SUMMARY DESCRIPTION OF THE PROJECT (ENGLISH)

Project title: "Recultivation of Jelonek and Winiary lakes in Gniezno by inactivation of phosphorus in bottom sediments" (LIFE07 ENV/PL/000605).

Objectives:

- inhibition of progressive eutrophication of natural waters in Jelonek and Winiary lakes in Gniezno and of the eutrophication-induced ecological risks related to effects of environment on health and life quality of Gniezno inhabitants,
- improvement of water quality in the degraded lakes, situated in parks in the centre of the town, the place visited by numerous tourists visiting the first capital of Poland,
- improvement of biotope quality, revival of biocenosis in lake environment, including restriction of toxic blue-green algae (Cyanophyta) blooming in water, increase in biodiversity, qualitative and quantitative transformation of ichthiofauna,
- protection of Island resources of surface water in Line with the Framework Instructions of European Community on Water Policy, No. 2000/60/EC,
- improvement of water quality in Jelonek and Winiary lakes throught the system of rivers will improve the general condition of water quality in the drainage-basin of Odra river.

Actions and means involved:

The recultivation of Jelonek and Winiary lakes in Gniezno will be conducted using the method of phosphorus inactivation in bottom sediments. Within the method, the planned activities include:

1. Actions in the direct drainage basin of the lakes
   - Monitoring and improvement of the situation in drainage basin of Winiary and Jelonek lakes
   - Revival of retentive potential of the pond by Jelonek lake
   - Eradication of reed fields which overgrow the lake surface
   - Reconstruction of lake coasts by turfing and sowing of the banks.
2. Inactivation of phosphorus in bottom sediments
   - Eradication of blue-green algae blooming in the pond and the lakes
3. Control and restructuring of fish stock
4. Stimulation of development and planting of additional macrophytes in Jelonek and Winiary lakes

Expected results:

Recultivation of lakes by phosphorus inactivation in bottom deposits will inhibit progressive eutrophication of Jelonek and Winiary lakes in Gniezno, causing:

- reduction in phosphorus content of water from 0.5 mgP/l to, approximately, 0.2 – 0.1 mg P/l
- decreased production of phytoplankton
- increased visibility of Secchi's disc: water transparency restored from 0.1m to around 0.6 – 1m
- reduction in content of chlorophyll a to around 15 mg/m^3
- increase in subaquatic plants and fishes with the resulting improved ecological balance
- stock reconstruction of immersed plants and of plants with floating leaves

- eradication of blue-green algae blooming
- increased landscape and recreational value of the lakes.

ENVIRONMENTAL PROBLEM TARGETED

Gniezno is situated in Gniezno Lake Region, the area most poor in precipitation in the entire Poland. Lakes (Jelonek and Winiary) are situated within administrative limits of the Town and they are expose to pression of municipal agglomeration. For tens of years municipal household and industrial sewage was drained to the lakes. The inflow of high loads of contaminants already in 19th Century induced massive death of fishes in the lakes. The lakes are particularly sensitive to various type of pollution and effects of such a change are of a permanent and irreversible nature. The restricted potential for water exchange in the lakes causes that processes of sedimentation and accumulation of suspensions and of dispersed components prevail. Used for several tens of years as containers of municipal sewage, they lost their potential for self-purification and without immediate recultivation they are bound to undergo full degradation. At present, Gniezno is equipped with Municipal Sewage Cleaning system and a network of sanitary and precipitation draining system.

In order to reach European Community recommendations in line with the Framework Directives No. 2000/60/EC on matters of water policy till the year of 2015 aqueous reservoirs in Poland should regain “undisturbed condition”. The directives aim at protection of inland resources of surface water and as a strategic aim it postulates that „good ecological condition of water should be reached”.

In the accordance to lakes classification criteria from the Water Framework Directive we can describe/classified both lakes included to the project in following way:

1. Jelonek Lake:

a) general status – poor status,

b) biological quality elements:

- phytoplankton – poor status,
- macrophytes and phytobenthos – moderate status,
- benthic invertebrates fauna – poor status,
- ichthyofauna – poor status,

c) hydromorphological quality elements:

- hydrological regime – poor status,
- morphological conditions – poor status,

d) physico-chemical quality elements:

- general conditions – poor status,
- specific synthetic pollutants – poor status,
- specific none-synthetic pollutants – poor status,

2. Winiary Lake.

a) general status – moderate status,

b) biological quality elements:

- phytoplankton – moderate status,
- macrophytes and phytobenthos – moderate status,
- benthic invertebrates fauna – moderate status,
- ichthyofauna – poor status,

c) hydromorphological quality elements:

- hydrological regime – moderate status,
- morphological conditions – moderate status,

d) physico-chemical quality elements:

- general conditions – moderate status,

- specific synthetic pollutants – moderate status,

- specific none-synthetic pollutants – moderate status,

The state of Winiary Lake is continuing to worsen. Nowadays this lake general characterization can be evaluated as moderate status, but with tendency to reach a poor status in a short time.

In 80s of XX^{th} century there were attempts undertaken to remove a part of bottom sediments from Lake Jelonek by dredging. Unfortunately geological conditions (the presence of peat layers) and direct proximity of Cathedral and otherpe buildings which could suffer with destabilization of their foundations made dredging impossible to carry out. This is also why the another attempts to use this method are pointless and despite of these serious consequences for old city buildings there are many other problems which will rise if this method is proceeded:

a. **generation of huge amounts of sediments**; Dredging only thin layer – approximately 20 cm thick – would not remove sufficient amount of phosphorus to enhance the water quality, and the deeper, exposed after dredging, layers would still supply water with nutrient, particularly with phosphorus. On the other hand if one meter layer would be dredged from the whole sediments surface, in case of Lake Jelonek it would give 144 000 m^3 of sediments.

b. **dredged sediments management**; In case of Lake Jelonek the sediments contains above-standard amounts of chromium, so sediments should be managed like hazardous wastes. In this situation, that kind of wastes could be only disposed at a garbage dump, what in consequences could generate high cost of transport and of waste disposal about 200 PLN per ton, what could give huge total cost of 43,2 mln PLN.

c. **sediments effluents management**; When dredging sediments are characterized by high water content – like in the case of Lake Jelonek – significant amounts of nutrients rich effluent will be generated. These nutrients, when getting in contact with the atmosphere, particularly with oxygen, in a very short time can be mineralized and become available for living organism, in particular phytoplankton and in consequences generating algae blooms – so these actions in the end would rather create opposite effect (supplying lake with nutrients) to the assumed one (lowering nutrient content). In this situation the effluent should be managed somewhere outside the watershed of lake, what again could generate additional costs.

d. **benthos organisms influencing**; Dredging sediments would cause rapid decrease of benthos organisms numbers by mechanical removal from an ecosystem and in consequence disturbances in food net, malfunctions in a whole lake and decrease of biodiversity.

e. **uncontrolled resuspension of bottom sediments**; Dredging of bottom sediments is causing uncontrolled resuspension during which huge amounts of nutrients and decay gases are realized into water. As the consequence of this realize mineralization processes can increase using available dissolved oxygen and creating anoxia conditions and mass fish dying.

f. **costs**; Dredging procedure can generate following cost of: sediment dredging, sediment transport, sediment management, effluent management outside of a lake watershed, fish losses. All these costs would be much higher than cost of inactivation of phosphorus directly in bottom sediments.

In the year 1996 the procedure of aeration of Lake Jelonek begun, by the use of EKO FLOX aerators, and it last till present time. Different researches indicates that in spite of the fact that aeration is being proceeded already for 12 years the environmental conditions in the lake are still the same – no significant changes (deterioration or improvement) were observed.

The aeration only prevents fish dying and cyanobacteria blooms by mixing the water. Moreover in many scientific publications from a last few years the aeration methods are recommended as a supporting methods rather than main reclamation method. The aeration can influence only the closest area in the rang of a few till several dozen of meters from

aerator, and this positive influence is observed only during active work of aerator and in short time after it stops working. In this situation the use of aeration method is justified only as a spot action, e.g. in deeper areas of lakes.

As the main reclamation method for both, mentioned in the project, lakes the inactivation of phosphorus in bottom sediments during controlled resuspension was chosen. This method includes positive ratio of costs and effectiveness, and also is relatively cheap and more effective (when comparing to dredging). Using this method can be very effective when applied in shallow, often mixed lakes – after coagulants application directly to bottom sediment, a protective layer of about 20-30 cm thick is created and it prevents the nutrient (particularly phosphorus) to migrate from sediment into the water. The immobilization of phosphorus in bottom sediments will also cause the decrease in nutrients amounts available for phytoplankton, what then will cause increase in water transparency. The higher will be the water transparency the deeper will be the influence of sunlight and in consequence it will create attractive conditions for macrophytes to rise and better consolidation of bottom sediments.

In the course of studies in the year of 2006 in Jelonek and Winiary lakes laboratory studies were conducted to evaluate inactivation capacity of available on the market coagulants and the ways of their administration. In the cases of Jelonek and Winiary lakes the coagulant should be added directly to the sediment. The best solution for the purpose is application of the „Proteus" equipment, which represents the only solution allowing for a very high precision in control of concentration and depth of coagulant administration, as related to horizontal and vertical variation in phosphorus concentration in the sediments.

Recultivation by inactivation of phosphorus in bottom sediments represents the only applicable method in cases of municipal lakes. Using the „Proteus" equipment no need arises for additional area for sediment storage (the stink problem!) which used to be required during lake dredging and the recultivation procedures are performed from the water surface, posing no risks or danger for the environment or biological life. The method is particularly recommended for shallow lakes and the depth of Jelonek and Winiary lakes amounts to around 2.5 m and 4.5 m, respectively. The presented above arguments indicate that this represents the only method to recultivate lakes situated in municipal centre and within domicile portion of the town.

Negative factors influencing lakes included in the project:

1. Failed role of retention pond – instead of playing role of sedimentation pond it plays the role of nutrients exporter to the Jelonek Lake.

2. Run-off of rainfalls from unprotected lake shores of Winiary Lake.

3. Rotting of reeds areas and re-enrichment of lakes waters with nutrients each time the vegetation period is ending.

4. Lack of any long-term effect of aerators working in Jelonek Lake.

5. Internal supplying/loading with nutrients (in particular phosphorus) from bottom sediment to both lakes waters.

6. Low water transparency cause by algae blooms (also cyanobacterial blooms) induced by high nutrients concentrations in both lakes waters.

7. Increasing toxins concentrations during mass dying of phytoplankton (in particular cyanobacteria).

8. Deficits of oxygen concentrations in bottom sediments.

9. Unstable fish structure and in consequence disordered food net.

In account of not taking into consideration very costly and environmentally disadvantageous process of sediments dredging, in both lakes the only possibility to switch the lakes into clearwater state with dominance of macrophytes instead of phytoplankton is to proceed with phosphorus immobilization in bottom sediments. It will give a chance to increase the water transparency, to rebuild macrophytes submerged and those with floating leafs, and to eradicate cyanobacterial blooms.

After regaining these positive results of phosphorus immobilization both lake ecosystems should be stable under following conditions: (1) monitoring of water quality parameters, (2) systematical limitation of overgrowing macrophytes the way it will not

influence the ecosystem functioning, (3) biomanipulation of fish quantity and quality structures, (4) total prohibition of water fowl feeding, (5) but above all taking actions preventing large quantities of pollutants, toxins and nutrients flowing or running-off into lakes.

OBJECTIVES OF THE PROJECT

The aim of the project involves dissemination of the lake recultivation method by inactivation of phosphorus in bottom sediments using coagulants directly administered to the bottom sediments and activities supporting the principal recultivation. The method will be implemented using the „PROTEUS" equipment. This involves the only known equipment allowing for a high precision in control of concentration and depth of coagulant administration as related to horizontal and vertical variation of phosphorus concentration in the sediments.
The aims include:

- inhibition of progressive eutrophication in Jelonek and Winiary lakes in Gniezno and avoidance of the eutrophication-induced ecological risks related to environmental influences on health and life quality of Gniezno inhabitants,
- improvement of purity conditions in the degraded lakes, situated in parks in the town centre, the site visited by numerous tourists who visit the first capital of Poland,
- improvement in biotope quality, revival of biocenoses in the lake environment, including reduction of blooming of toxic blue-green algae, increase in biodiversity, qualitative and quantitative alteration in ichthiofauna,
- protection of inland resources on surface waters in line with the Framework Directive of European Community on Aqueous Policy, No. 2000/60/EC,
- the improvement in sanitary condition of water in Jelonek and Winiary lakes, through the network of rivers, will improve the general condition of water cleanness in the entire Drainage Basin of Odra river.

STATE OF THE ART AND INNOVATIVE ASPECTS OF THE PROJECT

The inactivation method is recommended for lakes in which high fecundity is supported by release of biogenic compounds from bottom sediments. It finds application first of all in shallow polymictic lakes. The highly eutrophic lakes are characterised by high content of biogenic nourishing compounds, which results in blooming of lakes, involving algae in particular. Chemical precipitation of phosphorus using coagulants restricts the amount of biogenic, nourishing compounds and, thus, reduces intensity of algae development with the resulting improved water quality and its transparency. The method is safe for biological life in the lakes.

The method of phosphorus inactivation has already been employed in various water reservoirs but application of phosphorus inactivation in bottom sediments and activities supporting the principal recultivation represent a novel activity and an innovatory project.

Implementation of recultivation by inactivation of phosphorus in bottom sediments, introduction of macrophytes and moluscs and manipulation with fish stock in Jelonek and Winiary lakes supported by a broad project promotion will induce interest of numerous users of degraded lakes and broader application of the technique for protection of lake waters. Taking into account the Water Framework Directive and the requirement to reach good ecological condition of eater till the year of 2015 it should be noted that such lake recultivation activities should be implemented in most of the Polish lakes. The suggested in our project innovatory method of lake recultivation will certainly find application in dissolving similar problems in other towns in Poland and abroad. For this reason a porticular stress will

be exerted on dissemination of results of project implementation among interested parties (for broader discussion see the part devoted to promotion of the project).

Inactivation of phosphorus in bottom sediments involves the most important procedure to be performed in the lakes of Jelonek and Winiary. Any other procedures, including aeration of water will provide no radical and stable alterations until the potential for release of phosphorus from bottom sediments is blocked and water content of phosphorus is reduced as far as it is possible.

While the two principal sources of phosphorus in Jelonek lake can be controlled by inactivation of phosphorus in bottom sediments of the exceedingly exploited retention pond and the lake itself, the additional, unrecognised sources may provide a problem.

The town of Gniezno for several years has been monitoring water in Jelonek and Winiary lakes and in 2007 has ordered preparation of a report on Jelonek lake monitoring with the idea to prepare recultivation activities in both lakes. In the course of preparation of the report preliminary studies have been performed as well as analysis of application the phosphorus inactivation method in bottom sediments of both lakes.

Conclusions from the analysis:

Both in the case of sediments from the retention pond and those from the lake the best potential coagulant for phosphate inactivation seemed to be $FeCl_3$. In anoxic conditions (or more accurately at a low redox potential) also this coagulant failed to warrant stable binding of PO_4. The chance is provided by application of a modified coagulant, PIX 111 or Depox. This is the synthesised in Germany $FeCl_3$–containing coagulant with stably incorporated NO_3 ion (in the form of $Ca(NO_3)_2$). The incorporated itrate ion maintains redox potential in the interstitial water of a sediment at the level precluding release of PO_4 ion. Administration of PIX 111 may be accompanied by provision to the sediment of substances which for a long time release oxygen (the so called ORC or oxygen releasing compounds). ORC are available on the market. In the case of Jelonek lake the optimal addition would involve calcium superoxide, CaO_2.

Another solution would involve application of Phoslock, the new substance which effectively traps phosphates and remains insensitive to alterations in pH and redox conditions. A disadvantage of using the coagulant includes its high price and absence of data which would prove long-term trapping of PO_4 as well as inprecise data on the dose of Phoslock whioch should be applied. Most frequently the literature sources provide that the dose of 2.0 tons are indispensable per hectar of sediment surface. Such an amount of Phoslock would coat the surface of 1 ha with, approximately, 1 mm thick isolating layer. In the case of Jelonek lake the layer of such a thickness certainly will fail to isolate the sediment and will not block the potential for phosphorus release from the sediment. Another premise for dose calculation involves the data that 290 mg (according to the other 250 mg) Phoslock are required to bind 1 mg of PO_4 ions.

Calculations on such grounds, performed during field experiments in August, 2007 result in very high required amounts of Phoslock per 1 ha (approx. 6.0 tons), which – in the current price of above 1500 Euro per ton yields costs severalfold higher than those in the case of PIX and PAX application.

Conditions in Jelonek lake fully exclude application of PAX as a coagulant. The permanent, high pH poses the risk of low phosphate-binding capacity by PAX. At pH above 9.0 the risk arises of release to water of both phosphates and of aluminium ion, which is toxic to hydrobionts. Studies of this year have shown that within half-a-year after application the coagulant undergoes aging and its binding potential becomes reduced to 50%. Phosphorus and the aluminium ion may be released even at a neutral pH.

The most frequent because the simplest and most economic way of applying the coagulant involves its uniform spreading on the surface of water, less frequently its addition to the surface layer of water. When applying the coagulant to the water surface it is assumed that it will uniformly sediment to the surface of bottom sediments, forming a uniform, compact isolating layer which prevents a release of PO_4 from the sediments. In practice, however, as shown by current studies, the coagulant of a significant fractional size and a small negative floatability sediments in non-uniform fashion, resulting in a island-type of coagulant layer at the surface of bottom sediments, with vast empty spaces. In the case of shallow lakes, even after a solid layer of coagulant has already been formed, slight waving may transplace the coagulant even when it does not yet cause resuspension of the sediment.

In the course of studies in the year of 2006 on the lakes of Winiary and Jelonek, laboratory tests were performed to evaluate inactivation capacity of the coagulants available on the market and on the ways of administering the coagulants (Report 2006). Three industrial coagulants were tested, including PAX ($Al_2(SO_4)_3$, PIX 111 ($FeCl_3$) and Phoslock. The tests were also performed with PIX 111 supplemented with calcium nitrate, treated as a substance which prevents decrease in redox potential. In every series of the tests two ways of coagulant administration were tested: administration to water and direct administration to a resuspended sediment. Nevertheless, the main aim of the experiment was to find out what will happen with the inactivated phosphorus when after administration of the coagulant to the water or to the sediments the sediments are resuspended due to, e.g., wind. The problem is quite a significant one since wind-induced resuspension of bottom sediments represents a frequent phenomenon, in particular in shallow lakes like Jelonek. Results of the tests demonstrated that in all cases in which the coagulant was added to water only resuspension of the sediment resulted in re-appearance of phosphorus in water, particularly when PAX coagulant was used. Less phosphorus re-appeared in water when the combination of PIX 111 and calcium nitrate was used. In all cases in which a coagulant was administered directly to the sediment sediment re-suspension resulted in significantly lower amounts of phosphorus which re-appeared in water.

In cases of Jelonek and Winiary lakes the coagulant should be administered directly to the sediment. The best solution in the case would involve application of the Proteus equipment. As far as we know, this is the only known equipment which allows for a very high precision in control of coagulant concentration and depth of administration depending on variable horizontal and vertical distridution of phosphorus concentration in bottom sediments.

The purpose of a device called PROTEUS is to proceed inactivation of phosphorus during controlled resuspension of lake bottom sediments. The device consists of two modules:

1. Surface module, which is responsible for:

- moving the whole apparatuses,

- transport of chemical substances used during reclamation procedure,

- dozing of chemical substances,

- navigation and scanning of lake bottom,

- controlling the work of underwater unit.

2. Underwater unit, which is responsible for:

- developing a resuspension of bottom sediments in its isolated volume,

- aeration of bottom sediments,

- dozing of chemical substances into resuspended bottom sediments,

- coagulation and resedimentation of bottom sediments.

The work begins when the underwater unit is being lowered just into external layer of bottom sediments and starts to move along previously determined axis. The set of different sensors is responsible for controlling the movement of this unit the way all dozing nozzles were always submersed into sediments where the resuspension will be the most effective as well as dozing of chemical substances.

The underwater unit has a shape similar to a very flat bell inside which, with a use of compressed air, the controlled resuspension of bottom sediments is carried. After the resuspension and aeration of sediments with first set of nozzles, chemical substances are dosed what initiate the coagulation of sediments and immobilization of phosphorus. When the underwater unit is passing by over the lake sediments, thanks to chemical coagulants, very rapid resedimentation occurs and there is no any uncontrolled resuspension within a lake.

In the project both lakes have serious problem with so called 'internal supplying/loading' of water with nutrients than with a threat of run-off from already controlled watershed. In situations when anoxia conditions occur in the sediments or the resuspension caused by wind occurs, there is a very rapid flux of phosphorus from sediments into the water. This flux is very often a trigger for phytoplankton blooms (especially cyanobacteria blooms) what decreases the transparency of water and suppresses the submerged macrophytes development in consequence decreasing biodiversity.

That is why it is so important to immobilize phosphorus directly in the bottom sediments what can decrease significantly or almost totally stop the above mentioned 'internal supplying'. PROTEUS is the only device which enables to carry out three different procedures – controlled sediment resuspension, aeration of sediments and phosphorus immobilization – at the very same time and very precise way.

The lake of Jelonek manifests exceptionally favourable conditions for blue-green algae induced water blooming. Application of the most important method or inactivation of phosphorus in bottom sediments could be preceded by placing a filter medium across the inflow to the lake, made of bales of barley straw. Experiments have confirmed that in the course of oxidative mineralisation of straw decomposition products are released to water, which inhibit proliferation of bue-green algae, functioning as natural algistatic agents. The straw used to be exposed to lake water most frequently in the spring or early summer. The results used to be noted after a period of 2 weeks to one month.

In Lake Jelonek this structure can be called as dominated by two families – Cyprinidae and Percidae – and the dominating species is perch (Rutilus rutilus) which is putting high predatory pressure on zooplankton. This kind of taxonomic structure is typical for highly eutrophic lakes. In accordance with theory of ichthyo-eutrophication high densities of both already mentioned families are significant factors intensifying the eutrophication process and responsible for worsening lake water quality. There is also a positive symptom cause small quantities of pikes (Esox lucius) were noticed in Jelonek Lake but only as 4% of whole fish structure.

To improve this structure a predatory species like pike (Esox lucius) should be re-introduced to support existing pike population and to limit the number of fish species feeding on zooplankton and zoobenthos.

When the pressure of zooplanktivoroues fish will decrease, zooplankton will have a chance to control more effectively the abundance of phytoplankton and in consequence the water transparency will increase. On the other hand, the limitation of benthivorouse fish which feed by digging into sediments will limit the effect of bio-resuspension of bottom sediment. Summing up the results of fish structure rebuilding it will cause the food net to become more stable, but to obtain this effect in an acceptable short time the biomanipulation has to be

carried out in very intensive way. To obtain desired effect the fivefold decrease of present fish structure is needed (the level of a few kilograms of fish per hectare) and the restock of about 1 thousand of pikes per hectare.

In order to introduce the lakes into a stable condition of clean water, with high amounts of inactive phosphorus in sediments with a significant surface fraction covered by aquatic plants macrophytes have to be re-introduced. Bedding with macrophytes form an efficient nutrient-removing element in the water, accompanied by formation of barriers and islands. When water transparency has been sufficiently augmented reconstruction of the sediment-rooted aquatic plant population by preparation of seedlings from rhizomes and seeds obtained from shallow clean water lakes dominated by macrophytes.

The lakes of Winiary and Jelonek were subjected to monitoring for few to more than ten years. The conducted analyses allow the conclusion that the water reservoirs can be transformed to a stable clean water condition, the contents of phytoplankton can be reduced, water transparency can be improved and macrophytes can be re-introduced. Manipulation with fish stock, the efficient water filters, will additionally promote improvement in water quality. The recultivation procedures will be conducted at the water surface providing no risks or dangers for the vicinity: they are safe for biological life. The chance to perform recultivation procedures on two polymictic lakes will provide consecutive experiences in development of phosphorus inactivation method in bottom sediments and the obtained results will be widely publicised.

The project will promote development and presentation of the innovative method of lake recultivation. Through the Municipal Office of Gniezno town, a branch of public administration, the lake recultivation method applied in the programme will undergo dissemination. The project provides solution which is safe for the environment and may be applied by many public institutions. The applied technology has not been applied previously. It offers more advantages for the environment than the currently used procedures.

DEMONSTRATION CHARACTER

The method of phosphorus inactivation has already been used in various water reservoirs but the method of phosphorus inactivation in bottom sediments and activities which support principal recultivation represent innovative actions and projects.

In cases of Jelonek and Winiary lakes the coagulant will be administered directly to the sediment. The best solution of the problem is application of the Proteus equipment, i.e. the only known equipment which allows for a highly precise control of concentration and depth of coagulant administration as related to variable horizontal and vertical distribution of phosphorus concentration in bottom sediments.

The activities which support the principal recultivation include procedures involving manipulation with fish stock, the effective water filters, planting of macrophytes, which additionally improve water quality.

Not in all aqueous reservoirs (particularly in towns) can bottom sediments be eliminated: this method is several-fold more expensive than other approaches and it poses technical and organizational difficulties. Considering the average thickness of the sediments in post-glacial lakes ranging from few to more than ten meters, the method frequently cannot be used.

The method of lake recultivation by phosphorus inactivation in bottom sediments can be applied in numerous eutrophied lakes. The procedure remains safe for biological life in the lake. Preliminary studies demonstrated a potential for improvement in lake situation and

for transformation of the ecosystem into a stable clean water condition with dominance of macrophytes.

The recultivation using phosphorus inactivation in bottom sediments, introduction of macrophytes and manipulations with fish stock in Jelonek and Winiary lakes plus broad promotion of the project results will allow for interest of numerous users of degraded lakes and for application of the method in protection of plant waters. Considering the Framework Water Directive and the requirement to reach good ecological condition of water till 2015 it should be concluded that recultivation work on lakes must be implemented within most of Polish lakes. The innovative method of lake recultivation suggested by our project will certainly find application in resolving similar problems in other towns in Poland and abroad. For this reason so extensive stress has been placed on dissemination of results in implementation of the project among interested parties (for broader discussion see promotion of the project).

The recultivation activities will be monitored continuously, including analyses of water and bottom sediments.

The activities will include:

- measurement and analysis of phosphates, total phosphorus, mineral, ammonium and total nitrogen, pH, sestone dry mass, transparency, phytoplankton, bacteriology,
- chemical analysis of bottom sediments, analysis of phosphorus fractions, determination of oxygen profile, determination of pH, of electrolytic conductance, temperature profile, determination of BZT_5 and ChZT. The stage of studies will terminate in preparation of the report.

The obtained results will be compared to indices which define class of cleanness in surface water. Every stage of the studies will provide a report in which particular attention will be paid to the extent in which the assumed in the project results and aims have been reached.