

Ecohydrology and physical habitat modification for fish – the integrative approach for reversing decline of fish communities and good ecological status of freshwater ecosystems.

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Abstract

Degradation of physical habitat for fish in lakes and reservoirs, especially in the face of global changes, has been a factor of increasing in importance for both fish biodiversity and fisheries. To develop the strategy and methods to prevent and reverse this detrimental process, there is an urgent need to identify the vulnerability of fishes to various forms of physical habitat modification, the hierarchy of driving forces in different geographic regions, and habitat assessment and rehabilitation techniques. Reports of the application of knowledge generated by the integrative sciences (hydrology-ecology) toward sustainable water resources and fisheries cross verifies the success of this approach. This issue of *Ecohydrology & Hydrobiology* contains a range of papers which describe experiences and highlight the important issues relevant to the above. It is hoped that this will be a starting point for enhancing the scientific background for development of the ecohydrological, integrative system approach that is necessary to achieve good ecological status of ecosystems and fish communities.

Key words: Ecohydrology, fish, lakes, reservoirs, habitat modification, ecological status, EU directive.

**Rehabilitation of urban lake fisheries for angling by managing habitat:
general overview and case studies from England and Wales**

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Abstract

In industrialised societies, angling provides a major recreational activity which creates high social and economic benefits. Urban fisheries in particular offer great potential for increasing angling opportunity. Many urban lakes and ponds, however, are situated in places such as city parks and industrial areas which has led to environmental problems of eutrophication, siltation, the absence of suitable fish habitat and poor angling quality. Not only has this resulted in low aesthetic value but the potential of these lakes as an angling resource was not being fully realised. A recent initiative promoted by the Environment Agency in England and Wales has identified lakes suitable for rehabilitation and an urban fishery development programme is now in place. This paper describes problems with urban stillwater fisheries and gives examples of the type of mitigation and enhancement measures that have been carried out. The primary techniques for physical habitat improvement in lakes include management of aquatic macrophytes, installation of artificial structures, desilting and adjusting the profile of the banks. Typical measures included floating reed rafts, restructured lake margins and fish refuges. Although such physical modifications were a key component of rehabilitation, it was also important to address the social context by raising awareness of issues amongst fishery owners and anglers in order to establish ongoing commitment to effective management. It is doubtful, however, that habitat rehabilitation alone can solve all the issues that impact on fishing quality in urban water bodies and a variety of management approaches might be needed to achieve desirable outcomes for all stakeholders.

Key words: habitat improvement, ecohydrology, recreational fisheries, socio-economic value

Assessment of human pressures and their hydromorphological impacts on lakeshores in Europe

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Abstract

Europe has a large number of lakes, many of them lie in densely settled areas. For instance, Germany has 1073 lakes with a surface area greater than 0.5 km², surrounded by lakeshore habitats of appr. 11 000 km. The lakeshore habitats are of outstanding significance for biodiversity, ecosystem function as well as a variety of human uses.

In this paper we give an operational definition of the lakeshore zone (i.e. the littoral zone, the shoreline and the riparian zone). We list significant human pressures directly on the lakeshores or coming from the catchment, and we describe the most important impacts resulting from such pressures. For illustration, we present some examples (eutrophication, morphological modifications, hydrological changes) from Lake Constance. Generally, many of these pressures are related to changes to the hydrological regime of the lake and/or to morphological modifications of the shore zone, but knowledge about the links between pressures and specific impacts is poor.

We briefly discuss four approaches, which have recently been developed to assess the hydromorphological quality of lakeshores. These procedures are designed to fulfil the requirements of the European Water Framework Directive (WFD), as well as the requirements of regional planning and nature conservation.

Key words: European Water Framework Directive, Lakeshore Habitat Survey, ecotone, littoral, riparian zone, human pressures, sustainable use

Ecohydrological management of Lake Kinneret: A case study

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Abstract

Droughts (1989-1991, 1999-2001) and water supply caused decline of the water level in Lake Kinneret. Nutrient status of the lake was lowered and decline of *Peridinium* with increase of nanoplankton was observed. Heavy floods came later (1992, 2003) causing an increase of nutrient influxes, *Peridinium* reappearance with relative decline of nanoplankton biomass. Abrupt elevation of water level enhanced zooplanktivory as a consequence of lavnun (*Acanthobrama* spp.) reproduction. Therefore, subsidized removal was carried out. Improved stocking and fishing restriction, enhanced the populations of the best *Peridinium* consumer, *Sarotherodon galilaeus*. The integration between physical and biological features aimed at optimal management is evaluated. The fishery management in Lake Kinneret is essential but ecohydrology is the driving force.

Key words: Lake Kinneret, ecohydrology, fishery, management.

Modelling the impacts of water level fluctuations on the population dynamics of whitefish (*Coregonus lavaretus* (L.)) in Haweswater, U.K.

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Abstract

The whitefish (*Coregonus lavaretus*) population of Haweswater, a reservoir in north-west England, U.K., exhibited a marked decline in abundance during the 1980s. A population model incorporating egg mortality induced by falls in water levels successfully simulated patterns in whitefish abundance, inferred from entrapment records, from 1973 to 2003. The model also predicted that future frequencies of occurrence of egg mortality of 50% and less would allow varying degrees of population recovery. If water levels continue to be managed sympathetically, as they have been since the mid 1990s, and predation by cormorants (*Phalacrocorax carbo*) is successfully controlled, then a recovery of the whitefish population will be achieved compatible with reservoir operation.

Key words: ecohydrology, reservoir operation, littoral habitat, RAMAS population modelling, fish spawning

Hydroacoustics as a tool for studies of fish and their habitat

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Abstract

Hydroacoustics offers a great variety of applications for studying fish in a changing environment, as well as aspects of their habitats (e.g. water depth, bottom type, macrophytes). Echo-sounding techniques, due to their high resolution in time and space, enable the observation of both short-term and long-term effects of habitat modification on fish populations. A number of examples of such studies are presented illustrating the effects of environmental stressors including eutrophication, water level fluctuations, temperature gradients and water heating. In addition, an example is presented of a hydroacoustic survey of macrophytes using a newly developed system, with estimations of their coverage and heights. Since hydroacoustic methods provide high resolution, area-based, synoptic, spatially-integrated data, they are particularly suitable for monitoring the dynamic changes of aquatic ecosystems and so can make a significant contribution to ecohydrology.

Key words: reservoirs, ecohydrology, eutrophication, water level fluctuations, macrophytes

Hydrology and angler's catches in the Czech reservoirs

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Abstract

Anglers' catch statistics are used to examine the fish species composition in 15 Czech reservoirs with different ecohydrological conditions. Three groups of reservoirs were defined: 1. reservoirs with a relatively natural regime ("natural reservoirs"), 2. cascade reservoirs and 3. reservoirs with extreme power generating use ("extreme reservoirs"). Two ordination analyses revealed differences between reservoirs. Fish species composition in cascade reservoirs differs from that in the other types. Extreme reservoirs have a much higher stocking rate of cyprinid species than other reservoirs. Stocking could 'recover' fish species composition even in reservoirs with very disturbed ecohydrological conditions, so the anglers' catch composition is similar to 'natural reservoirs'. Bream/perch ratio in the anglers' catch was found to be a good criterion to differentiate between the reservoirs types. It is negatively correlated with water level fluctuation and positively correlated with retention time. Cascade reservoirs have bream/perch ratio below one, usually between 0.5 – 0.1 (2-10 times more perch). Ecohydrological disturbances can alter the fish stock succession from natural tendency to cyprinid-dominated fish stock (eutrophic conditions) to perch dominance (mesotrophy).

Key words: angler's catch, fish species composition, PCA, RDA, bream/perch ratio, reservoirs

Effect of meteorological conditions and water level fluctuations on the year-class strength of pikeperch (*Sander lucioperca* L.) and perch (*Perca fluviatilis* L.) in a French reservoir

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Abstract

The impacts of environmental factors on biological functions of fish are well documented but the consequential effects on population dynamics in natural hydrosystems are rarely assessed. The year-class strength (YCS) of pikeperch (*Sander lucioperca* L.) and perch (*Perca fluviatilis* L.) were estimated in the Eguzon hydro-electric reservoir located in central France. The relationships between the water level fluctuations, meteorological data and the YCS were then analysed. No co-variation was observed between the YCS of the two Percids. Weak relationships were observed between water level change, mean temperature during the spawning period and pikeperch YCS. The summer temperature post-spawning was the only variable positively correlated with perch YCS. These preliminary results show that in Eguzon reservoir different factors control perch and pikeperch YCS.

Keywords: Year-class strength, Percids, water level fluctuations, temperature, cohort

The effect of water level fluctuation on tributary spawning migration of reservoir fish

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Abstract

The Římov Reservoir (Czech Republic) was chosen as a model object to study the importance of the tributary zone (Malše River) for the fish populations of the reservoir. The migrating fish were captured by two specially constructed large fykenets during four seasons 2000 - 2003. One trap was sampling upstream- and the second one was sampling downstream- migrants. The spring spawning migration of cyprinids was found as the most important event of every season and the number of migrating individuals of individual fish species corresponded to the total abundance in the reservoir and to affinity of individual fish species to the spawning in the tributary area of the reservoir. During first three seasons, the water level had a similar pattern with maximum level in the beginning of spring and flooded terrestrial vegetation was available for phytophilic fish to spawn along the shoreline of whole reservoir. In 2003, the water level was maintained down by at least 2 m and no plant-spawning substratum was available in the reservoir and therefore a much stronger upstream spawning run of the phytophilic fish to the tributary area was expected. Increased numbers of migrating individuals were found only for white bream (*Blicca bjoerkna*) and to a small extent bream (*Abramis brama*). Roach (*Rutilus rutilus*) and bleak (*Alburnus alburnus*) tributary run seems to be proportional to the number of adult fish in the reservoir. None of the above factors determined the strength of run of perch (*Perca fluviatilis*), chub (*Leuciscus cephalus*) and roach x bream hybrid. Most reservoir fish (bream, bleak and roach) used rocky shores with small stones for alternative spawning in the reservoir, perch spawned on old tree stumps. Timing sequence of the main tributary spawning run is determined by the temperature. Absence of submerged plants played no role in timing. During four years, up to 43% of adult bream stock of the reservoir, 30% adult bleak, 15% roach, 22% roach x bream hybrid and 4% perch used tributary for spawning during the main spawning run.

Key words: freshwater fish spawning migration, tributary, reservoir, water level fluctuation

Drift of juveniles after riverine spawning of fishes from the Římov reservoir, Czech Republic

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Abstract

Downstream drift of fish eggs and larval and juvenile fish was investigated in close relation to upstream spawning runs of the reservoir parent stock during two seasons in the tributary of the Římov Reservoir (Malše River, South Bohemia, Czech Republic). Five drift nets were set across the river at weekly intervals from the end of April to mid June. Drift of fish eggs was bimodal with the highest peak in early May (massive cyprinid spawning). A distinct evidence of riverine spawning by some of the reservoir fish species like asp (*Aspius aspius*) and roach (*Rutilus rutilus*) has been shown. The asp was the prevailing drifting species at the beginning of May, the roach on the remaining sampling dates. In mid May bullhead (*Cottus gobio*) also contributed significantly to the drifting fish. On the other hand, absence of otherwise very abundant species in the migrating parent stock like bream (*Abramis brama*) and bleak (*Alburnus alburnus*), suggests differences in preferences for the spawning area, even within the short river/reservoir ecotone. Apparent tendency for drifting during night time was reported in bullhead. In other fish species no differences were found between the day/night numbers of drifting individuals. Diurnal changes in spatial distribution of drifting eggs across the river profile suggested slight tendency for spawning closer to the right riverbank during night time, where lowest flow velocities were reported.

Key words: egg and larval drift, 0+ fish, spawning, migration, river, reservoir

Effects of water level variations on the dynamics of the reed belts of Lake Constance

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Abstract

Following the extreme flood at Lake Constance in 1999 the reed belts of the shore of Baden-Württemberg lost approximately 30 ha (24%) of their lakeside reed beds. This loss is comparable with the situation in the late 1960s, when approximately 40 ha died back due to the extreme flood in 1965 and due to the high spring water levels in the subsequent years. In the time period between the extreme floods of 1965 and 1999, the reed areas expanded to nearly 85% of their original area before 1965.

As a consequence of the extreme flood in 1999 a loss of 44% of the above ground biomass of 1998 occurred. One third of this loss was regenerated in the subsequent years 2001 and 2002. Similar results were obtained for the calculation of the biofilm area provided by the submerged culm parts of the reed stands. A loss of 47% of the biofilm surface area was estimated. By 2002 only one fifth of the lost area had been regained. This reflects the fact that the regeneration of the lakeside stands at lower elevation levels proceeds much more slowly than that of the inner stands on higher elevation levels, which contribute less to the submerged surface areas of the reed stands.

Simulations of the extreme flood event of 1999 show a strong association with the results of the aerial photo interpretation. This confirms the concept of the model and supports the hypothesis that water level fluctuations play a major role in the reed dynamics of Lake Constance. The results demonstrate the close interaction of hydrological processes with dynamics of biota, thus the necessity of an ecohydrological approach for the understanding and for the sustainable management of littoral ecosystems.

Key words: ecohydrology, hydrological variations, vegetation dynamics, *Phragmites australis*, flood tolerance, growth model

Effects of seasonal water level fluctuations on the benthic fish community in lakes - a case study of juvenile burbot *Lota lota* L.

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Abstract

A significant disagreement between the expected (modelled) and the observed average cohort lengths of littoral dwelling juvenile burbot (*Lota lota* L.) was observed in Lake Constance, Germany. From September of their first year (age-0), particularly the largest members of the cohort were under-represented in littoral habitats but over-represented in the profundal zone. This indicates a size-selective inter-habitat migration, with autumnal lake level drawdown as the major proximate factor. The study shows that water level fluctuations affect not only the behaviour and distribution of individual fish within the littoral itself but can also control the temporal and spatial distribution patterns of a particular fish species in an entire lake ecosystem.

Key words: modelling, controlling factor, littoral, profundal, size-selective behaviour, inter-habitat migrations

The influence of water level fluctuations and associated hypoxia on the fishery of Lake Võrtsjärv, Estonia

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Abstract

Lake Võrtsjärv is a large (area 270 km²), shallow (maximum depth 6.0 m) and turbid eutrophic lake in which eel *Anguilla anguilla* (L.), pikeperch *Sander lucioperca* (L.), northern pike *Esox lucius* L. and bream *Abramis brama* (L.) are the main commercial fishes, while perch *Perca fluviatilis* L. and burbot *Lota lota* (L.) are of secondary economic importance. High water level of the lake has a strong positive influence on the abundance and total catches of fish. Constant low water level and severe winters cause hypoxia and consequent fish kills. In winter, fish movements are negatively affected by oxygen content with fishes reducing their activity to economize on the use of oxygen. During March 1996, when the oxygen level was extremely low and stayed for a long time below 1 mg O₂ dm³ throughout the water column, fishes had predicted this hard situation two months earlier. In this year the mean CPUE was 3 times lower than in winters of normal oxygen concentration. The present investigation shows that the CPUE decreases rapidly when the oxygen 1 m below the ice falls to below 4 mg O₂ dm³. In winter, eel moves out of the bottom mud before the oxygen level falls below 0.5 mg O₂ dm³ near the bottom. It either emigrates from the lake or else can be easily preyed upon by pike. Due to the extremely low water level in 1996-1997, the southern end of L. Võrtsjärv was full of macrophytes. Therefore, the normal migration of pikeperch, which prefers open water, was seriously hindered by dense vegetation and its conditions for spawning were disturbed.

Key words: shallow lake, catches, winterkills, migration of fish.

Influence of the HEPS Djerdap I and Djerdap II dam construction on catch of economically important fish species in the Danube River

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Abstract

Construction of the HEPS Djerdap I and Djerdap II dams on the Danube River, in 1970 at 943 km and in 1984 at 863 km, had a great impact on river morphology and consequently on qualitative and quantitative structure of the ichthyofauna in that part of the river. We analyzed catch of economically important fish species during the period 1960 to 1997, which encompassed the times before, during and after construction of the dams. Catch of anadromous species beluga (*Huso huso*), Russian sturgeon (*Acipenser gueldenstaedtii*) and stellate sturgeon (*Acipenser stellatus*) decreased after the dams' construction. The most pronounced effects were in the catch of stellate sturgeon owing to its shorter maturation period and life span. Sterlet (*Acipenser ruthenus*) showed a significant decrease in catch during two periods (1974-1980 and 1992-1997), linked with upstream migration due to its preference for faster and more abundant flows. Bream (*Abramis brama*) and planktivorous fish species (grass carp, *Ctenopharingodon idella*; silver carp, *Hypophthalmichthys molitrix*; bighead carp, *Aristichthys nobilis*) found favourable conditions in the newly formed reservoirs and showed increases in catch.

Key words: dam construction, change in catch, sturgeon, bream, planktivorous fish

Habitat degradation and subsequent fishery collapse in Lakes Naivasha and Baringo, Kenya

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Abstract

Lakes Naivasha and Baringo in the eastern Rift Valley of Kenya are shallow, freshwater lakes that are subject to major fluctuations in water level and suffer from habitat degradation as a consequence of riparian activity. Lake Naivasha is approximately 160 km², is bordered by *Cyperus papyrus* and its aquatic macrophytes are in a state of flux. The most significant riparian activity is the large scale production of flowers for the European market. Lake Baringo is approximately 140 km² and lies in a semi-arid region. Its most noticeable feature is its extreme turbidity which is mainly due to excessive soil erosion resulting from deforestation and overgrazing. This turbidity has led to near extinction of submerged macrophytes and a lake bed virtually devoid of benthic fauna. Fishing pressure has added to the environmental stresses being endured by the fish populations and commercial catches have been detrimentally affected. Accordingly, periods of fishery closure are now imposed upon both lakes. Limited remedial action is feasible and some local stakeholders are attempting to introduce mitigation measures. For Lake Naivasha there is an agreed riparian owners' management plan which tackles issues such as water usage and protection of the *C. papyrus* margin. For Lake Baringo there is a Rehabilitation of Arid Environments initiative which promotes such activities as restoration of riparian vegetation and appropriate stock management.

Key words: Rift Valley lakes, ecohydrology, fish, macrophytes, turbidity, soil erosion

Stock and fishery dynamics of *Coregonus lavaretus* in changing ecological conditions of Lake Sevan, Armenia

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Abstract

Reduction in the water level of Lake Sevan since 1939 has essentially changed its ecological regime. Consequently, there was considerable disturbance to the natural reproduction of fish and to the availability of fish food. Coupled with recent intensified illegal fishing, this has led to depression of the commercial stocks of the lake.

Analysis of the dynamics of the *C. lavaretus* stock from 1979-1998 was conducted and a short-term forecast of its catch attempted. During the 1990s a tendency for rejuvenation was observed in parallel with depletion of the stock. Whilst in the preceding period the main regulating factor for the stock was water quality deterioration, in the most recent years investigated, fishing pressure has become the main limiting factor for the population.

Key words: eutrophication, whitefish, prediction, retrospective analysis, overfishing

Mass hermaphroditism in forms of *Coregonus lavaretus* (L) as a reaction to high water temperature

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Abstract

The investigation of gonad development in the early life history stages of the whitefish *Coregonus lavaretus baeri* (Kessler) under experimental conditions revealed the phenomenon of mass hermaphroditism as response to high temperature influence. In almost all young (3 months) female gonads the spontaneous development of testicular tissue was observed. Later, the male generative tissue in ovaries did not develop and quickly underwent resorption. Some one and two year old females conserved the hermaphroditic characters and this phenomenon corresponds to data previously obtained for another whitefish, *Coregonus lavaretus maraenoides* (Poljakow), from Chudskoje Lake. From analyzes of own data and that from the literature it is possible to propose the existence of an "intercalary" hermaphroditic stage in whitefish forms of the "*lavaretus*" group as a specific reaction to poor environmental conditions and, in particular, high temperature. The issue of adaptive significance of the phenomenon at both the organism and population levels is discussed.

Key words: Whitefish, gonad development, unfavorable conditions, abnormalities of sex differentiation