Ministry of Environmental Protection of Ukraine

Ukrainian Scientific Research Institute of Ecological Problems (USRIEP)

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Integrated Environmental Monitoring Programme
for the Danube-Black Sea Navigation Route Project Component:
Operational Dredging in the Seaward Access Channel

Summary Report on the Results and Progress in Implementing the Integrated Environmental Monitoring Programme as Part of the Danube-Black Sea Navigation Route Restoration Project

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Kharkiv 2007

Introduction

The design documentation for the Danube-Black Sea Navigation Route Restoration Project has been developed by the RichTransProject River Transport Research and Design Institute. The Feasibility Study (FS) for the Investment Project "Development of the Danube-Black Sea Navigation Route in the Ukrainian Part of the Danube Delta" provided for the phased approach towards the project implementation, where the first project phase would involve the pilot development and operation of navigation route in order to assess its impact on the Danube Delta ecology and the effects of natural factors on the navigation route itself. It was anticipated that the detailed design for the full-scale development of the navigation route would incorporate findings and results of the first project phase.

The detailed design "Development of the Danube-Black Sea Navigation Route in the Ukrainian Part of the Danube Delta. Phase 1" was approved by the Resolution of the Cabinet of Ministers of Ukraine on 12.05.2004. The construction activities under the present project design commenced on 15.05.2004 and continued till May 2005. The navigation operations commenced in August 2004 for vessels of draught up to 5.0 m.

Special monitoring programme was launched upon the commencement of channel restoration works in order to facilitate:

- The control of status, dynamics and trends in the components of the natural environment during the restoration and pilot operation of the Danube-Black Sea navigation channel;
- The forecasting of changes in the state of natural environment due to the effects of anthropogenic factors;
- The assessment of damage caused to the natural environment and its components as a result of restoration of navigation route;
- The development of recommendations designed to mitigate and minimize potential adverse impacts;
- The justification, taking account of environmental and economic considerations, of future environmental monitoring programme to be implemented during the operation of the Danube-Black Sea navigation route.

From October 2004 onwards, separate monitoring activities was consolidated to form the Integrated Environmental Monitoring Programme for the channel restoration phase. This programme was coordinated by the Ukrainian Scientific Research Institute of Ecological Problems (USRIEP) under the Ministry of Environmental Protection of Ukraine. In 2004-2005, fifteen research organizations were involved in the implementation of this Programme, including the research institutes and organizations operating within the system of the Academy of Sciences of Ukraine, Hydrometeorological Service of Ukraine and leading sectoral research institutes. Geographically, the Integrated Monitoring Programme covers the entire territory of the Ukrainian part of the Danube Delta and the related coastal area of the Black Sea within the Ukrainian jurisdiction.

The 2004-2005 results of the Integrated Environmental Monitoring Programme for the Danube-Black Sea navigation route restoration phase showed no indication of any significant adverse environmental impact of construction activities.

The detailed design for the “Danube-Black Sea Navigation Route in the Ukrainian Part of the Danube Delta. Full-Scale Development", prepared by the RichTransProject Institute, was submitted for the State Environmental Review procedure in August 2004. The State Environmental Review process lasted from August 2004 through April 2006, and for this period

the channel restoration activities remained suspended. The implementation of the integrated environmental monitoring programme had been also suspended since 2006.

The detailed design documentation for the project was revised and updated to take account of comments and recommendations from the non-governmental environmental organizations. The results of additional specialized surveys, commissioned at the detailed design finalization stage, confirmed key technical solutions employed in the channel design.

At the present stage, the Comprehensive State Review process for the design documentation for the full-scale project has been completed, and the permission to implement the project has been granted.

The updated project design includes, *inter alia*, a provision for the removal of sediment/silt deposits accumulated in the seaward access canal and previously deepened shallow areas (due to the force-majeure situation developed in 2005).

The operational dredging activities in the sandbar section of the navigation channel commenced on 2 November 2006, in order to achieve the design depth specified for the first phase of the project. The planned duration of these works is from November 2006 through June 2007.

In parallel with these works, the environmental monitoring activities resumed in order to facilitate the environmental compliance of project activities planned for 2006-2007, including the operational dredging works planned to be undertaken in the seaward access canal, which is part of the Danube-Black Sea navigation channel.

The scope of planned environmental monitoring activities is as follows:

- The implementation of field surveys prior to and during the operational dredging works, designed to ensure the control over the status and trends in the natural environment and its components;
- The assessment of damage caused to the aquatic environment;
- The assessment of damage caused to fish stocks;
- The collection and summarization of available sectoral and academic research data on the ecological status of the Danube Delta in the project area in 2006-2007, in order to ensure the continuity and consistency of data series used in the Integrated Environmental Monitoring Programme for the navigation channel project;
- The development of continuous monitoring programme for future stages of construction and operation of the navigation channel via the Bystre arm (to take account of findings and recommendations of the Inquiry Commission set up under the Espoo Convention on the Environmental Impact Assessment in the Transboundary Context).

Key institutes and agencies involved in the programme include: Ukrainian Scientific Researc Institute of Ecological Problems, Odessa Oblast State Department of Environmental Protection, Danube Hydrometeorological Observatory, Odessa Branch of the Institute of Marine Biology of the National Academy of Sciences of Ukraine, the ChernomorNDIProject State Research and Design Institute, the PivdNDRO Odessa Centre, the Noosphere Research Centre.

Results and Progress in Implementing the Integrated Environmental Monitoring Programme as Part of the Danube-Black Sea Navigation Route Restoration Project

1. The Current Status of Programme Implementation and Scope of Works

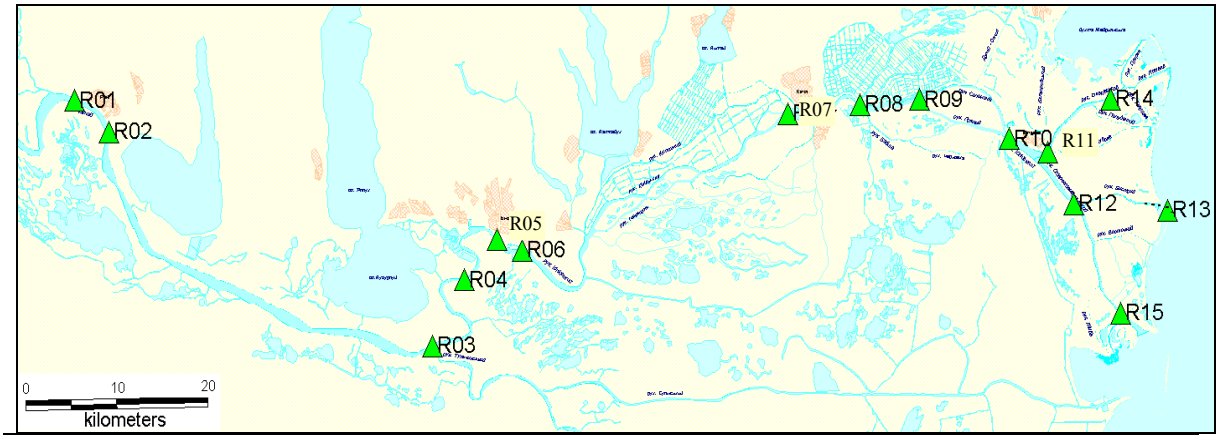
1.1. In 2005, the integrated environmental monitoring programme for the navigation channel restoration phase was fully completed. Taking into account specific hydrometeorological characteristics recorded over that year, the monitoring results collected are considered to be very significant in describing the baseline situation, against which the future anthropogenic impacts could be assessed and relevant adjustments made in the engineering design if and where necessary.

Given that the restoration activities for the Danube-Black Sea navigation route were temporarily suspended in 2005, the monitoring activities in the dredging locations resumed in November 2006. The results of other surveys undertaken in the Danube Delta in the area of the navigation channel were therefore used to assess the environmental situation and ensure the continuity of data series established as part of the project-related monitoring programme.

1.2. All measurements and data processing operations involved in the hydrological monitoring programme for the Ukrainian part of the Danube Delta are consistent with the internationally recognized techniques. The results of this monitoring programme are reliable and can be used as a basis for the establishment and operation of a hydrological data base.

1.3. The regular chemical monitoring programme carried out in the Ukrainian part of the Danube Delta in 2005 included the analysis of about 450 water samples for 55 individual compounds. The total number of element determinations completed was 12150.

In 2006, 265 water samples were taken and analyzed for 39 individual compounds; the total number of element determinations was over 5850.



Locations of regular chemical monitoring stations

1.4. The scope and features of the Integrated Environmental Monitoring Programme are described below:

- Average number of monitoring stations: 60;
- Average number of water quality determinations: 2000-2200;

- Average number of sediment quality determinations: 300-360;
- Average number of hydrobiological samples: 300-400.

The biological monitoring component involved the microbiological survey, analysis of zoo- and phyto-plankton, plant periphyton, zoobenthos etc. Other monitoring activities included the biological testing of water and bottom sediment samples.

1.5. The monitoring programme involved the study of fish fauna, which provided the information on the state of migratory and indigenous fish species. Regular ichthyoplankton surveys were carried out in the Ukrainian part of the Danube Delta in the spring/summer period with 10-day intervals in order to examine the spawning efficiency of the Danube herring.

1.6. The ecological monitoring in the area of the Danube Biosphere Reserve involved special bird fauna surveys in the Bystre arm area and on the Yermakiv Island. Other ecosystem components covered by the monitoring programme included the plant communities of the riparian and wetland areas, macrozoobenthic communities of fresh-water and saline-water sections and bays located within the Danube Biosphere Reserve, herpetological fauna and rare fish species.

2. Key Findings of Hydrological and Morphological Monitoring

2.1. The 2005 hydrological monitoring results provided no indication of any trend changes in the current pattern of flow and sediment load distribution among the delta arms and its water-level, temperature and ice-cover regime. In 2006, during the spring/summer flood period, which lasted about 4 months, the water levels in the Danube Delta hit the historical highs recorded over the whole period of observations since 1921.

2.2. Under the natural conditions, average sediment flow in the upper part of the Danube Delta was over 60 million tonnes per year. By the present time, the average annual sediment flow in the Danube Basin has decreased by over 2-fold due to the construction of major water reservoirs. However, the long-term variability of annual suspended solid flows remains high even in the conditions of strong anthropogenic impacts.

2.3. Based on the analysis of the 1980-2005 data, the average annual amount of sediments accumulated in the sandbar section of the Bystre arm is about 2.5 million cubic metres per year, with the historical low and high being at 0.6 (1990) and 6.11 million cubic metres (1991), respectively. According to the preliminary estimates, the annual sedimentation rate in the seaward access channel (SAC) may be between 20 to 30% of the total annual sediment load accumulated in the sandbar section of the Bystre arm.

2.4. The analysis of delta development processes on the basis of space images indicates that in the Ukrainian part of the Chilia Delta, 240 ha was lost due to inundation over 1950–2004, while 2100 ha of new land surface emerged over the same period due to the sediment deposition.

2.5. The analysis of available data on the outer (marine) delta dynamics suggests that the Chilia Delta formation process is river-dominated, which means the outward propagation of the delta into the sea with the surface flattening and smoothing of the shelf-edge delta.

2.6. At the present time, the Ptashyna Spit represents the shelf-edge part of the delta. The available monitoring results show no indication of effects associated with soil dumping operations under the Danube-Black Sea navigation route project on the Ptashyna Spit development. The analysis of retrospective space images undertaken as part of the Programme also suggests that the current development of the Chilia Delta is consistent with the long-term trend in the natural delta formation process. Generally, the

development pattern of the Ptashyna Spit is similar to that of the Potapivska Spit. The northern end of the Ptashyna Spit gradually approaches the right-bank estuarine spit located within the Bystre arm, and is likely to merge with it within the next few years. The southern end of the Ptashyna Spit has been progressively growing, though the progress of its development is likely to slow down within the next few years, as was the case for the Potapivska Spit. This can be attributed to the fact that the southern end of the Ptashyna Spit has already reached the Skhidny (Eastern) arm mouth, which provides an outlet for the part of the Danube flow.

3. Water Chemistry

3.1. The changes in water quality in the Danube River were mainly shaped by such hydrometeorological factors as flow availability, temperature and turbidity.

3.2. The upwelling processes in the sea trigger the marine water invasion into the Bystre arm mouth. According to the monitoring data, the invasions of marine waters into the Bystre arm were recorded in February (up to 1 km upwards) and March (up to 0.5 km upwards) 2005, when the flow discharges in the Bystre arm were low. Elevated permanganate oxidability levels are more characteristic of the Bystre compared to other areas of the Danube Delta.

3.3. The oxygen regime of the Danube River and its delta was generally good. Minor decreases in oxygen concentrations to below 6 mg/l were recorded at some monitoring locations only in the summer period (to 5.6 mg/l), during the rainfall-induced flooding events characterized by higher water temperatures and turbidity levels.

3.4. In 2004, the concentrations of nitrogen and phosphorus in their mineral and organic forms were close to the average levels of these substances recorded in the Danube Delta over the past decade. There was an increase in nutrient levels during the spring and summer flooding events in 2005. According to the 2005 monitoring data, the average concentrations of nutrients in the Ukrainian part of the Danube Delta were as follows: mineral nitrogen (1.55 mgN/l (maximum recorded value 2.75 mgN/l)), orthophosphate phosphorus (0.1 mg P/l (maximum recorded value 0.5 mgP/l), total phosphorus (0.33 mgP/l (maximum recorded value 0.6 mgP/l)). In 2006, the following average concentrations of these substances were recorded in the monitored area: mineral nitrogen (1.24 mgN/l), mineral phosphorus (0.057 mgP/l (0.005-0.190 mgP/l), total phosphorus (0.134-0.409 mgP/l). According to the Water Quality Classification adopted within the framework of the TNMN Programme, the river water quality in the survey period corresponded to Water Quality Classes II (N-NO2, N-NO3) and III (N-NH4) in terms of nitrogen-related parameters, and to Water Quality Classes III (P-PO4) and IV-V (P total) in terms of phosphorus-related parameters.

3.5. The levels of surfactants in the river water were generally within the admissible MAC limits, while a 4.6-fold exceedance of MAC limit was recorded in oil products. The average concentrations of phenols exceed the MAC limit by 3-fold, being generally close to the historical averages recorded in this part of the Danube River.

3.6. The total concentrations of heavy metals in the Danube river water were greatly affected by flooding events and turbidity peaks. In relative terms, the levels of heavy metals in their suspended form could be expressed as Fe>Mn>Zn>As>Pb>Ni>Cu>Cd, with Fe and Mn mainly present in the suspended form, and the rest of the determined metals dominated by the soluble form. According to the TNMN Water Quality Classification, the river water quality in the Danube and its delta arms in terms of total levels of heavy metals corresponded to the Water Quality Classes II (Cd, As, Zn, Ni) and III (Cu, Pb,

Hg). In 2006, the elevated levels of soluble copper were recorded in all analyzed water samples.

3.7. The picture emerging from the analysis of historical monitoring data is one of the long-term and large-scale contamination by persistent chlorinated organic pesticides (lindane, DDT). In 2005, the elevated levels of DDT were recorded in August (during the rainfall flooding period in the Lower Danube Basin) in water samples taken in the Chilia Arm – 49 km (0.054 – 0.1 μg/l) and Chilia Arm – 21 km (0.1 μg/l). Higher levels of α-HCCH were recorded in water samples during the spring period (0.012 – 0.025 μg/l). γ-HCCH was detected in three spring samples and one summer sample of river water. The highest concentrations of γ-HCCH were recorded in spring samples taken from the near-bottom water layer from the Danube River near Reni and from the Chilia arm – 21 km (0.016-0.018 μg/l). In 2006, the DDT metabolites (DDD and DDE) were found to be the main contributors to the pollution by chlorinated organic compounds, being present in 7.1% of bottom sediment samples. The recorded levels of chlorinated organic pesticides in mollusk samples ranged between 0.0016 to 0.037 mg COP/kg.

3.8. The hydrochemical regime of the Danube Estuary is affected by the downstream propagation of river water and various biological processes, including, *inter alia*, the phytoplankton vegetation. The hydrochemical regime (including changes in hydrochemical parameters and concentrations of suspended substances, nitrates and silicon, expressed in absolute terms) of the Bystre, Eastern and Starostambulske arms is closely linked with physical and chemical processes occurring within the geochemical barrier zone river-sea, where the salinity level is up to 5.0 ‰.

3.9. The hypoxia phenomenon was recorded in September 2005 in the bottom layer of the Danube Estuary at the depth of over 20 m, when the oxygen content was below 30% (monitoring stations 6, 10, 25, 4). The summer and autumn hypoxia in this area is triggered by specific hydrological conditions and biological processes, and is not considered to be caused by soil dumping operations at the offshore dumping site.

3.10. The results of the ecological quality assessment of the Danube River water for the period of 2004-2006 indicate that the value of the integral ecological quality index is within the Class II (Category 3), i.e. the river water status can be described as good and rather clean. As compared to the results of ecological quality assessments made for the earlier period of 1986-1991, the value of the integral index showed a decrease by 0.33-0.72 points, caused by changes in values of specific group indices.

The analysis of trends in specific group indices indicates that the value of group index describing the salt composition of water sampled in the monitoring locations decreased by 0.31-0.49 points. The value of group index describing the trophic state of the river water increased by 0.03-0.86 points. The value of group index describing the levels of specific contaminants decreased by 1.01-1.81 points.

4. Control Measurements

4.1. The results of control measurements undertaken in 2005 and 2006-2007 in the dredging locations confirmed findings of the 2004 monitoring programme, suggesting that the limited localized impact of dredging activities on water quality within the 1 km zone downstream of a dredging location was within the estimated ranges of increases in pollutant concentrations, specified in the EIA document for the Danube-Black Sea Navigation Route Project.

Dredging activities in the sandbar section induce a turbidity plume with the horizontal length of up to 200 m and vertical length of up to 3 m from the river bottom.

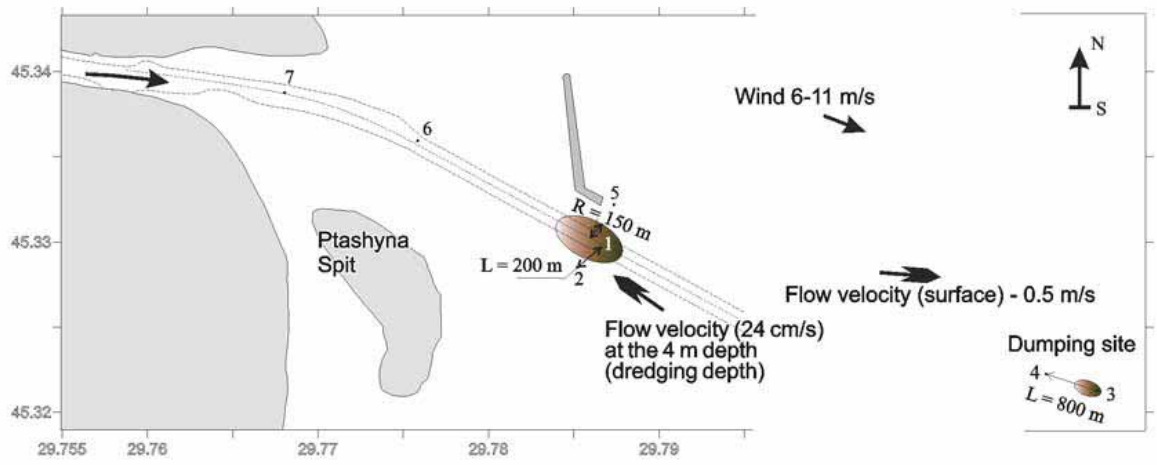
Offshore soil dumping induces a turbidity plume with the radius not exceeding the radius of the seaward access channel (R = 5 kbt or 926 m).

4.2. The concentrations of toxic contaminants in soil sampled in the shallow sections dredged in 2005 were found to be significantly lower than the levels recorded prior to the commencement of the navigation route restoration works. The levels of mercury, cadmium and lead in soil dredged in the river section between the 60th and 74th km were significantly lower than the relevant MAC limits set for agricultural land use category. The levels of oil products were 1.3-1.5 times higher than the admissible limits in the river section between the 67th and 68th km, being below the MAC limits in the rest of dredging locations. Copper concentrations were 1.8-12 times higher than MAC limits, and zinc concentrations were 20.7-50.8 times higher than MAC limits.

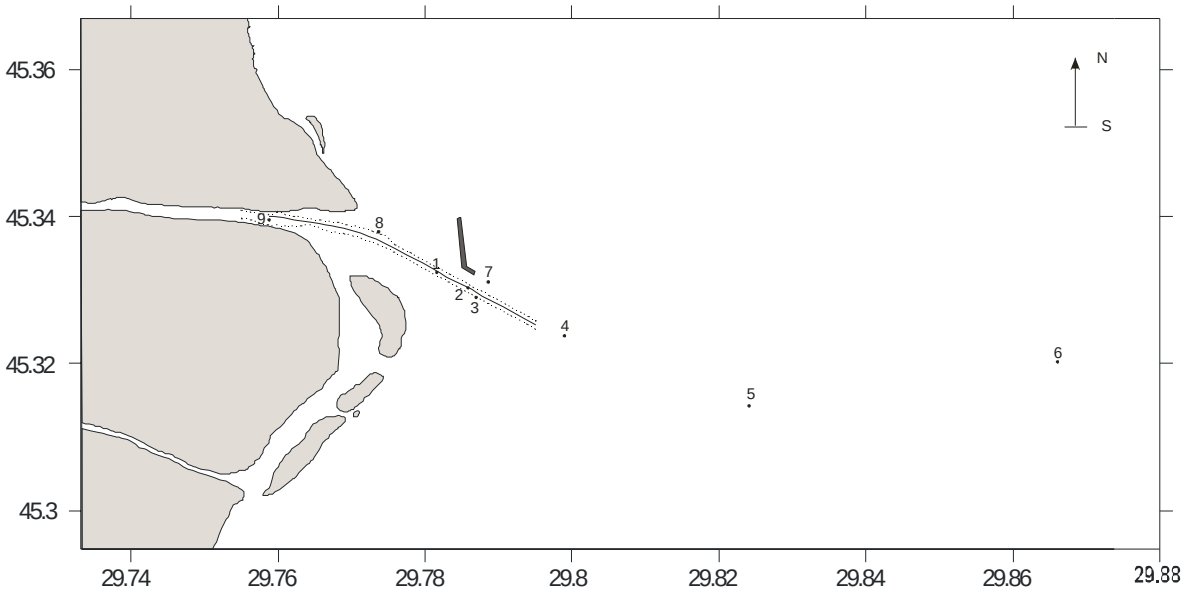
These relatively high levels of copper and zinc, and oil products in some locations within this section of the Danube River are not considered to be caused by dredging activities, since background concentrations of these substances, measured prior to the commencement of dredging operations, were significantly higher.

4.3. The bottom soil of the Danube Estuary, analyzed for a range of contaminants, including heavy metals (mercury, cadmium, lead, copper and zinc) and oil products, falls within the Class A-II of the Azov Sea/Black Sea Dredged Soil Material Quality Classification. The soil present at the offshore dumping site falls under the Soil Quality Class III due to elevated mercury levels, though the value of integral index derived for this soil is within the range set for the Soil Quality Class II.

According to the 2006-2007 monitoring data, the soil dredged in the sandbar section of the Bystre Arm represents the well-graded quartz sand with silt, black organic and mica inclusions (density 1.51 g/cm^3), corresponding to the Soil Quality Class A-I (clean and conventionally clean natural material), which can be safely disposed of at the offshore dumping site.



Locations of Monitoring Stations Used for Control Purposes in November 2006 in the Dredging Areas Associated with the Seaward Access Channel (L – distance to the baseline monitoring stations, m; R – estimated radius of turbidity plume created by diffusion of suspended substances, m)



Locations of Monitoring Stations Used for Dredging Control Purposes in February 2007 in the Area of Seaward Access Channel and Offshore Dumping Site (Locations 1-4: dredging area, Location 6: offshore dumping site)

5. Hydrobiology

5.1. The results of microbiological survey carried out in the navigation route area (fresh-water, or river section) suggest that the situation has been relatively stable. The water meets the criteria set for α-mesosaprobic zone, both in terms of total bacteria population and quantity of saprophyte microflora, which is generally consistent with the previous survey results.

5.2. The results of saprobiological assessment of the surveyed section of the Danube River and delta arms based on the indicator phyto- and zooplankton species indicate that the water in the study area mainly corresponds to the β(α)-mesosaprobic zone. The comparison of these results with the results of earlier surveys undertaken in the 1940s, 1950s and 1980s suggests that there have been no significant changes in the saprobiological status of the Ukrainian part of the Danube Basin.

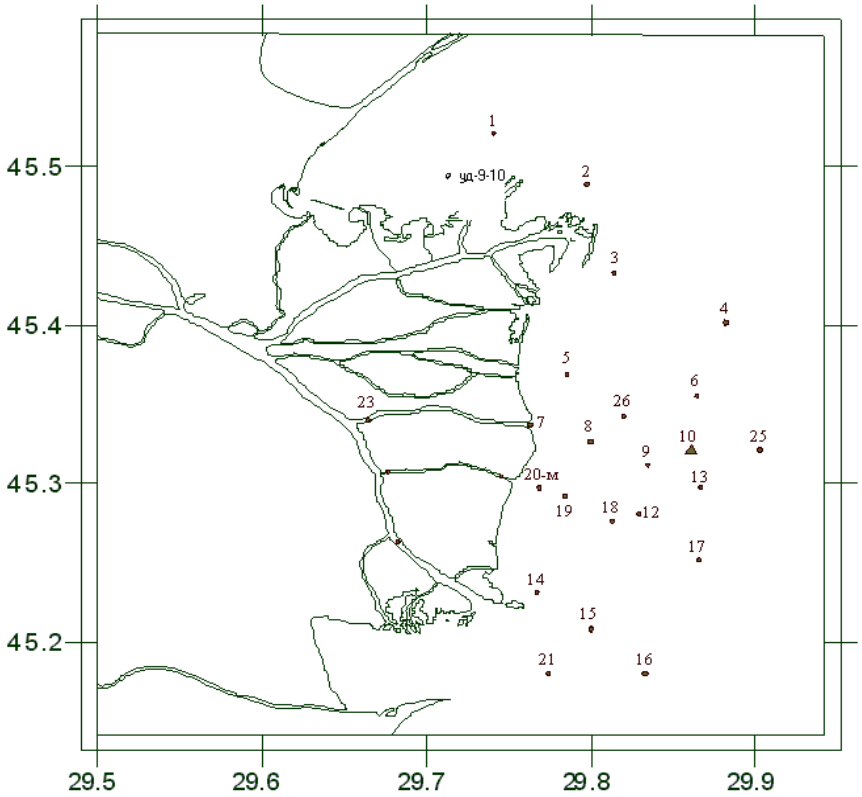
5.3. The assessment of saprobic state on the basis of indicator microzoobenthos species (for the river section of the navigation route) demonstrates that the water in the study area meets the criteria set for the β'–α"-mesosaprobic zone, which is generally consistent with the results of earlier assessments. The decreases in bottom invertebrate species population (and even their complete disappearance) were recorded in the dredging locations, being the direct consequence of dredging operations. Throughout three seasons in 2005, the macrozoobenthic community of the Ukrainian part of the Danube Delta was represented by 65 invertebrate species, and by 57 macrofauna species and forms in 2006. The assessment of species diversity in this macrozoobenthic community suggests the lack of stability in the habitat conditions for this community.

5.4. The monitoring data on the zooperiphyton communities present in the Ukrainian part of the Danube Delta indicate that the development of macro-invertebrate species has followed a relatively stable pattern.

5.5. The assessment of water pollution levels on the basis of Woodiwiss's Biotic Index (TBI), derived from monitoring data on various community groups, indicates that the water

quality in various sections of the study area can be described as “polluted” or “slightly polluted”.

5.6. The level of development of saprophyte and, especially, enteric bacteria in the water and bottom sediments of the Danube Estuary is relatively high, suggesting that the anthropogenic impacts on the ecosystem have been relatively strong during all survey periods. The elevated levels of saprophyte and enteric bacteria were recorded at the monitoring locations 1, 2, 4 (the Zhebriyansky Bay, opposite to the Prirva and Potapivsky arms), and at the monitoring locations downstream of the Starostmbulsky arm (14, 15, 16).



Locations of Monitoring Stations in the Ukrainian Part of the Danube Estuary

5.7. The average quantity and biomass of phytoplankton, recorded in November 2004 and September 2005 were relatively low for the study area; while in 2005 they were well within the ranges recorded in the previous years.

5.8. The zooplankton development pattern within the marine section of the navigation route and at the centre of the offshore dumping site is quite similar to patterns observed in other sections of the near-mouth area. Its key trend relates to the downstream direction of increase in zooplankton quantities as one moves along the navigation route towards the mouth and the sea (which is the main zone of river water transformation).

5.9. In November 2004 and May 2005, the environmental conditions were conducive to the intensive development of macrozoobenthos. In the majority of deep-water monitoring locations, the mass kills of benthic species were recorded due to the oxygen depletion in the bottom water layer. The signs of bottom macrofauna restoration were recorded in November 2005.

5.10. The survey results provided no indication of any direct effects of seaward access channel construction and operation on the composition and status of bottom macrofauna. Lower values of benthic biomass and quantity, recorded at a number of shallow-water monitoring locations along the channel route, were mainly attributed to be the result of

conditions prevailing in this river/marine water transformation zone and sedimentation of suspended solids. The benthic species composition and quantities recorded in the deeper sections of the navigation route were close to the background values reported for the baseline stations.

5.11. The offshore dumping area started to show the signs of gradual fauna restoration as a result of significant decrease in the scope and volume of dredging operations in 2005 as compared to 2004. The macrozoobenthos development indicators in the area of old and currently defunct dumping site (the Ust-Dunaisk port) remained high during all seasonal surveys undertaken in 2004-2005. Generally, the status of macrozoobenthos of the coastal area of the Black Sea near the Danube Estuary at the time of the survey can be characterized as satisfactory.

5.12. Dredging operations and associated dumping activities were found to have adversely affected the mussel habitats. However, the mass kill of mussels observed in the study area in September 2005 is considered to have been caused by the mass depth of bottom fauna, which is characteristic of the north-western part of the Black Sea with its strong stratification of highly eutrophic water masses. This conclusion can be illustrated by the mass kill of mussels at the depth of over 20 m, recorded near the Zmyiny (Snake) Island in late September 2005 (data provided courtesy of the Institute of Marine Biology of the National Academy of Sciences of Ukraine).

5.13. The status of aquatic ecosystems of the Danube Estuary is mainly affected by changes in concentrations of nutrients, organic compounds (both soluble and suspended), suspended solids and detritus. Relative to the total Danube contribution to the eutrophication process (and transboundary transport of nutrients), the effects of the navigation route project were localized and limited to the dredging areas and offshore dumping site. It should be however noted that an increase in the scale and volume of dredging activities would result in the increased area of the direct impact zone, both for hydroengineering construction and navigation activities.

5.14. This section presents key findings made on the basis of the 2006 survey results provided by the Odessa Branch of the Institute of Marine Biology for the Ukrainian part of the Danube Delta, describing the situation prior to the commencement of navigation route project activities (chemical characteristics of river water, pore fluid, bottom sediments), and comparison of these results with available monitoring data for earlier periods.

Generally, the hydrochemical regime of the Danube Estuary has been shaped by the hydrological factors and seasonal changes in biological processes occurring in the mouth section of the Danube River.

In 2006, the morphology and functional organization of phytoperiphyton communities in the area of the navigation route were characterized by a more simple floristic structure and higher ecological interaction intensity of its elements, represented by green and blue-green algae. The 2006 values describing the biomass density, production intensity and ecological interaction intensity showed a significant increase (by 1.5 to 4 times) relative to the 2004-2005 levels. In terms of phytoperiphyton-related indicators, the status and quality of aquatic environment in the Bystre arm area in 2006 can be described as polytrophic and heavily contaminated, representing the shift to the next water quality class as compared to the status observed in 2004-2005. The increased intensity of autotrophic process, recorded in 2006, can be attributed to the elevated concentrations of nutrient compounds and abnormally warm winter.

The macrozoobenthic communities inhabiting the water bodies within the Danube Delta changed significantly over 2006. This change was caused by the abnormally high flow

levels and suspended solid loads. The progressive reduction in the salinity levels within the saline-water parts of the delta caused a decrease in the number of Pontocaspian relic species (i.e. Crustacea), which triggered the development of fresh-water fauna, mainly represented by Chironomid larvae. As a result, the numbers of bottom invertebrate species decreased in these water bodies.

6. Fish Fauna

6.1. The massive spawning migration of the Danube herring in the spring 2005 hit a historical record due to favourable hydrometeorological situation. High water levels observed during the spring flood period also helped provide favourable conditions for fish spawning in the Danube River and its lakes.

6.2. Generally, the weather conditions in 2005 were very conducive to spawning and development of food base, and this enabled the intensive growth of commercial fish stocks in the north-western part of the Black Sea Basin. However, higher temperatures and frequent calms in the summer period caused massive fish kills, which especially hard hit the bottom fish species, plankton and benthic fauna.

6.3. The 2005 trends in individual sizes and masses of the Danube herring species were well within the long-term trends.

6.4. Dredging operations carried out in the period of official fishing ban (May through June 2005) had a significant adverse impact on fish larvae migrating near the dredging locations. This impact was assessed and taken into account in the evaluation of damage and related compensation payments.

6.5. The slow warming up of river water in 2006 caused a delay in the spawning period of smaller fish species, though the spawning efficiency was relatively high due to the elevated water levels in the spawning areas. The size and mass patterns of bream, zander, crucian carp and sea-roach in the Danube River showed close similarity with historical averages.

6.6. The intensity of spring floods in the Danube Basin in 2005 and 2006 was significantly higher than in the previous years, and the 2006 flood was abnormally high. In 2005, the spawning population of the Danube herring was highest over the past decade and showed a significant decrease in 2006, which may be the result of intensive utilization of reproduction capacity in 2005.

6.7. The 2005-2006 survey results showed no or little correlation between the migration intensity of young herring species and adult fish population entering the Danube river for spawning. The young fish migration pattern in 2006 showed a relatively even distribution of migrating fish among the delta arms. In the past two years, the downstream migration peak for the herring larvae occurred between the middle and late June in various arms of the Danube.

These survey results provide a basis for the assessment of herring spawning efficiency, suggesting a significant increase in the population of 3-year old fish by 2008-2009.

6.8. The survey results indicate that the sturgeon stocks in the Danube Basin have been depleted. However, the growth of young populations of various sturgeon species observed over the past 2 years suggests a certain increase in the population of key Danube sturgeon species (sterlet, white sturgeon, stellate sturgeon) in the near future. At the same time, the low number of spawning population and extremely weak downstream migration of young Russian sturgeon species are the issues of serious concern.

7. Monitoring Results for the Danube Biosphere Reserve Area

Given that the dredging activities in the area of the seaward access channel commenced only in November 2006, being concentrated in the sandbar section, no special monitoring was carried out in the DBR area as part of the Integrated Environmental Monitoring Programme. At the same time, the DBR specialists continued their routine research and activities, and the results of these activities enables the assessment and forecasting of potential changes that may be associated with the completion of navigation route restoration and commencement of navigation operations in 2007.

7.1. In 2005, one of the most intensive floods recorded in the Danube Basin over the past 60 years, and a relatively short duration of dredging operations were key factors that complicated the assessment of impacts of the Danube-Black Sea navigation route construction on the plant and animal life at the DBR site.

7.2. In 2005, the expansion of adventive species continued, especially such new species as *Torulinium ferrax, Chaenopodium pumilio, Eclipta prostrata, Diplachne fasciculari*. The *Solanum retroflexum Dunal* species, new for the Danube Biosphere Reserve site and Ukraine as a whole, was recorded at the Yermakiv Island, in the locations of hydraulically filled sections, which is considered to be one of the consequences of human activities. The presence of this species was also recorded on the Ptashyna Spit.

7.3. The following adverse trends in the vegetation cover of the Yermakiv Island continued throughout 2005: the shrinkage of aquatic, wetland and floodplain/forest plant communities and progressive development of meadow plant communities characteristic of saline-alkali soil, featuring the high proportion of ruderal and adventive flora, including shrub species.

7.4. The adverse trends in the vegetation cover of the Yermakiv Island[1] are considered to have been triggered by the establishment and operation of the dredge spoils site No. 15 in 2004 (the site area 14.36 ha; actual 2004 disposal volume 283 thousand cubic metres; no disposal operations undertaken in 2005), exacerbated by poor land management practices on the part of land tenant. The environmental rehabilitation of the island would require appropriate restoration of the dredge spoils site after the completion of dredging operations, and reconstruction of existing water engineering structures designed to divert flow to the island's water bodies. According to the conclusion by the DBR experts, the island tenant's failure to take proper actions aiming to maintain adequate flow regime at the island, along with the existing grazing pressure, would completely destroy the island's ecological and amenity value. A special expert group was set up under the Programme in 2005 to develop a suite of scientifically justified recommendations concerning the environmental rehabilitation of the island.

7.5. The habitat shrinking trend continued for rare aquatic plants (*Aldrovanda vesiculosa L., Trapa natans L.*), being progressively substituted with *Nymphaea alba L.*, *Nuphar lutea (L.) Smith.* and *Salvinia natans L*.

7.6. In summer 2005, elevated turbidity levels in the Danube and its arms caused intensive silt deposition in many fresh-water and open saline-water sections of the DBR site, which affected the state of bottom fauna.

7.7. The analysis of the state of bottom fauna inhabiting saline-water sections of the DBR site, based on samples taken 3 times per year over the period of 5-6 years, indicates that a

[1] Total island area is about 2300 ha. In the 1960-1970s, the island was dammed along its perimeter, and this has had a profound impact on its hydrological regime. The island became a part of the DBR site in 1998 due to its significant environmental value as a bird habitat. The island is currently used as a grazing ground by the Yermak Ltd. on the basis of land tenancy agreement.

downward trend in the density and biomass of macrozoobenthos emerged before the start of construction activities associated with the navigation route project. The main cause of a decrease in quantity and biomass of bottom invertebrates in the land-locked water bodies of the Chilia Delta of the Danube Basin is considered to stem from intensive eutrophication triggered by human activities in the 1970-1980s. This has led to the progressive development of macrophytes in the water bodies, which has affected their flow regime. Monitoring activities should be continued in order to provide a basis for more comprehensive assessment of the status of these water bodies and potential effects of navigation route project.

7.8. While the total number of colonial land-nesting birds at the DBR site remained stable in 2003-2004, it nearly doubled in 2005. This is mainly attributed to over 3-fold increase in population of Caspian Gull (*Larus cachinnans*) on the Nova Zemlya (New Land) Spit, located in the southern part of the Chilia Estuary, beyond the impact zone of the navigation route project.

7.9. In 2005, the Ptashyna Spit located in the sandbar section of the Bystre arm, which is part of the navigation route, remained the main habitat for land-nesting colonial birds, not only within the Danube Biosphere Reserve site, but in the context of the entire Danube Delta. The only exception was the Caspian Gull (*Larus cachinnans*). The appearance on the Ptashyna Island of new (not only for the DBR site, but for the entire Danube Delta) colonial bird species represented by Slender-Billed Gull (*Larus genei*) and Great Black-headed Gull (*Larus ichthyaetus*), recorded in 2003 and 2005, along with a significant increase in the number of common tern in 2005, represent an additional and obvious evidence of exceptional value of this area as a bird habitat.

7.10. In 2005, the bird colonies nesting on the Ptashyna Spit set their nests further from the Bystre arm, which might be attributed to be the result of disturbances occurred in 2004. the bird colonies moved over a half kilometre further from the navigation route to the lowland area less suitable for nesting. The sea storm, which normally occurs every year during the nesting season, has nearly completely destroyed their nesting areas, with only one remaining. Therefore, the overall breeding efficiencies of these species were as follows: 13.5% for common tern (*Sterna hirundo*), and 10.3% for sandwich tern (*Thalasseus sandvicensis*), as opposed to the normal efficiency ranging between 60-80%.

7.11. In order to minimize the project-related disturbances for birds, a suite of special measures was developed and implemented in 2005 with the involvement of the DBR specialists. These measures included the introduction of restrictions on smaller vessel movements in the nesting areas and installation of 2 prohibition signs. The data on the 150-m no-access area were reflected on the electronic map used by the operators of technical vessels working in the sandbar section. Unfortunately, poorly anchored buoys marking the prohibited area were lost after the first encountered storm. Nonetheless, there was no indication of any project-related adverse impact on bird colonies in 2005. Given that the possibility existed for the bird colonies to move back closer to the navigation route, these measures remained valid in 2006.

7.12. The Ptashyna Spit was spared of invasions by wild boar, raccoon dog and fox, which could have led to catastrophic consequences for the nesting bird colonies. This was due to extremely high water levels recorded in the Delta in 2005 and, consequently, complete isolation of the spit. However, this threat may be more serious in the future, when water levels are low or normal, and this factor is considered critical for future survival of bird colonies nesting on the Ptashyna Spit.

7.13. The protective dam constructed in the sandbar section of the Bystre arm may become attractive for birds (including nesting birds) in the future due to its remoteness and inaccessibility for predators. It was already used as a nesting ground in 2005 by three

pairs of Caspian Gulls. However, taking into account the dam shape and surface, made of large stones with deep niches, it may become a fatal trap for all young birds bred on this dam. This is illustrated by the sad fact that all nestlings produced in three nests in 2005 were trapped and died in the stone niches. Given that this isolated and remote structure may be very attractive for nesting birds, consideration should be given to the design solutions aiming to avoid the formation of deep niches during the construction of this dam.

7.14. The number of other waterfowl and riparian bird species using the DBR site on seasonal basis varies greatly from year to year. Although certain changes in the bird distribution pattern were recorded with regard to the entire DBR site and the Bystre arm area, they could hardly be attributed to the construction and operation of navigation route. The abnormally high water levels and long flood period, recorded in 2005, is considered to be a more reasonable and obvious cause of these changes.

7.15. The distribution of wintering birds over the DBR site was mainly shaped by the natural factors.