

Pond aquaculture in European fisheries fund 2007–2013

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The European Commission is working on proposal for an European Fisheries Fund (EFF) for the period 2007–2013. This fund will succeed the current Financial Instrument for Fisheries Guidance (FIFG) in realization of the Common Fisheries Policy (CFP). We did not learn how to utilize Structural Funds offered within FIFG yet, but we had to develop strategy for the future.

Both funds: present FIFG and forthcoming EFF are marine fisheries oriented with visible tendency of resources conservation and permanent “greening” of activities. According to officials “...the fund will make a major contribution to securing environmental, economic and social sustainability in fisheries.” It sound smooth and trendy but it does not mean that the problems of the pond aquaculture in new member countries could be solved by this fund. **Aquaculture** in EU is mostly recognized as raceways trout and salmon cage culture, with some addition of the shell culture. Warm water pond aquaculture, valuable from the environmental point of view, thanks to water retention and biodiversity of the water plants and animals, has no special meaning. Certain limitations planned in EFF for pond culture, can reduce fish farmer’s ability to farm fish, keep water retention and people employment.

Marine fisheries united in “Friends of Fisheries” group is working hard to keep possibilities to renew fleet and keep the branch vital. It would be good idea to organize parties interested in, into the “**Friends of Aquaculture**”!

New Challenges in Pond Aquaculture

Book of Abstracts

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Foreword

Over the years, the international conferences and workshops convened by the Research Institute of Fish Culture and Hydrobiology Vodňany (University of South Bohemia České Budějovice) on various aspects of fish culture with particular attention to pond farming technologies, have become an established tradition in South Bohemia – the region of thousands of ancient ponds. The workshop on “New Challenges in Pond Aquaculture” held in České Budějovice (Budweis) – the University of South Bohemia Campus – will consist of following sessions:

- Biological Background of Pond Aquaculture
- Interactions with Protected Plant and Animal Species
- Multipurpose Pond Usage
- Pond Management Strategies
- Pond Aquaculture Economics, Marketing, Networking and Product Development

The sessions have been selected with respect to fish production under conditions of sustainable development of the pond environment. These issues cover a wide range of approaches associated with pond production, such as integrated farming systems, organic farming, nature friendly control mechanisms of pond environment, animal welfare in reproduction, pond harvesting, fish transportation etc.

Thus, the workshop will address the wide ranging concept of pond aquaculture, although particular importance will be given to less intensive and environmentally friendly approaches. Semi-intensive and extensive fish farming technologies in earthen ponds, usually exceeding several hectares in area, are the major types of fish production in the Czech Republic and in some regions of Central and Eastern Europe. Recently, the pond aquaculture sector has been facing increasing demands for implementation of non-production pond usage, notably landscape formation and protection, recreation, water protection and pond management issues.

An open debate on recent advances in different technologies and their impact upon pond-fish quality and environmental consequences will be a useful tool for the pond aquaculture sector to increase knowledge, exchange ideas and draw conclusions and recommendations on the challenges required for the present and future of pond aquaculture.

The workshop is a joint event co-organised by the Research Institute of Fish Culture and Hydrobiology (University of South Bohemia) and the Aqua-Innovation Network as a part of the EC supported project “Creating Supporting

Personnel provision in the sphere of hydrobioresources and aquaculture in connection with European integration process

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Social assignment under market relations determines the need of hydroecosystems utilization by ways of fishery and hydrobiont production in aquaculture. World experience and current state of knowledge in the sphere of hydrobioresources and aquaculture leave no doubt as to the necessity of scientific provision of this most important area of human activity supplying people with valuable protein food.

For continuous fishery perfection and development of new aquaculture technologies, the intellectual potential capable of generating new quality of theory and practice is required. Hydrobioresources and aquaculture specialists trained in the higher education system are transmitters of professional intellect.

All-European integration in the sphere of education underlying the Bologne process is aimed at developing unified standards of programs and study courses, setting up author groups for elaborating the integrated methodological concept and preparing updated teaching material. Special attention is paid to the unity of science and education, and this meets the requirements of the present-day situation as to the rational use of hydrobioresources and aquaculture technologies improvement.

The formation of a modern specialist-researcher is a long, complicated and costly process having two stages. The first one is a higher education establishment providing basic and special training with exceptional importance of a close relationship between science and the teaching process. The second stage includes profound research in post-graduate and doctoral projects guided by leading scholars in specific areas of hydrobioresources and aquaculture.

Test results of organoleptic characteristic of carp flesh

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Supplemental cereal feeding (wheat, maize and triticale compared to control group with natural food only) and its effect on organoleptic characteristics of common carp (*Cyprinus carpio*) flesh was investigated in fish from ponds in Třeboň region (Czech Republic).

Panel of evaluators judged odour, taste, flavour and consistence of fish flesh. A protocol with an unstructured graphic scale was used for expressing the intensity of perception. Ten evaluators participated to the classification and the evaluation was repeated three-times. The best values of taste were determined in the group which was fed with triticale (102 mm). Other groups achieved slightly worse results, in the concrete wheat (188 mm), control group (201mm) and the worst group was maize where maize was consumed (214 mm). Statistically conclusive influence (at the level of significance $p < 0,05$) of cereal additional feeding on organoleptic characteristics of common carp flesh wasn't proved. Analysys of organoleptic characteristic of common carp (*Cyprinus carpio*) flesh proved the positive influence tendency of additional cereal feed (triticale) in contrast to maize in taste and flavour parameters.

Network for International Transfer of Innovative Technologies in European Aquaculture (CSN-INTRAN)” in co-operation with the European Aquaculture Society. Also local institutions - European Information Centre of the University of South Bohemia and Attavena o.p.s. contributed to the workshop organisation. The help and support of all partners involved was highly appreciated.

On behalf of the organising and scientific committees,

Zdeněk Adámek
workshop convenor

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and efficient updates for all portals within the AW Network. Many of the inputs from the AgroWeb authors are on a voluntary basis.

FAO's role is to facilitate AgroWeb's development by providing advice and support to the national working groups, assisting in the improvement of services in the most important subjects, and working closely with national coordinators and the web editors. The AgroWeb network is also used as a communication platform between the participating countries FAO, IAALD and other international organizations. Special sites have been established for the "National FAO Committee" under the guidance of the National FAO Committees, and linked to the AgroWeb pages. The costs associated with the participating countries' contributions to the AgroWeb network are borne entirely by the participating countries', projects and on a voluntary basis of participating institutions and experts.

Future steps

Capacity building and inter-institutional cooperation among fishery and aquaculture related institution in the CEE region in the collaboration with HAKI, Szarvas, Hungary:

- Fishery and aquaculture subportal development
- Fishery and Aquaculture CEE network creation

AgroWeb also exploits its personal, professional and institutional capacities to organize professional events, such as the “Roundtable of CEE Agricultural Information Specialists”. The 9th IAALD CEE Roundtable will run parallel with our workshop in Nitra, Slovakia, in cooperation with the Nitra University of Agriculture and FAO.

Access points paths:

<http://www.agrowebcee.net>

<http://www.agrowebcac.org>

<http://management.usab-tm.ro/awsee>

<http://www.iaaldcee.hu/index.asp?page=awnt>

<http://www.fao.org/Regional/SEUR>

Objectives

Collect and provide information from of the agricultural sector: monitor information and related links of agricultural institutions, important agriculture, food and nutrition, veterinary, fishery and other related subjects and information resources; monitor and promote national and international events related to the objectives of AgroWeb.

Capacity building and inter-institutional cooperation; to build capacities and inter-institutional cooperation; development of communication and cooperation amongst the countries in the region, and with international organizations such as FAO; development and promoting common standards and guidelines for information management.

Organisation and management

The national portal sites are managed by the hosting organizations which bear full responsibility for the contents of their countries' AgroWeb portals. Hosting organisations provide space on their servers to publish the national AgroWeb portals.

The relationships of the hosting institutions to the Ministries of Agriculture vary, in some cases the AW national portal is an official site of the Ministry (e.g. Czech Republic, Bulgaria, Romania, Ukraine), in all the others the Ministry simply supports the development of the site in an informal way. This support may take the form of training courses, workshops, or the participation of the AW team members in regional or international events.

Updating and maintenance of the AgroWeb portal pages are managed by national working groups, that consist of the national coordinators and AgroWeb authors on the country level. All national AgroWeb sites are created and updated by local experts, who are known as the AgroWeb authors. The authors' work is supported by the IT Working Group of AW CEE, which also ensures the quick

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AgroWeb Network in the CEE region

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AgroWeb international network has been established by organizations and individuals involved in agricultural and rural development in Central and Eastern Europe (CEE). Participants started to develop a collaborative network, in view of the lack of information on the Internet about agricultural topics in the region in 1998. The AgroWeb Network was established and is maintained by representatives of participating countries, and facilitated by the regional chapter of International Association of Agricultural Information Specialists (IAALD) and by FAO. Countries from the CEE region, Balkan countries, New Independent States, Baltic states, Caucasus region and Central Asia are participating in the network. Main objectives, main tasks, new technological standards, possibilities of the network for the forthcoming years will be most important questions to be discussed during the workshop.

National web pages have been established as portals for the countries in the region, which provide access to information in a standard format and structure about agriculture-related institutions – ministries, libraries, information centres, universities, research centres –, NGOs, agro-marketing organisations and organisations involved in the European integration process. The AgroWeb national portals provide Internet links, if available, to these national institutions and to other relevant national web sites.

In addition to the national portal pages, cross-cutting subject areas have been identified and a growing number of thematic sectors of the network are being coordinated by regional focal points. The national AgroWeb portals are published in English and national languages to help the web-based communication within and among the participating countries and worldwide. The content and services published in the national languages also differ significantly, due to the differences in capabilities and resources between countries, and the institutional background of the AgroWeb authors.

Most of the software tools and applications used in the AgroWeb have been customized by the members of the network. Content elements are stored in common formats, increasing cross-compatibility of the same type of information between countries.

Responding to challenges - fostering innovation in pond aquaculture

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Pond aquaculture has a long tradition in Europe, but is constantly challenged to adapt to new demands and pressures. Previous markets and roles appear in decline whilst new opportunities may be opening up. However, discerning those opportunities and taking advantage of them can be very difficult.

The Aquaculture Innovation Network is bringing people together across national, professional and sectoral boundaries to find new solutions. The network is being developed by a consortium of 14 organisations under the EC Innovation project “CSN-INTRAN”. These include organisations involved in networking (EAS), producer cooperation and representation (FEAP, HRP), research & education (SINTEF, IFREMER, University of South Bohemia, University of Stirling, Estonia Agricultural University), information dissemination (Eurofish), SME support and consultancy (Aquapark, Double Delta, Aqim), and companies with innovative technologies (Schering Plough & Aquacultur Fischtechnik). An initial study has identified markets, environmental control and health management as key areas of challenge and opportunity. Enlargement of the EU adds a further dimension, accelerating the rate of change especially in the New Member States.

The Aquainnovation network activities are designed to support individuals and organisations that are seeking to embrace change and adapt to new environmental and market conditions. In addition to promoting personal networking, key elements include support for technology transfer, learning and collaboration. Specific actions underway include hosted study visits, training courses, web services and supporting studies. The presentation explores these themes and opportunities for involvement in the context of pond aquaculture.

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5. Raising Product Quality from Pond Aquaculture, Economics and Networkinhg

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Use and market value of fish ponds in Poland

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The use value of ponds determines their ability to satisfy owner needs. It is measured in points – the best pond complexes are in the range from 90 to 100 and the worst below 30 points. In this expert method such characters are analyzed as ponds water conditions, fertility, technical state and organization of ponds as a complex. The use value exists independently of supply and demand for ponds on the market and individual preferences of its participants - it exists regardless of whether or not people are conscious of the value. Because of that it is possible to compare use value of ponds from different regions. There is difference between use and market value. In current market conditions fish ponds with significant use value can have insignificant market value and vice versa. This paper presents method of fish ponds use value evaluation and shows examples how use value and points can be apply to an anticipation of fish ponds market value. The difference between use, market and total economic value of fish ponds is also discussed.

Influence of long-term storage of common carp flesh on PUFA content

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Supplemental cereal feeding (wheat, maize and triticale compared to control group with natural food only) and its effect on fatty acid (FA) in the flesh during long-term storage of common carp (*Cyprinus carpio*) was investigated in fish from ponds in Třeboň region (Czech Republic). The content of fatty acid was investigated in flesh of carp for 9 month. Sixty of common carp (*Cyprinus carpio*) were selected in the third year of live among fish reared in ponds. The live weight of the fish ranged from 1358 to 2221 grams. Fatty acid (FA) content in fish flesh was determined by gas chromatography (VARIAN 3300). The percentage of saturated and monounsaturated FA did not changed ($P < 0,05$) and increased ($P < 0,001$), respectively. Polyunsaturated FA (PUFA) decreased ($P < 0,01$), with the decreased of n-3 PUFA being faster in comparison with n-6 PUFA. The content EPA (eikosapentaenoic acid) a DHA (dokosahexaenoic acid) was in the test group DHA 0,65 a EPA 0,61 and control group EPA 2,32 a DHA 2,95. The ratio of n-3 to n-6 PUFA in heavier fish was less favourable for consumers.

1. Biological Backgrounds of Pond Aquaculture

Hypertrophic fishponds and their ecological functioning

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The present high level of fishponds eutrophication has resulted from nutrient overloading and top down control of plankton by high fish stock densities. The main consequences of a high trophic state are excessive primary production and large fluctuations in basic environmental parameters (pH and dissolved oxygen), including unbalance in the ratio of the most important nutrients (C:N:P). Sudden and considerable fluctuations impair the proper functioning of the fishpond biocenoses and support the dominance of decomposition processes. The efficiency in utilization of the enormously high primary production for secondary production and fish production through food web is low. Increasing oscillatory patterns can be considered as a general indicator of reaching instability in the aquatic ecosystem due to advancing eutrophication. In the hypertrophic fishpond culture natural ecosystem structure is strongly simplified. It also results in a decrease of the ecosystem stability. Therefore, maintaining ecological stability and a healthy-sound functioning of the ecosystem represent an important task in the sustainable management of fishponds.

Polar algae in aqua-culture: An assessment

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Cyanobacteria and algae play a key role in the Arctic and the Antarctic ecology as primary producers. The potential of polar algae for application as aquaculture feed is still a little explored area of research. Photosynthetic micro-organisms occurring in polar regions provide evidence for adaptive evolutionary change and deserve an intensified study to understand better the mechanisms by which they are able to resist extreme environment of different polar habitats. They possess a multitude of physiological, biochemical and molecular strategies with biosynthetic pathways resulting in a number of complex organic molecules belonging to the category of bioactive compounds. Detail investigations on mass-culture of polar algae especially the knowledge of eco-physiological conditions for optimum yield of biomass of polar strains is an important prerequisite for a successful assessment of the bio-potential of polar strains for their application in aquaculture. We have studied the eco-physiological parameters (light, temperature and mineral nutrients) for optimum growth of ten polar strains belonging to the genera – *Chlorella*, *Bractaeococcus*, *Muriella* and *Pseudomuriella*. The results of these eco-physiological tests and the bio-potential of polar algae as aquaculture feed will be introduced and discussed.

Investigations of dry matter and lipid content in carp species smoked by hot and cold methods

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In recent years the fresh water fish market requires more processed goods, as young consumers purchase ready-to-cook food products. In Middle European aquaculture systems the carps are the main species. Appearance of new species (African catfish, trout, salmon), as well as the improved import possibilities of value-added fish products set up new challenges for fish farmers. In order to maintain the share of carps in fish sales, it is indispensable to develop up-to-date products, which meet the request of present generations. It is necessary to find processing methods, which remove the fish bone and the occurring off-flavour of Cyprinids. Smoking of carp has traditions in the region, thus there are advantages to develop smoked carp products, mainly in forms of boned fillets.

Present study investigates two smoking methods aiming to ensure basic information for product innovation.

Analyses the variation of weight, dry matter and lipid content during hot and cold smoking in case of three species, such as common carp, silver carp and grass carp.

In order to determine the most accepted products, the paper details the results of organoleptic tests, in which five characteristics (appearance, consistence, flavour, smell, and succulence) were investigated. Evaluation results indicate, that the hot smoked carp products are more acceptable, therefore these products in modified atmosphere packaging hopefully will achieve strong market shares in the near future.

A study on the processing potential of European common carp, *Cyprinus carpio* L., as a means of enhancing the carp market

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Common carp, *Cyprinus carpio* L., dominates world aquaculture, constituting over 70 % of production. In Western Europe, carp is a popular sport fish for anglers but its consumption is limited to certain regions and sub-national populations. Reasons for its unpopularity are attributed to its high, tiny bone content and muddy taste. In Eastern Europe, in countries such as Hungary, Poland and the Czech Republic, it is the major fish produced. Most of production gets harvested during the winter and is sold whole and live, and carp remains the traditional meal served at the Christmas table.

With the accession of many Eastern European states to the European Union, trade barriers will be lifted allowing for more cross-border trade of fishery products. The disparity between exports and imports of the New Member States will increase, as more marine fish will be available for Eastern markets.

Over 35 % of fishery products get processed in Western countries, which make them more marketable and available for consumers through large supermarket chains. In the East, less than 20 % of carp gets processed due to its limited yearly supply and demand. Processing equipment and machinery is limited with regards to *Cyprinus* species due to its low demand and poor fillet yield rate. Increasing single-family homes and an increase in supermarkets have created the need for a more ready to cook products. The carp industry must try to fill this need by allocating a larger portion of production for processing or risk losing consumers.

At the 12th annual Seafood Expo in Brussels it was obvious that carp and carp related value-added products were insignificant as very few companies displayed such goods. Many company spokespersons attributed this to low demand and to the reputation carp has as a low-grade fish with little appeal.

Fact-finding trips to France and Hungary to observe companies and interview people involved in the production of carp and processed carp products revealed that much of the same products produced were similar to those offered by the salmon industry; fillets, steaks, smoked fish, and a variety of sauces. The quality of the products was good but demand has remained low, due to a lack of promotion and cooperativeness among carp farmers. Measures similar to those undertaken by the tilapia and catfish industry in the US, a to a smaller scale, trout in the UK in forming large central associations, primarily involved in marketing and promotion of their fish are recommended to reverse falling demand patterns.

Periphyton-based aquaculture ponds

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The introduction of hard surfaces in the water column to induce biofilms and periphyton growth on them is a way to increase natural productivity of the water body and food for cultured aquatic organisms. Periphyton-based systems have been used in Africa and Asia as a traditional way of enhancing fisheries in coastal lagoons. This technology was adapted for aquaculture purposes in small lakes and ponds within the African rain forest where agriculture by-products to enhance the heterotrophic pathway are scarce or unavailable, and in Bangladesh and India its application is recently expanding mainly in polycultures of Indian carps. In those systems it was found a positive effect of substrate introduction and its consequent periphyton development on the target species production and on water quality.

In Israel this technology is being tried in the culture of 'organic' tilapia. Among other 'organic' restrictions, low fish densities must be stocked and only 'organic' feeds and manures can be supplied. The cost of 'organic' pelleted feeds doubles the cost of regular feeds. To improve natural food production for tilapia and reduce added feed costs, an experiment was performed at Dor Aquaculture Station adding underwater plastic surfaces equivalent to 40 % of the pond surface and reducing by 40 % the amount of feed supplied to a polyculture of 85 % hybrid tilapia (*Oreochromis niloticus* X *O. aureus*) and small amounts of other fish species. The results were only 10 % lower tilapia growth rate with 40 % feed saving, which points to periphyton-based aquaculture as an appropriate technology to reduce costs and allow an economically viable 'organic' tilapia production.

Whether periphyton-based technology is advantageous also under the temperate – cold conditions of Central Europe fish ponds has still to be tried.

Impacts of trophic level and fish stock on fishpond zooplankton

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At the end of the 19th century most of Czech fishponds could have been considered as oligotrophic and mezotrophic water bodies. They were extensively used for fish breeding and in their catchment intensive agriculture was not practised. Trophic potential and primary production of the fishponds was low and the structure of zooplankton was similar to that in shallow low productive lakes. First attempts to increase the trophic level were started in 1930s. Liming and fertilization resulted in increase of plankton biomass and production, but the fish stocks were still low (50–100 kg/ha). The main part of zooplankton biomass consisted of large Cladocera species (*Daphnia pulex*, *D. longispina* and in some cases *D. magna*) which are effective filter-feeders. Between 1930 and 1970, the fishponds became eutrophic as nutrient and fish stocks increased. The large Cladocera still formed a considerable part of zooplankton biomass. Under such conditions the efficiency of energy transfer through food web was very high. Nowadays, most of fishponds can be considered as hypertrophic. They also have a high fish stock (often more than 1000 kg/ha). The zooplankton is represented by small zooplankton such as nauplii, small cyclopoid copepods, small species of Cladocera and rotifers, which are not so effective filtrators. The high trophic level brings high primary production, which can not be used by this type of zooplankton. It is possible to expect that efficiency in utilization of the enormous primary production through zooplankton into fish production is therefore low.

Geosmin and carp off-flavors in France

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Off-flavors represent one of the most economically significant problems encountered in continental aquaculture. The appearance of a repulsive odor, or taste, in fish may cause a major reduction in the consumption of the products, or even makes it impossible to sell them. Economic repercussions can become very important if no product quality management is developed in the near future.

Carp farmers and processors are well aware of this problem and have decided to keep it under control. We made a first study in 2002–2003 to accumulate some cross-disciplinary results to tackle this problem following three approaches : estimation of water quality and the composition of the phytoplankton community in carp ponds; sensory analysis of the carps caught from June to October; quantification of odoriferous volatile compounds in fish.

The results show that strongly off-flavored carps are found in ponds colonized by cyanobacteria, with the appearance of geosmin. An experiment in “clear water” with off-flavored carps has been tested, to determine the kinetics of depuration of geosmin, and to define a new strategy of fishing, stocking and processing the carp during the summer.

Influence of nutrition on the fatty acid composition of pond fish: carp and tench

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Like marine fish freshwater fish are an important source of essential fatty acids for human nutrition. However, the fatty acid composition of pond fish can vary considerably and strongly depends on that of the ingested feed. Investigations on the fatty acid composition of common carp and tench have shown that different methods of rearing and feeding cause substantial variations in the proportions of n-3 polyunsaturated fatty acids of these fish species.

Carp reared on the basis of natural food in ponds exhibit high contents of n-6 as well as n-3 fatty acids in their muscle triglycerides. On the other hand carp fed supplementary wheat in ponds resulted in somewhat lower levels of these essential fatty acids. Remarkable amounts of n-3 fatty acids can be found in carp fed high energy diets containing high levels of fish oil.

Analogous results were obtained in experiments with tench reared under different nutritional conditions. While rearing on the basis of only natural food in ponds as well as feeding supplementary wheat yielded in similar levels of n-3 and n-6 polyunsaturated fatty acids, higher contents of n-3 fatty acids were recorded in tench fed pellets

High levels of n-3 polyunsaturated fatty acids in foodstuffs have positive effects on human health. Since experiments with Atlantic salmon and red seabream proved that it is possible to increase the proportions of long-chain polyunsaturated fatty acids by administering a fish oil diet within several weeks it also seems attainable to control the nutritional quality of pond fish by feeding a fish oil based finisher diet.

Changes in natural food resources in ordinary and “untypical” nursery ponds – i.e. where is the plankton?

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One of the most important features of carp farming is the possibility in their multipurpose usage and policultural ponds stocking, resulting from big carrying capacity and very different and rich natural food resources in earthen ponds. On the other hand, fish farmers still search for new species to be reared in ponds. In Poland production of rheophilic cyprinids for rivers restocking is becoming now very popular. Except ide, fluvial species are very sensitive, and they rather can not be reared together with carp on mass scale, which still remains as the basic and most important species.

Limited ponds area enforces farmers to find new opportunities, especially for rearing the youngest stages. Such possibilities give overwintering ponds and storing ponds, not used for carp in late spring and early summer.

However, several years observations carried out at Research Fisheries Station “Łąki Jaktorowskie”, Warsaw Agricultural University, showed big distinctions in zooplankton development, especially Cladoceras, between ordinary and such “untypical” nursery ponds, regardless to the reared species. Consequently big differences in fish survival rate and yields could be obtained. The aim of the paper is also to present practical guidelines for optimal management in such non standard overwinter ponds utilization.

Radio telemetry as a useful tool for monitoring of fish in pond aquaculture

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Radio telemetry has proven to be a powerful tool to study the biology, ecology and ethology of free swimming fish. Beside applications for the study of fish migration and fish biology in the wild, there have been several successful attempts to use this technique in fisheries and aquaculture. These investigations include the monitoring of individual free swimming common carp (*Cyprinus carpio* L.) in pond aquaculture in winter. This study will be presented in brief as an example for the use of radio telemetry in aquaculture. In the course of these investigations on common carp valuable data have been collected on the activity patterns of overwintering fish. Furthermore, the reaction of carp under the ice to low levels of dissolved oxygen have been monitored as well as the reactions of the fish to disturbances on the ice.

The radio telemetry technique and methods of radio telemetry transmitter implantation applied in this carp monitoring program will be presented. Moreover, an overview on the potential impacts of the technique on the fish, which have to be considered in study design, will be given as well. Finally, perspectives for future applications of advanced telemetry techniques in pond aquaculture, including elektromyogram (EMG) telemetry, which allows to evaluate energetics of free swimming fish, will be presented.

Can fish be a bioindicator of pond contamination?

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Common carp sampled from pond influenced by pesticide tomb and from control one and bream and roach sampled from a lake collecting water from contaminated ponds and from a lake nominated a protected reservoir have been analyzed for chloroorganic pesticides contamination. Concentration of HCH and Σ DDT in experimental carp (n=10) averaged to 0.0004 and 0.0680 mg kg⁻¹, respectively and in a control group (n=14) 0.0013 and 0.1051 mg kg⁻¹. The difference resulted from the age of fish: the experimental group was fry and the control one was 2–3 years old. Concentration of HCH and Σ DDT in bream (n=10) caught in contaminated lake averaged to 0.0031 and 0.3224 mg kg⁻¹, respectively, and in control ones (n=10) 0.0015 and 0.1771 mg kg⁻¹. In roach (n=18) from contaminated lake the HCH concentrations averaged to 0.0006 and Σ DDT 0.1880 mg kg⁻¹, and from control lake (n=10): 0.0006 and 0.1947 mg kg⁻¹, respectively.

There were 54 tons of pesticide wastes in 36 wells and 2 unprotected holes stored for over 30 years in the nearness of ponds and lake. It is assumed that from ten to twenty tons of deposit have been washed out into the surrounding environment but concentrations of OCl in fish do not confirm the contamination.

Biosecurity concept

Eradication and free pathogen zoning is not possible using regulation which is why we need to explore and propose alternative solutions targeting disease control. The biosecurity concept adapted to fish husbandry is one of the main possible response to this challenge offering pathogen free eggs and larvae to aquaculture (ie. free from disease and pathogens, fully immunocompetent, no therapeutic residuals...).

Biosecurity: an added value for aquaculture image taking care of our common environment

The biosecurity concept when developed at early fish stage (breeders and eggs) is thus a strategic winning card for sustainability of this activity. However, the private sector has to take in account this concept and methodology in the existing fish production chains as well as in the new one in order to establish a safe, secure and reliable fish fry production for open sea rearing.

This strategy will benefit the aquaculture sector at different levels: farm economy (health status, no disease and subsequently less treatment), aquaculture product image (market and labelling), environmental care (limit and control of the pathogen spreading).

Reproduction capability of triploid tench (*Tinca tinca* L.) males

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The tench *Tinca tinca* is an interesting fish from the viewpoint of polyploidy and related atypical reproduction aspects. Triploid tench were produced artificially. Studies of spermiation as well as of sperm motility and structure were performed on several triploid and diploid males simultaneously with individual experimental crosses with diploid females to define their reproductive capacities. The testes of triploids visually looked less developed in the most of cases with lower sperm production (0.05 ml sperm per male), GSI and weight of testes compared to diploids (0.58 ml sperm per male). Analysis of variance showed significant influence of ploidy level on the percentage of motile spermatozoa. Triploidy did not change percentage of live spermatozoa and velocity of spermatozoa at the first time of sperm movement. The study of sperm structure by scanning electron microscopy revealed that most sperm cells were of normal structure with some anomalies. Sperm heads of triploid and diploid males were mostly round-shaped, 1.86 ± 0.2 and 1.6 ± 0.18 μm in diameter. The midpiece of triploid spermatozoa was slightly narrower than that of diploid ones with typical cylindrical shape. Flow cytometry revealed sperm cells of triploids to be largely aneuploid (1.47 n) with high mosaic DNA, oscillating from haploid DNA content (1.0 n) to diploid DNA content (1.9 n). Experimental crosses between triploid males and diploid females revealed that these males were capable to stimulate effective development with relatively high level of fertilization and hatching rates from 0 to 70 %. In conclusion, triploidisation does not seem to guarantee sterility of tench.

Egg quality of Arctic char (*Salvelinus alpinus*)

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The n-3/n-6 polyunsaturated fatty acid ratio in the natural diet of all organisms differs between fresh and marine environment, being much lower in freshwater compared to marine water. Arctic char (*Salvelinus alpinus*) eggs were reared over the past few decades, allowing a comparison between the eggs from females on a diet based on lipids of limnic (natural food chain) origin and eggs from females fed an artificial diet of marine origin. Fatty acid composition was analyzed in groups of females of natural and farmed origin. Because of the different importance of membrane and storage lipids respectively, these two lipid fractions were separated and analyzed. The content of 20:5n-3 in phospholipid fraction was higher in eggs from reared females compared with eggs from natural population. Further, in PL fraction, 20:4n-6 levels in these eggs were significantly lower (1.5 % versus 8.9 %). Also, the content in the triacylglycerol fraction differed greatly between wild and eggs from reared females, whereas this fraction showed almost no corresponding difference in EPA content. In addition, the level of 22:6n-3 differed greatly between the two groups, 31 % in the farmed fish eggs vs 22.5 % in the wild. The results indicate that the natural balance of essential fatty acids in terms of eicosanoid precursors and membrane properties is greatly altered, possibly being the cause of low hatching success in the eggs of farmed broodstock.

5. Raising Product Quality from Pond Aquaculture, Economics and Networking

Biosecurity in juveniles production: a major concept in European aquaculture

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New constraints: taking into account the main stream requirement of “society”

Production is no longer the unique objective of Aquaculture, but must now include the increasing requirements in society, in term of « biosecurity », ethic, environment footprint, sustainability, toward a new image for the citizen. This is the only way to ensure market.

The Sanitary security of aquaculture products

The safety of food for human consumption is the major requirement of EU consumers. This requirement is namely supported by consumer associations and is now included in specific EU regulations regarding « product “traceability” » In addition, this new requirement is a legal opportunity to control the access of foreign products, from less regulated countries, into the EU market. This opportunity will provide market advantages for EU products in EU market.

Ethics and Quality image of aquaculture products (Eco & Etho labelling)

The goal is to develop safe and high quality products in the cleanest possible environment. The requirement is no longer only for the treatment of diseases, but also the certification and holding of optimal sanitary status. Being safe is more than not being sick, it includes the welfare status and so the Etho-labelling. Good husbandry practices (rearing density, physical and chemical water parameters, etc...) should finally optimise rearing performances such as growth, and survival rate, leading to an increase of our private sector competitiveness.

Economical and financial constraints

Commercial pressures within our industry necessitate an adjustment to a real-time market/production. This real-time production management is now fully developed in fish hatcheries. The fish fry supply is a key point for aquaculture and this lead us to establish a safe, secure and reliable fish fry production.

Diludine – an effective growth stimulator in common carp

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Earlier we have shown diludine properties as an antioxidant in food and as an antimutagen and complexon in fish. The effect of diludine, a dihydroisonicotinic acid derivative (2,6-dimethyl-3,5-dicarboxy-1,4-dihydropyridine; C₁₃H₁₉N₂O₄), on the growth rate was studied in common carp fry reared under normal ecological conditions of fish-rearing. Feeding of 55-day old carp fry with combined food with the agent additive for 23 days was revealed to increase the weight gain on the average by 80 % as against the control variant. The mean relative growth rate per day under the diludine effect was much higher than in the control. The weight gain in the experiment was higher as compared to that in the control pond for the next 63 days, when the agent was not used. During this period the mean relative growth rate in fish age-0 in the experiment per day was much higher than in the control. This fact indicates the aftereffect of the diludine. Growth-promoting activity under the diludine influence was also observed when measuring the length, height and width of a fish body (L, I, H, B). It is important that diludine is ecologically safe and is not a hormone. Thus, diludine is an effective agent for increasing fish productivity and improving the quality of aquaculture fish rearing. It may be successfully used in production of fish food as an antioxidant additive.

Plankton primary production and its relationship to other ecological factors in control and treatment organic fishery carp ponds

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The experiments were carried out on four ponds with a water area of 0.18–0.38 ha and depth of about 0.7–0.8 m at the IFA - Varna, Branch of Freshwater Fisheries, Plovdiv, during the summer, 2004. The structure of pond polyculture included carp and phytophagous fish. The gross plankton primary production was measured by the Oxygen and Chlorophyll methods applying the 'light-and-dark bottle technique' (Vollenweider 1969) and standard analytical procedure (ISO-1/1980 and ISO 5667-2/1991) for chlorophyll-a determination. Two of the ponds were manured in doze of 3000 kg/ha, while the two others served as reference. The values of the gross primary production in the treated ponds were in the range 1.30–11.77 mgC.dm⁻³.d⁻¹ (0.1 m depth), 0.96–9.25 mgC.dm⁻³.d⁻¹ (0.3 m depth) and 1.2–6 mgC.dm⁻³.d⁻¹ (0.5 m depth). In the reference (unfertilized) ponds the values in the corresponding depths were as following: 0.30–10.10 mgC. dm⁻³.d⁻¹, 0.30–9.64 mgC. dm⁻³.d⁻¹ and 0.06–6.71 mgC. dm⁻³.d⁻¹. The values of chlorophyll a were in the range 26.54–269.57 (Chl, kg 10-6m⁻³) for fertilized ponds and 2.22–463.73 (Chl, kg 10-6m⁻³) for the reference ponds.

ANOVA and correlation analyses were applied for determination of the effect of the manuring and for studying the relationship between plankton primary production and other factors.

Reduction of cyanobacterial blooms in the Třeboň fishponds – searching a sustainable development strategy (pilot study)

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The Třeboň fishponds site embraces a highly complex of artificial fishponds in the floodplain of Lužnice and Nežárka Rivers. This whole site is situated inside the Třeboň Protected Landscape and, since 1990, the Třeboň UNESCO Man and Biosphere Reserve. In total, there are 460 fishponds (180 within Ramsar Site), which were constructed in the 15th and 16th century. However, since the end of 19th century the intensity of fish-farming has constantly increased. The basic aim of this study was to compile current situation on the quality and quantity of cyanobacterial blooms in the Třeboň ponds.

20 ponds were selected according to different environmental variables (producing or non-producing pond, volume, surface area, mean depth, type of sediment, amount of macrophytes in littoral, conductivity, pH, fishpond system affiliation) and seasonal changes in phytoplankton communities were studied during the period June-October 2004. Our results show that almost one half of ponds suffer from extensive cyanobacterial blooms (CB). We recorded only 25 % ponds without and 30 % with very low amount of CB. The most extensive and prolonged CB occurred in the large fishponds, except the fishpond Svět (CB occurred only for a short period at the end of the summer). The most common cyanobacterial morphotype was *Microcystis aeruginosa*. In two ponds, CB were dominated by one genera only: in the Břilický pond by morphotypes *Microcystis aeruginosa* and *M. ichtyoblabe*, in the Rožmberk pond by *Planktothrix isoethrix*. According to the scientific literature, these three morphotypes are the most toxic from all bloom-forming cyanobacteria. These results should be taken very seriously, since CB cause not only increase of fish receptivity to diseases, but also loss of small fry. Further it causes decrease of fish yield and the biodiversity of the whole wetland ecosystem. Moreover cyanotoxins could cumulate in fish body. The consequences of consumption of fish contaminated with

Investigation on reproductive potential of male narrow-clawed crayfish *Astacus leptodactylus* Esch

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Experiments to study the reproductive potential of male narrow-clawed crayfish *Astacus leptodactylus* Esch. are carried out in two contiguous years. Pond cultured crayfish, placed into 20-litres aquariums at the following sex ratio between male and female: 1:1, 1:2, 1:3, 1:4, 1:5, 1:6, 1:7 and 1:8 are investigated. The following parameters are studied: period of mass copulation, number of copulations, interval between two copulations, the time from spermatophor placing on female's body to the eggs ovulation and fertilization. Two or four repetitions for each ration are carried out.

It was observed, that one male crayfish could place a spermatophor on 8 females. A mass placing of spermatophores on the female's body occurred at water temperatures of 8-12°C. One and the same individual can copulate with 2 or more females in a period of 1 to 3 days. Mass ovulation of oocytes was observed at the same day when spermatophor was put on female's body or 1 to 2 days after that.

Effects of integrating Nile Tilapia (*Oreochromis niloticus* L.) in cage cum open-pond system on growth, feed utilization, water quality and economic performance

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A study was conducted to evaluate the potential for improving yields, feed utilization economic returns and water quality in cage cum open-pond integration system with *Oreochromis niloticus*. There were four treatments with four replicates; 300 open-pond fish, no cages (T1-control), 150 open-pond fish, 150 caged fish (T2), 300 open-pond fish, 150 caged (T3) and 300 open-pond fish, 300 caged fish (T4). Male fingerlings were stocked in ponds and cages and the caged fish fed at 1.5 % body weight for 125 days. In T1 all fish were fed in the open-pond. Introducing Caged fish in ponds significantly improved open-pond harvest weight in T2 (91.6g) compared to T1 (63.5g). However, the caged fish in T2 registered the lowest mean weight (64.7g). T2 had significantly higher combined harvest weight (77.5g) than other treatments (62-66g). Gross and net yields were lowest in T1 (13,768 and 8,856 kg/ha respectively) but highest in T4 (30,391 and 18,795 kg/ha respectively). Survival was similar in all treatments but fingerling production was lowest in T2. At lower densities, FCRs and some key water quality parameters significantly improved in the integrated systems. T1 and T3 made losses of US\$ 4.26 and US\$ 0.56 respectively while T2 and T4 made respective profits of US\$1.45 and US\$ 4.17. It was concluded that cage-cum-pond integration has potential for improving pond yields, feed utilization water quality and economic returns in cage cum open-pond integration of *O. niloticus*. With this system feed input might be reduced by about 50 % as compared to non-caged systems.

cyanotoxins for human are still unknown. We plan a complex study to specify the crucial factors for the mass development of toxic CB. This study should search possible ways of prevention of CB with regard to the nature preservation and, also to the Czech traditional fish-farming industry. We would like to stimulate cooperation with fish aquaculture specialists and limnologists focused on prevention and management of CB.

Basic lines of analysis of water ecosystem parameters behaviour in carp ponds

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The behaviour of water ecosystem parameters in carp ponds has been analyzed in accordance with the elaborated concept for modeling of interrelations between water ecosystem parameters in carp ponds and on the basis of formed schemes for probable dependencies between traced parameters, by means of working out adequate models in three basic lines that are the purpose of the present work.

On the first basic line a sample model has been worked out for statistic characteristics study of each one of the parameters that have been traced out. The model is applied for each pond separately.

The second line of study has been developed on the basis of a second sample model that reflects the interrelation between the studied characteristics. Only the dependence in pairs has been analyzed at this stage by applying a classical statistic approach. The interrelations have been analyzed in the following two aspects on the principle of “each one with each one”.

The third line of study has been drawn up on the basis of a sample model that gives the chance to compare the changes of a particular characteristic for all ponds simultaneously by comparing the trends and range of changes.

European catfish as an object of Belarus pond fish-breeding in polyculture

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Feeding fish is fish-breeding intensification basic method in Belarus. Species requiring mixed fodders consumption dominate in grown fish volumes.

Mixed fodders consumption reduction is possible through polyculture practising, the relevant role in which belongs to predators. European catfish is fish breeding perspective object in Belarus. Thus broodstock forming, yearlings development and commodity fish cultivation technology problems arises.

Catfishes caught in Liuban water storage basin became broodstock formation starting material. Catfish artificial reproduction by traditional factory way is labour-intensive process including many manual operations. Therefore Belarus scientists offered new reproduction way eliminating sexual products selection, fertilization and degluing eggs processes. This way is approved and positive results are obtained. Catfish cultivation results according to elaborated technology show that growing up fry survival in ponds amounts 49 %, with average fish mass 1,5g. Yearlings survival rate achieves 40 %, with average fish mass 64–200g; fish productivity achieves 21–31 kgs/ha. Yearlings cultivation results depend on accessible forage availability and stocking density.

Fish productivity according to commodity fish depends on stocking density. Yearlings stocking with density 80 and 120 thousand/ha provided fish productivity 43 and 80 kgs/ha.

Thus results obtained testify that catfish normally grows and develops in Belarus pond conditions and allows to receive fish products 40–80 kgs/ha additionally without concentrated forages consumption.

Current status of Ropsha carp in Ropsha Fish Farm

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Reproduction of 9th generation Ropsha carp was realized in Ropsha fish farm of Russian Federal Center for Fish Genetics and Selection during 2001–2002. At least 12 males and females of growth rate and exterior corresponding to standards of selection have been chosen for crossing. Average female fecundity was about 300–350 thousand ovulated eggs and 100–110 thousand three-days-old larvae, and it corresponds standards. One-summer-old fish survival was not less 30–35 % of amount three-day-old larva, and average weight – 24–25 g. During second year of live pedigree fishes increased their weight up to 400–500 g. All this parameters also corresponded selection standards.

Strain structure has been investigated by DNA fingerprinting. HaeIII has been used for DNA restriction. Some different sondes has been tested for fingerprinting. As known, strain structure includes three subunits of different rate of Amur sazan heredity. Subunit MM (most distant from Amur sazan) and sublayer BM (intermediate) contain marker strips which are rare in BB subunit (closest to Amur sazan). There are some strips of high frequency in one subunit which are not presented in other ones.

The highest similarity factor (0,60) has been found in BM subunit. Similarity factor in MM subunit was a little smaller (0,57), and BB had minimal similarity factor (0,54). The longest genetic distance has been found between fishes of subunits BB and MM. BM located intermediately and a little close to MM. Based on analysis of similarity factors and strip frequency we can conclude about genetically apartness different subunits of Ropsha carp. Heterozygosity factor has been calculated also. BM subunit had the least variability and BB had the highest one.

Obtained results are evidence of:

1. Keeping and breeding conditions of Ropsha carp provide apart reproduction of subunits
2. In accordance with origin BM subunit is located intermediately between BB and MM ones.
3. Lower heterogeneity of BM subunit is a signal about low quantity spawners of this subunit.

Elaboration of a concept for modeling the interrelations between water ecosystem parameters in carp ponds

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The present article is connected with elaboration of the concept for modeling the interrelations between basic abiotic, biotic and technological parameters of the water ecosystem in carp ponds.

The tests have been conducted at the experimental pond farm in the Branch of Freshwater Fisheries for the period 2002–2004. Ponds with area from 0.13 to 0.38 ha with different fish polyculture and technological regime have been used.

Different schemes for probable dependencies between traced parameters and problem issues between them have been formed and offered on the basis of traced 9 abiotic (physic-chemical), 6 biotic (biological and microbiological) and 7 technological parameters of ponds. They are a basis for elaboration of imitation models for separate components of the ecosystem in carp ponds.

The feeding in larval and juvenile whitefish *Coregonus lavaretus* and their impact to the trophic cascade

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Seasonal dynamics (abundance and biomass) of the plankton organisms (bacteria, planktonic ciliates, phytoplankton, metazooplankton) was studied in three natural food ponds (mean depth 1.6 m, mean surface area 5.1 ha) in Härjanurme fish farm where larval and juvenile whitefish *Coregonus lavaretus* were reared prior to stocking. Over a rearing season (April–October) the growth and diet of whitefish was followed – the TL of caught fish was measured to the nearest 1 mm and their weight to the nearest 0.01 g. The gut contents were analysed under a microscope at a magnification of x 50–100.

The mean TL of whitefish was 18 mm and weight 0.02 g in May and 135 mm and 14.3 g in October. One whitefish ate in day an average 4026 cladocers (maximum 13333), 376 copepods (maximum 1401), 88 rotators (maximum 1322) and 67 chironomids (maximum 662). Young whitefish started to eat chironomids already in May and there was no clear shift to the benthivory during summer. Juvenile fish had very strong impact to the plankton. When whitefish ceased to eat in July due to very high water temperatures (28 °C) the whole plankton community changed rapidly – abundance of metazooplankters increased, abundance of phytoplankton and ciliates decreased due to stronger grazing pressure, which lead in turn to the increased abundance of bacteria. The nature of the trophic cascade in natural food ponds will be discussed in more details.

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Toxicity of Diazinon 60 EC prepare for fishes

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The prepare Diazinon 60 EC (organophosphate – active substance diazinon in a concentration of 600 g.l⁻¹) is being used in fishery practice as a biocide to reduce excessive development of the coarse daphnian zooplankton in well-founded cases. This prepare, in a concentration of 10 µg.l⁻¹ (i. e. 100 g per 1 hectare of pond area at average depth of 1 m), eliminates very selectively daphnian zooplankton, it is relatively rapidly decomposed in aquatic environment and exhibits harmless effects on fish at this concentration. Presented results are documented by the acute test of toxicity on fishes: 96hLC50 for *Poecilia reticulata* (3 mg.l⁻¹), and *Cyprinus carpio* (10–25 mg.l⁻¹). Neither the embryonic and larval tests on *C. carpio* at a concentration of 10 µg.l⁻¹ showed any damage of carp during these sensitive periods of ontogeny.

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Seasonal temperature preferences of a mixed carp (*Cyprinus carpio* L.) and tench (*Tinca tinca* (L.)) stock

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The seasonal preferred temperatures of a mixed carp (17 individuals, 1+, 10 ± 0.32 cm T.L.) and tench (17 individuals, 2+, 10 ± 0.36 cm T.L.) stock was determined in a 26 m long gradient (maximum temperature 34°C, minimum temperature 9°C). The results (Table I) showed an overlap of the preferred thermal niches in all the seasons.

Season	Optimal niche (mean selected temperature ± standard deviation) (°C)	Selected niche (range between minimum and maximum temperature selected) (°C)
Spring	29.50 - 31.12	23.50 - 31.50
Summer	29.62 - 31.07	23.50 - 31.50
Autumn	29.61 - 31.08	27.50 - 30.50
Winter	Carp: 23.16 - 31.51 Tench: 20.60 - 31.39	19.50 - 31.50

Hydrolytic Enzymes of Maturing Fish Eggs

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The presence of hydrolytic enzymes, mainly endopeptidases, in the aqueous medium in which fertilized fish eggs were incubated was reported more than twenty years ago. Choriolytic enzymes are assumed to be responsible for the disruption of the egg envelope, thus enabling the hatching of the fry. The presence of the enzymes could also help to protect the eggs against bacteria. Since 1994, we have been studying aminopeptidases with different specificity in the eggs and the surrounding water. As the eggs mature and hatching approaches, the activity of certain aminopeptidases increases considerably in the eggs. This has been observed in a number of fish species, recently in the case of the Atlantic Salmon (*Salmo salar*). Egg aminopeptidases are apparently part of the protein vitellogenin from which they are released. The enzymes are very stable and could persist in untreated incubation systems and possibly accelerate the disruption of the immature egg envelope during incubation.

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Some aspects of reproduction of Acipenseriformes in the south of Ukraine

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The southern region of Ukraine plays a great role in the question of sturgeon aquaculture. Dneprovski production-experimental sturgeon hatchery (DPESH) is the leading enterprise in this branch of aquaculture.

Until recently all objects of DPESH have been presented by marine sturgeons, inhabitants of the northwest part of the Black sea. These are *Acipenser guldenstadti colhicus*, *Huso huso*, and *Acipenser stellatus*. A constant decrease in sturgeon stock has necessitated a search for additional species as cultivation objects and other ways of technology optimization. Since 1996 DPESH has started cultivating *Polyodon spathula*. In 2004 the reproduction of *Acipenser ruthenus* was initiated.

In 2004 during the process of reproduction there were used 1 female of *H. huso* (115 thousand larvae received), 13 females of *A. guldenstadti colhicus* (2515 thousand larvae received), 25 females of *Polyodon spathula* (151 thousand larvae received) and 19 females of *A. ruthenus* (72 thousand larvae received).

For the introduction of technology that provides preservation of spawners, there was an attempt to receive the eggs without killing the female. Females, whose life was saved, were put in the ponds with the prospect of their further domestication.

The received data show an essential change in species' structure of spawners, which have been used, as well as the material produced.

Thus, DPESH has forced to increase the number of cultivated species, and also to introduce the technologies different from those envisaged by the project of DPESH. These facts show that there is an active and effective search of a solution to a difficult situation in sturgeon reproduction.

Carp (*Cyprinus carpio*) substrate preferences under controlled experimental conditions

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The substrate preferences of a *Cyprinus carpio* stock (33 individuals, 1 year old, $10 \pm 0,32$ cm T.L.) was determined. A 26 m long channel in which four substrates (concrete, artificial vegetation, gravel and mud) were placed was used. Six trials were performed combining the substrates by pairs (mud-vegetation, mud-gravel, mud-concrete, vegetation-gravel, vegetation-concrete and gravel-concrete). Selection order was: mud (86.7, 98.7 and 99.0 % when compared with vegetation, gravel and concrete respectively), vegetation (97.8 and 99.8 % when compared with gravel and concrete respectively) and there was not a clear preference between gravel and concrete (51.2 % of the stock selected gravel in the gravel-concrete trial).

Rearing success in ide, *Leuciscus idus*, fry culture with different duration of initial feeding with live food

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The ide, *Leuciscus idus* (Linnaeus, 1758), belongs among autochthonous, scarce and vulnerable fish species of the Czech Republic with necessary increased attention regarding their protection and reproduction issues. Thus, the possibilities of artificial spawning and fry production in a controlled environment have been tested. The aim of this study was to find an optimum time for shifting larvae from live food (nauplii *Artemia salina*) on self-starter fodder ASTA (50.48 % nitrogen substances, 9.11 % fatty matters) with sustained good survival and growth rates. Hatched larvae were reared since they commenced the exogenous nutrition based on live food (D0) in sixteen flow-through aquariums incorporated into the recirculation system. At the end of experiment (D25), high levels of survival and individual weight were recorded in the groups D (90.6 %, 178.6 mg; 15 days *A. salina* + 10 days starter), A (89.9 %, 169.9 mg; only *A. salina*) and C (88.6 %, 160.4 mg; 10 days *A. salina* + 15 days starter). Significantly lower values were found in the group B (57.1 %, 92.6 mg; 5 days *A. salina* + 20 days starter) and the lowest one in the group E (29.8 %, 75.6 mg; only starter). At the end of the experiment, the mean values of ontogenic development level in the groups A-E were analogous as for longitudinal and weight growth (downward succession groups = D > C > A > B > E). The groups D, C, A consisted completely of juvenile individuals (J1, J2) and the groups B and E of larvae and juveniles (L5, L6, J1, J2). Also condition and production parameters (FWC, TL:w ratio, SGR, FCR) and relationships between TL, FL and SL were evaluated.

The content of total mercury and methylmercury in common carp from selected Czech ponds

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This work was aimed to monitor of total mercury (THg) and methylmercury (MeHg) contamination level in Rožmberk, Spolský, Nezmar and Velký Bědný ponds in the Czech Republic. Seven individuals of common carp (*Cyprinus carpio*) were sampled from each pond. Muscle and pooled samples of liver, milt and egg were used for analysis. THg and MeHg contents were found in all samples of muscle and liver. MeHg content in milt and egg were under detection limit. THg content in muscle was in range 0.018–0.063 mg·kg w.w. and MeHg content was in range 0.019–0.063 mg·kg w.w. The proportion of MeHg to THg in fish muscle was in range 90–100 %. THg and MeHg contents were significantly higher ($p < 0.05$) in fish from Spolský pond in comparison to Nezmar pond. The MeHg/THg proportion was significantly higher ($p < 0.05$) in fish from Rožmberk, Spolský and Nezmar ponds in comparison to Velký Bědný pond. There was not found significant correlation between weight and length of fish and the content of THg and MeHg because of similar fish age. Results show low contamination level of monitored ponds and predominance of MeHg.

Fish parasite fauna of the Dnepr River and the Dnepr-Bug Firth

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The prospect of combating fish helminth in the open-air reservoir lies in preventive measures. The basis of all preventive measures is in parasitological inspection of reservoirs.

During 2003–2004 there were inspected 1134 samples of 16 fish species in the delta of Dnepr and the Dnepr-Bug Firth. From the total number of all fish which have been examined helminths were detected in 1024 samples which make 90.3 %. Detected helminths belong to 5 classes: Trematoda, Monogenoidea, Cestoidae, Nematoda, Acanthocephalae. Our research has established qualitative and quantitative discrepancies in the fauna of fish helminth of the Dnepr River and Dnepr-Bug Firth delta. The fish of the delta reservoir differs by higher figures in the degree of helminth infection as well as the quantity of parasites found. Significant distinctions in fish invasion are accounted for by the differences in hydrological and hydro biological conditions of these reservoirs and the discrepancies in specific composition of invertebrate animals which inhibit the indicated reservoirs. The comparison of helminth fauna has given us the opportunity to define the specificity of helminth species composition of the comparable areas which is connected with various hydrological and hydro biological conditions. As a result of the research there have been distinguished 109 species of fish helminth. The most numerous systematic groups are Trematoda (76 species), Cestoidae and Nematoda (in 14 species) and Acanthocephalae (5 species). The most infected species found in the Dnepr River Delta are roach, herring, cat-fish and perch (96.6 %; 78.7 %). Bream and cat-fish (96 %; 78.1 %) are the helminth infected species detected in the Dnepr-Bug Firth.

This fact should be taken into consideration for the organization of fishing and fish processing. The obtained data testifies to the necessity of complex systematic ichthyopathological research work in the lower of the Dnepr River which should underlie the system of fish infection preventive measures in the open-air reservoirs of the south of Ukraine.

Resazurin reduction test evaluation of african catfish semen quality

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The resazurin reduction test (RRT) depends on the ability of metabolically active cells to reduce the resazurin dye to resorufin. In the present investigation spectrophotometric evaluation of RRT to assess the color change of resazurin reduction in butanol extracted color to evaluate goat semen quality. 5 samples of catfish semen were included in this study and the absorption was read at 580 nm and 615 nm respectively. Results indicated that RRT ration decreased as the preservation time increased and the highest correlation was observed with sperm motility % ($r=0.962$, $P<0.0001$) and acrosomal integrity ($r=0.803$, $P<0.0001$).

In conclusion, RRT could be used as an additional diagnostic tool for evaluating the quality of catfish semen.

Key words: resazurin, semen, catfish

Sex control of common carp – a review

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The common carp is a leading species in the Czech pond aquaculture. Artificial sex regulation and sex control of common carp as well as other fish species is connected mainly with hormonal sex reversal methods. Common carp is a convenient subject for this type of investigation. Hormonal sex reversal is made by influence of sex steroid hormones on the normal process of sex differentiation which lead to sex inversion of common carp. These technics may be successfully used for producing of all-female progenies of common carp. Rearing of all female progenies in condition when fish normally reach sexual maturity before reaching of market size increased production yield by 7–8 %. This could be a new opportunity to efficient breeding of common carp in the Czech pond aquaculture. The aim of this review is to summarise data about sex reversal and sex control of common carp together with unpublished data of the authors from our institute.

Ammonia autointoxication of common carp: three case studies

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The aim of the study was to describe three case studies of ammonia autointoxication of the common carp (*Cyprinus carpio* L.). In the first case, carp yearlings with full digestive tract were transported during the growing period from pond water (17 °C) into tap water (12 °C). In the second case, marketable carp after one-month storage were transported into storage ponds with markedly lower temperature of water. In addition, stress due to harvest and transportation occurred in this case as well. In the third case, marketable carp were transferred from fishing ground of a pond (18 °C) to a storage pond (10–12 °C). Harvest was carried out in late September, when the fish were still ingesting natural feed. In all cases, highly increased concentrations of ammonia in blood plasma of the fish were found. Highly congested, dark-red coloured, oedematous gills were registered in all specimens.

2. Interactions with Protected Plants and Animal

Restoration of pond ecosystems and adequate management of pond preserves in Czech Republic

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Four years project “Environmentally friendly fishery pond management” was worked out by Agency for Nature Conservation and Landscape Protection of the Czech Republic. On the basis of investigation more than 200 ponds with different level of nature protection factors damaging pond ecosystem were found out. Different aims of pond ecosystem restoration, adequate pond management and possibility to adjust nature protection and fish production are described.

Possibilities for reducing protein content in carp (*Cyprinus carpio* L.) diets by using cottonseeds and their influence on some exterior and immune-biochemical parameters

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The aim of the research is to trace out the influence of diets with three levels of non-extracted cottonseed and reduced protein content on some exterior and immune-biochemical parameters in one-summer old carp (*Cyprinus carpio* L.). Two experiments have been conducted with one-summer old carp, reared in ponds in polyculture at following initial density: 10-day old carp fry – 8000 pcs.dka⁻¹. Experimental diets prepared on the basis of fodders most frequently used in carp rearing have been used when feeding the fish at 3 levels of cottonseed – 2, 12 and 56 %. The increase of cottonseed level in the experimental diets against the control is for the account of sunflower groats.

The results of the conducted investigations outline the possibility for reducing the level of raw protein to 23 % and increasing the concentration of non-protein energy to 3120 kcal.g⁻¹ by introducing 12 % and 56 % non-extracted cottonseed in the diets for one-summer old carp. For optimal quantity 12 % of cottonseed is recommended in case of combination with suitable protein fodders.

Investigation on fecundity of cultured and natural crayfish populations of *Astacus leptodactylus* Eschscholtz, 1823

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The objective of the present study is investigation on fecundity (pleopodal eggs number) and eggs size (weight and diameter) of both – a cultured and a natural narrow-clawed crayfish population (*Astacus leptodactylus* Eschscholtz, 1823). Further the relationship between these features and the body weight and length, and length and width of the carapace is studied.

The investigation is carried out in May 2001 on 71 berried female crayfish, reared in carp ponds and in May 2004 on 60 berried female crayfish from “Pyasachnik” dam-lake. Using tweezers 10 pleopodal eggs from each crayfish are detached and the diameter as well as the weight are individually measured in a fresh status. A total number of 1310 eggs were investigated.

It was found out that the fecundity of the pond crayfish population is 162.7 ± 104.1 pleopodal eggs; the average eggs weight is 13.62 ± 1.72 mg and the diameter 2.96 ± 0.2 mm. The crayfish fecundity of the natural population in “Pyasachnik” dam-lake is 200.8 ± 89.2 pleopodal eggs; the average eggs weight is 12.36 ± 1.71 mg and the diameter 2.75 ± 0.17 mm.

There are significant differences between the eggs number of the both investigated populations. The crayfish females from “Pyasachnik” dam-lake have with more pleopodal eggs compared to the pond cultivated ones ($p < 0.05$). On the contrary, the average values from the eggs weight and diameter of the pond-reared population are bigger ($p < 0.001$) in comparison to the dam-like ones.

A low correlation coefficient ($r \leq 0.3$) is found out between the eggs weight and diameter and the investigated morphometric body features, but a considerable correlation ($0.6 \leq r \leq 0.7$) was proved between the eggs number and the same morphometric body features.

Aquatic and marsh plants in hypereutrophic fishponds

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In Central Europe, intensely or semi-intensely managed ponds, densely stocked with fish (mainly common carp *Cyprinus carpio* L.) and receiving high nutrient inputs in mineral fertilisers, organic manure and washout from fields or from waste effluents, are good examples of hypereutrophic water bodies. Their originally extensive management has now become strongly intensified. The lime, fertiliser, manure and feed inputs, and the fish stock itself, profoundly affect the environment. This paper uses as examples mainly the results of research on macrophytes and algae living in the ancient and nowadays mostly hypereutrophic fishponds in the Třeboň Basin Biosphere Reserve, Czech Republic. The paper tries to summarise and evaluate the importance of various ecological and ecophysiological adaptive strategies employed by macrophytes in their struggle for survival in these shallow water bodies. Macrophytes – both hydrophytes and helophytes – are here regularly exposed to a strong competition with algae for carbon dioxide, irradiance, phosphate and other nutrients. The plant adaptations may be grouped under several headings. (a) Physiological adaptations; (b) growth and life-cycle adaptations; (c) adaptations to the shading effect of algae. The responses of macrophytes to various fishpond management practices (water level and fish stock manipulation, liming, manuring, etc.) are discussed with respect to the above adaptations.

Growth patterns of reed (*Phragmites australis*) – on the development of reed stands in carp ponds

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Reed stands in carp ponds are of great value for conservational interests because they are inhabited by numerous animal species, especially birds. On the other hand, reed expands quickly if not prevented and can soon strongly restrict the pond area suitable for carp cultivation. During three years, the growth of reed stands in carp ponds in Saxony, Germany, has been investigated. The main growth traits measured were diameter, density and length of the shoots. A comparison of their means, their annual development and the annual development of their coefficient of variation revealed the existence of five characteristic growth patterns. The growth patterns represent states of a long-term change of the reed stand structure dependent on age and environmental influences.

Basically, the development is directed from thin shoots growing at high densities towards less and thicker shoots. The change of growth patterns is an adaptation to the accumulation of matter in the stands and is caused by the growth of reed itself.

The environmental conditions in carp ponds provide very good conditions for the growth of reed. Thus, the long-term development will be irreversible by natural influences. The pond aquaculturist has to interfere if he wishes to avoid lasting siltation of pond areas. Usually, this is done by mowing the stands, what turns the irreversible siltation into a circulation of stand structures.

Determination of a mixed carp (*Cyprinus carpio* L.) and tench (*Tinca tinca* (L.)) substrate preferences under controlled experimental conditions

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The substrate preferences of a mixed carp (17 individuals, 1+, 10 ± 0.32 cm T.L.) and tench (17 individuals, 2+, 10 ± 0.36 cm T.L.) was determined using four different substrates (concrete, artificial vegetation, sand and mud) in a 26 m long channel. Both species showed a high preference (100 %) for the mud. Six more trials were performed combining the substrates by pairs (concrete-vegetation, concrete-mud, concrete-gravel, mud-vegetation, mud-gravel, gravel-vegetation). Carp and tench showed the same selection order: mud (100 % when compared with concrete and sand and 99.18 ± 0.91 % when compared with vegetation), artificial vegetation (100 % when compared with gravel and concrete), gravel (100 % when compared with concrete) and concrete.

Testing of performance in common carp (*Cyprinus carpio* L.) under pond husbandry conditions: Top-crossing with Northern mirror carp

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Performance tests of Northern mirror carp (M72) and its three different crossbreds were conducted in semi-intensive pond conditions from the larval stage up to market size. The aim of this study was to evaluate the possible utilization of new hybrid combinations (M72xPL – Pohořelice mirror carp) and (M72xDor – Israeli mirror carp) and to compare them with a hybrid widely reared as a commercial product (M72xM2) and with M72 purebred. The testing model was derived from similar studies carried out in the conditions of the Czech Republic, where an internal control of different scale cover is used to eliminate all non-genetic effects. ANCOVA revealed at market size significantly better growth in M72xDor ($1,619 \pm 28.3$ g; LS mean \pm S.E.) and M72xPL ($1,475 \pm 29.8$ g) compared with M72 ($1,278 \pm 26.3$ g). Survival during whole test in duration of 3 years was in M72xDor hybrid significantly the best as well as the dressing out parameters measured at market size even if these were significantly different only at proportion of fillets with skin (39.1 ± 0.28 %). Interestingly, the commonly used crossbred M72xM2 by Czech fishermen showed at growth ($1,371 \pm 26.2$ g) and survival the lowest values among crossbreds and with regard to dressing out parameters mostly among all tested groups.

Computer-assisted image analysis in evaluation of fish injuries caused by cormorant (*Phalacrocorax carbo sinensis*) attacks

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Cormorants grasp prey fish by sharp tip of the beak with the tendency to hit the proximal body area behind gill cover (*operculum*). They emerge with the prey on water surface before swallowing it head forwards. Fish, which escaped from cormorant's grasp and/or which could not be swallowed due to their big size, suffer from various deep injuries resulting in consecutive infections and subsequent mortality. The computer assisted image analysis was applied to describe the time dependent course of injury infection and progress. Two-year-old mirror carp ($\cong 250$ mm TL, 200 g W) which escaped from cormorant's beak grasp had injuries ranging over approximately 10 % of the total body surface. Immediately after wounding, the damaged epithelium makes about 8 %, and deeper under-epithelial wounds caused by beak tip represent the area of 1–2 % of the total body surface. With the time progress, these ratios change – deeper necroses represent up to 10 % body surface and healing epithelium makes just 1–2 %. Major part of wounded fish die due to these injuries, particularly if the course of healing is complicated by saprolegniosis. Two- to three-year-old silver carp, *Hypophthalmichthys molitrix*, and bighead carp, *Aristichthys nobilis* ($\cong 350$ mm TL, 600 g W) are particularly susceptible to this disease already after a relatively small injury due to cormorant attacks despite the deeper sub-epithelial wounds are not so spacious in these species. The total proportion of damaged silver carp body surface is similar to mirror carp amounting to approximately 10 % but the share of sub-epithelial wounds usually does not exceed 0.5 % due to their compact scaly cover.

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Relation of the “European Beaver Management Plan for the Czech Republic” to aquaculture

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The European Beaver became extinct in the Czech Republic in the beginning of the 18th century. The experiments to establish beaver farms in southern Bohemia in the second half of the 18th century experienced beaver damage that could also happen on fishponds. All the beavers, which escaped from the farms, had to be captured and removed from the area during the first half of the 19th century.

Development of the beaver population around Europe in the second half of 20th century made it necessary to prepare a management plan for the fast grown population in most central and east European countries, including the Czech Republic. The prepared Management Plan recommends in relation to the ponds:

- to allow the beaver population out of areas with a high density of fishponds (Třeboňsko, České Budějovice, Blatná),
- to create a technical manual for the protection of dams from beaver activity in other areas,
- to prepare the tools for control of the beaver population during next 10 years

These precautions could not prevent all possible damages, especially on the isolated fishponds and some streams. Present legislation has proved unusable when addressing beaver damage to constructions such as pond dams. That's why in 2005 there will be published a technical manual with some solutions for preventing damage made by beavers. The next step we will take is to ask the Czech Ministry of the Environment to prepare some changes to the legislation to help pond owners. This would allow a better control over the beaver population in the future.

In the absence of food topmouth gudgeon (*Pseudorasbora parva*) found to be parasitic on tench

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Four experimental groups were formed and one tench with a live weight of 70 g was placed in each of the four experimental aquariums (40 l, 16 °C). Group 1 (control): tench with 20 small carp and tench; group 2: tench with 20 small topmouth gudgeon with a size of 3,3–6,0 cm; group 3: tench with 20 topmouth gudgeon of medium size (6,1–7,0 cm); group 4: tench with large topmouth gudgeon (7,1–9,0 cm). The experiment lasted for 3 weeks. In group 1 and 2 the tench remained very relaxed on the bottom and did hardly move. After some days without feeding the topmouth gudgeon began to attack the tench in group 3 and 4 from behind, where the tench could not see them. In most cases the caudal body areas around the origin of the tail fins came under attack first; later on other body parts such as the sides were attacked also. In a first step the mucus of the fish's skin was bitten off. Then large, white spots formed in the places that had previously been attacked. After some days of continual attack the skin had been completely removed in these areas and the topmouth gudgeon were starting to feed off the muscle of the tench. In contrast the tench of group 1 and 2 survived the experiment without any stress and were not harmed. But even the small topmouth gudgeon in group 2 tried to attack the tench. Yet after a couple of days a number of the small gudgeon were eaten by the tench. In group 3 and 4, where the tench had been subjected to constant stress, they had developed huge holes in their muscular tissues.

As a result we can say that hungry topmouth gudgeon can turn parasitic and as a consequence keeping hungry topmouth gudgeon together with other fish species can have severe disadvantages.

Influence of a high presence of topmouth gudgeon (*Pseudorasbora parva*) on the yield and meat quality of carp

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Eight ponds were stocked with two-year-old carp at different stocking densities (group 1:300 K2/ha; group 2:800 K2/ha group 3:900 K2/ha and group 3:1500 K2/ha) in April. Each group had one pond without topmouth gudgeon and one pond with topmouth gudgeon. The yields of topmouth gudgeon ranged from 72 kg to 550 kg/ha. Carp yields from ponds stocked with topmouth gudgeon were reduced and consequently their FCR was higher. Additionally due to the presence of topmouth gudgeon the meat quality of the carp was negatively affected. The fat content of carp filets from ponds stocked with topmouth gudgeon were distinctly higher than in the ponds without them.

Nature-Friendly Fishpond Management in the Czech Republic

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Problems connected with the attitude of the Czech fishpond managers to the natural values of fishponds were studied in a grant project funded by the Czech Ministry of Environment in 2000–2003. The results of this project together with the experience from earlier studies can be summarised as follows:

In the Czech Republic, as a landlocked country, fishponds represent not only economically important fish-producing units, but also important landscape-forming elements which serve as substitute biotopes and often as the last refuges for numerous endangered plant and animal species.

In the Czech Republic, there are about 22,000 fishponds occupying about 51,000 hectares. They contribute to an equilibrated water balance of the surrounding agricultural or forested land and protect large areas from inundation; this was confirmed during the catastrophic flood of 2002.

Fishponds are reserve pools also of other natural resources than fish (peat, medical plants, etc.) and of genes of species potentially suitable for human use. They possess a high production potential of exploitable natural vegetation (reeds), birds and hunted game.

The value of fishponds for the biodiversity of Central Europe is irreplaceable: they comprise ecologically highly valuable biotopes hosting a wealth of rare plant and animal species. In most fishpond-rich areas of the Czech Republic, certain fishponds or fishpond systems comprising valuable biotopes have therefore been selected to be managed with respect to their natural values, and potential or actual conservation status.

Fishponds suitable for recreation (swimming, sailing, angling, etc.) have to be managed accordingly.

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Habitats and performance of *Calla palustris* L. in the Třeboň Basin Biosphere Reserve, Czech Republic

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The aim of this study was to clarify whether the protected plant species *Calla palustris* is threatened by high N and P supply to fishponds and by removal of trees shading most of its habitats. In 5 different habitats (3 of them in fishponds) of *Calla palustris*, total N and P contents were measured in interstitial water in sediment and in free water above the sediment 3x during growing season. The values mostly ranged from 0.98 to 9.25 mg.l⁻¹ N_{tot} and 20 to 770 µg.l⁻¹ P_{tot}. Diurnal courses of O₂ concentration in water were recorded on two sites with dense *Calla palustris* cover, in habitats varying from deeply shaded to fully sunlit ones. Unmeasurable or very low O₂ concentrations were recorded in all measurements. Biometric characteristics of and dry matter production by *Calla palustris* plants were examined in an experiment with different doses of NPK fertilizer. Its dose of 32 g.m⁻² produced the lowest plant dry mass, while the difference between the effects of 132.8 and 267.2 g.m⁻² was non-significant; the plants grew well, with no symptoms of over-fertilization. In an experiment with 0, 50 and 75 % artificial shading, the plants grew best in the deepest shade: they had the significantly highest dry mass and number of rhizome branches, longest petioles, largest specific leaf area and longest aerial shoots. Shading thus has beneficial effects on vegetative growth of *Calla palustris*, whereas full irradiance enhances flowering of the plants and, also, earlier senescence of their leaves.

Experiments for production of hybrid striped bass (HSB) in in-pond circulation systems

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(IPCS) were carried out in Königswartha in 2003 and 2004. The Circulation system consisted of two tanks with a productive volume of 8.5 cubic meters each. The tanks were installed tightly in a pond which served for the biological cleaning of the expiry water. In the first year HSB-fingerlings with an average weigh of 46.4 grams were produced. The average yield in the basins was 51.2 kg/m³. The survival rate from stocked 0.44 gram advanced fry was 97.8 percent. The food conversion was 1.16. Converted on the whole pond area the yield was exact 3,000 kg/hectare. Almost the same yield was obtained in the second rearing year.

In 2004 two year old HSB were reared in the same IPCS. The tanks were stocked with two different stocking densities, 1,038 resp. 2,074 fingerlings with a mean weight of 36.5 grams.

In the tank with the double stocking density, the yield lay almost exactly twice as high as in the other tank (502.0 resp. 248.8 kg), what corresponds to a stocking density of 59.06 or 29.27 kg/m³ at the end of the rearing season. The stocking density didn't have influence on the individual increase yet. Obviously HSB can therefore still be reared at higher stocking densities.

Growth and survival of paddlefish (*Polyodon spathula*) in the first year raised on natural and artificial diets

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Paddlefish (*Polyodon spathula*) is the latest fish introduced to Bulgaria. Up to now its distribution as an aquaculture species is confined in Plovdiv and Vidin regions, where the fish is reared at fish farms under effective control.

The aim of this study was to investigate the growth and survival of paddlefish up to one-summer age, when rearing this species under pond and dam-lake conditions. The investigation was carried out in pond farm of the IFA, Plovdiv and in "Drenovez" dam-lake in Bidin Region.

One kilogram fertilized eggs (ca. 100 000 eggs) were imported from BIOS, Astrakhan, Russia to the private sturgeon farm "Beluga" in the town of Vidin. The eggs incubation took place in a special hatchery unit "Oserta" at 17 °C and 8.5 mgO₂/l. Hatchery rate was 93 %. First feeding occurred one week after hatching when fry weigh 0.027 g. 60 % survival rate was registered after the passage to exogenous feeding. When rearing paddlefish larvae in tanks only on zooplankton 12–15 cm length and 6–7 g weight were obtained at the end at the 8-week after hatching. After two months pond rearing the survival rate was 51 % and the juveniles reached an average weight of 27.74 g and length of 22 cm.

Much better growth rate was achieved when rearing both paddlefish fry and juveniles only on artificial food ("Kraft") in plastic tanks. A strong stage of over 12 cm was reached at the 5-week, at the 8-week paddlefish weight 27 g and at the 12-week 52 g. When stocking "Drenovez" dam-lake with this both weight groups the fishes caught at the end of October weigh over 400 g. Paddlefish grow faster in "Drenovez" dam-lake than in carp pond, because of increased abundance and availability of food.

Influence of ecological factors on breeding success of grebes (*Podicipediformes*) at fishponds

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Breeding populations of Dabchick (*Tachybaptus ruficollis*) and Great Crested Grebe (*Podiceps cristatus*) were investigated at ponds of the south-eastern margin of the Czech-Moravian highland (Czech Republic). The total breeding success (rate of fledged chicks from all laid eggs) was only about 26 %. Higher losses during the incubation period were found in the case of Dabchick, whereas for Great Crested Grebe the losses were higher during the looking after brood period. An analysis of influence of ecological factors on the breeding success in particular stages of breeding was carried out. Factors related with predation mostly influenced the nest success during the incubation stage. The breeding success in the stage of looking after brood was affected mainly by climatic conditions. That is obviously connected with the insufficient thermoregulation of hatched young. Overall 33 % of Dabchick chicks perished within the first 15 days and 47 % of Great Crested Grebes chicks perished within the first 10 days after hatching. Dabchicks were more successful at smaller and weedy ponds with a low density of fish. Great Crested Grebes had higher nest success at larger ponds with a higher density of fish. Dabchicks feed on aquatic invertebrates, which are hunted near littoral vegetation. Therefore the food supply increases with the length of the littoral vegetation line. Great Crested Grebes specialize in small fish. The low nest success of grebes is obviously compensated by their longevity. The main part of the population is formed by adults, which can afford to have lower reproduction.

River otter in the eyes of Czech fishermen

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The River Otter in the Czech Republic became almost extinct through hunting for the meat, pelt and as the competitor to the fishermen, as well as through poor water quality.

Conservation activities, giving the River Otter protected species status, brought about an increase in the population by the end of 20th century.

Legislation was put in place to allow landowners to claim compensation for any verifiable damages caused to fish stocks by the River Otter.

We have analyzed how the fishermen feel about and accept the Otter on their fishponds and rivers, and how they use legislation to cover the damages.

The sources of informations for the study were gathered in three different areas of the Czech Republic from 3 groups of fishermen (managers of big companies, owners of small fishponds, anglers).

The damages to fish production made by the otter were estimated by fishermen to be from 0 to 50 %, rarely up to 80 %, depending on the area. The Otter was considered as a serious pest along with Cormorants, Herons, diseases and poachers. Unfortunately, killing the Otters was highlighted by the fishermen as the simple solution to the problem.

The managers of big companies had the best knowledge of Otter ecology, as well as the legislation relating to them. The technical tools for protection of property have at present been used very rarely.

The results of the study indicated gaps in the River Otter conservation strategy and will be used in management plan preparation include public relations and environmental awareness campaigns.

Intensive rearing of common barbel (*Barbus barbus* L.) juvenile for stocking purpose

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In our study, the larval and juvenile rearing of common barbel (*Barbus barbus* L.) under controlled (aquariums and troughs) and pond conditions till 105-days age is described. The rearing was distributed in two periods: the 1st period – from the beginning of exogenous nutrition till 21st day; the 2nd period – from 21st to 105th day. In the 1st period, larvae were fed by different feeding (the 1st group – from the beginning of exogenous nutrition by fodder ASTA only; the 2nd group first 7 days by ARTEMIA and following 14 days by fodder ASTA; the 3rd group – first 14 days by ARTEMIA and following 7 days by fodder ASTA) in aquariums and troughs. Individual weight (W), total length (TL), cumulative survival (S), condition of the fry (condition coefficient according to Fulton FC) and specific growth rate (SGR) were observed in 7-days interval (aquariums and troughs) and in 21-days interval (pond) during this period of rearing. At the end of the 1st period, statistically the highest growth (W=226.2 mg; TL=25.6 mm) and condition of the fry (FC=1.4) were found with larvae reared in pond. In controlled conditions, statistically the highest growth (W=173.5 mg; TL=24.3 mm; SGR=12.9 %.d⁻¹) and insignificantly the highest condition of the fry (FC=1.2) was observed with the 3rd group of larvae reared in aquariums. In controlled conditions, all groups of larvae were achieved same values of cumulative survival (from 88.1 to 90.4 %) without statistically differences. In the 2nd period of rearing, only the 3rd group was continued to rear under controlled conditions (in aquariums and troughs). The values of growth and survival were checked in 21-days interval. These values were compared to growth of juveniles in pond. Statistically the highest growth was achieved with juveniles reared in aquariums (W=3.2 g; TL=73.7 mm; SGR=6.9 %.d⁻¹). Between juveniles reared in pond (W=2.2 g; TL=64.8 mm) and troughs (W=2.1 g; TL=60.7 mm; SGR=5.7 %.d⁻¹) no differences was found in growth. Statistically the best cumulative survival was reached with juveniles in aquariums (66.5 %). Statistically the highest condition of the fry was observed with juveniles in troughs (FC=0.9).

Carp pond as a potential environment for asp (*Aspius aspius* L.) larvae culture.

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Asp (*Aspius aspius* L.), belonging to fluvial cyprinids, has no economic value. But from ecological and recreational fisheries point of view it is very important species and perspective for pond production. There are many publications relating to asp larvae cultivation in fully artificial conditions in tanks, but not so many deals with the same problem in more natural conditions, which offers carp ponds.

The aim of the paper is to presents three years results of asp larvae rearing in first nursery ponds. Newly hatched larvae were stocked for six weeks into ponds at three stocking densities: 200000 pcs. /ha, 150000 pcs./ha and 50000 pcs/ha. During rearing period fish feed on natural food only, no additional artificial food was offered.

Changes of zooplankton composition and fish feeding preferences were analyzed in relation to stocking densities and size of the fish. Basic production parameters like survival rate, individual growth, yield as well as practical guidelines for mass asp larvae pond rearing were elaborated.

The development of damages caused by otters (*Lutra lutra*) in fishponds of the Waldviertel (Austria) 1984–2003

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In the last 20 years otters have expanded in the whole Waldviertel. Beside an effective protection the numerous ponds in this region seemed to be the reason of this development. Ponds represent an adequate environment and offer enough food. From 1984 until 1994 the Government of Lower Austria, the WWF Austria, the Hunters Organisation of Lower Austria and the Austrian Naturschutzbund paid for damages caused by otters under special conditions. Since 1995 the Government of Lower Austria alone pays this compensations. Until 2003 1.358 cases of such damages appeared. No relation between size and situation of fishponds, fish stock and the appearance of the otter could be found. With the increase of the fishpond size the damage per hektar decreases, nevertheless the damage per fishpond increases evidently. Electric fences seemed to be the only effective protection against damages up to now.

3. Multipurpose Pond Usage

Multi-purpose use of small water bodies in north-east Poland – new kind of fish farming?

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The small water bodies such as natural and artificial backyard ponds, clay-pits, gravel and peat exploitation hollows with water and others give specific character to rural landscapes. Their function was perceived variously in the past. They became an object of fish culture very rarely because of its too small scale. Usually they were perceived as wastelands which drainage could increase an agriculture production area. With time their important role in water relations has been gradually realised. From the beginning of 1990 there was observed significant increase in new ponds building and adaptation of the existing natural reservoirs. The total number of the farms with this kind of ponds is estimated at over 2 100 only in Warmia and Mazury region (north-east Poland). The objects are usually small and in majority below 0,5 ha. The phenomena can be explain by general decline in profitability of agriculture production, necessity of looking for a new additional sources of income and, because of this, farmers increasing interest in services from the range of recreation and tourism. The ponds are usually used as angling grounds and on this level it is possible to indicate many different types of their management. The small water bodies exceptionally fulfil conditions for rational fish culture, but their recreational and ecological purposes are very often more important than the volume of fish production.

Investigation on absolute fecundity, follicles and larval size of pond – reared pike (*Esox lucius*) of different size

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The aim of this study was investigation on usage of one-year-old female pond-reared pike as spawners and their absolute fecundity. In addition the follicles and larval size in relation to female' size were reported.

The investigation was conducted in February 2004 at the experimental fish farm of the Brach of Freshwater Fisheries in Plovdiv. The study involved two weight groups of females, differing in body weight and length – one-year old (BW=514 g, SL=36.1 cm) and two-year old matured pike (BW=1454 g, SL=49.3 cm). Ovary samples were fixed and ovarian follicles counted and weight. Weight and length of larvae from artificial spawning from females of the same size were measured.

The results showed when raising this species under farmed condition more than 35 % (in rarer cases 90 %) from one-year old pike females reached over 400 g (BW) and 35 cm (SL) and reached puberty. Absolute fecundity of 15030 follicles (30 follicles per gram body weight) was observed, the GSI was nearly 15 % and the follicles size reaches 0.0037 g. This data differs significantly from the obtained from the bigger fishes – absolute fecundity 41363 follicles (28 follicles per body weight), GSI nearly 20 %, follicle size 0.0058 g.

Results showed that the different follicle size determines the larvae size. The larvae differ significantly both in terms of their weight (7.13 mg against 10.61 mg) and length (0.81 cm against 0.97 cm), the differences being 1.5- and 1.2-fold, respectively.

Seasonal dynamics in fish assemblages and diet pattern of the piscivore community in a pond channel

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The annual course of changes in fish assemblage structure was studied in a typical pond channel supplying and connecting four ponds (1,28–8,68 ha) in a pond system of the lowland carp farm. The diversity of fish community and the dynamics of its development depend predominantly upon the fish stock of ponds discharged (particularly during the period of pond harvesting), which contributed to the considerable increase in occurrence of common carp (*Cyprinus carpio*), herbivorous fish (grass carp, *Ctenopharyngodon idella*, silver carp, *Hypophthalmichthys molitrix* and bighead carp, *Aristichthys nobilis*), tench (*Tinca tinca*) and some predatory fish (zander, *Stizostedion lucioperca* and perch, *Perca fluviatilis*). The pond channel was an important reservoir site of persistent survival and subsequent spreading of some undesirable alien fish like Prussian carp (*Carassius auratus gibelio*) and topmouth gudgeon (*Pseudorasbora parva*). Therefore, a special attention was given to food analyses of piscivorous fishes with respect to invasive species.

Multifunctional pond fish farms in Hungary

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The last ten years have brought substantial changes in Hungary on both political and economic level. The laws, regulations and measures issued to implement political decisions led to radical changes even in pond fish production. The process of privatisation eliminated most of the previously existing large state-owned fish farms, and led to the appearance of several new, privately owned and family enterprises. Beside privatisation, there have been other impacts on pond fish farming namely the changing environmental considerations, the increasing need to protect the aquatic resources and maintain biodiversity. Pond fish farms have to explore their potential to find out how they can diversify their activities in order to be able to produce various fish products and to provide services, for which there is demand by the market and the society. A pond fish farm, which is a part of the rural economy also functions as valuable aquatic habitat, plays important role in regional water- and landscape management, provides services for various recreational activities and contributes to the preservation of cultural heritage. The application of the multifunctional approach proved to be a realistic option for many fish farms for their survival and sustainable development.

The presentation will demonstrate some examples of multifunctional fish farms, which clearly shows the business opportunities lying in the diversification of farm activities.

Waste treatment and reuse of intensive fish production in pond recirculation systems

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Considerable efforts are being made for minimising the negative impact of fish farm effluents on the environment, like the use of recirculation systems with biofilters, the application of wetland systems and sedimentation ponds, and special equipment for effluent treatment.

The combination of intensive and extensive fish culture ponds (CIE system) with water recirculation was already proved to reduce significantly of nutrient discharge to the surrounding aquatic environment, primarily due to the high nutrient processing and retention capacity of the extensive fishpond ecosystem. Biological processes of primary production, consumption and mineralisation in the extensive fishpond occur side by side. To enhance the efficiency of biological treatment these processes were separated into different compartments of the pond system. The combined aquaculture-algae (CAA) system was developed for the purification and reuse of effluent water from intensive fish production in two different compartments: a high-rate algal pond and a fishpond. The compartmentalisation to algal pond and fishpond parts allows higher control over the biological processes, therefore the carrying capacity of the production system increases and minimises environmental impacts of intensive aquaculture. The integrated systems reduce water demand through recirculation of the treated water. Additionally, the algae-based water reuse system produces valuable food for filter feeder fish.

The objective of this study was to describe and evaluate the nutrient transformation efficiency of the fish production in a CAA system through the analysis of the organic carbon, nitrogen and phosphorus budgets and to compare the nutrient processing capacity with a CIE system.

Current status and outlooks of development pond aquaculture in Ukraine

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The extent of the territory of the present Ukraine is 603 thousand square km and has a population about 48 million. Consumption of fish products per capita in Ukraine have decreased to 3.5 kg/year in 1995, now it has risen up to 12.1 kg/year. Total production of freshwater aquaculture was approximately 40 thousand tonnes in 2003. That is less in 3 times than in 1990. The structure of production of freshwater fish also considerably has changed.

The production of carp has reduced approximately in 6–8 times in comparison with 1990. Its part has decreased from 86 % to 46 %. It is caused by the low prime cost of herbivorous fishes in comparison with common carp.

The main species of cultivated fishes in Ukraine are common carp and Chinese herbivorous carps. Trout, buffalo, catfish, paddlefish and sturgeons are cultivated in small quantity.

returns on 300m² to 600m²-area ponds, based on the socio-economic conditions, Sagana.

Results showed significant differences in DO, % recruitment, and annualized yields between treatments as well as growth rates in ponds and cages of Trt III and IV, with caged fish recording faster growth rates. Growth rates were similar between treatments implying that the combined fertilizer-cage wastes effects in cage-pond integration produced similar results as fertilizer-feed treatments in Trt I. Annualized Gross yields were similar in Trt I, II and III but were significantly ($p \leq 0.033$) lower than in Trt IV, though net fish yields appear similar ($p \geq 0.156$) in all the treatments. Positive returns above variable costs were recorded in Trt II, III and IV at Ksh 508, 4124, and 8359 respectively, but Trt I made losses against both variable and total costs. Partial enterprise budgets however showed that Trt II (Split) performed poorer than Trt I (base) attributed to reduced fingerlings' revenue. Both Trt I and II demand for higher breakeven prices than the current prices of Ksh 1Euro/ kg of tilapia, under Sagana market conditions. The smallest pond needed at breakeven against total costs under 'Base' scenario was estimated as 400m². It is concluded that the future of earthen pond tilapia culture and its adoption as a sustainable tool for rural development depends on how fast commercialization of loss making enterprise is done to increase its profitability!

Fishponds and wetlands – natural tools for water quality improvement

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Constructed or natural fishponds are important part of European, especially Eastern European landscape. However, the function of fishponds has been changing and diversifying in the last decades and new services are provided beside the fish production. One of the most important roles is the environmental influence of fishponds. Often it is stated that fish production is a pollutant activity to the natural environment but at suitable management practices fishponds can serve as nutrient traps and water treatment tools.

In our experiment, earthen fishponds and wetlands were used, connected in series, to treat intensive aquaculture effluent. The discharged water was directly pumped into Fishpond1 and the water flew by gravity into Fishpond2 and Wetland1 and Wetland2. The fishponds were stocked in polyculture of silver carp, common carp and grass carp at various biomass of 984 to 2388 kg ha⁻¹ during the three-year experimental period. Dense vegetation dominating by cattail and reed developed by their own in the wetland units.

The results showed that the concentration of all nutrient forms decreased after the treatment and also the mass removal of total nitrogen, phosphorous and organic carbon was significant. The fishponds were efficient in phosphorous removal and aerobic nitrogen transformation processes while in wetlands nitrogen removal and suspended solid sedimentation were important.

The influence of carp farm on river drainage area water quality

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Actual environment protection regulations in Europe are very rigorous and pressure fish producers to invest in a very expensive purification systems or to minimize production what sometimes even causes farm liquidation. The influence of pond farming on natural waters is rather easy to estimate in case of salmonids production. However, in case of carp ponds situation is not so clear. Carp ponds were so far considered as to be rather “cleaning systems”, not pollutants. But now also carp farming is under very high pressure, and the opinions on influence of carp farms on an environment differs extremely. There are not so many observations relating to this problem, specially obtained in ordinary production cycle from typical ponds.

The aim of the paper is to present results changes of water oxygenation, pH, temperature, BOD₅, suspended solids, total phosphorous and total nitrogen in inflowing water during all production season and in water flooded out during autumn carp harvesting at the Research Fisheries Station “Łąki Jaktorowskie”, Warsaw Agricultural University. Changes in outlet water were analyzed directly below outlet monk, in outlet channel and in a receiver (supplying river). An interaction between quality of inflowing and removed water and carp production was estimated. General influence of carp farm on total water quality balance in river drainage area was calculated.

4. Pond Management Strategies

Growth, yields and economic performance of Nile tilapia (*Oreochromis niloticus*) in integrated cage cum earthen pond culture systems, Sagana, Kenya

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An experiment was carried out to compare growth rates, yields and economic performance of Nile tilapia (*Oreochromis niloticus*) in fertilized earthen ponds and cage cum earthen pond culture systems, at Sagana aquaculture centre, Kenya, between April-August 2003, for a 125-day culture period.

Sixteen earthen ponds of 150m² and 2.8 m³-volume cages were used and a simple randomized design used to allocate ponds to four treatments with four replicates each. All-male *O. niloticus* hand-sexed fingerlings, of 29.9± 0.27g and 18.6± 0.72g mean weights were used stocking the cages and ponds respectively. Open ponds in treatments (Trt) I, III and IV were stocked at a density of two fish/ m² while in Trt II, only stocked one fish /m². All the cages were suspended at 0.1m above pond bottom, and stocked at an effective density of 65 fish /m². Trt I carried no cages, Trt II and II; 1 cage/pond while Trt IV carried two cages, giving total pond stocks 300 in Trt I and II and 450 and 600 fish in Trt III and IV respectively. The treatments were labeled ‘Base’ (S₃₀₀), ‘Split’ (S₁₅₀-C₁₅₀), ‘Base⁺’ (S₃₀₀-C₁₅₀) and ‘Base⁺⁺’ (S₃₀₀-C₁₅₀-C₁₅₀) respectively. All ponds were initially limed at 2500 kg ha⁻¹, before stocking, and weekly fertilizer application done , at 20 kg and 8 kg / ha/ wk nitrogen and Phosphorus respectively, using DAP and Urea. The fish were fed at 1.5 % live biomass of caged fish only, except in the S₃₀₀, where open pond fish were also fed. Sampling was Monitor of physico-chemical parameters and fish growth was done by sampling every two weeks. Daily feed rations (DFR) were adjusted after each sampling, on 25 % and 30 % of open pond and cage fish respectively. At the end of the experiment, relative profitability of cage-cum open pond culture of the Nile tilapia in earthen ponds was evaluated using enterprise budgeting and the minimum pond size at breakeven-on production costs in the S₃₀₀ scenario estimated by extrapolating

Fish culture in rain fed ponds in Pakistan: An integrated approach

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During the last 25 years, hundreds of small rain fed ponds and reservoirs has been build in Potohar region of Pakistan with aid and subsidies from government agencies. These ponds were never impounded for fisheries development and primary purpose was to store water for agriculture and livestock development. But fish culture is beginning to be recognized as important secondary users of pond water resources. In certain instances, it is reported that the income from fisheries exceeds that from intended primary function of these ponds. In the light of increasing human population growth, these ponds are becoming increasingly important as an important provider of animal protein and income generating opportunities, particularly to poorer sectors of the community which often happens to be rural. Trophic status of these ponds and proper cost effective integrated fisheries management plan has been discussed.

Aquacagricomplex – complex use of reservoirs and adjoining landscapes

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Negative consequences of technogenic activity demand ecolization of economic activities, that is adaptation to the environment. Ecological efficiency is a key to stability, both from economic and ecological points of view. Transition to the complex, integrated technologies where all the resources available in reservoirs and adjoining landscapes should be involved allows to make a wide spectrum of production and raw material, technologies also suitable for farms. One of such integrated technologies should become aquacagricomplex.

The main principle of this model should be biologization and ecolization housekeeping on reservoirs and adjoining territories, a combination of extensive and intensive methods of fish-breeding and agricultural production with the balance of reservoir ecosystems and the ponds.

We offer system of complex use of natural potential of reservoirs and adjoining territories which is developed for certain reservoirs and applied territories. Aquacagricomplex is defined as system of complex, harmless use of aquatic and agricultural ecological groups of reservoirs and the grounds, adjoining to these reservoirs, focused on production of the certain quantity and quality in accordance with public requirements (not only market, but also for dietary and wholesome products) in accordance with natural and industrial resources, providing stability of aquatic and agricultural ecosystem, fish reproduction reservoirs and fertility of soils.

Creation of aquatic and agricultural ecosystems is aimed to optimize the major conditions of life, rational use of natural reservoirs and adjoining territories resources, their increase of production potential and stability, reliability and aesthetism.

Fish culture in small-size different-purpose water reservoirs in the arid zone of Ukraine

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The area of inland waterbodies of Ukraine is about 1.7 mln ha, and they have different fish farming status. A state program of the fish industry development envisages a greater role of inland waterbodies as suppliers of cheap and valuable human protein food. Small-size different-purpose water reservoirs (drinking water, technical, irrigation, recreational) constitute 15 % of the water fund and form the potential for increased fish production. Such waterbodies have favorable ecological conditions for cultivating valuable endemic species (carp *Cyprinus carpio*, sander *Stizostedion lucioperca*, bream *Abramis brama*), fresh-water fish (carp *Cyprinus carpio*, silver *Hypophthalmichthys molitrix* and spotted *Aristichthys nobilis* carp, grass carp *Ctenopharyngodon idella*, paddlefish *Polyodon spathula*), and in some cases brackish-water species (mullet *Mugil soiyu*).

Small-size water reservoirs can be included in fish production as fattening fish farms within the framework of natural aquaculture that should be based on protection and rational use of commercial stocks of endemic fish, introduction of modern resource-saving technologies of fish production. It will ensure integral water resources utilization (strategically important for arid regions), high quality and low cost marketing fish production, and pond ecology perfection due to organic matter removal in the form of fish produce.

Small-size water reservoirs utilization does not require additional land and water allocation, or construction of expensive hydrotechnical installations. Natural aquaculture introduction into such waterbodies will allow getting annually 20000–30000 tons of highly valued fish produce, a certain ameliorative effect also being provided.

Strategy of ponds and salt lakes ecological monitoring

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Study of ecological situation in ponds and salt lakes is very important for the optimization their management and application their natural resources. The seasonal changes of salt lake environment were examined. The abiotic parameters (temperature, salinity, optical density of water, pH) and the content of heavy metals (Zn, Cu, As, Pb, Cd and Hg) were detected in the water. Additionally the microbial pollution was determined also. The heat production of water and sediments was measured by Monitor Biological Activity TAM 2277. The results showed the changes in all examined parameters in water and sediments of the salt lake in different seasons. The variations of heavy metals content were determined. The high concentrations of pathogenic microorganisms in water was determined in spring and summer when the temperature was + 20 °C and higher. The changes in heat production was demonstrated also that was connected with the metabolic activity of microalgae inhabited the water. The obtained data could be applied for the development methodologies to measure the indicators of ecological status of ponds and lakes for assessment environments and use a suit of these parameters of exposure to environmental stressors in for future evaluation of the ponds and salts lakes ecosystems health.