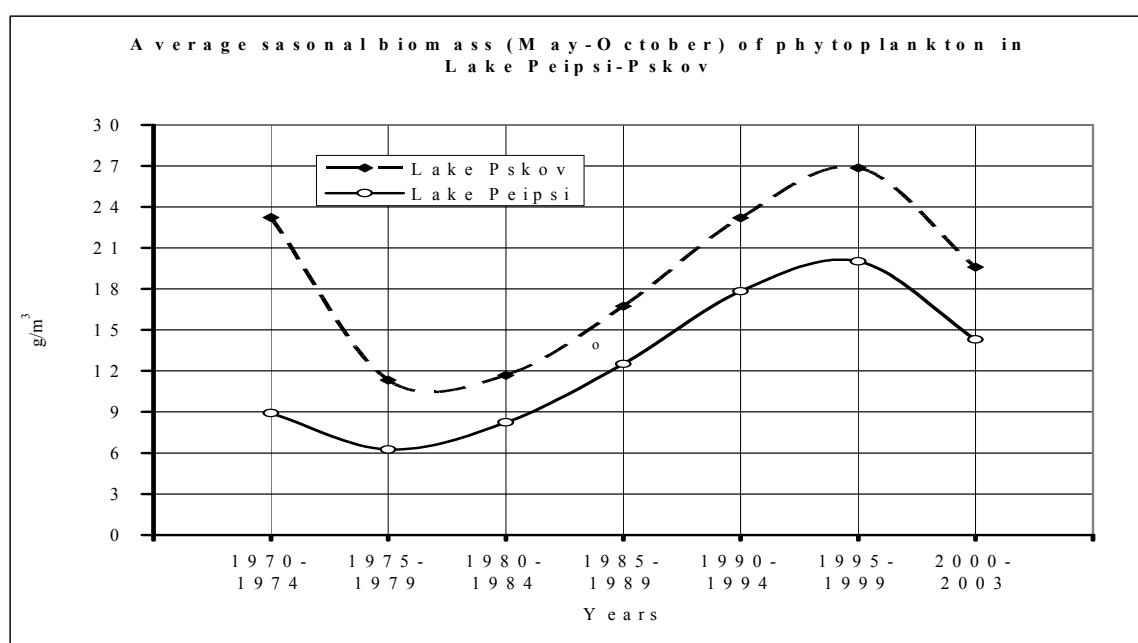


Fig. Average seasonal biomass of phytoplankton in Lake Chudsko-Pskovskoe.

However, despite of some modifications in structural and functional characteristics of phytoplankton, occurred in the end of XX century main composition of predominant forms has not changed essentially. Till now the large total species diversity of phytoplankton is preserved. It is not observed distinct trend in the modification of portion of fine fraction to one or another side. From 1997 the trend of phytoplankton biomass decrease in the lake is observed, and noted above 2 species of cyanobacteria (characteristic for hyperretrophic water bodies) do not

enter any more into the number of mass forms.

During the long-term period the primary production of plankton remains approximately at the same level: about 2.4 mgO₂/l per day in Pskovskoe Lake and 1.2 mgO₂/l per day in Chudskoe Lake. All this testifies to the large plasticity of ecosystem of Lake Chudsko-Pskovskoe.

In pelagial of Lake Chudsko-Pskovskoe 290 species are found in **zooplankton**. Here there are species characteristic both for eutrophic and for oligotrophic waters. In the forming of biomass main role belongs to cladocerans (about 60% from the total) and to copepods (38%). The ratio of these groups considerably changes over years. In 2000s in comparison with 1980s in Pskovskoe Lake some raise of the portion of cladocerans in the total biomass of zooplankton, in Chudskoe Lake on the contrary decrease, especially in comparison with the middle of 1980s is observed.

In 1990s the increase in number of rotifers, appearance of large number of representatives of genus *Brachionus* and among them *Brachionus calyciflorus* (Pallas) being typical for eutrophic water bodies (Afanasyev, et al., 1995) were noted. Especially clearly it was expressed in 1992, as in the mouths of rivers (Velikaya, Chernaya), and in Pskovskoe Lake. Other species *Brachionus diversicornis homoceros* also reached significant number up to 155.2 thousand ind./m³ (Afanasyev, et al., 1997).

During the long-term period average for vegetation season biomass of zooplankton varied in Pskovskoe Lake within the limits of 0.57-5.50 g/m³ and in Chudskoe Lake within 0.35-6.40 g/m³. Dynamics of zooplankton abundance and a biomass is characterized by presence of one-two peaks in its development. The maximal zooplankton biomass (in some years up to 9-13 g/m³) in each lake was registered typically in June-July. In 1990s both biomass and total number of zooplankton have increased, so in Pskovskoe Lake they increased in comparison with the previous decade by 1.6 times and have become: mid-annual biomass – 3.99 g/m³ (in summer up to 9 g/m³), mid-annual production – 71.2 g/m³. In Chudskoe Lake they have become 3.04 and 46.6 g/m³ accordingly.

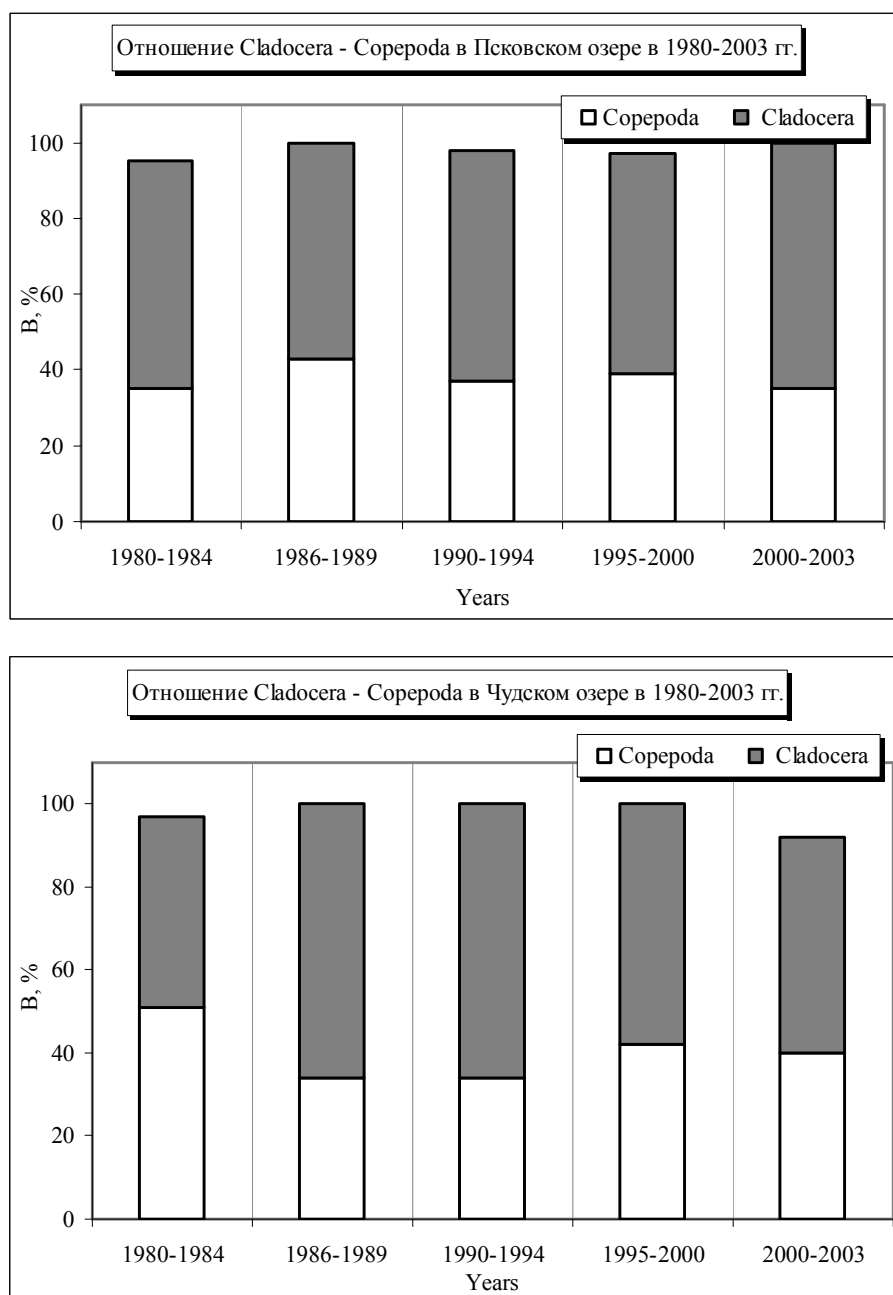
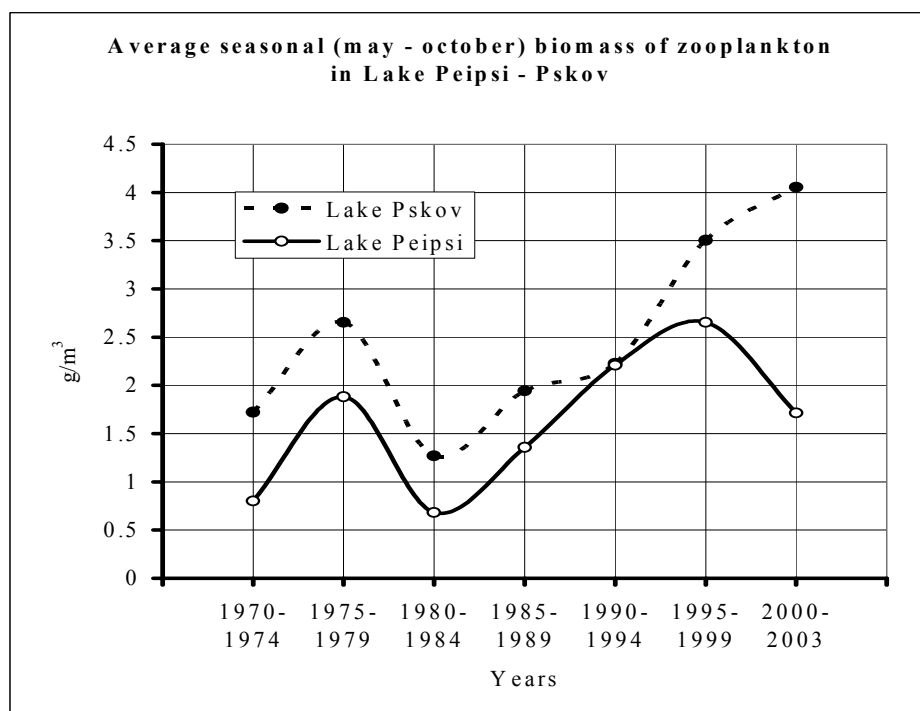


Fig. Proportion Cladocera–Copepoda Pskovskoe and Chudskoe Lakes

From the middle of 1980s growth of general quantitative indicators of zooplankton both in Pskovskoe and Chudskoe Lake is observed. Last years in Pskovskoe Lake average seasonal biomass of zooplankton continues to grow, while average seasonal biomass in Chudskoe Lake tends to decrease (Melnik, Yastremsky, 2003).



**Fig. Average seasonal (May-October) biomass of zooplankton in Lake
Chudsko-Pskovskoe.**

Increase in general quantitative indicators of zooplankton, inter-annual amplitude of biomass change and role of rotifers testifies increase of water body trophic status, however a constancy of the species composition and the predominating groups, the outlined trend to the decrease of average seasonal biomass of zooplankton in Chudskoe Lake, confirm high stability of planktonic communities of this water body.

Lake Chudsko-Pskovskoe is one of the most productive lakes of the Baltic region with high level of reproduction of **fish population**. 32 species and varieties of fishes live in the lake. From them 23 species are constant local inhabitants: white-fish, vendace, smelt, bream, roach, dace, ide, gudgeon, bleak, asp, silver bream, zarte, wels, eel, pike, pike-perch, perch, ruff, bullhead, three-spined stickleback, nine-spined stickleback and burbot. Besides this to the number of fishes living in Lake Chudsko-Pskovskoe it is possible to relate Amur carp introduced to the lake in 1947-1951 and presumably acclimatized here.

Despite of the common species composition in Pskovskoe and Chudskoe Lakes, there are certain differences in the number of fish populations of in each of lakes. So, in more shallow Pskovskoe Lake representatives coldwater complex of fishes; white-fish and vendace are met seldom in not commercial quantities. The species composition of fishes during century practically has not changed. From fish fauna of water body only eel has disappeared, earlier it naturally came to the lake for pasturing from the Baltic Sea. After river Narva flow has become

controlled (with creation of the Narva water reservoir) migrations of eel became impossible.

Results of long-term supervisions show, that under influence of ecological factors of environment and also due to intensification of fishery in the structure ichthyocenosis of Lake Chudsko-Pskovskoe significant changes have occurred. While it is impossible to approve unequivocally their irreversibility, however last decades it was formed a complex of factors, both natural and connected with the fishery regime and anthropogenic acceleration of eutrophication processes, which have led to transformation of fish community. So, for example, warming of climate, the strong "flowering" of water body resulting decrease of water transparency, silting of grounds are conditions favorable for life activity of pike-perch and extremely unfavorable for white-fishes. Becoming frequent in last years suffocations occurring in large scale and affecting increasing number of fish species are causing anxiety. At the same time, for all period of water body studies, species composition has not changed and high fish stocks are preserved. At the majority of species high rate of growth and fertility is observed. Ichthyo-toxicological and ichthyo-pathological studies testify to the absence of infectious diseases of fishes and the low content toxicants (heavy metals) in fishes.

8.3 Benthos, Avifauna

Chudskoe Lake can be named the most productive of large lakes of the Europe by development of macrozoobenthos in it. Here 421 species and subspecies of benthic organisms (Timm et al., 1996) have been met. Was Most widely there are presented chironomids (111 taxa), mollusks (83) and oligochaenes (59). Overwhelming number of species in the benthic fauna is eurytopic with wide natural habitat. Qualitative composition of benthos and its quantitative distribution are connected with depth, type of grounds, type and extent of overgrowing in coastal area, and also with the level of pollution of various parts of lake. Littoral fauna in the thickets of macrophytes is especially diverse by qualitative composition. Here there are practically all species of animals living in lake. Clusters of *Dreissena polymorpha* (sublittoral) are rich by species, they are forming "ring" of zebra mussel on the most part of Lake Chudsko-Pskovskoe perimeter. Fauna on sandy and silt-sandy bottom without vegetation and zebra mussel in the north of Chudskoe Lake is characterized by small species diversity. Profundal occupying up to 60% (Pskovskoe Lake) and 80% (Chudskoe Lake) of the lake area has limited species composition (typically within the limits of 30 species).

For both lakes at least three quarters of all found species are common. Differences in the structure of benthic fauna are caused by the difference of depths, peculiarities of hydrological and hydrochemical regimes, extent lakes trophic, etc. Originality of Chudskoe Lake is in the presence of species characteristic predominantly for coldwater oligotrophic water bodies: *Stylodrilus heringianus*, *Orthocladus saxicola*, *Monodiamesa bathyphila*, *Pallasiola quadrispinosa*. Character of annual and seasonal zoobenthos dynamics in the lake as a whole is defined by state of pelophylic cenosis occupying the main part of area. For profundal

two maxima of quantitative indicators are typical: vernal and autumn, and minimum in summer. Peculiarities of seasonal changes at the limited species composition and strongly pronounced dominance of *Chironomus plumosus* (by biomass) and *Potamothenis hammoniensis* (by number) are defined by features of their life cycles.

Despite of practically constant species composition of pelophylic cenosis, for more than thirty-year period it is possible to mark out some trends of changes in benthos structure and quantitative indicators in Pskovskoe Lake. Structural changes are connected with increase in the portion of mollusks (Pisidiidae, species of genus *Valvata*) in the creation of biomass of profundal communities. So, on the average for 1981-1985 mollusks made 9.78% of biomass in pelophylic cenoses of Pskovskoe Lake (Aselborn, 1987), in 1986-1992 it was already 16.1%, and in 1993-1998 it was 36.2%

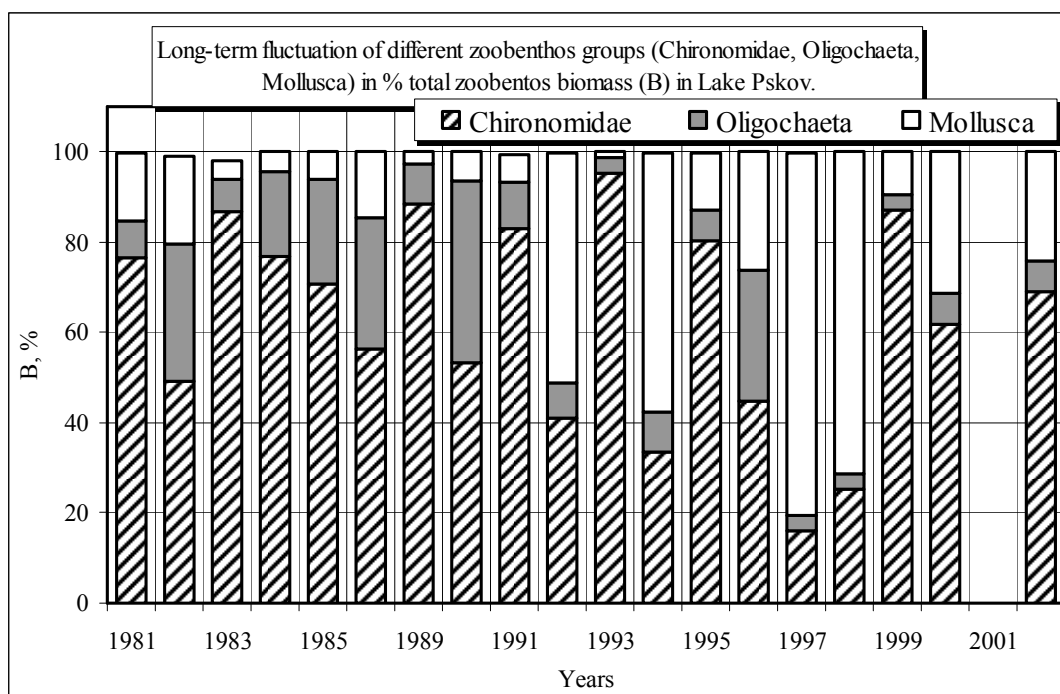


Fig. Long-term fluctuation of different zoobenthos groups in Lake Pskov

Average seasonal biomass of oligochaetes in pelophylic communities in comparison with the last decade has dropped a little; absolute predominant among them was *Potamothenis hammoniensis*, and the extent of its dominance last years increased up to 81-100%. In the ninetieth-two-thousand years the amplitude of interannual and seasonal fluctuation of biomass of bottom invertebrates in Lake Chudsko-Pskovskoe has increased. Last decade amplitude of interannual fluctuations in Pskovskoe Lake was from 4.78 up to 45.24 g/m², in Chudskoe Lake it was from 2.78 up to 26.20 g/m² (Melnik, Yastremsky, 2003). As a whole in Chudsko-Pskovskoe Lake some raise of average seasonal biomasses in profundal from 12.25 g/m² (in 1970-1978) up to 14.8 g/m² (in 1993-2003) is noted.

During XX century in benthos of Lake Chudsko-Pskovskoe 2 new species has appeared that strongly have changed biocenotic structure of the bottom population: bivalve *Dreissena polymorpha* (Pallas) and fresh-water amphipod *Gmelinoides fasciatus* (Stebb.). *D. polymorpha* for the first time was registered in single areas of Chudsko-Pskovskoe Lake in 1935-1936. Now *D. polymorpha* is settled over all lake, forming in sublittoral “zebra mussel ring”, power natural biofilter. Its biomass during some periods reaches 3195 g/m² (Antipova, 1992). Characteristic feature of last years is invasion of *D. polymorpha* into the central zone of Pskovskoe Lake. It is caused by strong pollution of lake with the lost fishing nets and other sunken objects, providing substratum for affixion of its larvae. Remaining on the nets shells of dying off zebra mussel in turn even more increase area of suitable substratum (Melnik, Yastremsky, 2003).

Gmelinoides fasciatus in Lake Chudsko-Pskovskoe for the first time was found in 1972 and is met constantly since 1980 (Timm, 1996). This species of fresh-water amphipod, alongside with *Rivulogammarus lacustris* (Sars), during wide acclimatization of Baikal crustaceans was settled in Lake Chudsko-Pskovskoe in the beginning of 1970s. *G. fasciatus* turn out to be more durable competitor in the relation to *R. lacustris*. From the end of 1980s *G. fasciatus* became a constant component of macrozoobenthos in the lake, often occupying leading position, has settled practically all types of grounds.

In the communities of macrozoobenthos, as well as in other parts of trophic chain of water body, the certain changes are observed. At least one of them plays positive role for decreasing in biogenic load and, accordingly, trophic level; this is wide distribution of *Dreissena polymorpha*.

Cane (*Phragmites australis*), common club-rush (*Schoenoplectus lacustris*) and pondweed (*Potamogeton perfoliatus*) dominate among **macrophytes** in Lake Chudsko-Pskovskoe. All these species are typical for eutrophic water bodies. Their distribution and biomass have changed considerably in the second half of XX century. Up to the end of 1960s macrophytes covered only 2.5% of area of all Lake Chudsko-Pskovskoe while in the end of 1980s they covered 7.5 and 7.9% of area of lakes Teploe and Pskovskoe accordingly. Rare species, such as *Subularia aquatica* L. and *Isoetes setacea* Lam., have disappeared to the end of XX century. Plants which were usual for shallow littoral earlier, such as *Alisma gramineum* C.Ch. Gmel., *Potamogeton filiformis* Pers., *Potamogeton panormitanus* Biv. Bern. and others, now are met very seldom.

8.4 Linkages (e.g., Describe briefly the ecosystem/biodiversity issues in general with regard to littoral wetlands, rivers, air (birds, etc.).

Total number of bacterioplankton is considerably higher in the southern part of lake, including part of Teploe Lake, and mouth of river Emajõgi. Average number of bacterioplankton in this part of lake is 3-4*10⁶ cells/ml, whereas in the other parts of lake is

2-3*10⁶ cells/ml. High abundance of saprophytes is observed only in the mouth of river Emajõgi. There is a trend of their number raise also in mouths of other rivers. The least number of saprophytic bacteria is in the north of lake in headstream of river Narva (Postuplenie).

9. State of the Basin



9.1 Description of the catchment area including its size (in km²), general geography of the region in relation to the lake and other neighboring water bodies (other lakes connected in chain, for example), catchment (draining-in) system, catchment area of the out-flowing river (draining-out) system

The basin of Lake Chudsko-Pskovskoe has area 44,245 km². Here live more than 1.1 million people, mainly in the country. The largest cities are Pskov and Tartu. Territory of the basin is located in the northwest of Russian plain, in the boundaries of Baltic lowland, 56-59.5°N and 25.6-30.3°E. Maximal length from the North to the South is about 400 km, and from the West to the East is 260 km. The average elevation above sea level is 110 meters.

Agricultural lands cover 42% of drainage area. Their significant part is not used or lies fallow. The total area under crops in the Russian part of catchment area is 8% of the area; from it 69% is covered by perennial grasses. Grain, potato and other cultures occupy accordingly 18%, 8% and 5% of the area under crops, i.e. only 2.5% of area of the Russian part of drainage area.

Forests occupy about 40% of drainage area. In Estonia now the fast developing branches are forestry and production of logs. In Russia the main obstacle in the development of forestry is the absence of roads in the remote wood regions. Deforestation on the drainage area leads to the increase in the emission of phosphorus, nitrogen and potassium compounds (Nutrient loads ..., 1999).

9.2 Basin hydrology (Briefly describe basin hydrology, including active as well as non-active parts.)

Basin of Lake Chudsko-Pskovskoe is characterized by high density of river network. Abundance of rivers and water bodies in the basin is explained by surplus wetting, flat relief and low permeability of prevailing grounds. About 11% of territory is waterlogged. Small lakes occupy about 7% of drainage area. Valleys of rivers and hollows of lakes as a rule are on the places of glacial topography elements, the largest (river Velikaya, Lake Chudsko-Pskovskoe) have under themselves ancient tectonic structures smoothed by activity of glaciers.

On the territory of Lake Chudsko-Pskovskoe basin there are about 2250 lakes. Inventory of more than 2184 lakes by area from 0.2 up to 1494.9 hectares is made, the total area of their water mirror is 462 km² (13% from the area of Lake Chudsko-Pskovskoe lacustrine complex); total volume is 1.52 km³ (6% from the volume of Lake Chudsko-Pskovskoe lacustrine complex).

Underground waters in the basin area are everywhere in the upper layer of sedimentary covering (Quaternary and Paleozoic deposits). Underground waters are pressure waters as usual. Feeding areas are confined to elevations (Sudomskaya, Bazhanitskaya, Haanja), and regional areas of underground waters unloading are lakes Chudskoe and Pskovskoe, local unloading is via riverine network. Thickness of fresh water zone in the feeding area is 200–400 m and in the unloading area is reduced to 50–100 m.

Climate of lake and its catchment area is moderately continental, transitional from marine to continental what determines unstable weather in all seasons. Features of marine climate are humid and moderately warm summer and relatively mild winter. Continentality is rising to the East where winter is longer and summer is warmer.

9.3 Soil types (refer to a soil map, if available)

Territory of Chudskoe Lake basin is in the sod-podzolic soil subzone of southern taiga and mixed forests. Diversity of natural conditions, rugged relief, and frequent change of soil-forming layers define complexity of soil covering. Wet and the temperate-cool climate

predetermine washing regime and overmoistening of soils. The forming of soil covering from geological point of view has started recently after recession of the Valdai glacier and continued about 12 thousand years.

The most widespread on the territory of basin there are podzolic and sod-podzolic soils. Besides them there are presented sod-carbonaceous, paludal-podzolic, sod-gley, peat-paludal and floodplain soils. Low-fertile podzolic soils are distributed mainly in the northern and partly in the southern parts of the basin on sandy and sabulous layers, under coniferous forests. Such type of soils requires application of much fertilizers and liming. Soils Sod-podzolic soils are the most widespread on agricultural lands as they are richer with nutritious elements than podzolic soils. The most fertile type of soils in the basin is sod-carbonaceous formed on limestone and carbonate moraine. Under conditions of overmoistening are formed sod-gley, paludal-podzolic and paludal soils. This type of soils is widespread on large lowlands – Velikoretskaya, Sorotskaya and the coastal part of Lake Chudsko-Pskovskoe.

9.4 Land cover with changes through time (Briefly describe seasonal land-use changes, by referring to a land-use map.)

When Estonia still was a part of Soviet Union, its agriculture specialized on production of meat and milk. Characteristic feature of such housekeeping was significant import of fertilizers and forage for cattle. After the announcement of independence of the Baltic countries in 1991, agriculture of Estonia, in the connection with sudden fall of demand for the Estonian food stuffs, it has been sharply re-structured. Import of fertilizers and forage for cattle has simultaneously sharply decreased. Now the production of agriculture of Estonia is used mainly in the internal market. Reducing in agriculture were accompanied by gradual decrease in the use of fertilizers which in the beginning of XXI century was 15-40 kg/hectare of nitrogen and 2-10 kg/hectare of phosphorus, that by 2-10 time is less, than in the Northern countries.

Similar economical changes were observed also in the Russian part of catchment area. If to see on the trend of areas farmland and forests change for the period since 1985 till 2003 significant decrease in the areas of agricultural lands by 376 thousand hectares or 40% is especially great in the districts of Pskov, Ostrov and OPOCHKA. Large part of these lands has got off from the use and concerns to the category of neglected. Agricultural lands mainly are in the basin of river Velikaya. For last decade the quantity of applied fertilizers has dropped essentially. Use of organic fertilizers (manure, liquid manure, etc.) is evaluated as 0.8-2.2 tons/hectare. According to urgent ecological recommendations use of organic fertilizers in the beginning of XXI century should be sharply reduced.

10. Uses of the Lake and Its Resource Development Facilities

Territory of catchment area possesses sufficient water resources for securing of population and objects of economy. So, in the Russian part there are used about 4 % of the minimal

surface runoff with provision by 95% and about 17% from the mastered reconnoitered stocks of underground waters, i.e. in the Pskov region the problem of provision with water resources on the prospect is not actual.

10.1 Water

The total amount of withdrawn water from aquatic objects as a whole in the Russian part of catchment area was in 2002 about 70 million m³, including 67.0 million m³ in the basin of river Velikaya. Directly from Lake Chudsko-Pskovskoe and running into it rivers (rivers Gdovka, Zhelcha, Piuza, etc.) it is taken away 2.77 million m³ (in 2001 3.36 millions). In 2003 the total amount of the taken away water from aquatic objects as a whole in the Russian part of catchment area was about 58 million m³, including 54.59 million m³ in the basin of river Velikaya. Directly from Chudskoe lake and the rivers running into it (rivers Gdovka, Zhelcha, Piuza, etc.) it is taken away 3.11 million m³.

In the basin of Chudskoe Lake from 57.7 million m³ of taken away fresh water 33.7 million m³ is used for economic-drinking needs (58.4%) and 16.73 million m³ for industrial needs (29%), 2.22 million m³ for agriculture water supply (3.8%), 4.07 million m³ in pond fishery (7.1%) and 0.98 million m³ for other needs (1.7%).

For water supply in the basin there are used fresh surface and fresh (and partly saltish) underground waters. Fresh water is the important source for economic-drinking water supply. 90 % from the total draw-off of underground waters of Pskov region concern to “not considered draw-off” not considered draw-off of surface waters is insignificant. The value of losses at transportation is 20% from the amount of water used for technological needs. It is possible to explain such high amount of losses by deterioration of water supply networks.

During last 15 years the general trend of decrease in the use of waters, connected with the reduction of population and recession in industrial production, use of systems of water recycling, reduction of cattle stock, and also installation of counters and water meters is observed. Thus it is possible to note, that in some large cities small growth of volumes of of surface waters use is noted.

10.1.1 Flood/drought control facilities

Rivers in the basin are characterized by high water fullness that is explained by overmoistening of territory. Their water regime is under large influence of marshiness, amount of forests and lakes in the basins. Marshiness and amount of forests reduce vernal runoff and increment summer runoff. Amount of lakes controls runoff of the rivers and regulates it doing it more even during the year. This regularity is traced on the map of territories subjected to underfloodings. Most of all settlements subjected to underflooding is located in the central part of basin, where area agricultural lands is higher, and amounts of forests, lakes and marshiness are lower.

The rivers in the basin are feed by snow, rain and underground waters. Rivers receive main part of water in the spring, during snow melting (about 50% of annual flow). In the first half of April the highest water level is observed. During vernal high water even on the small rivers the water level rises by 1-2 m., on the large ones by 3-6 m. River Velikaya in headwaters flows through 21 lakes which take away surplus of water, therefore the water lifting in its headwaters is rather low.

Analyzing situation with floods in the catchment area it is possible to conclude:

- Underfloodings of territories have local character;
- The flood situation is seasonal is a part of natural processes;
- In the most cases flooding and underfloodings of territories can be predicted, because there is information about the places of possible underflooding, obstructions and territories of possible evacuation, periodically flooded during high water and flood flows;
- Flood flows and high waters negatively influence the property, health and human life, about 50 settlements, about 1000 houses with the total number about 3000 people are periodically flooded.

10.1.2 Drinking water withdrawal and facilities

The water supply in Pskov is implemented due to surface and underground waters in the ratio 18:1. Quality of the drinking water supplied to the plumbing of Pskov conforms to sanitary norms by all parameters of GOST except for oxidability. Concentration of this parameter sometimes exceeds norm of maximum concentration limit by 3 times. Technological process of purification and preparation of drinking water consists of several stages: chlorination (with the purpose of water decontamination), coagulation (with the purpose of adsorption and the further sedimentation of suspended substances), coagulant is aluminium sulphate, and following stage of filtration by means of sand filters.

According to the results of analysis of the water which are taken from river Velikaya, its quality does not exceed norms of maximum concentration limit for the majority of parameters. The primary goal of station on purification and preparation of drinking water is mechanical purification and decontamination. Dump of service water after washing filters has no polluting effect on the river.

Underground waters as a source of water supply have significant advantage before surface waters by conditions of natural defense against pollution why negative anthropogenic impact becomes apparent sporadically and as consequence of this the quality of underground waters is higher and stable.

10.1.3 Agricultural water withdrawal and facilities

10.1.4 Industrial water withdrawal and facilities

10.2 Fisheries and their facilities

By the value of fish productivity and catches which, since 1930 were 9000-11000 tons/year (25-31 kg/hectare a year), Chudskoe Lake is the most productive among large lakes of the Northern Europe. During most part of XX century it was possible to consider Lake Chudsko-Pskovsko as smelt-bream, but since the second half of 1980s it became as well as pike-perch lake. Commercial species in last decade there are smelt, pike-perch, bream, pike, perch, roach (the Plan ..., 2006).

Regular commercial fishery on Lake Chudsko-Pskovskoe exists from the middle of XIX century; however the regular account of the caught fish (trade statistics) is carried out only from 1931. Prior to the beginning of 1920s for fisheries there were used fixed nets, weirs, etc., used only for catching smelt. Besides this on the lake there were used close-meshed seines and with the help of them there were caught not only roach, perch, ruff but also their numerous juveniles. In the following years on Lake Chudsko-Pskovskoe fisheries with sail and later with mechanized drag-nets began active development.

During last two decades in the fisheries there are used from 11 up to 13 kinds of catching, instruments, however the most mass of fishes is taken with weirs, mechanized "mutniks" and beach seines (80-90% of annual catches). The number of fishery organizations in 1993–2003 was at the level of 12–65. Last years their number was 49-59. Number of fishermen working on Lake Chudsko-Pskovskoe in 1993-2003 changed within the limits of 427-988 persons. Last years their number was 773-903 persons.

On a background of decrease in the stocks white-fish species, observed in Lake Chudsko-Pskovskoe from the end of the 1980s, the trend to the growth of abundance and catches of pike-perch and bream was outlined. Improvement of the state of pike-perch herd has started in the end of 1970s – beginning of 1980s and already to 1985 catches were increased up to 147 tons. Especially sharply stocks and catches of pike-perch have increased in 1988 when it was began fishery of high-yielding generation of year 1985. In 1990s stocks of pike-perch in Lake Chudsko-Pskovskoe in comparison with 1980s continued to grow. The high level of stocks of pike-perch in 1990s was provided predominantly due to extremely numerous of year 1991. By the end of 1990s regime of fishery with wide-meshed nets which intensity progresses from year to year, has essential influence on the state of stocks of pike-perch. Stocks of pike-perch in the first half of 2000s, both in Pskovskoe and Chudskoe lakes, mainly consist from fishes of fruitful generations of 1999-2000 and those of 2001-2002.

The tendency of growth of stocks of bream in Lake Chudsko-Pskovskoe has started to appear in 1970s and continued in 1980s. Not only well conditions for natural reproduction, but also measures on regulating fishery favored to this. Stocks of bream in 1980s were formed

predominantly by fishes of middle-yielding and high-yielding generations of 1975, 1979 and 1981-1982 years. In an origin of the ninetieth years a stock of a bream has replenished with two more high-yielding generations 1985-1986 that promoted increase in a trade part of herd. In second half of 1990s and in the beginning of 2000s the tendency of increasing commercial stock of bream in Lake Chudsko-Pskovskoe remained. Owing to substantial increase of stocks of bream in the end of 1990s, its catches increased up to 1100-1200 tons.

Stocks of other commercial fishes (pike, perch, roach) in Lake Chudsko-Pskovskoe have not undergone essential fluctuations during last two decades.

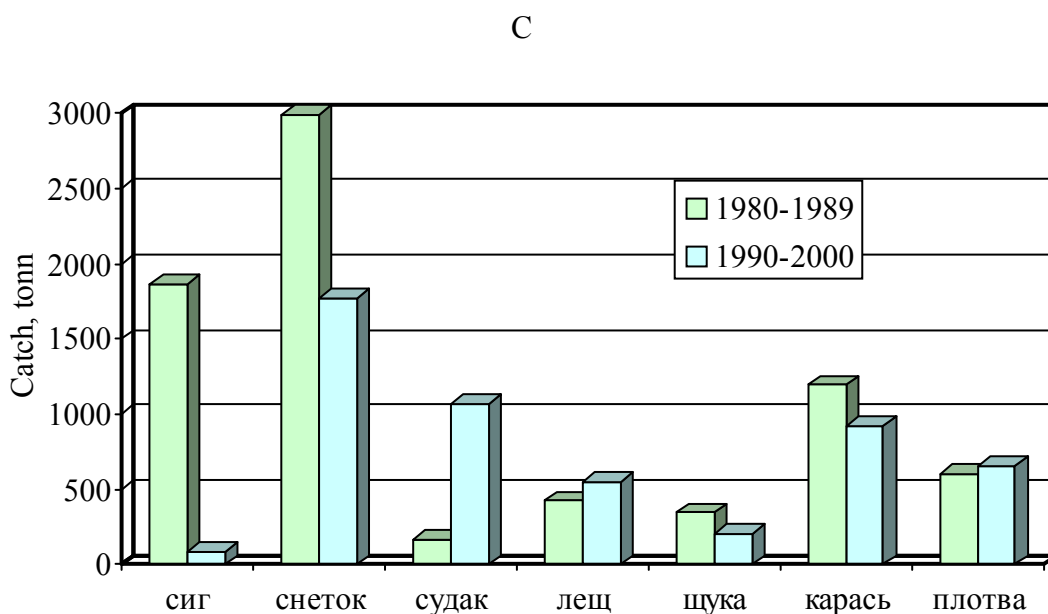


Fig. Average catches of main commercial species of fishes in Lake Chudsko-Pskovskoe in 1980-2000.

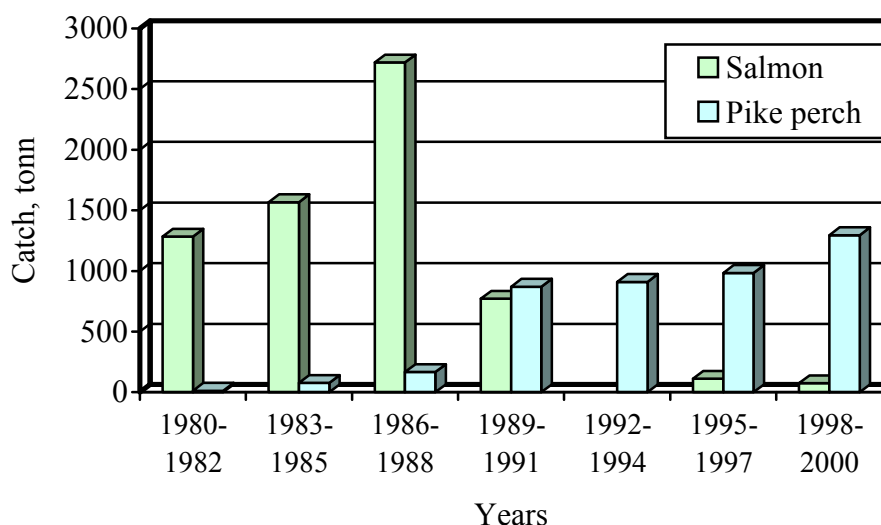


Fig. Catches of white-fish and pike-perch in Lake Chudsko-Pskovskoe in 1980-2000.

Licensed fishery. Licensed fishery has received the greatest development on Pskovskoe Lake in the connection with its location near regional centre where the Pskov regional inspection of a fish protection issues licenses. Catches of fishes under licenses in Pskovskoe Lake in 1998-2002 varied within the limits from 82 tons (in 2000) up to 315 tons (in 1998). The base of catches consisted of roach, and its most volume has been caught in spring by close-meshed nets. In Chudskoe Lake in 1998-2002 under licenses it was caught from 14 tons (in 1998) up to 83 tons (in 2002) of fish. Catches, as well as in Pskovskoe Lake, have been presented mainly by roach. As a whole on Lake Chudsko-Pskovskoe the catches of fishes under licenses for last years tends growth.

Amateur fishery. Amateur fishery was widely developed on Lake Chudsko-Pskovskoe. Especially intensively it began grow both in Pskov and Chudskoe lakes from the beginning of 1990s in the connection with changes in social-economic situation in the country. To evaluate its influence on the state of stocks of main commercial species of fishes without special studies it is enough difficult. According to the Inspection for fish protection in 2002 due to amateur fishery catch has made 96.6 tons in Pskovskoe Lake and 63.9 tons in Chudskoe Lake.

10.3 Tourism facilities

Lake Chudsko-Pskovskoe is favorable vacation place. In summer days on its beaches simultaneously there are tens thousand person on vacation. By recreational value the most suitable beaches are on the Russian side of Chudskoe Lake. The coast of Teploe and Pskovskoe lakes belong to category of low suitable or unsuitable beaches.

On the lake coast it is already observed irreparable traces of negligent attitude of people to

the nature – faults in the building politics, intensive trampling down, contamination, etc., requiring immediate dispersal of holiday-makers on the lake coast. Distribution of main recreation centers “Cudskoe podvorye”, “Lukomorye”, boarding house in Krivsk and a holiday house in Zhidilov Bor corresponds to the most suitable sandy beaches. Besides this many tourists have a rest on the beach of river Velikaya also and visit small lakes located in the Pskov and Pechory districts and islands on Pskovskoe Lake (mainly islands Talabskie).

Presence of not used stocks of medical dirts and mineral waters (Vyarska, Raskopelye, Gorodets, etc.) can extend resort facilities. Also well alternation of types of shores and wide development of their sandy kinds allow not only to disperse having a rest but also to increase their number, in particular at the eastern coast of Chudskoe Lake.

11. Impairments to Uses

11.1 Increased algal growth

Annually during the aestivo-autumnal period in Lake Chudsko-Pskovskoe water "flowering" of various intensity due to mass development of cyanobacteria is observed. The most intensive "flowering" occurs in the years with prevalence of anticyclonal weather conditions (low levels of water, high summer temperatures). During the long-term period the primary production of plankton remains approximately at the same level – about 2.4 mgO₂/l per day in Pskovskoe Lake and 1.2 mgO₂/l per day in Cudskoe Lake. By average for season values of saprobity indexes Lake Chudsko-Pskovskoe belongs to β -mesosaprobic type, i.e. moderately polluted with organic matter. Eutrofication of lake is one of the most serious consequences of its pollution.

In August, 1992 for the first time for all history of studies it was noted "flowering" of water in the river Velikaya, the main tributary of Lake Chudsko-Pskovskoe, induced by abundant development of cyanobacteria. The biomass of phytoplankton in the river at Pskov has reached 97.5 g/m³, and in the mouth area in September it reached up to 152 g/m³. About the same level reached at this time biomass of phytoplankton in some areas of Pskovskoe Lake. Such high biomasses lead to biological pollution of water body.

11.2 Increased salinity

Not observed

11.3 Destruction of wetlands

Analysis of drained lands distribution within the boundaries of the Russian part of catchment basin shows, that the total area of reclaimed lands to the present moment on the territory of Pskov region is 173.9 thousand hectares. From them agricultural lands are 163.9 thousand hectares (about 94% from the total area of the drained lands). Drainage mainly was spent by drainage mean (about 85% from the total area of drainage) and has made 147.1 thousand hectares. Because of a sharp reducing of financing since 1990s many ameliorative constructions function now without major repairs and maintenance (about a quarter of

reclaimed lands are in unsatisfactory state).

Observations over dump of waters from ameliorative systems and analysis of their chemical composition on the territory of Pskov region were not carried out. However, since 1975 in the area of OPOCHKA (villages Kostrovo and Lyutskovo) complex constant monitoring of drainage waters and their chemical composition have been organized on experimental testing area.

11.4 Declining fish stocks

In the beginning of XX century in the villages near headstreams of river Narva the main object for fishery was eel. Annually 12-17 thousand eels were caught here. Eel migrated into Lake Chudsko-Pskovskoe from Baltic Sea via river Narva. Now Narva Hydroelectric Power Station has practically blocked this path for eel. Now it is got to fishermen seldom and comes from Estonian lake Võrtsjärv via river Emajõgi.

From 1951 till 1956 fishery on Lake Chudsko-Pskovskoe was extremely intensified, that has led in the follow-on years to significant reducing of stocks, first of all valuable species of fishes (chudskoy white-fish, pike-perch, bream, pike). For recovering stocks of such species as pike-perch and bream it was required more than twenty years. For recovering stocks of valuable species of fishes in 1960s many measures of fishery regulation (prohibition of trawls, limiting number of mechanized "mutnik" which in 1958 replaced trawls) were undertaken. Annual and vernal limits of valuable species of fishes catches have been introduced, time of catching was limited. All these measures gave positive effects and from the end of 1970s and beginning of 1980s the trend of increase in the stocks of a white-fish, pike, bream and, especially, pike-perch was outlined.

Before 1990s one of main commercial fishes was vendace, it was by volume of catches on the second place after smelt. Maximal catches of vendace were in 1987-1988 (2700-3271 tons). One of the main causes affected decrease of vendace stocks in Chudskoe Lake was excessive fishery in the second half of 1980s, especially in 1987-1989, therefore number of spawners has sharply decreased that should reflect on the level of natural reproduction of this species. It is undoubted, that decrease of vendace stocks was influenced also by abiotic and biotic factors of environment which especially became apparent in 1990s (unfavorable hydrometeorological conditions during the time of spawning and incubation of spawn; press from predatory fishes, predominantly pike-perch). Stocks of vendace in Chudskoe Lake till now remain on low level. While for period of more than 10 years of observations in Chudskoe Lake there was no high-yielding generation of vendace capable to restore its stocks up to the level of 1980s.

Alongside with vendace in Chudskoe Lake in 1990s decrease of white-fish stocks was noted. It is necessary to say, that number of this species in Chudskoe Lake always was on rather low level. The cause of this are enough intense conditions of its inhabiting in the lake

(limit of spawning areas, high warming-up of water, press of the predatory fishes eating spawn and juveniles of a white-fish, high rate of invasion with *Tetracotyle*). However the sharpest decrease of whitefish abundance was observed in the second half of 1990s and in the beginning of 2000s, and it was connected with unfavorable weather conditions of autumn-winter period (late and unstable freezing-over, abnormal early breaking up of lake). All this broke conditions of natural reproduction of white-fish and times of spawn incubation caviar, increasing its death.

12. Causes of Impairments

12.1 Upper-watershed degradation including erosion and siltation

Considering enough small volumes of sewage runoffs processing in the cities river Velikaya headstream and ability of the river to the self-cleaning at rather small pollution it is possible to predict enough favorable ecological conditions concerning pollution of water systems with silts sediments of sewage disposal plants in the basin of Lake Chudsko-Pskovskoe.

The most critical is problem with silt deposits of Pskov, the largest contaminant in basin of Lake Chudsko-Pskovskoe. Before construction of silt store sediments were stored on 24 concreted platforms for biological neutralization. Now these deposits, which have been accumulated within the first years of sewage disposal plant operation, are stored on two concreted platforms. Deposits by the concentration of color and heavy metals are related to the second class of danger, as substances high-danger.

12.2 Point and non-point source runoff from urban areas

In the forming of biogenic load on Lake Chudsko-Pskovskoe two main groups of agents are participating: point and diffused sources of biogenic substances. Point sources are concentrated mainly in settlements and are presented by sewer systems of municipal services and industrial enterprises. Now majority of settlements on drainage area have sewage disposal plants with biological and chemical methods of purification. Mid-annual income of biogenic substances from point sources from the Russian part of drainage area is by nitrogen 862 tons/year and by phosphorus 106 tons/year (Skakalskiy, 2003). The most part of the loading falls on river Velikaya.

Two largest sources of point pollution on the catchment area of lake are sewage disposal plants of Pskov and Tartu. As a whole on the Estonian territory dumps of sewage disposal plants make about 90% from the total load generated by point sources. In the most sewage disposal plants of Estonia mechanical sewage treatment is used predominantly. On the Russian territory the most of sewage waters dumps from point sources of pollution is connected with housing and communal services, agriculture and industry (mechanical engineering, the food-processing industry). The portion of the sewage waters dumped without purification (up to 17% from the total amount) is large here.

Draining of waste, mine and collector-drainage waters in the basin of Lake Chudsko-Pskovskoe has made 60.93 million m³ in 2003, that is a little lower, than in the previous period. From them in natural surface objects it is dumped 57.55 million m³ (9.2% without purification, 86% insufficiently cleared, and 4.4% normally clean without purification), and to the stores and hollows it is dumped 3.39 million m³.

Main pollutants in the Russian part of basin are Pskov (7588 %), Ostrov district (4-10%), Pechory district (1.5-2%), Pskov district (1-2%) and Gdov district (about 1%). Portion of all other areas does not exceed 1% from the total amount of dump. In the Russian part of catchment area in the end of 1990s the trend of decrease in the total Draining of sewage waters in comparison with the first half of 1990s (by 25%), mainly because of reducing of the total number of enterprises and decrease in the volumes of production was observed. To the mid 2000s due to outlined trends of gradual growth of production, the total amount of dumped waters increased (by 13% to the level of 1998). First of all it was observed in Pskov, owing to its constant growth and faster escaping of crisis.

Diffusion sources of anthropogenic origin include agricultural lands, mineral and organic fertilizers, runoffs from objects of animal husbandry. Both the Russian and Estonian parts of Lake Chudsko-Pskovskoe catchment area belong to regions with advanced agriculture and a significant percentage of plow-lands. On the Russian part of Lake Chudsko-Pskovskoe catchment area on the fields it is used about 21 000 tons of fertilizers in a year (65% - nitric fertilizers, 14 % - phosphoric, 21 % - potash). Use of organic fertilizers is evaluated about 380,000 tons/year. Agricultural lands here are mainly in the basin of river Velikaya. Annual removal due to natural and anthropogenic factors from drainage area of river Velikaya is evaluated as 11 thousand tons of N_{total} and 493 tons of P_{total}, the anthropogenic component reaches 73 and 88%, accordingly (Skakalsky, 2003). Use of fertilizers on the Estonian part of catchment area makes 15-40 kgN/hectar and 2-10 kgP/hectar (Nutrient loads ..., 1999).

12.3 Shoreline degradation and alterations

12.4 Other

13. Structural Management Response

For reduction of aquatic objects pollution by agricultural activity agricultural enterprises carry out organizing-economic, agrotechnical, hydraulic engineering and melioration measures.

In order to reduce containing manure dumps adverse affecting on environment, under the Russian-Danish project in 1996 and 1999 on pig-breeding farm "Pskovskiy" two reservoirs of 16 thousand m³ for utilization of manure are put into operation. This project provided to construct reservoirs also for 64 thousand m³ and to reduce expense of drinking water for manure removing. But in the connection with complex financial situation to make it was not

possible. Now in the stores of farms there are stored suitable pesticides unallowed for application and subjected to utilization. On this question together with Denmark in the mid 2000s the project «Out-of-date pesticides of the Pskov region» was developed.

In modern conditions society, enterprises and the state are giving increasing attention to ecological aspects of economic activities. At the same time they are specially monitoring processes of production because this is the basis for improvements of environmental safety and the state of environment .

13.1 Sewerage system

In the Russian part of catchment area, on the territory of the Pskov region from 17 cities and settlements of city type in 16 there are centralized sewerage systems with sewage disposal plants for sewage purification. Most of them do not purify sewage water up to parameters close to normative, except for sewage disposal plants in Pskov and Ostrov. In other cities and settlements sewage dump is implemented on the relief and into aquatic objects without sufficient purification. The most adverse conditions are observed in Novorzhev, Pustoshka, and also in Gdov and Krasnogorodsk. In country on territory of the basin in Pskov region there are 28 sewage disposal plants in settlements of village type and villages where sewage purification is made not effectively.

Economic-household and industrial drains of Pskov enter to the city sewage disposal plants of Pskov and village Mon'kino of Pskov district located in immediate proximity from delta of river Velikaya in water-protection zone. Sewage disposal plants have been put into operation in 1970s and are one of the most high-performance in the northwest of Russia. Daily volume of treatment in 2002 was about 120 thousand m³ per day. Sewage passes through inlet chambers, are defecated in sand collectors and in primary sedimentation tanks (mechanical purification). Until 1997 practically 50% of sewage (approximately 50-60 thousand m³ per day) directly after mechanical purification was dumped into river Vilikaya, now all sewage passes biological treatment. Sewages further are neutralized biologically in two aero-tanks and are additionally defecated in secondary sedimentation tanks. Chlorination on discharge is absent. Significant improvement of quality of purification from suspended substances has occurred in 2004-2005, after putting into operation two extra secondary sedimentation tanks.

Sewages from the complex of apartment buildings in Ostrov and industrial dumps of enterprises collected in inlet chambers of sewage disposal plants, are defecated on grids-crackers and in sand collectors, precipitate in primary sedimentation tanks, are treated in aero-tanks, are refined in secondary sedimentation tanks, pass contact basins and are dumped into river Velikaya. Daily volume of treatment is up to 4000 m³; volume of industrial sewage is about 10%. Technology started in 1985, is modern and is kept in good technical state, engineers and workers have high qualification. Sediments from sewage disposal plants

are partially dry (humidity 93-95%) in concentration tanks and are placed on three special sludge drying beds.

Mostly, in sewage disposal plants of district centers it is used simplified technology mechanical and a biological purification, in a number of centers disposal plants are absent. The main problems are: old technologies, out-of-date processes and equipment, troubles in the work of individual lines of technological process, the system of the State Control is broken, long-term work on recovering system of account and control is required, given parameters in many cases are doubtful.

13.2 Industrial wastewater treatment system

On the Russian part of catchment area there is about hundred industrial enterprises (the enterprises concerning the industry or similar kind of activity). The total amount of sewage dumped from the Russian part of catchment area is evaluated as much as 8.2 million m³/year.

13.3 Solid and hazardous (опасный) waste management system

For a number of years in the Russian part of catchment area the urgency of problems connected with **soil pollution with wastes of production and consumption, and also with domestic waste**. In various storages, scrap-heaps and other objects has been accumulated significant amount of wastes from production and consumption, including toxic ones. By results of inspection of places of scrap-heaps on the Russian part of catchment area of Lake Chudsko-Pskovskoe the following is revealed:

- The most of surveyed scrap-heaps of cities and district centers in the basin are potential polluters of surrounding natural habitat and do not meet the regulations of exploitation.
- The oldest scrap-heaps are located in Pskov (since 1947), Ostrov (since 1950), Pustoshka (since 1957) and in Pushkinskie Gory (since 1960).
- The greatest extent of filling is characteristic for scrap-heaps in OPOCHKA (99%), Pskov (90%), Sebezh (77 %) and Ostrov (75 %).
- The largest scrap-heaps (by volume of collected scraps, in thousands m³): 1200 thousand m³ in Pskov, 150 thousand m³ in Ostrov, 102 thousand m³ in Sebezh, 88 thousand m³ in OPOCHKA and 78 thousand m³ in Pushkinskie Gory.
- Some scrap-heaps require closings with carrying out isolation of surface with soil and further conversion of areas into forest plantations.

By the carried out studies it found that maximal content of heavy metals and mineral oils in the soils of sanitary buffer areas exceeds the prescribed meanings of maximum concentration limit, and by the extent of scrap-heaps impact on the state of adjoining lands they can be related to the group of negative influence. For further exploitation of existing it is

recommended:

- To execute calculation (project) of sanitary buffer.
- To provide measures on protection of surface and underground waters against pollution by filtrate carrying out detailed hydro-geological researches.
- To construct observation wells.
- To equip economic zones.
- To arrange account of wastes receiving.
- Institutions of local government should to approve the list of scraps permitted for putting on scrap-heaps.
- To develop measures on arrangement of places for placing scraps in order to bring to conformity with working standards and of scraps treatment.
- To organize works on certification of scraps in order to determine their composition and relation to the corresponding kind and class of danger.
- To pay attention to prohibition of suitable to use in a national economy as secondary resources scraps removal to the scrap-heaps,.

Federal State Institution "Center of State Sanitary and Epidemiological supervision in Pskov region" carries out constant **control over storing, application and transport of toxic materials** in Pskov region. In the region there are 211 stores for a storing toxic materials, from them 101 are standard. According to the carried out inspections it is found that agricultural enterprises in districts use pesticides permitted to application on the territory of Russian Federation. The majority of stores for storing of toxic materials are not passported, since pesticides are delivered in small amounts directly just before their use. All stores are old, toxic materials in some of them are stored during 10-15 years. In the connection with sharp reduction of areas under main crops in the stores of Pskov region there was significant accumulation of toxic materials. In mid 2000s their quantity has reached 312 tons, including 45.7 tons of highly toxic. From them: class 1 of danger (granozan) - 46.1 tons, classes 3 and 4 of danger (mixes) - 271.5 tons. In 2004 the Government of Russian Federation with financial help of DEPA and DANCEE had been started the pilot project to help regional authorities to solve problem of the out-of-date or becoming unfit for use toxic materials in Pskov region. For secure conservation of about 250 tons of pesticides in the region it was created secure temporary store for storing pesticides till the time when there will be opportunity of their destruction by ecologically comprehensible mean.

14. Non-structural Management Response

14.1 Rules

14.1.1. Informal (informal community rules and voluntary restrictions)

14.1.2. Formal (industrial effluent regulations, protected areas (land use restrictions, ecological reserves), etc.)

Diversity of landscapes and soil covering, and also dense hydrographic net of Lake Chudsko-Pskovskoe basin define rich species composition of its flora and fauna. Owing to high biological variability just on the Russian part of catchment area there are 19 special protected natural territories of a federal and regional meaning having total area 537 thousand km². "Pskovsko-Chudskaya lakeside lowland" located on Russian coast of Lake Chudsko-Pskovskoe concerns to Ramsar wetlands of international meaning. Pskovsko-Chudskaya lakeside lowland is one of the best reserves mass gatherings of waterfowl and near-water birds (up to 200-300 thousand individuals during migrations and post-nesting migrations) and rare species in the Northwest of Russian Federation. In it there are found new for Pskov region sphagnous mosses *Sphagnum compactum* and *S. quinquefarium*. Among vascular plants it is met 69 species protected or rare in Pskov region and 25 kinds included in the Red book of Estonia. From vertebrates there are registered more than 80 rare species of Pskov region including 2 species of lampreys, and one species of fishes, 25 species of birds and species of 2 mammals included into Red Book of Russia, and also one species of lampreys, 9 species of fishes and by one species of amphibians and reptiles, 46 species of birds and 2 species of mammals included into Red Book of Estonia. This wetland plays important role in the preserving and recovering of number not only rare but also commercial species of Pskov region

Besides this in the basin of Lake Chudsko-Pskovskoe there are specially: National park "Sebezhskiy" and also reserves , Bezhanitskiy, Krasnogorodskiy, Novorzhevskiy, Opochetkiy, Ostrovskiy, Palkinskiy, Lyadskiy, Nikandrovskaya dacha, Pskovski , Pustoshkinskiy, Pushkinogorskiy progorniy, Pytalovskiy, Pechorskiy, Sebezhskiy, Knyazhetskiy, Nikolaevskiy. In the biodiversity preserving the role federal reserve "Remdovskiy" is especially great. In it there are spawning areas of valuable commercial fishes: bream, pike-perch, smelt; it is included into the list of biotopes registered in the Eastern Baltic under the project "Corine Biotopes Project in the Baltic States and Northwestern Russia", and in the system of band "corridor" of specially protected natural territories of Pskov region and located in the band boundary with Estonia, Latvia and Belarus.

14.2 Economic Incentives (subsidies, taxes, etc.)

The most important industries in the Russian part of basin are the food-processing industry and mechanical engineering. These branches have provided 32.7% and 32.3% accordingly from parameter of industrial production in 2001. Food-processing industry is the only developing branch (since 1996), both by absolute parameter and by percentage from all industrial production.

Large industrial centre of the Russian part of a catchment area is Pskov in which it is

concentrated 6 enterprises of mechanical engineering and 9 enterprises of electrotechnical industry. Three machine-building enterprises use more than 100,000 m³ of water in a year, and provide 72% of sewage volume in this branch: Open Society "Pskov plant of heavy electrowelding equipment " (equipment for contact and an arc welding, welding transformers, etc.), Joint-Stock Company "Pskov plant of precise moulding AMO ZIL" and Pskov Open Society "Plant of mechanical drives" (equipment for branches of building complex). The drawoff exceeding 100,000 m³ of water in year, is noted at four enterprises of electrotechnical industry. The enterprises of this branch produce electric motors, condensers, resistors, cable wires, telephone devices and apparatuses, mini-ATS, equipment for multichannel telephone and cable communication, etc.

In other urban settlements of the Russian part of catchment area traditional industries - light and food prevail. Among the enterprises of food-processing industry 4 use more than 100,000 m³ of water in a year, all of them are in Pskov or the Pskov district. The enterprises are presented by a number of branches: flour-grinding, baking, meat, milk, fruit and vegetable packing and fish industries. The most important branches in light industry is flax-manufacturing, leather-shoe, knitting, sewing industries. The drawoff of the enterprises of light industry does not exceed 100,000 m³ of water in a year.

In the Russian part of basin there is only 1 thermal power station which is in Pskov: the Pskov thermal power station-18. Besides this in each city there are boiler-houses (heating of water).

Agrarian complex of region is the major component of its economy, basis of population supply by food stuffs. Priority directions of agriculture development in Pskov region are: production of milk, industrial swine breeding and poultry farming, vegetable growing in sheltered ground, flax production.

Structure of sowing areas characterizes and reflexes development of forage production, defining state of leading branch – dairy cattle breeding. Now agriculture works on the path of biologization. It is caused by deficiency of financial resources for acquiring agents of chemization. Biological agriculture is provided due to cultivation of long-term leguminous forage crops, such as a clover, galega, lucerne, sweetclover, bird's-foot, and also saturation annual and grain crops with leguminous mixes. Forage crops form basis for agriculture biologization, preserving of soil fertility and preservation of the environment. Except for the forage crops, the certain position in the structure of crops allocated to the branches of flax production, potato growing and vegetable growing.

The branch of animal husbandry is basis for supplying of commodity output. The swine breeding gravitates to large centers - Pskov, Pechory, Opochka. The branch of animal husbandry gives more than 80% of gain to agricultural enterprises; from it 50% are from milk. In swine breeding pig-breeding farm Open Company "Pskovagroinvest" works. In the region

two integrated poultry farms: eggs producing "Pskovskaya" with annual production of eggs more than 70 millions (60% of the total production in agricultural enterprises) and "Ostrovskaya" cultivating broilers.

Extraction of turf in Pskov region is implemented mainly for needs of agriculture (fertilizer for fields). Here there are 2575 deposits of turf with total stocks 1.736 million tons. In the basin of Lake Chudsko-Pskovskoe there are had 15 peat extracting enterprises having license for extraction of turf. From them 11 are within the limits of Pskov and Pskov district. In mid 2000s peat extraction was implemented only in one peat extracting enterprise "Kripetskoe" (Pskov district), that is connected with the absence of agriculture financing and, as consequence, decrease of demand.

14.3 Awareness Raising (public awareness-raising including environmental education, environmental campaigns, activities of environmental NGOs and CBOs, etc.)

15. Socioeconomic Information (partial duplication of 1.5)

15.1 Population dynamics (numbers, distribution, main cities, percent urban/rural, etc.)

In the catchment area of Lake Chudsko-Pskovskoe live 1.1 million people. The population of Pskov region in the end of 2007 was 705.3 thousand people, including 476.9 thousand people (68%) of urban and 228.4 thousand people (32 %) of rural. Economically active population (end of June, by estimation) is 354.3 thousand people (49.7% from the total number of population). Portion of youth (up to 15 years old) is 17% of population. Portion of older persons (men older than 60 years and women 55 years old) is 24% of population. On the territory of Estonian part of basin the largest city is Tartu (102 thousand people).

From 1990 till 2002 birth rate in the Russian part of catchment area has decreased more than by 1.5 times, and mortality increased by 1.4 times. Decrease of population occurs at speed of 15.1%. Average life expectancy of the population drops - from 68.5 years in 1990 up to 61.1 years in 2002; especially sharply drops average life expectancy of men in the country (51.8 years in 2002). Increase in mortality is connected with general "ageing" of population in the basin, and decrease in birth rate is connected with complicated economical situation in the country and in region. Though it is necessary to notice that situation about birth rate after 2000 gradually improves. In 2007 in comparison with 2006 the number born counting upon 1000 of population increased by 9%, in urban settlements by 7.6%.

In the Estonian part of Chudsko-Pskovskoe Lake basin urban population is 69.4%, rural one 30.6%; birth rate (in 2006) was 11.1 per 1000 persons, mortality (in 2006) was 12.9 per 1000 persons.

15.2 Education (extent and types of education, literacy rates, etc.)

Education system in the Pskov region includes:

- Preschool education;
- Elementary and general basic education;
- Secondary education;
- Extra education of children;
- Vocational:
 - elementary
 - secondary special
 - высшее
- Extra education of adults (improvement of professional skill, retraining)
- Postgraduate education.

As of in 1/1/2008 in the education system there were: 177 infant schools, 110 infant classes and groups of short-term staying of children at general education schools; 328 daytime general education schools, including their 32 branches; 5 establishments elementary school – kindergarten, 11 evening (sessional) general educational schools, 22 establishments of initial vocational education, 17 establishments and branches of secondary and 22 establishments and branches of the higher vocational education. The total number of the children's population of Pskov region for January, 11, 2008 was 122,600 persons. In the system of preschool education 23006 children were educated. In general educational establishments of region it is learning 62979 of people. Number of students of all education forms is 24657 persons. Number of pedagogical workers in the system of preschool education in the region on 1/1/2008 was 3000 persons, and 6608 teachers. 5412 persons (88.6% from the total number of employee) are women.

15.3 Culture (languages, ethnicity, including indigenous peoples, religion, legends/beliefs about the lake)

Before appearance of Slavs from the end of II millennium B.C. up to the middle of I millenium A.D. in the region there was meeting-point of *Baltic-Finnish* and *East-Baltic* ethno-cultural blocks. *Finno-Ugric* and *Baltic* tribes belong to various, unrelated language families. Finno-Ugric tribes and nationalities together with Samoyedic make the Ural language family. The Balts together with related by language and origin Slavs, Germans, Celts and other ethnoses are Indo-Europeans. To the *Baltic-Finnish ethnolanguage group* Estonians, Finns (Suomi), Karelians, Livonians, Votians, Izhorians and Vepsians nowadays belong. Their languages are close enough among themselves and make a segregate group of Finno-Ugric language family.

From end of X century the Christianity became official religion of Ancient Russia, Today the overwhelming majority of believers in Pskov region are *Orthodox Christians*. Here

the Russian Orthodox Church has 80% of parishes from the total number of the registered religious organizations. On the territory of Estonia the main religion is the Lutheranism. Among other large confessions there are presented Orthodoxy, Baptist, Methodist and Catholic churches.

15.4 Economic sectors (major industries and their production statistics, regional economic development issues including energy, transportation, commerce sectors, livelihood issues in different parts of the lake basin, i.e., coastal regions, upland regions, upper-watershed regions, Gross National Income per capita within the basin (noting how it might differ from the national average(s))

16. Political Situation (partial duplication of 1.2)

16.1 Nations within basin

The main population of Pskov region is Russians (94.3%), there live also Ukrainians (1.8%), Byelorussians (1.5%), and representatives of other nationalities. On the territory of Estonia live following nationalities: Estonians – 69%, Russians – 26%, Ukrainians – 2%, Belorussians – 1%, Finns – 1% and others – 2%.

16.2 Sub-national boundaries

Basin of River Narva and Chudsko-Pskovskoe Lake is transboundary basin of the Baltic Sea. It occupies about 57 thousand km² and is located on the territory of 4 countries: Russian Federation (63.1%), Estonia (30.4%), Latvia (5.9 %) and Belarus (less than 1%).

The Russian part of basin is located on the territory of three subjects of Russian Federation: Pskov (92%), Leningrad (7.8%) and Novgorod (less than 0.3%) regions. Pskov region in the West borders Estonia and Latvia, in the south it borders Belarus. It in the east borders Tver and Novgorod regions, in the North – Leningrad region, in the South – Smolensk region.

16.3 Describe briefly the political history of the region

Period before X century. Before occurrence of Slavs the border zone of modern Estonia and the Pskov land were colonized by Finno-Ugric and Baltic tribes. To draw precise boundary between areas of moving of Finno-Ugric and Baltic tribes is difficult.

X – beginning of XIII century. The initial stage of Slavic-Chud interactions at the presence of political, ethnic and confessional boundaries (Christianity in Russia, paganism at Chud) is X-XIII centuries. To the Southwest from Pskov Lake Russian-Chud ethno-contact zone existed.

Political boundary, obliged by its becoming to the creation of the Old Russian state – the Kiev Russia, has passed a little to the West of the ethnic boundary. The boundary between the Old Russian state and Chud-Protoestonians, was formed at Svyatoslav up to 972, in the

further it became very stable, having existed with little changes to the Northern War (1700).

However in end of X – beginning of XI century the boundaries of Old Russian state were temporarily removed away to the West from Chudskoe Lake, into lands of Protoestonians and Latgalians. From chronicles it is known, that Vladimir, and then also Yaroslav, took a tribute from all “Livonian Chud”.

As it is known from the chronicle “Povest vremennyh let”, in 1030 Kiev grand duke Yaroslav has undertaken campaign against Chud, has subjugated them and has laid the foundation of the city named Yuryev (*modern Tartu*) by Christian name of prince. Apparently, then neighboring tribes have started to render tribute to Russian princes. According to the Novgorod first annals, in spring 1061, having opposed gathering of tribute by prince Izyaslav, Chud has burnt Yuryev and, having begun with ruin of neighboring villages, has reached Pskov, however it has been defeated by Pskov and Novgorod armies.

In XI century Pskov land was governed by the Novgorod deputies of Great Kiev prince. In the end of XI – beginning of XII century Novgorod has separated from the Kiev Russia and the Novgorod feudal republic was formed. One of centers of this state, a “minor brother of Novgorod”, became Pskov. Pskov people was engaged in Novgorod popular assemblies (“veche”), sent the army to help Novgorod. At the same time, Pskov possessed significant independence: Pskov people had the veche and administration. After the Novgorod revolt in 1136 Pskov people have invited Prince Vsevolod Mstislavovich to reigning, expelled from Novgorod. It was the cause of a military trip of Novgorod to Pskov, but, having received strong repulse, Novgorod people have receded. From this year in Pskov there was a princely table independent of Novgorod.

The Novgorod republic considered Pskov as the major support of the authority over Baltic. From Pskov collectors of tribute went to the lands of Old Estonians and Latgalians and if those refused to pay, the armed orders were sent from Pskov to force to obedience.

XIII century – 1550. In XIII century in the south of modern Estonia expansion of the Sword Brethren, and Danes in the north has started. The Danish crusade to Estonia took place in 1219-1220 during which Danes had been seized northern Estonia.

Pskov and Novgorod people together with Old Estonians tried to resist aggressions of German knights on territory of modern Estonia. As a result of revolt of year 1223 which has started from the capture and destruction by people from island Saaremaa the castle built shortly before this by Danes, almost all territory of Estonia has been released from crusaders and Danes. An alliance with Novgorod and Pskov has been concluded. In Dorpat, Viliende and other cities small Russian garrisons have been placed. However in 1224 Dorpat (Yuryev), as well as other continental part of Estonia, has been again seized by crusaders and Russian

armies have left their territory.

By 1227 lands of the Estonian tribes have been included into domain of the Sword Brethren. In 1237 the Sword Brethren has been liquidated, and its lands have entered as Livonian Brothers of the Sword into domain of Order of the Teutonic Knights. Old Estonians have been converted in Catholicism. In the cities of Estonia groups of German migrants began to settle.

The greatest battles with aggressors were in the 40th of XIII century. In 1240 when Russia has been devastated by the Tatar invasion, German and the Swedish feudal lords by means of the German Emperor and Roman Pope have organized campaign on the northwest of Russian lands. Approach of Swedes has been beaten successfully off in battle on Neva on July, 15th, 1240 by the Novgorod armies led by Prince Alexander Yaroslavovich (Nevsky). During the same time German crusaders have besieged Izborsk. Pskov people tried to help Izborsk people, but were defeated and were forced to recede. The enemy chased them and has surrounded Pskov. After week of siege and only owing to treachery of boyar Tverdilo Ivankovich, night of secretly he let in enemy in the city, the Pskov fortress in first and last time for all history was occupied by the enemy.

In the beginning 1242 army of Alexander Nevsky has loosed Pskov. After that Pskov people have participated in campaign against Livonian Order and in the well-known fight on the ice of Chudskoe Lake April, 5th, 1242 – the Ice Battle.

Victories of Russian armies in the Neva Battle and Ice Battle have broken plans of crusade to Russia, however for Pskov people during XIII century repeatedly it was necessary to repulse attacks of German knights. It is remarkable, that in the second half of XIII century struggle of Pskov people was headed by prince Dovmont who came from Lithuania. In youth he participated in intestine struggle of the Lithuanian princes, was defeated and was forced to run. With family and team Dovmont has come to Pskov and has sought asylum. Pskov people have accepted Dovmont and have made him prince. Dovmont reigned in Pskov from 1266 to 1299 It is known nine campaigns of Pskov people under its leadership. Two first were against the Lithuanians quite often attacked southern possession of Novgorod and Pskov, the others were against German knights. The loudest was a victory of Russian armies over German in 1268 at the city of Rakvere.

In 1238 northern lands of Estonia have transferred to Denmark, but in 1346 they have been sold by the Danish king to the Teutonic Order which has passed these possessions in 1347 to Livonian Order in mortgage.

From territory of Livonian Order onto the Pskov land moved Estonians, rushing to avoid a religious and political press of German knights.

Pskov veche republic which from XIII century guided foreign policy independent of Novgorod, in 1510 has been joined to the Moscow state.

In the Estonian history the period from XIII to XVI centuries (prior to the beginning Livonian War) is called as “time of the Order“. In the beginning of XVI century all administrative and judicial authority was in the hands of German city councils. In the cities merchant guilds and guilds of handicraftsmen were formed. The cities of Reval, Derpt, Pernau and Fellin entered in the Hanseatic League (Hansa).

1550 – 1700s. Result of Livonian War 1558-1583 became the termination of existence of Livonian confederation. The Northern part of Estonia has fallen under authority of Swedes, and Southern Estonia under Rzeczpospolita (the Polish–Lithuanian Commonwealth). Tallinn purposing trading interests, has voluntarily accepted the patronage of Sweden. In 1559 Denmark has occupied island Saaremaa and a part of the Western Estonia. The Danish king has given these lands to possession of duke Magnus of Holstein. Derpt episcopacy (Tartu) has been occupied by Russia In 1561.

During Livonian War Russian armies approached under walls of Tallinn by the order of tsar Ivan Groznyy twice: in 1570 and in 1577, but both times the siege has finished in anything. Russia has yielded all the territories occupied in Livonia to Poland (the treaty is signed in 1582) and Sweden (the treaties of 1583 and 1595 years).

To the moment of Livonian War end the population of Estonia has decreased almost by 2 times. The Pskov lands also have suffered from Livonian War and during Smutnoye Vremya (the Time of Troubles) (the end of XVI – beginning of XVII centuries) the population has decreased by 6–7 times.

In the beginning of XVII century struggle for Baltic between Sweden and Rzeczpospolita has continued, and according conditions of finished it Altmark armistice of 1629 all Duchy Livland (included modern Southern Estonia and Northern Latvia) has departed entirely to Sweden. After defeating in the war of 1643–1645 Denmark has yielded the control over Saaremaa, and Sweden owned all modern territory of Estonia.

Swedes began moving on the territory of Estonia, predominantly on islands and coast of the Baltic Sea. The population of Estonia has accepted Lutheranism.

The Swedish domination was challenged by Poland in the war of 1654–1660 and by Russia in the war of 1656–1661, but Sweden has preserved the positions in Estland up to the end of century.

1700s – 1917. In the beginning of XVIII century interests of Russian Empire in the Baltic region have collided with interests of Sweden. Northern War (1700–1721) has come to the end with capitulation of Sweden and joining of Estonia and Latvia to the Russian Empire that

has been officially secured by Nystad peace treaty (1721).

Northern Estonia has become province Estlandia, the southern part became a part of province Liflandia. Russians began to move actively to the territory of Estonia, occupying lands on the coast of Chudskoe Lake and in the river basin of Narva.

As the result of Northern War the Russian border was removed to the West and went now across the Baltic Sea. Pskov for the first time in the history was in deep rear. With originating of St.-Petersburg Pskov has lost its position in the trade with Baltic countries. In 1708 the Pskov land has been included into makeup Ingermanland province (from 1710 – St.-Petersburg province), and in 1727 into Novgorod province. From 1777 Pskov became a centre of Pskov region ruled by governor, renamed in 1796 into province.

In the middle of XIX century resettlement of Russians on the western coast of Chudsko-Pskovskoe Lake was almost completely stopped. In the 1870s, after canceling of the serfdom, Latvians and Estonians whom the Pskov landowners sold out most unsuitable lands have started to move into Setumaa land (modern Pechory district of the Pskov region) .

1917 – 1919. By the Decree from March 30, 1917 all areas of Estonia have been united in the uniform administrative unit, and April 12, 1917 both parts of Estonia (Estonia – Northern Estonia and Northern Livonia – Southern Estonia) have been united under control of Provincial parliament with executive board – Zemskiy Soviet. The provisional government has formed the Estonian division in the structure of the Russian army.

In October, 1917 when Bolsheviks came to power, their ideas of expropriation and nationalization have not found support in the greater part of Estonia population.

In the Pskov province the Soviet regime has been established in November, 1917

February, 24th, 1918, when Bolsheviks have left Tallinn, Estonia has declared itself independent democratic republic, neutral in the relation to the Russian–German conflict. The next day German armies have entered Tallinn.

In November in Germany revolution has started, and under the decree of German occupational authorities in Estonia the government under control to Berlin was formed from ethnic Estonians. It was headed by prime-minister K. Päts. On November, 19th in Riga representatives of this government have signed with representatives of Germany the pact about rising of authority to Provisional government of Estonia. In Tallinn in the meantime Soviet of working deputies has appealed for support to the Bolshevik government which 13th of November cancelled the Brest Treaty unilaterally and then has increased the help to probolshevist forces in Estonia. In the Red Army special Estonian regiments were formed.

November, 9th, 1918 parts of Workers'-and-peasants' Red Army including the Estonian regiments, have occupied Narva where Estland Labor Commune has been proclaimed this day.

The government of RSFSR on December, 7th 1918 by the decree signed by Lenin has recognized independence of the Soviet Estonia. By January, 1919 the Red Army has occupied two thirds of territory of the country and stayed by 35 kilometers from Tallinn. On the occupied by Red Army territory decrees of the Soviet authority began to act again.

To aid the government Pääts armies of the Entente were sent. The joint forces of White Army, national Estonian army and English squadron in the beginning of January 1919 have begun the offensive and have forced out troops of Red Army and Estland Labour Commune over the borders of Estonia.

On May, 19th, 1919 was proclaimed creation of Estonian Republic.

1920 - 1944. February, 2nd, 1920 between the Russian Soviet Federal Socialist Republic and the Estonian Republic has been signed Tartu peace treaty according which both sides have officially recognized each other (the first international treaty of both states). According to Tartu peace treaty, RSFSR has recognized independence of Estonia, and also has passed to it a part of territory that moment being in the structure of RSFSR, but controlled after termination of war by the Estonian armies. According to Tartu peace treaty all Pechory land passed to Estonia. On this territory the district Petserimaa (from Estonian name of Pechory – Petseri) has been created. Other name of the district, which has remained in a southeast of Estonia till now, is Setumaa.

In 1920 according to the Riga treaty a part of territory of Ostrov district has passed to Latvia.

In 1929 the trading agreement between the Estonian Republic and Soviet Union has been signed. In 1932 the nonaggression pact has been signed with the USSR.

The USSR also carried out secret negotiations with Germany. August 23, 1939 the Nonaggression Pact between Germany and Soviet Union has been signed. According to the confidential extra protocol defined delimitation of spheres of interests, Estonia has entered in the sphere of interests of the USSR.

After beginning of the Second World War, Estonia has declared neutrality. Soon the Estonian government has begun negotiations with Moscow as a result of which the Mutual-assistance pact providing disposition of the Soviet military depots and 25-thousand Soviet contingents on the territory of Estonia has been signed September 28, 1939. In 1940 extra contingents of the Soviet armies have been introduced. On the territory of Estonia military depots of the USSR were established.

June 16, 1940, Molotov has handed to the Estonian ambassador the categorical note in which he required immediate input of extra contingent of the Soviet armies in number 90,000 person to Estonia and dismissal of the government, threatening otherwise occupation of Estonia. Päts has accepted the ultimatum.

June 17, 1940 the Soviet armies have entered in Tallinn; simultaneously on a raid there were ships of the Baltic fleet and the navy troops has been landed. July 31, 1940 the territory of Estonia has been included into Leningrad military district. August 6, 1940 VII session of the Supreme Soviet of the USSR has accepted the decision about an accepting Estonian SSR into the USSR.

July 7, 1941 German armies have approached to the boundary of Estonia, and August 28 last parts of Red Army have left Tallinn. Together with Lithuania, Latvia and Belarus Estonia became part of *Reichskommissariat Ostland*, being a special district in its boundaries.

January 14, 1944 there has been begun offensive operation of the Leningrad and Volkhov fronts as a result of which in February the Red Army has got off on the boundary of the river Narva. There have been undertaken some offensive operations. Only September 25, 1944 the authority in Tallinn has passed to communistic government of ESSR.

August 23, 1944 on the basis of the Pskov district of Leningrad region the Pskov region has been established. January 16, 1945 the Decree of Presidium of the Supreme Soviet of RSFSR included the Pechory district, organized from 8 *volosts* (districts), entered earlier into structure of Estonia, into Pskov region.

Since 1945. September 29, 1960 Council of Europe has accepted the resolution condemning military occupation of the Baltic countries by the USSR.

January 13, 1983 the European Parliament has accepted the resolution concerning the Baltic states in which has condemned the fact of annexation as inappropriate to "international law" and obligations of the USSR under bilateral contracts with the Baltic countries, having emphasized the international non-recognition of annexation.

November 12, 1989 the Supreme Soviet of Estonian SSR cancelled the manifest from July 22, 1940 about including ESSR into the USSR.

November 16, 1989 the Supreme Soviet of Estonian SSR by the majority of voices has accepted a manifest about the sovereignty. Simultaneously with elections to Supreme Soviet of Estonian SSR elections to the Estonian Congress, presented the persons that were citizens of the Estonian Republic till August 6, 1940 (date of including of ESSR into the USSR) and their descendants, took place in February 24, 1990.

March 23, 1989 the Communist party Estonian SSR has declared leaving from CPSU. May 8 the same year Estonian SSR was renamed into the Estonian Republic.

September 6, 1991 the USSR has officially recognized independence of Estonia. According to official position of Estonia, independence of the Estonian Republic proclaimed February 24, 1918, has been restored August 20, 1991.

September 17, 1991 Estonia became the full member of the United Nations.

Last parts of the Russian Army have been removed from the country August 31, 1994.

March 29, 2004 documents on the entrance of Estonia in NATO have been deposited in Washington, and April 2 flags of new members of the alliance were hoisted in Brussels.

May 1, 2004 Estonia has entered the European Union.

3. Management of the Lake and Its Basin (based in part on Annex 1 Questionnaire items, 10 through 14)

3.1 Overview of Management Needs

Ecological studying of Chudskoge Lake has been begun in 1851-1852 by Karl Ernst von Baer (Baer, 1852). More regular hydrobiological observations on the lake were carried out in 1962 by Institute of Zoology and Botany of Russian Academy of Sciences and Pskov Pedagogical institute. Chemical composition of lake water was studied by the Hydrometeorological service in 1950-1991, and general chemical analysis was made by Institute of Zoology and Botany in 1982-1992 and by Southern Estonian laboratory (its name was changed in 1998, now it is Tartu Centre of Ecological studies). From the beginning of 1990s in the connection with appearance of independent states in the Baltic region and transformation of Chudsko-Pskovskiy lacustrine complex into transboundary water body, provisional complications in the coordination of work on monitoring and information interchange between Russia and Estonia have arisen. However from the beginning of 2000s essential progress was outlined in the integration of efforts on the joint studying of lake. Now use of water resources of the catchment basin of Lake Chudsko-Pskovskoe is regulated by number of international conventions among whom the most significant is agreement between the governments of Russia and Estonia on cooperation in the field of protection and rational use of transboundary waters, (Rumyantsev, etc., 2006).

Main parameter at evaluating of surface waters quality in the system of state monitoring in Russian Federation is index of water pollution. In the system of state monitoring of Lake Chudsko-Pskovskoe, besides index of water pollution, at evaluating of water quality hydrobiological parameters (species composition, abundance and biomass, saprobity indexes by phytoplankton, zooplankton and zoobenthos) are used.

According to made evaluations of index of water pollution surface water layers of Pskovskoe Lake, Teploe Lake and eastern part of Chudskoe Lake concern to III-IV classes of quality, i.e. they are moderately polluted and polluted (Plan ..., 2006). Benthonic waters are moderately polluted (III class of quality). Often there are fixed significant excess of maximum

concentration limits for mineral oil, phenols, BOD₅, COD, ammonia nitrogen, and also metals (iron, copper, magnesium, zinc, cadmium).

According to the values of index of water pollution, by hydrochemical parameters of water river Velikaya can be characterized as "moderately polluted" (III class), trends of water deterioration in comparison with 1980s is not observed. In other tributaries water quality by index of water pollution in the mid 2000s in comparison with 1980s has worsened.

According to joint Russian-Estonian studies (Lake Peipsi ..., 2001; In the Mirror ..., 2007) means of biogenic elements concentration in Lake Chudsko-Pskovskoe is 30-40 mgP_{total}/m³ and 630-680 mgN_{total}/m³ in Chudskoe Lake and 50-70 mgP_{total}/m³ and 750-850 mgN_{total}/m³ in Teploe Lake. In Pskovskoe Lake at relative constancy of general nitrogen concentration (~ 900 mg/m³) it is revealed double increase of general phosphorus concentration (about 65 mg/m³ in 1995 up to 130 mg/m³ in 2005). The breaking of nitrogen and phosphorus balance in favour of the last can promote dominance of blue-green algae at water bloom. The least values of N:P parameter were 11-13 and are noted in 1995 and 1996. The trophic status of main parts of water body is various. Pskovskoe Lake is considered to be hypereutrophic, Teploe Lake is considered transferring to hypereutrophic, Chudskoe Lake is considered to be eutrophic (Nutrient loads ..., 1999).

External load of P_{total} Lake Chudsko-Pskovskoe is about 830-900 t/year. Thus the ratio between meanings of loads from the Russian and Estonian parts of catchment area approximately corresponds to the ratio of their areas. So in 2004 the phosphoric load on the lake from Russia and Estonia was 507 and 255 t/year or 67 and 33% of total external load of P_{total} accordingly (Kondratyev, 2007). Thus portion of anthropogenic component of load from the Russian part of catchment area was 267 tons of P_{total} per year or 35%. The most significant anthropogenic contribution in the Russian territory is given by anthropogenic landscapes – 131 tons of P_{total} per year (17 %). The least significant anthropogenic sources of P_{total} income to the lake are the animal husbandry and rural population (66 tons of P_{total} per year), and also point sources of pollution (70 tons of P_{total} per year). The natural component of external phosphoric load on the lake from Russian part of catchment area is 240 tons of P_{total} per year or 32% of the total external phosphoric load (Kondratyev, 2008). In the Estonian part of catchment area more than 13% of total phosphoric duty are formed due to agricultural activity, portion of point sources is about 10% (Nutrient loads ..., 1999).

3.2 Management Programs and Processes

According to the Russian-Estonian program of rational use and protection of water resources of Lake Chudsko-Pskovskoe for 2005-2015 the main direction of joint acts on prevention of further eutrophication of lake is decrease in dumps of phosphorus with sewage waters of cities and large settlements. The told, first of all, concerns to sewage disposal plants of Pskov and Tartu where works on perfection of systems of water purification are constantly

spent, to biological neutralization silt deposits, to construction of shops of mechanical dehydration of silt. Besides this, the complex of measures on decrease in phosphoric load on the lake, generated due to agricultural activity in the catchment area (strict observance of fertilization technologies, organization of the equipped dung-pits and places for storing of fertilizers) is spent.

5. Some of the major Lake Basin Governance Issues (See Annex 3)

Monitoring of Lake Chudsko-Pskovskoe state and quality of surface waters in its basin is carried out by various organizations by various programs. In the studying of Lake Chudsko-Pskovskoe from the Russian side there are participating specialists from Institute of limnology of Russian Academy of Sciences, GosNIORH, Pskov State Pedagogical Institute, Control of Natural resources and Preservations of the environment of Ministry of Natural Resources of Russia for Pskov region, the Baltic fund of the nature of St.-Petersburg society of naturalists, Botanical institute of Russian Academy of Sciences, from the Estonian side there are specialists of Institute of Zoology and Botany, Southern Estonian laboratory (since 1998 Tartu Centre of Ecological studies), etc.

In Estonia, in the national program of monitoring it is included its carrying out on 8 rivers draining 90% of territory of the Estonian part of catchment basin of lake. On them the intensity of flow is monthly defined and water samples for analysis of content of nutrients are taken. In Russia this program is carried out only on 2 rivers (Velikaya and Gdovka), but these rivers drain 87% of water-producing territory of Russian part of the basin. Samples for determination of nitrogen and phosphorus concentration are taken in Russia are 2-6 times yearly. Determination of nutrients concentration in water of Lake Chudsko-Pskovskoe and other parameters, characterizing extent of eutrophication, in the beginning of 2000s was carried out on 5 stations on the Estonian side and at 10 stations on Russian one.

In spite of the fact that realization of regular monitoring of environment state by the Estonian and Russian sides is spent a long time, after disintegration of Soviet Union between these countries overall data exchange and the joint analysis of the received results was not spent. Disintegration of Soviet Union in the beginning of 1990s and follow-on economic crisis have led to that overall performance of monitoring program became problematic. Besides in Russia in 1990s problems with equipment of laboratories by chemical reactants and accompanying materials took place. From the beginning of 2000s essential progress was outlined in integration of efforts on joint studying of lake by interested sides (Lake Peipsi ..., 2001; In the mirror ..., 2007).

In the end of 1990s there was Swedish-Estonian-Russian project on the monitoring of Chudskoe Lake, directed to the improvement of quality of work of regional ecological institution being responsible for preservation of environment in the catchment basin of Chudskoe Lake, and also for improvement of information interchange between the Estonian

and Russian sides.

6. The Key Challenges (See Annex 4)

Use of water resources of catchment basin of the Lake Chudsko-Pskovskoe lacustrine complex is controlled by international conventions and bilateral agreements among which the most significant is the agreement between the governments of Estonia and Russia on cooperation in the field of protection and rational use of transboundary waters, signed in Moscow on August, 20th, 1997. At the same time modern requirements of water frame directive of the European Community (the Directive of the European parliament and Council of EU No 2000/60/EC from October, 23rd, 2000) indicate on necessity of development of more detailed joint Russian-Estonian program of rational use and protection of water resources of the Lake Chudsko-Pskovskoe lacustrine complex. Components of program should be creation of the coordinated system of monitoring both the water body and aquatic objects of catchment basin, and also development of methods and patterns for evaluating consequences of affecting various economic measures on the water resources of water body and its catchment area (Rumyantsev, 2006, Kondratyev, 2007).

Necessary condition of successful control of environment protection on lakes is gathering base material on ecological situation: receiving of empirical data on water quality, quantitative studying of sources of nutrients income and their retention, and also determination of buffering capacity both catchment area and the lake. For the international or transboundary lakes such as Lake Chudsko-Pskovskoe, good cooperation in the field of ecological monitoring is necessary, and also exchange of received data between the countries which possess lake and its catchment area. Though this problem also looks trivial, world experience shows, that cooperation in the field of information exchange and monitoring between the coastal countries is reached not so lightly.

The successful introduction of correct program of of Chudskoe Lake monitoring is restrained by insufficient financing of local authorities for environment protection being responsible for it, and by insufficient coordination of work in the field of monitoring between Estonia and Russia. Frequent reorganization of the ministries and local organizations responsible for monitoring, complicate the problem of development of cooperation and harmonization of strategy of the state monitoring. The following problem consists of distinctions in the organization of monitoring and exchange of information in Estonia and Russia (institutional incompatibility), also as well as significant difference in applied techniques and the labware used by Estonian and Russian sides. Besides this language problems also often lead to bad interaction between partners at presentation of reports and received data. The problem is especially difficult that the Chudskoe Lake became international recently and in this connection the international cooperation in the monitoring should be framed from the very beginning. Among the recommendations which have been put forward as a result of carried out joint Swedish-Estonian-Russian project on Chudskoe Lake, the actual are the following

(Postuplenie): use of identical analytical techniques by both sides (both Russia and Estonia) is necessary; the regular giving of materials of observations for their enclosure in uniform database on lake is necessary.

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