Kala- ja riistaraportteja nro 34

PERCIS II

Second International Percid Fish Symposium
Vaasa, Finland, August 21-25, 1995

Symposium program
Abstracts

Helsinki 1995

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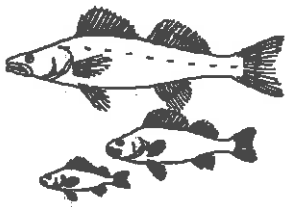

Vaasa, Finland, August 21-25, 1995

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Finnish Game and Fisheries Research Institute

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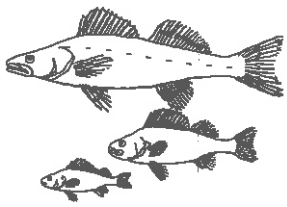

SYMPOSIUM PROGRAM

Vaasa, Finland, August 21-25, 1995

	Date	Session I	Session II
Su	Aug 20	Registration	Registration
Mo	Aug 21	Biology	
Tue	Aug 22	Biology	Taxonomy, physiology, diseases
We	Aug 23	Biology	Aquaculture Aquaculture workshop
Thu	Aug 24	Impact studies Management	Aquaculture workshop
Fri	Aug25	Working groups Summary	

Sunday 20 August

16.00-20.00 **Registration**
18.00-20.00 **Welcome reception**

Monday 21 August

8.00-10.00 **Registration**
8.00-09.45 **Coffee, posters up**

09.45-10.00 **Welcome and opening remarks**

SESSION I BIOLOGY

Chair: J. Treasurer

10.00 **Urho L.,** Finland: The strategies of the early stages of perch to survive

10.20 **Roseman E. F., Taylor W. W. and Hayes D.,** USA: Walleye egg deposition and survival on two reefs in western Lake Erie (Ohio: USA)

10.40 **Egloff M.,** Switzerland: Effects of egg size on survival, size and swim bladder inflation of perch larvae (*Perca fluviatilis*, L.)

11.00 **Wanzenböck J., Matena J. and Kubecka J.,** Comparison of different methods to quantity pelagic early life stages of perch, pikeperch and ruffe

11.20 **Hudd R., Kjellman J. and Urho L.,** Finland: The habitat choice of perch (*Perca fluviatilis* L.) 0+ juveniles in the estuary of the Kyrönjoki River

11.40 **Mikheev V.,** Russia: Do ecological flexibility and food demands influence mass active movement in juvenile percids?

Lunch

Chair: J. Matena

13.00 **Mehner T.,** Germany: Seasonal patterns of predation and resource partitioning in a community of age-0 percids

13.20 **Thiel R.,** Germany: Production, food consumption and predation impact of juvenile percids in two German estuaries

13.40 **Flesch A., Masson G. and Moreteau J.-C.,** France: Biology of *Perca fluviatilis* in a heated water reservoir (Moselle, France)

14.00 **Aubin-Horth N. and Boisclair D.,** Canada: The potential relationship between growth and activity rates of yellow perch (*Perca flavescens* Mitchill)

14.20 **Boisclair D. and Rasmussen J.,** Canada: Empirical analysis of influence of environmental variables on perch growth, consumption and activity rates

14.40 **Neuman E., Sandström O. and Thoresson G.,** Sweden: Swimmimg activity pattern in perch (*Perca fluviatilis* L.)

Coffee

Chair: I. Winfield

15.30 **Hudd R., Kjellman J. and Urho L.,** Finland: The conditions on reproduction areas rules the year class strength of perch (*Perca fluviatilis* L.)

15.50 **Karås P.,** Sweden: Basic conditions of perch fry production in the Gulf of Bothnia

16.10 **Eckmann R. and Imbrock F.,** Germany: Diurnal vertical migration of European perch (*Perca fluviatilis* L.) during winter

16.30 **Byström P.,** Sweden: Competition induced resource limitation in young-of-the-year perch (*Perca fluviatilis*)

16.50 **Engelmayer A. and Baranski B.,** Poland: Effects of predator-released cues on foraging efficiency of perch (*Perca fluviatilis*)

17.10 **Shatunovsky M. I. and Makarova N. P.,** Russia: 1. Fecundity of the perch from some water basins of Russia. 2.Fatness and growth of perch from some water basins of Russia

Tuesday 22 August

SESSION I BIOLOGY

Chair: L. Persson

9.00 **Le Cren E. D.**, U. K: Exceptionally big individuals in perch populations

9.20 **Jorgensen C. and Reckahn J. A.**, Canada: Factors affecting stock and recruitment of walleye (*Stizostedion vitreum*) in Lake Nipissing, Ontario, 1968 to 1994

9.40 **Smith P. A., Leah R. T. and Eaton J. W.**, U. K.: The successful colonisation of British canals my an alien percid, zander (*Stizostedion lucioperca* L.)

10.00 **Frankiewicz P., Zalewski M. and Dabrowski K.**, Poland: Mechanism of establishing bimodality in a size distribution of age-0 pike-perch, *Stizostedion lucioperca* (L.) in the Sulejow Reservoir, Central Poland

Coffee

Chair: L. Persson

11.00 **Steinmann P.**, Switzerland: Perch population monitoring in lake Zurich by counting and measuring eggstrands

11.20 **Escbaum R., Kikas L., Mölder M., Trahv A., Vetemaa M., Vaino V. and Saat T.**, Estonia: Coastal fish monitoring in western Estonia. 1. Species composition and their relative abundance in different areas of western Estonia

11.40 **Jansen W.**, Germany: Life-history of stunted perch (*Perca flavescens*) in central Alberta, Canada

Lunch

Chair: R. Eckmann

13.00 **Helminen H. and Sarvala J.**, Finland: Changes in abundance of perch (*Perca fluviatilis*) in Lake Pyhäjärvi, southwest Finland

13.20 **Persson L.**, Sweden: Cannibalistic cycles in perch? - The timing of competitive and predatory processes

13.40 **Toivonen A-L. and Hudd R.**, Finland: Behavioural aspects in creating traps for perches for prolonged trap net fishery

14.00 **Christensen B.**, Sweden: Predator foraging capabilities and prey antipredator behaviours: pre versus post capture constraints on size-dependent predator-prey interactions

14.20 **Kubecka J., Seda J. and Matena J.**, Czech Republic: Perch (*Perca fluviatilis*) effect upon pelagic zooplankton in the spring period

14.40 **Ohlsson J.**, Sweden: Growth rates and morphological characters in perch as a function of different resource availabilities

Coffee

Chair: W. Jansen

15.30 **Peltonen H. and Ruuhijärvi J.**, Finland: Prey selection and seasonal pattern in feeding of pikeperch (*Stizostedion lucioperca* (L.)) in Lake Vesijärvi, southern Finland

15.50 **Radke R. and Eckmann R.**, Germany: Piscivorous eel in Lake Constance: can they influence year-class strength of European perch?

16.10 **Matena J.**, Czech Republic: Diets of European percids during the pelagic stage of life in early ontogeny

16.30 **Dgebuadze Y. and Skomorokhov M. O.**, Russia: Mechanisms of size differentation in even- aged groups of young perch

16.50 **Belova N. V., Riabov I. N. and Haddering R.**, Russia: The seasonal feeding peculiarities of different size perch inhabiting the Kiev Reservoir

SESSION II TAXONOMY, PHYSIOLOGY & DISEASES

Coffee

Chair: C. Wahl

11.00 **Saat T. and Veersalu A.**, Estonia: Oocyte final maturation and ovulation in the perch, *Perca fluviatilis*

11.20 **Krpo-Cetkovic J. and Stamenkovic S.**, Yugoslavia: Differentiation of the pikeperch *Stizostedion lucioperca* (L.) populations from the Yugoslav part of the Danube

11.40 **Rutherford E.S., Rose K. A.,SinghDermott D., Forney J. L. and Mills E. L.**, USA: Modeling effects of alternate prey type on walleye and yellow perch recruitment in Oneida Lake, NY., USA

Lunch

Chair: Y. Reshetnikov

13.00 **Ciereszko R. E., Dabrowski K., Ciereszko A., Toth G. P., Christ S. A., Ottobre A. C. and Ottobre J. S.:** Plasma steroid consentrations and steroidogenic potential of gonads in the ontogeny of juvenile yellow perch (*Perca flavescens*)

13.20 **Nikolic V. and Simonovic P.**, Yugoslavia: Paracitic ciliates of perch *Perca fluviatilis* L.
1758 from Vlasinsko lake reservoir (Serbia, Yugoslavia)

13.40 **Saat T. and Veersalu A.**, Estonia: The rate of embryonic development in perch and ruffe at different temperatures

14.00 **Wahl C.**, USA: The role of special senses in feeding behaviour of the walleye, *Stizostedion vitreum*

14.20 **Billinton N.**, USA: Geographical distribution of mitochondrial DNA variation in walleye, sauger and yellow perch

Coffee

Chair: T. Saat

15.30 **Simonovic P. and Nikolic V.**, Yugoslavia: Morphology of the Eurasian perch (*Perca fluviatilis* Linnaeus, 1758): a multivariate approach

15.50 **Loew E. R. and Mills E. L.**, USA: Visual factors affecting prey recognition and preference by larval perch

16.10 **Machiels M. A. M. and Wijsman J.**, The Netherlands: Size-selective mortality in an exploited perch population and the reconstruction of potential growth

16.30 **Popova O. A. and Reshetnikov Yu. S.**, Russia: The analysis of morphological variability on perch in areal

16.50 **Rab P., Slechta V., Slechtova V., Rabova M., Berrebi P., Ozouf-Costaz C. and Lusk S.**, Czech Republic: Genetic differentiation of endangered Danubian *Zingel zingel*: 1st results on isozyme polymorphism and chromosomal markers

Wednesday 23 August

SESSION I BIOLOGY

Chair J. Sarvala

9.00 **Rask M., Järvinen M., Kuoppamäki K. and Pöysä H.**, Finland: The collapse of perch population in a small lake: responses in the food chain and in the rest of the perch population

9.20 **Wahlström E. and Persson L.**, Sweden: Intertrophic effects on zooplankton community structure

9.40 **Escbaum R., Kikas L. and Saat T.**, Estonia: Coastal fish monitoring in western Estonia. 2. Growth rate of perch

10.00 **Beier U.**, Sweden:Population structure and habitat selection of perch (*Perca fluviatilis*) related to zooplantivores and abiotic factors

Coffee

Chair: J. Sarvala

11.00 **van Densen W.**, The Netherlands: Positive skewness in the size distribution within cohorts of pikeperch, perch and smelt

11.20 **Winkler H.**, Germany: Feeding modes of pikeperch and perch and their role in the coastal fish communities

11.40 **Rösch R. and Schmid W.**, Germany: Ruffe, newly introduced into Lake Constance: population dynamics and possible effects on coregonids

Lunch

Chair: M. Appelberg

13.00 **Krpo-Cetkovic J., Stamenkovic S. and Savic I.**, Czech Republic: Age distribtion and growth of the pikeperch *Stizostedion lucioperca* (L.) from the Yugoslav part of the Danube

13.20 **Svirsky A. M.**, Russia: Adaptations of perch *Perca fluviatilis* to temperature and light cycles

13.40 **Vinogradov G. A. and Umorin P. P.**, Russia: Modelling impacts of juvenile perch upon main ecosystem components

14.00 **Cohen Y.**, USA: Water levels and identification of fish assembleges

SESSION II AQUACULTURE

Chair: K. Dabrowski

8.30 **Czesny S. and Dabrowski K.**, USA: The effect of fatty acid concentration in walleye (*Stizostedion vitreum*) eggs on embryos viability

8.50 **Vlavonou R., Masson G. and Moreteau J.-C.**, France: Use of *Artemia salina* as unique starting food for cultured perch *Perca fluviatilis* larvae

9.10 **Schlumberger O. and Proteau J. P.**, France: Intensive rearing of *Stizostedion lucioperca* larvae

9.30 **Mélard C., Baras E., Mary L. and Kestemont P.**, Belgium: Relationships between growth, cannibalism and survival rate in intensively cultured larvae and alevins of perch (*Perca fluviatilis*)

Coffee

Chair: O. Schlumberger

10.30 **Steffens W., Geldhauser P., Gerstner P. and Hilge V.**, Germany: German experience in propagation and fingerling rearing of pike-perch (*Stizostedion lucioperca*)

10.50 **Fiogbe E., Kestemont P., Micha J.-C. and Mélard C.**, Belgium: Effects of dietary protein and amino acid contents in growth and body composition of the European perch *Perca fluviatilis*

11.10 **Kestemont P., Fiogbe E., Tahir K., Micha J.-C. and Mélard C.**, Belgium: Assessments of the quantitative feed requirements of European perch *Perca fluviatilis* juveniles reared in intensive conditions

11.30 **Fontaine P., Vlavonou R. S., Tamazouzt L., Masson G. and Capdeville B.**, France: A strategy for the development of a common perch aquaculture in Lorraine (France)

11.50 **Vlavonou R., Masson G and Moreteau J.-C.**, France: Cannibalism among intensive cultured perch *Perca fluviatilis* populations

12.10 **Tamazouzt L., Dubois J. P., Fontaine P., Capdeville B. and Terver D.**, France: Zootechnical performances and body composition of *Perca fluviatilis* pelleted diet in a floating cage

Lunch

14.00- **European Workgroup on Aquaculture of Percids**

Thursday 24 August

SESSION I IMPACT STUDIES

Chair: L. Urho

9.00 **Komov V. T.**, Russia: Perch populations of acidified lakes of North Western Russia

9.20 **Appelberg M. and Ångström C.**, Sweden: Individual growth of perch (*Perca fluviatilis*) as a measure of environmental stress in lakes

9.40 **Halmetoja A. and Hudd R.**, Finland: The use of deformed operculum bones of perch (*Perca fluviatilis* L.) in environmental monitoring

10.00 **Linløkken A.**, Norway: Density, growth and production of perch (*Perca fluviatilis*) in a heavily fished population

Coffee

Chair: L. Urho

11.00 **Reshetnikov Yuri S. and Popova O. A.**, Russia: Estimation of state of fish populations in conditions of antropogenic influence

11.20 **Busch W.-D.**, USA: Factors affecting Lake Erie´s yellow perch strength during a period of severe environmental stress (1959-74) and implications to ecosystem rehabilitation (1975-94)

11.35 **Riabov I. N.**, Russia: The effect of water intake from the Leningrad NPP to percid fish inhabiting the Kopor Bay of the Finnish Gulf

11.50 **Dumont P., Leclerc J., Roy G., Hontela A., Fournier M., Spear P. A. and Fortin R.**, Canada: A comparative study on the dynamics of yellow perch exposed to different levels of contamination

Lunch

SESSION I FISH STOCK MANAGEMENT

Chair: M. Machiels

13.00 **Ruuhijärvi J., Salminen M. and Nurmio T.**, Finland: Releases of fingerling zander (*Stizostedion lucioperca* L.) in lakes with no established zander stock

13.20 **Nyberg P., Degerman E. and Sers B.**, Sweden: Movements and growth of the zander, *Stizostedion lucioperca*, in Lake Hjälmaren, central Sweden

13.40 **Johnson B. M., Vogelsang M. T. and Stewart R. S.**, USA: Effectiveness of stocking and harvest regulations to enhance a walleye population for biomanipulation

14.00 **Green D.**, USA: Restructuring of a fish community resulting from the establishment of a walleye (*Stizostedion vitreum*) population

14.20 **Gerster S., Staub E. and Krämer A.**, Switzerland: Dynamics of the perch population of Lake Constance monitored with multimesh nets

14.40 **Bolotova N. L., Reshetnikov Yu. S. and Zuyanova O. V.**, Russia: Introduction and inclusion of pikeperch (*Stizostedion lucioperca*) in feeding relation system of Vozha Lake

Coffee

Chair: D. Green

15.30 **Schultz H., Wieland F. and Werner M.-G.**, Germany: Development of the perch population in the hypertrophic Bautzen reservoir: Results of a biomanipulation experiment

15.50 **Salonen S., Helminen H. and Sarvala J.**, Finland: Feasibility of controlling coarse fish populations through pikepearch (*Stizostedion lucioperca*) stocking in Lake Köyliönjärvi, southwest Finland

16.10 **Winfield Ian J., Adams C. E. and Fletcher J. M.**, U. K.: Recent introductions of the ruffe *Gymnocephalus cernuus* to three *Coregonus* lakes of the U.K.

16.30 **Järvalt A.**, Estonia: Estimating of fishing mortality and abundance of pikeperch in Lake Vortsjärv by Cohort Analysis

16.50 **Melnikov A.**, Russia: Regulation and control of fisheries selectivity as related percid fish

17.10 **Maletin S., Jovanovic R., Djukic N., Ivanc A. and Miljanovic B.**, Yugoslavia: Effects of pikeperch nests stocking in Danube river system in Yugoslavia

8.30- **European Workgroup on Aquaculture of Percids**

Friday 25 August

09.00-10.30 **Working groups**
10.30-11.00 **Coffee**
11.00-12.00 **Working groups**
12.00-13.00 **Lunch**

13.00-15.00 **Summaries of the working groups, general discussion etc. Chair P. J. Colby**
15.00 **Closing the symposium**

POSTERS

BIOLOGY

1. **Appelberg M., Rask M., Hesthagen T., Berger H. M., Kleiven E., Kurkilahti M. and Raitaniemi J.**: Development and intercalibration of methods in Nordic freshwater fish monitoring
2. **Auvinen H., Auvinen S. and Vuorimies O.,** Finland: Size selective predation of perch on vendace larvae and juveniles - a bioenergetics modelling study
3. **Baccante D. A. and Colby P. J.**, Canada: Harvest, density and reproductive characteristics of North American walleye populations
4. **Baranski B. and Engelmayer A.**, Poland: How persistant are changes in foraging behavior of perch (*Perca fluviatilis*) exposed to predator-released chemicals?
5. **Böhling P.**, Finland: Migrations of perch (*Perca fluviatilis*, L.) in a Baltic archipelago
6. **Böhling P.**, Finland: Maturation of perch (*Perca fluviatilis* L.) in the coastal waters of the Gulf of Finland
7. **Dubois J.-P., Gillet C., Bonnet S., Inra T. and Weber Y. C.**, France: Stock assessment of mature perch females (*Perca fluviatilis* L.) by the study of the egg ribbons
8. **Feklov Y. A. and Belousov I.**, Russia: Experimental influence the different photoperiod on the perch spawning
9. **Hansson S., Post D. M., Mc Comish T. S., Belonger B. J. and Kitchell J. F.** Effects of predation by yellow perch (*Perca flavescens*) in southern Lake Michigan - a model analysis
10. **Helminen H., Kurkilahti M. and Wright J.**, Finland: Problems in obtaining unbiased samples of perch (*Perca fluviatilis*) populations with gillnet series
11. **Huusko A. and Eironen K.**, Finland: Survival of pikeperch (*Stizostedion lucioperca*) during their first winter: laboratory studies
12. **Imbrock F., Eckmann R. and Appenzeller A.**, Germany: Horizontal distribution patterns of perch (*Perca fluviatilis*, L.) in Lake Constance: a hydroacoustic study
13. **Ivanc A., Maletin S., Djukic N. and Miljanovic B.**, Yugoslavia: Comparative haematology of some European *Percidae*species
14. **Kangur K. and Kangur A.**, Estonia: Feeding of ruffe (*Gymnocephalus cernuus*) in Lake Vortsjärv (Estonia)
15. **Karjalainen J., Lehtonen H., Turunen T. and Viljanen M.**, Finland: Growth, recruitment and fishing of pikeperch in two different lakes in Finland
16. **Keskinen E., Pääkkönen J.-P., Tapaninen M. and Marjomäki T. J.**, Finland: Temperature selection of ruffe (*Gymnocephaluss cernua*) in laboratory and natural habitat
17. **Lappalainen J., Lehtonen H., Böhling P. and Erm V.** Covariation in year-class strength of perch (*Perca fluviatilis* L.) and pikeperch (*Stizostedion lucioperca* (L.))
18. **Le Cren D. E., des Clers S. and Winfield I. J.**, England: The Windermere perch and pike project, 1940-1994
19. **Legky B.**, Russia: Changes of photoreaction in the perch, *Perca fluviatilis*, during its early ontogeny
20. **Lehtonen H., Hansson S. and Winkler H.**, Biology of the pikeperch in the Baltic Sea
21. **Martin M., Exbrayat J.-M. and Goubier V.**, France: Some observations on final ovary maturation of perch (*Perca fluviatilis)* in captivity
22. **Mikheev V.**, Russia: Foraging plasticity and selective feeding in juvenile percids, *Perca fluviatilis* and *Stizostedion lucioperca*

23. **Milenin S. A., Dgebuadze Y. Y. and Skomorokhov M. O.**, Russia: Late size differentiation of perch in two Russian lakes
24. **Pavlov D. S. and Lupandin A. I.**, Russia: Behaviour of perch, *Perca fluviatilis*, in streams with different levels of turbulence
25. **Pavlov D. S., Kostin V. V. and Lupandin A. I.**, Russia: Down-stream movements of the perch, *Perca fluviatilis*, from reservoirs situated at different climatic zones
26. **Popova I.**, Russia: Settlement strategy in perch fry - the largest individuals are the first ones
27. **Popova O. A.**, Russia: Peculiarities of feeding of perch and pike in waterbodies of Pasvik River system (Kola Peninsula)
28. **Popova O. A. and Reshetnikov Yu. S.**, Russia: The role of percid fishes in ecosystem of eutrophicating lake
29. **Rudstam L., Green D. M., Forney J. L., Stang D. L. and Evans J. T.**, U.S.A: Evidence for biotic interactions among percids in New York lakes
30. **Tamazouzt L., Sulistyo I. and Georges A.**, France: Biological characteristics of brood stock perch *Perca fluviatilis* under thermophotoperiodic programs
31. **Treasurer J. W.**, U. K.: Percids in single species, simple and complex fish assemblages in Scotland
32. **Urho L.**, Finland: Perch, pikeperch or ruffe larvae?
33. **Vatemaa M. and Saat T.**, Estonia: Effects of water salinity on the embryological development of perch (*Perca fluviatilis*) and ruffe (*Gymnocephalus cernua*)
34. **Vuorimies O., Auvinen H., Kolari I., Auvinen S., Jurvelius J., Heikkinen T., Sikanen A.-P. and Hirvonen E.**, Finland: The fish community structure and the significance of perch in various habitats of Lake Puruvesi
35. **Wiik T., Björkgård K. and Hudd R.**, Finland: The food of first feeders of perch (*Perca fluviatilis*) in the Gulf of Bothnia, the Baltic
36. **Winfielf I. J. and McCulloch I. D.**, U. K.: An annotated bibliography of the ruffe *Gymnocephalus cernuus* (L.)
37. **Wistbacka R.**, Finland: Changes in the status of small water bodies as spawnings places for perch in the quark

IMPACT STUDIES

38. **Golovanov V. K., Bazarov M. I., Poddubny S. A. and Kudrjakov S. V.**, Russia: Percid thermal habitat in warm-gradient waters: Experiments and natural realization
39. **Komov V. T. and Matey V. E.**, Russia: Scale morphology of perch as the indicator of lake acidification
40. **Krizek J. and Albertova O.**, Czech Republic: Impact of the perch population on zooplankton in the Hubenov Reservoir
41. **Laitinen M. and Valtonen T.**, Finland: Quality of reproductive products of the perch (*Perca fluviatilis* L.) in an acid and a neutral lake
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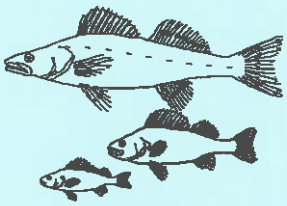

Vaasa, Finland, August 21-25, 1995

ABSTRACTS

INDIVIDUAL GROWTH OF PERCH (*Perca fluviatilis*) AS A MEASURE OF ENVIRONMENTAL STRESS IN LAKES.

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The effects of an environmental perturbation are determined both by the abiotic and biotic effects caused by the stress and the life history traits of specific species. In the present study we assessed the effects of acidification and liming in relation to fish assemblage composition and biomass using individual growth rate in European perch (*Perca fluviatilis*) as response variable. Growth estimates were based on back-calculated lengths from operculum bones, sampled during a five year period in twelve limed and six non-limed, oligotrophic, lakes. No differences in the relationship between operculum size and fish length were found when comparing fast and slow growing individuals, neither differed the back-calculated lengths when the same year classes were sampled sequential years. However, growth rate varied considerably between years, emphasizing the importance of the temperature dependance. The response to acidification and liming could mainly be attributed to changes in competitive interactions and availability of prey organisms. Growth was found to be disfavored by acidification, expressed by low individual growth rates in acidified lakes, intermediate in limed lakes and high in neutral lakes. In lakes with a large number of fish species and a large fish biomass, growth of young perch was low indicating strong interspecific competition. Piscivorous perch growth rate, on the other hand, was favored by an increased number of species, especially cyprinids and vendace. The study emphasize that individual growth rate of E. perch is a useful measure in order to determine direct and indirect effects of environmental stress.

DEVELOPMENT AND INTERCALIBRATION OF METHODS IN NORDIC FRESHWATER FISH MONITORING

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The awareness of the effects of transboundary pollution has increased the necessity to use comparable methods and to initiate joint studies between countries in environmental monitoring. In freshwater fish monitoring a number of different methods have been used, strongly reducing the possibilities to comparative assessments between countries. In 1990, a workshop on freshwater fish sampling was initiated in order to develop and intercalibrate methods used in freshwater fish studies in the Nordic countries. During a three year period, a new type of multi-mesh gillnet to be used for fish monitoring in Norway, Finland and Sweden have been developed. Comparative studies and gillnet-selectivity assessments show that these new multi-mesh gillnets better describe the actual population structure of European perch (*Perca fluviatilis*) and roach (*Rutilus rutilus*) than do the traditional Finnish

gillnet series. Similar experiences are also obtained in Sweden. Ageing of fish is central in most environmental studies, however, the comparability of analyses performed at different laboratories may be low. Comparative analyses of ageing fish between the three countries have been performed for a number of species. The results of ageing E. perch and whitefish (*Coregonus* sp) indicate that differences between laboratories can be reduced by intercalibration. In the future, the workgroup will be focused on a further development of joint methods within studies of freshwater fish and on joint internordic assessments on species distribution, abundance and life history characteristics in relation to airborne pollutants and liming.

THE POTENTIAL RELATIONSHIP BETWEEN GROWTH AND ACTIVITY RATES OF YELLOW PERCH (*Perca flavences* Mitchill)

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Perch growth is expected to increase when environmental conditions favour an increace in consumption rate or a decrcasc in activity costs. Definition of the relative magnitude of these two processes determines the predictions of models developed to assess predator-prey relationships. Studies on the relative importancc of consumption and activity on growth have been impeded by the lack of method to directly estimate fish activity rates in the field. Our objective was to quantify activity rates of perch from two populations that vary significantly in terms of growth rates. The growth of perch between age 1+ and age II+ was 25 g wet in Lake Connelly and 17 g wet in Lake Patrick (Lower Laurentian region of Quebec). Fish from the littoral zone of both lakes were filmed for 1 h at 4 h intervals between 06:00 h to 20:00 h during 3 consecutive days. Filming was performed using two pairs of video-cameras (one in a rocky area, one in a weed bed of both lakes). We estimated the number of movements (n/m3) executed by perch and their swimming characteristics (speed, acceleration, angle of turns) in both habilats and lakes. Activity costs were estimated using an empirical relationship between fish respiration, weight, and speed. These information together with field estimates of perch abundance (n/m^3) allowed the estimation of an average activity cost per perch. Our results suggest that perch activity costs vary significantly between the populations studied. Our work further supports the hypothesis that lower growth rates call be associatcd with higher activity costs.

SIZE SELECTIVE PREDATION OF PERCH ON VENDACE LARVAE AND JUVENILES - A BIOENERGETICS MODELLING STUDY

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The size-distribution of perch (*Perca fluvialilis*) differed between areas with a high fishing pressure and with no fishing in a lake. The year-class strength of vendace (*Coregonus albula*) was constantly lower in areas with bigger perch. A decline in vendace stock happened simultaneously with an increase of perch density. In order to estimate the potential

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effects of perch stock density and size distribution on the survival of vendace larvae and juveniles a simulation model based on the bioenergetics consumption equations was used. The cathing success of perch on vendace larvae was studied in aquarium tests. The simulations showed that even small changes in the density of predators can have drastic effects on the density of vendace larvae and juveniles during the summer The diffrences in size distribution of perch could explain the differences in year-class strength of vendace in the exploited and unexploited areas of a lake.

HARVEST, DENSITY AND REPRODUCTIVE CHARACTERISTICS OF NORTH AMERICAN WALLEYE POPULATIONS

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This paper provides a synoptic summary of walleye population characteristics from North American lakes. Harvest, density and reproductive data from the primary literature, agency reports and personal communications were collected and summarized. Harvest information from sport fishing is expressed as annual yield in kilograms, and exploitation rates, measured as percent of the population harvested. Density data are represented by population size as determined by mark-recapture sampling. Reproductive data include relative fecundity, expressed number of eggs per kilogram, and age to 50 percent maturity. Empirical relationships between yield, population, lake area, relative fecundity, age to maturity and growing degree-days are described. Factors affecting these empirical relationships are discussed. Quartiles were used to describe the frequency distributions of harvest, yield and density parameters. Managers can use these empirical relationships and descriptive statistics as comparative diagnostic tools for interpreting the status of their walleye fishery. We feel this is a useful approach because mangers are often faced making decisions about their fishery with little or no available information. The interpretive value of minimal data can be enhanced when comparative information is available.

HOW PERSISTANT ARE CHANGES IN FORAGING BEHAVIOR OF PERCH (*Perca fluviatilis*) EXPOSED TO PREDATOR-RELEASED CHEMICALS?

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Effect of different times of exposition to pike-odour on the foraging behavior of perch was studied in the laboratory experiments. *Daphnia magna* individuals were offered as a prey. Foraging efficiency was measured by the number of prey individuals eaten per time unit. The prey was offered to perch after different exposition times to the odour. The longer perch was exposed to the pike-odour the smaller decrease of foraging efficiency was recorded. The strongest decrease of foraging efficiency was observed when prey was offered together with pike-odour. The sensitivity of perch to pike-odour decreased also when the same fish was again exposed to predator-odour during the consecutive experimental procedures. This experiment shows that effect of predator-released cues on perch foraging behavior is short lasting. Perch habituates to the pike-odour presence when the "smell" is not followed by real attack.

OPULATION STRUCTURE AND HABITAT SELECTION OF PERCH (*Perca fluviatilis*) RELATED TO ZOOPLANKTIVORES AND ABIOTIC FACTORS

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It has earlier been shown that perch biomass in lake ecosystems seems to reach a maximum in the same interval of productivity as coregonid biomass, and that perch biomass is negatively related to roach (*Rutilus rutilus*) biomass. Perch are assumed to be limited both by competition at early stages and the possibilities to eventually become piscivorous. Coregonids, especially vendace (*Coregonus albula*), usually dominate the pelagic zone in low to medium productive lakes, affecting other zooplanktivorous species and stages. It may be proposed that the competitive and predatory interactions between perch and other species in both the pelagic and littoral/benthic habitats are directly and indirectly affected by the presence of one or more specialized zooplanktivorous species. The outcome of these interactions together with abiotic factors can be traced in habitat selection, population structures, and relative biomasses of coexisting species. I related biomass and size structure of perch in the littoral/benthic and pelagic habitats of a total of 117 Swedish lakes to biomasses of zooplanktivorous and other fish species as well as abiotic factors. Perch populations were affected by the presence and amount of zooplanktivores, especially vendace, but certain observed effects were partially coupled to abiotic factors.

THE SEASONAL FEEDING PECULIARITIES OF DIFFERENT SIZE PERCH INHABITING THE KIEV RESERVOIR

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When conducting racioecological monitoring of fish in the zone of the Chernobyl NPP it was revealed that large fish, notably perch *Perca fluviatilis*, have a higher ^{137}Cs concentration as compared with small species (Koulikov, Riabov, 1992). Large perches (240-370 mm) are seemed to consume fish which comprises more than 80 % in their feeding in all seasons. Gastropoda and Decapoda comprise only 5-10 %. Middle perches (150-239 mm) have a wide feeding spectrum in the warm seasons, whereas in winter for the most part they consume fish (83.2 %). As to the feeding of small perches (80 149 mm) in summer fish comprise merely 1.1 %, whereas Chironomidae and Ephemeroptera larvae are of 40 % and 28.9 %, respectively. It is significant that in winter small perches consume primarily fish as well (68.5 %). Thus, the "size-effect" it most pronounced in summer but in winter distinctions in xxxxxxxxxxxxxxxx accumulation between large and small species become less substantial.

The works have been carried out on the ECP3 project to be implemented within the framework of the CES/CIC Agreement on the consequences of the Chernobyl accident.

GEOGRAPHICAL DISTRIBUTION OF MITOCHONDRIAL DNA VARIATION IN WALLEYE, SAUGER AND YELLOW PERCH

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In order to assess its usefulness as a tool in stock identification and for resolving post-Pleistocene recolonization events, mitochondrial DNA (mtDNA) variation was examined in three economically important North American percid species: walleye (*Stizostedion vitreum*), sauger (*S. canadense*) and yellow perch (*Perca flavescens*). Walleye was most extensively surveyed with >1000 fish from >80 populations being examined. Thirty-five walleye mtDNA haplotypes were identified which could be divided into five groups that showed distinct geographic distributions. Three of these groups likely represent fish that spent the Pleistocene in separate glacial (Atlantic, Mississippian, and Missourian) refugia. The forth group represents more southerly haplotypes whose diversity and distribution suggests that they were not subjected to severe bottlenecks during the Pleistocene, and a fifth group, which are genetically very distinct (2.3% sequence divergence), exists only in the Mobile Drainage basin.
Sauger showed very little genetic variation with only two haplotypes being found in 54 fish from 10 populations from across the species' range. No conclusions can be made concerning post-Pleistocene recolonization events for this species based on mtDNA haplotype distributions. However, rare cases of introgression of walleye and sauger mtDNA were observed.
Thirteen mtDNA haplotypes were identified in 89 yellow perch from 10 populations. Although one haplotype predominated in all populations, there is some indication yhat yellow perch spent the Pleistocene in two different glacial refugia.
These results suggest that mtDNA haplotype distribution and frequency will be useful for stock identification in walleye, but will be of limited use in sauger and yellow perch.

EMPIRICAL ANALYSIS OF INFLUENCE OF ENVIRONMENTAL VARIABLES ON PERCH GROWTH, CONSUMPTION AND ACTIVITY RATES

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The purpose of our analysis was to develop models to predict perch growth consumption, and activity rates (all in g wet/d) using environmental variables such as fish and prey community characteristics. The data set we used consisted of 1) estimates of growth, consumption, and activity rates for age I+, II+ and III+ perch from eleven populations of the Eastern Townships region of Quebec (26 combinations of age classes and lakes), 2) values of fish biomass and abundances, and 3) biomass of planktonic, benthic, and epibenthic prey for the littoral zone of each lake.
Perch growth decreased with total fish community abundance ($R2 = 0.64$). Fish weight (partial $R2 = 0.68$) and the biomass of the total prey community (partial $R2 = 0.08$)

explained 76% of the variability of perch consumption. Consumption increased with fish size but decreased with prey biomass. The variability of perch activity (R2 = 0.56) was explained by fish weight (partial R2 = 0.46) and the biomass of the total prey community (partial R2 = 0.10). Perch activity costs increased with fish weight but decreased with prey biomass. Perch activity multipliers ("cost of activity + standard metabolism"/standard metabolism) were related to fish weight (partial R2 = 0.28), total fish community abundance (partial R2 = 0.16), and the biomass of the total prey community (partial R2 = 0.13). Activity multipliers increased with fish weight and fish community abundance but decreased with prey biomass

Our analysis indicates that when prey biomass increases or fish abundance decreases, perch growth may increase not necessarily through an increase in consumption rate (in fact consumption may decrease) but via a decrease in activity costs.

INTRODUCTION AND INCLUSION OF PIKE-PERCH (*Stizostedion lucioperca*) IN FEEDING RELATION SYSTEM OF VOZHE LAKE

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Vozhe Lake has a total area of 418 sq.km, fish community represented 14 species, but only 3 predators populate this lake: pike (*E. lucius*), burbot (*Lota lota*) and perch (*Perca fluviatilis*). In the last years the eutrophication had led to increasing small-sized cyprinid fish, the abundance of predacious fish was low, that was a reason to introduce new predator. Pike-perch was introduced in Vozhe Lake in 1987.

Pike-perch in the new ecosystem didn't meet a food competition, its number was increasing, and pike-perch had become a commercial species after 5 years. At present pike-perch has a fast growth and good condition. He consumes roach, smelt, perch and ruffe, which may be considered as competitors for bream - the main commercial fish in lake. Therefore, the role of pike-perch in the Vozhe Lake is that of improver of the biological environment, because it enhances the stability of the ecosystem by regulating the abundance of different prey species.

Study of the biology of predacious fish anf their importance in lake ecosystem provides a basis for the introduction of fish faunas into newly created or already existing ecosystems.

FACTORS AFFECTING LAKE ERIE'S YELLOW PERCH STRENGTH DURING A PERIOD OF SEVERE ENVIRONMENTAL STRESS (1959-74) AND IMPLICATIONS TO ECOSYSTEM REHABILITATION (1975-94)

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The environmental condition in Lake Erie, due to anthropogenic stresses, reach a low point in the mid 1960s and started to recover in the early 1970s. Improvements in biological indicators were noted by the mid 1970s as nutrient levels decreased. The decrease in nutrients has continued and is now a new concern. Yellow perch (*Perca flavescens*) have been and are the premier sport and commercial species in western Lake Erie. Year-class strength, as measured by young-of-the-year (YOY) and yearling (Y) index of abundance

values, was highly variable during the 1959-74 and 1975-94 periods and subsequent recruitment to the fishery provided by individual cohorts fluctuated accordingly.
The reproductive success of each year's brood stock (1959-70) was determined by calculating a coefficient of hatching and early survival (CHES) from a ratio of the potential egg deposition and the August YOY index of abundance. The potential egg deposition was derived from an estimate of the brood stock determined from cohort analyses and information on the fecundity and sexual maturation characteristics of western basin fish. During this period the relative index of progeny survival between the April/May egg deposition and mid-August abundance of yearlings was strongly influenced by environmental conditions.
In order to predict the strength of cohorts prior to their entry into the fishery, we calculated the multiple linear regression: $H = 99.1261 + 0.0601X_1 + 0.1322X_2$ ($R^2 = 0.80$ SE_{est},= 57.82), where H is the harvest from the cohort, X_1 and X_2 is the abundance of YOY and yearlings respectively. The predicted harvest and the actual harvest from each cohort are presented with descriptions of the changing environmental setting during the rehabilitation process.

COMPETITION INDUCED RESOURCE LIMITATION IN YOUNG-OF-THE-YEAR PERCH (*Perca fluviatilis*)

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The suggestion that fish during their first growing season generally are not resource limited has been contradicted by a number of recent studies. In a replicated whole-lake experiment, the effects of the presence of roach on habitat selection, diet and growth of young-of-the-year perch were investigated. Directly after hatching the perch larvae moved out into the pelagic. A habitat shift back to the littoral took place 4 to 5 weeks after hatching. The size of young-of-the-year perch was negatively affected by the presence of roach at the end of the growing season. The growth pattern of young-of-the-year perch in the lakes differed during the season possible due to different impacts of intra- and interspecific competition.

MATURATION OF PERCH (*Perca fluviatilis* L.) IN THE COASTAL WATERS OF THE GULF OF FINLAND

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Maturation of perch (*Perca fluviatilis* L.) was studied in three bays on the northern coast of the Gulf of Finland, Baltic Sea. The bays have different eutrophication histories but in all of them the water quality has improved since the 1980's. The material was collected in May-June in 1980-1994 from wire trap catches, which consist mainly of perch between 13 and 20 cm. The fish of this size group are relatively stationary. Samples taken in winters 1982-1987 were used to confirm the results.
Generally the attainment of maturity is a function of sex, length and age. Males of the populations studied are usually mature at the age of 3 years and females at the age of 3-5 years. The corresponding size groups are 13-14 cm and 14-16 cm.
The proportion of non-maturing individuals was exceptionally high in the middle of the

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1980's. The phenomenon was more common in females than males. The proportions were lowest in the least eutrophicated bay. The changes in age and size distributions indicate that the peak was mainly due to many relatively old and large non-maturing individuals. It is not known whether it was a matter of delayed maturation or 'resting' years. The simultaneous changes in different populations point at some infection rather than at a direct effect of environmental stress. Occurrence of the phenomenon and the mechanisms behind it are essential when assessing its consequenses to perch populations.

MIGRATIONS OF PERCH (*Perca fluviatilis* L.) IN A BALTIC ARCHIPELAGO

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The migrations of perch (*Perca fluviatilis* L.) were studied by Carlin-taggings in a eutrophicated bay, Vanhankaupunginlahti, on the northern coast of the Gulf of Finland, Baltic Sea. Altogether 1400 perch caught in May and June in 1990-1991 by wire traps (fish mainly smaller than 20 cm) and trap nets (over 20 cm) were tagged. The corresponding recapture rates were 5% and 21%. The recapture rate for small perch was relatively low because of low fishing effort in this size group.

The tag recaptures show that the spawning area is shared by individuals / sub-populations whose migratory habits differ. Perch smaller than 20 cm stay in the vicinity of the spawning bay and show homing to it. Bigger individuals have wider distribution areas and homing to the spawning area is not so clear. Their migrations are directed parallel to the coastline, mainly to the east. The most distant recaptures are 100 km to the east and 300 km to the west from the tagging place. The growth rate of the migratory individuals is higher than that of the stationary ones.

The migratory habits and possible mixing of populations are to be considered e.g. when planning experimental fishings, analyzing their results and using population variables as indicators of environmental quality. Stationary populations are useful when the effects of environment are to be studied. The migration pattern of the population studied is probably true also in other perch populations living on the coast of the Gulf of Finland.

PREDATOR FORAGING CAPABILITIES AND PREY ANTIPREDATOR BEHAVIOURS: PRE VERSUS: POST CAPTURE CONSTRAINTS ON SIZE-DEPENDENT PREDATOR-PREY INTERACTIONS.

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In order to understand patterns of predator diets and foraging efficiency relative to predator and prey size, it is essential to determine which particular suite of constraints determines the outcome of predator prey interactions. Feeding experiments were carried out with differently sized piscivorous Eurasian perch and prey fish, roach, at two different spatial scales, tanks and wading pools. The tank experiments focused on morphological constraints in the predation process, while the pool experiments focused on prey anti-predator behaviour, such as schooling capacity, evasive behaviours, predator and prey swimming capacities, and predator reaction times. In the tanks, for a given predator size, the number of attacks and the manipulation time after prey had been caught increased with prey size. The maximum size

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of prey caught appeared to be related mainly to predator gape limitation. In the pools the maximum size at which prey were captured by predators generally was smaller than in the tanks, indicating that prey evasive behaviours were important in determining predator success. The scaling of prey schooling, positioning in the water column and evading by jumping out of the water with prey size did not indicate that these behaviours were determining the maximum size of prey consumed in pools. Rather, the relation between predator and prey mobility seemed to be the most important factor determining the maximum sized fish consumed in the pools. This suggests that standard foraging models using handling time as currency may be poor predictors of piscivore foraging patterns.

PLASMA STEROID CONCENTRATIONS AND STEROIDOGENIC POTENTIAL OF GONADS IN THE ONTOGENY OF JUVENILE YELLOW PERCH (*Perca flavescens*)

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Plasma concentrations of estradiol (E_2), testosterone (T) and 11-ketotestosterone (11kT; only males) were monitored in juvenile yellow perch from July to December. In addition, basal and hCG-stimulated steroid production by gonads was determined *in vitro*. Two populations of perch were studied. One population had a normal growth rate (NGR) and the other had an accelerated growth rate (AGR). The body weight in November (n=5-9) in AGR fish was 4-6 times higher than that in NGR fish. Plasma level of 11kT (n=6-7) was elevated in AGR males vs. NGR fish (1.2 vs. 0.7 ng/ml). However, there was no difference in gonadosomatic index (GSI, Nov: 6-7%) and plasmaconcentrations of E_2 (Nov: 0.03 ng/ml) and T (Nov: 1.2 ng/ml). Contrary to males, GSI and plasma concentrations of E_2 and T in AGR females were higher than in NGR females (n=5-6; Nov: 6 vs. 0.3%; 0.7 vs 0.03 ng/ml; 0.7 vs. 0.02 ng/ml, respectively). Temporal analysis of plasma concentrations of steroids revealed that 11kT was low in July (0.07 ng /ml) and peaked in Nov/Dec in both populations of male perch (0.7-1.2 ng/ml). In contrast, plasma concentrations of E_2 and T peaked in July and October, respectively, and then declined. In AGR females, plasma levels of E_2 and T increased to peak values (0.75 and 1.0 ng/ml, respectively) in Nov/Dec, but these hormones were consistently undetectable in NGR females. Steroid production *in vitro* was higher in younger males (July vs. November). hCG (10IU) stimulated *in vitro* 11kT production by testis and did not affect E_2 production (n=5-6). Testicular steroid production was similar in AGR and NGR fish. hCG stimulated production of E_2 and T by ovaries of AGR, but not NGR, fish (n=4-5). Ovaries from NGR females produced low levels of steroid hormones. We conclude that AGR and NGR yellow perch males can mature during the first year of life. In contrast, only AGR females seem to demonstrate ovarian function when they are less than one year old.
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WATER LEVELS AND IDENTIFICATION OF FISH ASSEMBLEGES

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Fluctuations in fish populations can be synchronized due to: (1) trophic interactions, (2) common exogenous factors, and (3) habitat requirement. How to identify such co-occuring fluctuations is a challenge. We show methods appropriate to identify fish assembleges based on their population interactions and fluctuations. These method indicate management goals, and the groups of species they must target concurrently. Results are applied to large N.American lakes.

DYNAMICS OF AN EXPERIMENTALLY EXPLOITED WALLEYE POPULATION

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In cooperation with the Department of Biology, Lakehead university, Thunder Bay, Canada, controlled exploitation studies are being conducted on two walleye populations: a pulse-fishing perturbation in Henderson Lake (151 ha) and a pressing-type exploitation (Bender et al. 1984) perturbation in Savanne Lake (364 ha). Results of the pulse experiment on Henderson Lake were reported by Reid and Momot (1985), and studies monitoring the rate of recovery are in progess. Here we describe the impact of the longer term press-type harvest on the walleye population in Savanne Lake for the purpose of testing Ontario's harvest guidelines, monitor certain fish populations and community changes, and test the reliability of various population and fishing experience indices. Thereafter, we increase the harvest and monitorthe effects over time.
Harvesting at a level recommended by our guidelines (1.8 kg/ha/yr) was associated with changes in size distribution and age sturcture, minimal change in growth, changes in P/B ratios, decrease in population size of the walleye and decline in Northern Pike abundance (although the Northern Pike were not harvested). An average exploitation rate of about 15% for walleye was observed the next step up in harvest resulted in a major decline in abundance, the harvest was terminated, and recovery monitored.

THE EFFECT OF FATTY ACID CONCENTRATION IN WALLEYE (*Stizostedion vitreum*) EGGS ON EMBRYOS VIABILITY

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The diet of broodfish is a likely source of differences in lipid and essential fatty acid content in eggs and larvae of fish fed formulated feeds in captivity, as well as those collected from the wild. A deficiency of polyunsaturated fatty acids in the broodstock diet resulted in a decreased fecundity, early embryonic mortality and caused physiological abnormalities in rainbow trout. We carried out preliminary experiments with walleye eggs collected from females of domesticated stock (London) and two wild stocks (Salt Fork and Seneca Reservoirs). Females fed formulated diet produced eggs which contained significantly higher level of linoleic acid, characteristic for plant lipids. However, the arachidonic acid of

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the same n6 family had been found at significantly higher level in eggs from wild walleye stocks in both, triglyceride and phospholipid fractions. These data make it also evident that differences between wild stocks are significant.
More importantly, the survival of walleye embryos is highly correlated with the concentrations of polyunsaturated long chain fatty acids. Hence, lipid content and its essential fatty acids are extremely important to embryos viability. Our data suggest that deficiency in n3 fatty acids might be associated with impaired development of walleye, and thus poor larval and juvenile viability.
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POSITIVE SKEWNESS IN THE SIZE DISTRIBUTION WITHIN COHORTS OF PIKEPERCH, PERCH AND SMELT

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A comparison has been made between two percids and their major preyfish with respect to their potential to develop positive skewness in their within cohort size distribution. Size distributions, stomach contents, preyfish density and temperature conditions were recorded for all three species within (inter-annual variation) and between Dutch lakes. In case of 0-grout pikeperch the development of positive skewness is known to have important consequences for the formation of year-class strength. Both high first summer temperatures and high smelt densities propagate strong year-classes. In case of 0-group perch the growth rate is enhanced by the availability of macro-invertebrates. Positive skewness seems only to develop in the second year in conditions with a high availability of smelt, but does not lead to a highly variable formation of year-class strength. Smelt only develops positive skewness in their first-summer when part of the population exploits macro-invertebrates. *Neomysis integer* especially, which in their turn might have depressed the aailability of zooplankton for planktivorous smelt. Cannibalism in their second year causes positive skewness, but will probably have marginal effects on smelt survival.
It seems that the development of positive skewness with pronounced consequences for the population dynamics of the species becomes manifest for obligatory piscivores especially. Smelt and *Neomysis integer* are key species for the development of positive skewness for all three species.

MECHANISMS OF SIZE DIFFERENTIATION IN EVEN-AGED GROUPS OF YOUNG PERCH

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The mechanisms of life history variability and ecological guilds formation of perch were studied. A long-term observations, conducted in the bay of Mozhaiskoe reservoir (Moscow district) demonstrated size differentiation of young perch in limits of one habitat.

The growth differentiation of even-aged population of perch are explained by seasonal changes of diet composition of fish of different sizes which were analysed on the base of 24-hour sampling data.
The connection of size-frequency distribution skewness level and distinctions in qualities and quantity of food consumed by "large-sized" young perch and all other individuals are suggested. "Large-sized" perch were fed mainly by *Cyprinidae* larvae, i.e. relatively large and high calorific prey. For more small-sized perch relatively large prey (*Cyprinidae* larvae) were inaccessible.
The experimental rearing of young perch confirmed the field results.

RECENT ADVANCES IN WALLEYE CULTURE R-D IN QUÉBEC

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Société de recherche et de développement en aquiculture (SORDAC) inc. is a private R&D. corporation jointly managed by private and public interests. Since 1994, the goverment of Québec has given SORDAC the mandate to coordinate and finance freshwater aquaculture research and technology transfert. Furthermore, recent changes in provincial regulations now permit the culture of several new species including Walleye (*Stizostedion vitreum*) and Yellow Perch (*Perca flavescens Mitchill*). As a result, in 1995, two R&D. projects have been launched under SORDAC funding. In Québec, climatic conditions (~ -25 °C to 25 °C) exert a strong influence on fish-farming and represent a challenge to R&D. of percid culture. The two projects described below investigate the optimization of important environmental factors related to larval survival and subsequent growth.
The first project, "Élevage intensif du Doré jaune (*Stizostedion vitreum*): optimisation de l'alimentation et de conditions d'élevage (Intensive Walleye culture: Optimization of feeding and rearing conditions) is applied research derected by Dr. Joël de la Noüe, Laval University. The goals of this project are two-fold. Firstly, optimal environmental conditions required to maximize larval survival and growth are investigared by measuring the effects of rearing conditions (microflora, turbidity, light intensity) on these parameters. Secondly, the effects of feeding 20-30 cm fish diets vontaining plant and animal-based proteins on dogestibility, growth, feed efficiency and stress resistance will be investigated. Our working hypotheses for the above work are that adapted microflora and turbid water in larval rearing tanks will improve survival and growth following hatching, and that animal and plant protein-based diets that are comparable to natural diets in terms of appetancy and biochemical composition improve growth performance.
A second project, "Élevage extensif de Dorés jaunes de 10 cm en étang" (Extemsove pond-rearing of Walleye up to 10 cm), is managed by a trout producer, Mr. Andre Paquette, and involves technology transfert. The main phases of this project include:
1) The collection of eggs and semen from wild populations.
2) Low-water temperature incubation until adequate pond conditions are established.
3) Pond preparations including fertilization and water quality maintenance.
4) Outdoor culture of larvae for 6-8 weeks in enriched ponds.
5) Subsequent vulture for 8 weeks in ponds with minnow and in indoor tanks with artificial feed delivared by automatic feeders.
6) Winter grow-out period in indoor tanks and winter survival in outdoor ponds.

STOCK ASSESSMENT OF MATURE PERCH FEMALES (*Perca fluviatilis* L.) BY THE STUDY OF EGG RIBBONS

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Spawning activity of perch in Lake Geneva has been recorded since 1984. Females lay their eggs as ribbons. The size of the ribbon (length and width) is in overall accordance with the size of the female.
We have sampled maturing females and collected the ovules. By the use of artificial spawners made of spruce branches, we have collected egg ribbons an recorded the size of the ribbons. The width (WR, in mm) is related to the number of eggs (NE):
WR = 837 NE - 12122; r = 0.83
The total length of the female (TL, in mm) is related to the number of ovules (NE):
TL = 424.6 NE - 69497; r = 0.95
Then the size of the female vs. the size of the ribbon can be obtained:
TL = 2.49 WR + 118
Reproduction activity of perch in Lake Geneva is lasting one month. Perch are spawning in waters of about 10 °C; old females are spawning later and deeper than young ones. The pattern of the histograms of ribbon size-distribution is the same every three years. The change in the population is cyclic, due to the dominance of a year-class, which diseappears by fishing.

A COMPARATIVE STUDY ON THE DYMANICS OF YELLOW PERCH EXPOSED TO DIFFERENT LEVELS OF CONTAMINATION

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The southern part of Lac Saint-Louis, a 148 km^2 enlargement of the St.Lawrence River near Montréal, has been highly contaminated by local industrial effluents of Hg and also receives important loads of PAHs, halogenous organic compounds and heavy metals. Hydrological conditions being favourable to sedimentation, it is among the most polluted aquatic sites in Quebec. The northern sector is less contaminated. Local loads are lower and the St.Lawrence Seaway, with its deep and fast moving waters, acts as a physical barrier that limits exchanges between the two sectors. From 1988 to 1990, a study, based on spring tagging of 20 530 yellow perch (*Perca flavescens*) (2008 recaptures) and fall experimental fishing (56 gill-netting stations per year), has demonstrated restricted movements between the two sectors (<5%) and highly significant differences in terms of vital statistics. In the most contaminated sector, lower values of relative abundance, growth rate, condition, relative fecundity, mortality (over age 2) and a delayed sexual maturity were observed. In the 1980s, year class strength did not follow the same pattern of variation and a higher part of the observed variability can be explained by climatic factors in the reference sector. Overall, during the study period, the relative reproductive potential has been 4.5 to 6 times lower in the most contaminated sector. These differences do not seem to be related to differences in thermal or limnological characteristics; densities of benthic invertebrates are similar and

exploitation rate is low in both sectors. However, they are associated with significant differences for some of the bioindicators of stress tested. The pattern of variation of five population characteristics in four additional pairs of sites sampled along the St. Lawrence River suggests that toxic contaminants, and exploitation, are important regulation factors of perch populations in this system.

DIURNAL VERTICAL MIGRATION OF EUROPEAN PERCH (*Perca fluviatilis* L.) DURING WINTER

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The distribution and migration patterns of overwintering perch were studied by hydroacoustics and gillnetting in Lake Constance. When thermal stratification breaks down in autumn, perch leave the littoral and move to deeper waters for overwintering. They return to the littoral next spring. During winter, they perform diurnal vertical migrations, resting on or close to the bottom during day and swimming off the bottom during night. Light is the proximate cause of this regular vertical migration.
In January and early February, perch inhabit the sublittoral between the 40 and 75 m depth contours. Towards spring, their habitat shifts to increasingly shallower depths, and they live between the 15 and 40 m depth contours in mid-April. Maximum vertical migration amplitude decreases during winter from 28 to 13 metres.
It is unlikely that perch gain an energetic advantage by migrating in a homothermal water column, and they do not gain access to other food resources either. Thus, a hypothesis is proposed that predator avoidance might be the ultimate cause of this particular overwintering behaviour.

EFFECTS OF EGG SIZE ON SURVIVAL, SIZE AND SWIM BLADDER INFLATION OF PERCH LARVAE (*Perca fluviatilis*, L.)

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Importance of egg size (expressed as dry weight) for survival and swim bladder inflation of perch larvae was estimated in an experiment using 38 naturally spawned egg strands. Egg size was measured as dry weight per egg. One sample per egg strand containing a mean number of 127 eggs was incubated in aquaria until 16 days after larvae had hatched.
Larger egg strands contained heavier eggs. Survival tended to increase with egg weight. 9 cases with poor survival (<10 %) occured over the entire range of weights (1.25-3.59 10^{-4} g per egg). They were disregarded. Survival and swim bladder inflation success in the remaining cases increased significantly with egg weight ($p=0.0037$; 0.02, ANOVA).
Small females spawning for the first time produced small sized eggs. When spawning for the second and the following times, they produced more and larger eggs, until a maximum weight was reached. In further spawnings, higher numbers of maximum sized eggs were produced.
This strategy is hypothesised to be a reaction to the high variation in larval survival common in perch populations, where one year class from a superiorly favourable year often dominate longer than the life span of an individual. In this situation it is most important for a female to

contribute offspring to every year possible to benefit from the superior year.
Producing larger eggs pays for older individuals only, if the spawning stock is small, in a bad year, when larger eggs can have an edge over smaller competitors.

EFFECTS OF PREDATOR-RELEASED CUES ON FORAGING EFFICIENCY OF PERCH (*Perca fluviatilis*)

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The effects of chemical released by pike (*Esox lucius*) on foraging efficiency of perch were studied in laboratory experiments. *Daphnia magna* and *Chaoborus flavicans* larvae were offered as a prey either separately or mixed. Perch foraged less efficiently in the presence than in the absence of pike-odour. Decrease of foraging efficiency in the presence of pike-odour was bigger when perch fed on *Chaoborus* larvae in comparison to experiments with Daphnia. Control perch selected *Chaoborus* larvae over *Daphnia* when fed on the mixture of prey. This selectivity decreased when the predator-signal was present. Prey which differed by susceptibility required different hunting techniques. Fast movements of perch hunting for *Chaoborus* could be easily detected by predator. This might explain decrease of prey selectivity and stronger effect of pike-odour on perch foraging for *Chaoborus* larvae than for *Daphnia*.

COASTAL FISH MONITORING IN WESTERN ESTONIA. 1. SPECIES COMPOSITION AND THEIR RELATIVE ABUNDANCE IN DIFFERENT AREAS OF WESTERN ESTONIA

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Using standard methods (Thoresson, 1993), several areas were studied in July-August 1993 and 1994: Hiiumaa Islands (reference area), Matsalu Bay, Virtsu, Vilsandi, and two bays (Jausa, Käina) south to Hiiumaa (Dagö). Species composition, species diversity, relative abundance of marine/freshwater species, cyprinid/percid species etc. will be compared in different areas and sections within these areas.

COASTAL FISH MONITORING IN WESTERN ESTONIA. 2. GROWTH RATE OF PERCH.

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Perch collected during coastal fish monitoring programme (Thoresson, 1993) in mid-summer 1993 and 1994 from western Estonia Matsalu Bay, Virtsu, Vilsandi, Jausa Bay) were aged and their growth rate was back-calculated using operculum bone. Growth rate

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of perch inhabiting coastal waters is remarkably higher than in Estonian inland waters. Growth rate of male and female perch from different areas will be compared.

EXPERIMENTAL INFLUENCE THE DIFFERENT PHOTOPERIOD ON THE PERCH SPAWNING

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During the experimental influence, under the constant lighting the females were spawning (water T +15°±1°C). From the females under the constant darkness (water T the same) there were no spawn. The males, which were under the same conditions with the females, have the ready sexual product. The larvae after spawning (10 days of incubation) were normal. From the experimental beginning till to the first spawning were 36 days (experiment begin in 6 of December I990), 30 days (experiment begin in 8 of January 199I), and 20 days (experiment begin 19 of March 1991). The oocyte of females, which were under the constant darkness during 70 days (from 6 of December 1990-), have the definitive size, but are filling in small, not stick together ovarian granule and lipid drops. In the both groups the testis state of males were similar. Spermatic channels and spermaduct were full of sperma. The males were active during the spawning, the degree of germination of spawn were about 70 % and more. Under the constant lighting, the females have the similar change in liver like under the normal environment, the hepatocyte size, the nuclear and the lipid amount were decreasing. Under the constant darkness, the females have more smaller hepatocyte (in 2 time), with the same nuclear change, without lipid at all. The liver state of the males in the both experiments were correspond to the control, and during the whole winter-spring time hepatocyte and their nuclear practically have'nt the changes, but only the cells size were reducing for the spawnig time, due to lowering lipid inclusion and glicogen.

ICHTHYOCOENOSES BIODIVERSITY OF THE LUZHSKAYA - KOPORSKAYA AREA (EASTERN GULF OF FINLAND)

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Biodiversity - the important fundamental phenomenon, concerning not only the species compositions, but the biomass ratio of different species populations.*Clupea harengus membras* L. during the long time have the 90-95 % in the catch. The using of pelagial seine just begin from the 1960. The main part of catch have been transmit to open sea part, where there are a lot of *Clupea* in the fall period. This process caused to decrease of *Clupea* storage, in the catch youth *Clupea* amount are increasing, and here there are not effective breeding populations.
After the ephtrophication increasing of the eastern Gulf of Finland - the large nuclear power plant is located on the shore of the Koporskaya Bight and the constraction of an immense port complex is planned for the Luzhskaya Bight - the *Cyanophyta* and sea-shore vascular plants were increasing their productivity. The *Cyanophyta* toxicant have a negative influence

on the food staff of youth *Clupea*. Due to the constaction different factories on the coasts, the turbidity of water were increasing, and have the negative influence on the well-fedness and viability of youth *Clupea*. The spreading the emergeneous plants along the coasts were causing to the silting the specific place for *Clupea* spawning. In the same time the changes in the hydrobios biocoenoses structure caused the bases for the population grown of *Percidae* and *Cyprinidae*. Overgrowning of the littoral zone got a fine possibility for spawning of these species and a plancton and bentos development in the silting zones provide enough forage for the larvae and adult fishes. Therefore in last time can obtain the constant increase in catch the percentage of Perch (dynamics of catch can judge since the 1980) in contrary the genus *Clupea*, more valuable in the food chains.

EFFECTS OF DIETARY PROTEIN AND AMINO ACID CONTENTS IN GROWTH AND BODY COMPOSITION OF THE EUROPEAN PERCH *Perca fluviatilis*

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Quantitative dietary protein requirements constitutes one of the main parameters to determine in order to improve growth performances and food conversion ratio in fish cultured in intensive conditions. Two feeding experiments were conducted to evaluate the effects of dietary protein and amino acid contents in growth and body composition of European perch *Perca fluviatilis* juveniles. In the first experiment (60 days), preliminary determination of protein requirements of 2.5 g perch were carried out with 6 semi-purified diets containing different crude protein levels ranging from 0 to 60%. Flsh were held in 3 recirculated systems, each diet being tested in triplicate. Significant growth and survival differences appeared between fish fed diets containing up to 30% and fish fed diets of higher protein contents (40-60%). A second order polynomial regression analysis between dietary protein content and specific growth rate indicated that the optimal and maximal dietary protein levels were 44 and 56 % respectively. A second-experiment (30 days) based on 5 semi-purified diets ranging from 42.5 to 52.5 protein contents (with 2.5 % increments) have been undertaken to specify with experimental data the optimal protein requirement of perch juveniles.
Assessments of the quantitative feed recruitments of European perch *Perca fluviatilis* juveniles reared in intensive conditions

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BIOLOGY OF *Perca fluviatilis* IN A HEATED WATER RESERVOIR (MOSELLE, FRANCE)

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Perca fluvliatilis is one of the most abundant fish species in a French North-East lake-reservoir. This reservoir of 95 ha, is characterized by its heated waters, the absence of thermo-stratification and its gradual increase of trophic level. It contains 7.3 millions cubic meters of water. The study deals with the ecological functioning analysis of the reservoir. Fish are caught over a five years period (1987 to 1991) with active and passive fishing gears. The reproductive study of the perch is based upon weight index and the maturity stage index (macroscopic examination and histology). Age is identified by the application of scalimetric

and operculometric methods. The reproduction of the perch takes place from February to mid-April. Males are mature at one year old and females at two years. Perch reaches 12 cm at one year. Under propitious thermic conditions, growth is fast but depends on seasonal fluctuations. Diet is established from digestive contents. *Perca fluviatilis* fed on zooplanctonic Crustaceans (*Daphnia longispina*), *Asellus aquaticus*, *Gammarus pulex*, Insects (*Chironomes*), Gasteropodes and Fish. The food composition variability is studied at spatial and seasonal levels. A results synthesis scheme of perch autoecology is suggested. Spatial occupation strategies and trophic resources exploitation are discussed.

A STRATEGY FOR THE DEVELOPMENT OF A COMMON PERCH AQUACULTURE IN LORRAINE (FRANCE)

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The larval rearing experiments on perch *Perca fluviatilis* L; promise. At age 15 days, the survival rates reach 21-32% and more than 80 % using respectively formulated diets and *Artemia salina* nauplii. Perch fed on these feed are weaning before 30 days with survival rates above 80%. Calibrating avoids cannibalism. At age 8 weeks, fry weighs 0,56 g. Nevertheless problems limit again to fry hatcheries productions (growth, prey availability...). At present, fry production under natural condidions in 30-60 m^3 managed spawningponds with a water quality monitoring (disinfection, fertilization...) to improve the zooplanktonic production, seems more suitable. In 50 days, these techniques allow the production of fry weighing 0,37-0.52 g with survival rate of 25-30% (final density > 2000 ind./pond). In 14 days, the weaning permits to obtain fry fed on formulated diet for Salmonids with a successful rate of 85-90%.
The rearing, of weaned fry (22-23°C) leads to the production of perch of 80-100 g in 8 months (mortality < 10%) According to the feeding rate (2-4%), food conversion rates varie between 1.13 and 2.58. Perch accept the over-crowding without disease.
With a rate of success above 90%, the weaning of 0+ perch is likewise a suitable technique. The weaning of fry produced in spawning-ponds or of 0+ perch harvested at the time of pond's fisheries and growing them in warmed water (closed system, geothermics) represent the strategy for the development of a perch-breeding in Lorraine

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PHYSIOLOGICAL CONDITION OF ZANDER (*Stizostedion lucioperca* L.) DURING FIRST SUMMER IN REARING PONDS

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In Finland, earthen ponds are employed to produce annually 5-8 million one-summer-old zander for stocking purposes. A common problem is that the ponds don't usually produce enough suitable food at the end of the summer. This leads to the retardation of growth and, finally, to starvation. The aim of this study was to find methods for the estimation of the nutritional state of young zander. Fish sampled from different ponds and fish starved in

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aquaria were studied. Muscle water content, sodium and potassium consentration, liver glycogen content and lipid content of the whole fish were measured. The shape of the fish was estimated by using the condition factor. Water content decreased gradually when the zander grew up to 6-6.5 cm. Growth had also an effect on the shape and on both the sodium and the potassium concentration of the fish. On the basis of the results we estimated that the muscle water content of over 6 cm long zander should not exceed 82 % and the sodium content 45 mmol/l, and that the potassium content should not decrease under 85 mmol/l.

MECHANISM OF ESTABLISHING BIMODALITY IN A SIZE DISTRIBUTION OF AGE-0 PIKEPERCH, *Stizostedion lucioperca* (L) IN THE SULEJOW RESERVOIR, CENTRAL POLAND

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The distribution and food of age-0 pikeperch were investigated in the lowland Sulejow Reservoir, Central Poland. Samples were taken weekly, starting from mid June to mid August 1994, both in pelagic and littoral zones. Up to the mid July, age-0 pikeperch were found to be divided into two unmixing groups.
The first one was located in the pelagic zone of the reservoir and consisted of planktivorous specimens; the second one occurred in the littoral zone and its members were piscivorous even at very small size (30 mm of a total length). These differences in feeding between the two groups of age-0 pikeperch were due to fish-prey availability and resulted in a slower growth rate of pelagic fish, as compared with that of littoral fish.
In mid July, after reaching mean length of about 5 cm, pelagic pikeperch invaded the littoral zone, but they were not able to shift from planktivory to piscivory, as available fish-prey were already to big. As larger littoral pikeperch continued foraging on fish, previously established size differences were further strengthened.

DYNAMICS OF THE PERCH POPULATION OF LAKE CONSTANCE MONITORED WITH MULTIMESH NETS

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In Lake Constance, Switzerland/Germany/Austria, perch is - beside coregonids - the most important species for commercial fisheries. Since interannual fluctuations of the perch catch are rather high (2- to 10-fold), a monitoring program has been established using a multimesh method.The aim of this monitoring program with multimesh nets, started in 1987, is to gain a better understanding of the population dynamics of perch in Lake Constance by gathering individuals of all age-classes. Catch-per-unit-effort correction factors including net selectivity and encounter probability have been computed in order to improve the accuracy and comparability of the data. Information is presented on the influence of net selectivity on age and length structure of the sample and the dynamics of different cohorts during the monitoring period (1937-93). Moreover, the possibilities and limits of sampling with multimesh nets for predicting future cohort strengths are discussed.

PERCID THERMAL HABITAT IN WARM-GRADIENT WATERS: EXPERIMENTS AND NATURAL REALIZATION

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Prediction of percid habitat in natural heterothermal environment is possible with great deal of preferred-lethal temperatures data.Fish temperature requirements realizaion results on optimal development path taking into consideration fenology, ontogeny and diurnal regularities. Some thermal zones as final preferred in experiments stand more significant. They serve some signal importance for youth and adult fish. Spring spawning migration in Rybinsk reservoir and Kostroma power-plant thermal effluent were analysed from view of percid thermal preference. As cyprinids it was supposed the participation of interspecific groupings in stocking and formation of warm- and coldwater populations in perch, ruffe and zanger. It was revealed 5 stereotypes of percid behavior and distribution: attraction, avoidance, steady-diffusioning, ribbon-mosaicing and spotting (at zones of circulation and prop waters). Displayment of each kind depended from level of warm load under freshwater, hydrophysical conditions and sort of thermal plume, diversity and abundance at fish communities. Accounting year seasons and size-aging population structure, preferred and lethal temperatures are important fishery guide marks, forming effective percid spawning, growth, development and reproduction at tolerance temperature areas.

RESTRUCTURING OF A FISH COMMUNITY RESULTING FROM THE ESTABLISHMENT OF A WALLEYE (*Stizostedion vitreum*) POPULATION

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The fish population of Canadarago Lake, New York consisted of low densities of predators (chain pickerel, smallmouth and largemouth bass) and high densities of slow growing prey species since the 1930's. Predator density was 9-13.5/ha and yellow perch density was 439-1845/ha in 1973-76. Golden shiner, white sucker and brown bullhead were also abundant. More than 40 years of predator stocking failed to increase predator and decrease prey density. Walleye fall fingerlings were stocked from 1977-82 (5-20/ha) to increase predator biomass, decrease prey abundance and improve the quality of fishing. First year survival averaged 17% in four of six years Walleye first spawned in 1981. Predator biomass increased five-fold, radically altered the fish community and substantially increased the number of fish of desirable size for anglers. Perch density declined to 44/ha by 1989 and mean length increased from 170 to 269 mm. Sucker density decreased, bullhead density remained stable and mean size of both species increased substantially. Rock bass density increased at least six fold while growth rate increased. Golden shiner declined drastically Growth and density of bass remained relatively stable and pickerel declined to <33 % of earlier density

OCCURRENCE AND IMPACT OF *HETEROPOLARIA* SP. (*Protozoa: ciliophora*), ON INTENSIVELY CULTURED PERCH *Perca fluviatilis*

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There is dearth of knowledge about the ecology of *Heteropolaria* spp. (Epistylidae) though these species may induce a severe pathology in intensively cultured perch. This colonial ciliate is most frequently detected in autumn when it colonizes the spiny dorsal fin of young perch (20 g and 130 days). The zooids (sessile stage of *Heteropolaria* sp.) mainly exhibit binary fission and spread over almost exclusively on the spiny dorsal fins in juvenile fish and all over the body in older individuals. The zooids' stalks are colonized by Gram - *Aeromonas* sp. which proliferation, resulting from the spreading of *Heteropolaria* sp. over the body, induces infections and increases the mortality rate in cultured perch
High density rearing favours the propagation of *Heteropolaria* sp., through direct contacts between infested and healthy fish and through the emission of telotrochs (free swimming stage). In perch averaging 40 g cultured at 23°C at stocking densities of 300, 600 and 1970 fish m^{-3} the observed infestation frequency after two months was 10, 50 and 91 % respectively. Similarly, high temperatures and repeated handlings (e.g. sorting) further increase the risks of infestation Considering the interesting perspectives with the intensive rearing of perch and the rather high mortality rate in infested fish, detailed investigations should be undertaken on the symbiotic complex *Heteropolaria - Aeromonas* living on *Perca f luvialilis*.

THE USE OF DEFORMED OPERCULUM BONES OF PERCH (*Perca fluviatilis* L.) IN ENVIRONMENTAL MONITORING

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The operculum bone is used in the ageing of perch (*Perca fluviatilis* L.) and therefore regularly collected in huge numbers. The possibilities to use the large collections of operculum bones to other purposes should be considered. About 2900 operculum bones collected between the years 1984 and 1994 in the Northern Quark (Gulf of Bothnia) were screened for deformations. Skin and fin damages of the perches were also examined. The purpose of the study was to find out if the deformations of the operculum bone of perch could be used in environmental monitoring, for example to study the effects of oil spill on fish. It was also studied if there was any connection between skin and fin damages, low gonad somatic indexes, high liver somatic indexes and deformed operculum bones.

EFFECTS OF PREDATION BY YELLOW PERCH (*Perca flavescens*) IN SOUTHERN LAKE MICHIGAN - A MODEL ANALYSIS

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By combining bioenergetic modelling and populations estimates, we assessed total food consumption of different year classes of yellow perch in southern Lake Michigan. Consumplion by the full population was dominated by young-of-the-year fish. Yellow perch abundance in southern Lake Michigan increased by more than an order of magnitude in the 1980's as compared to the 1970's. Meanwhile, individual growth rates decreased considerably, corresponding to a 50% reduction in per capita food consumption. For four important prey groups (zooplankton, the amphipod *Diporeia hoyi,* conspecific 0+ fish and alewife egg), consumption rates in the mid 1980's were similar to estimated productions, supporting the hypothesis of predation as structuring the prey community. This structuring predation probably resulted in, or increased, intraspecific competition, explaining the drop in growth rate observed in the 1980's. Intensive cannibalism on 0+ yellow perch in the 1980's may have been a population regulating bottleneck. Yellow perch predation on alewife eggs may, together with intensive predation by salmonids on adult alewife, maintain the alewife population at a low population level. In the 1980's, when yellow perch were very abundant in southern Lake Michigan, they were, to a considerable extent, dependent on prey production originating from offshore areas.

CHANGES IN ABUNDANCE OF PERCH (*Perca fluviatilis*) IN LAKE PYHÄJÄRVI, SOUTHWEST FINLAND

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Lake Pyhäjärvi is farmous for its productive vendace (*Coregonus albula*) stock. Recent population analyses have revealed that the abundance of predators in the lake and the warming of the water in spring together determine the final year-class strength of vendace. The abundance of 2-year-old perch seemed to be a good indicator of total predation pressure on vendace larvae. We have here analysed in more detail possible factors influencing the year-class formation of perch. We have since 1988 applied a two-stage sampling strategy to work out the age and size composition of the winter seine net catches by species. On the basis of these analyses we could estimate relative abundances of perch for the years 1985-1993. During this period the year-classes of 1988 and 1992 were strong. Year-class 1988 dominated in catches from 1990 to 1994. The year-class 1992 is predicted to dominate from 1994 to 1998. Year class strength of perch is correlated with an index based on summer water temperature.

PROBLEMS IN OBTAINING UNBIASED SAMPLES OF PERCH (*Perca fluviatilis*) POPULATIONS WITH GILLNET SERIES

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We fished perch with three different gears in Lake Kulolampi (SW Finland) in order to estimate the size and age structure of its perch population. In the springs 1993, 1994 and 1995 during the spawning time of perch we used traps and new Nordic multi-mesh gill nets and in 1994 and 1995 in addition a very efficient beach seine. Since Lake Kulolampi is very small, only 0.9 ha, we could use intense catch effort with all gears. Simultaneously we did multiple mark-recaptures using fin clipping and calculated population estimates with the Schnabel method. The results were controversial: while abundant trap and seine samples implied the existence of dense perch population with poor growth, only a few perch were caught with gill nets at the same time. Thus, also the new multi-mesh gill nets seemed to be very selective gear, at least in a small lake, and extra caution should be observe when interpreting their catches.

THE HABITAT CHOICE OF PERCH (*Perca fluviatilis* L.) 0+JUVENILES IN THE ESTUARY OF THE KYRÖNJOKI RIVER

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Rivers and their estuaries are important reproduction areas for coastal perch stocks in the Gulf of Bothnia, Baltic Sea. Juvenile abundance for spring spawning fish species were monitored from 1980 to 1994 in the episodically acidificated inner estuary of the River Kyrönjoki. Two thirds of the inner estuary is covered with dense macrophyte vegetation. Seining for perch larvae were carried out on 30 fixed stations in the middle of the summer. The depth at the seining stations were less than 2 m with a variable coverage of submerse and floating vegetation. The dispersion of abundance and size of perch juveniles were tested in relation to depth and vegetation coverage over time. The wide range in size distribution supports an assumption of existing cohorts. The significance of habitat choice in monitoring programs in relation to time and schooling event is discussed. Special attention is paid to interpret the results in relation to a varying level of acidification

THE CONDITIONS ON REPRODUCTION AREAS RULES THE YEAR CLASS STRENGTH OF PERCH (*Perca fluviatilis* L.)

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The year class success of 8 stocks of perch (*Perca fluviatilis* L.) in the Northern Quark, Baltic Sea were compared using a relative year class strength index. Coastal stocks reproducing in rivers or estuaries tended to have coinciding year class fluctuations. Stocks reproducing in small archipelago glo lakes or archipelago inlets showed discrepancy in the year class strength calculations, where only a few year classes could be named strong or weak.
The year class success in the Northern Quark area diverged from the general pattern of in the Baltic Sea. The temperature conditions during the first summer of life affects the year class formation of perch in the Northern Quark, but is overruled by acidification in the river or estuary spawning stocks. In the glo lake spawning stocks the precipitation i.e. the size of the nursery area, was additionally a limiting factor for the year class success. Sea spawning in the Northern Quark seamed to be a high risk strategy, with high profits in warm years.

SURVIVAL OF PIKE-PERCH (*Stizostedion lucioperca*) DURING THEIR FIRST WINTER: LABORATORY STUDIES

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To evaluate their first winter survival, pike-perch (45-85 mm total length) from natural-food-ponds were placed in 150 l tanks at three different temperature (constant +2 °C, +4°C and naturally variable (+1-+3 °C) in September 1992. Survival ranged from 10 % in smallest size-groups to over 80 % in the largest ones. Practically all fish smaller than 55 mm did not survive the winter. Small fish died earlier during the course of winter than the large ones. Size-dependent overwinter survival should be taken into consideration in introductions and stockings of pike-perch in northern lakes.

HORIZONTAL DISTRIBUTION PATTERNS OF PERCH (*Perca fluviatilis* L.) IN LAKE CONSTANCE: A HYDROACOUSTIC STUDY

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The aim of this study was to investigate temporal and spatial dynamics of perch distribution in Lake Constance, which provide the necessary basis for abundance estimates and associated management decisions.
From July 1993 to March 1994 near-shore areas were surveyed using a single beam echosounder to map the horizontal distribution of perch. Furthermore, diurnal and seasonal changes in the vertical distribution were studied. According to a self-etablished relationship target strength was transformed into perch wet weight. The species and age distribution of fish was investigated by gill-net fishing, together with SCUBA-diving and underwater photography. In summer the distribution of perch was very patchy. Population density declined from east to west, and highest abundances were found close to ports and jetties. Biomass estimates resulted in 42 to 162 kg perch per hectare. In this season a spatial separation of different age-classes was found. During daylight one-year-old juveniles and adults stayed in the epilimnion in water depths of 3 to 15 m. At dusk they migrated into the littoral zone, where they rested on the bottom at night.

In winter perch were concentrated between the 35 and 70 m depth contour and performed strong diurnal vertical migrations. The horizontal distribution was much more homogeneous than during summer.

COMPARATIVE HAEMATOLOGY OF SOME EUROPEAN *Percidae* SPECIES

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Number of erythrocytes, haematocrit, haemoglobin concentration, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), proportion of erythroblasts, number of leukocytes, differential blood count and cytochemical analyses were studied in dominated species inhabiting waters of Danube river system in northern Yugoslavia. Fish were caught during autumn and spring by electrofishing, were let to recover for 24 hours in net cages kept in the river and then analyzed. Blood was collected by heart puncture. All analyses were performed with native blood without addition of anticoagulants. On the basis of the results obtained haematological characteristics of the studied species were established and discussed from the point of view of comparative ecology and taxonomy of these species.

LIFE HISTORY OF STUNTED PERCH (*Perca flavescens*) IN CENTRAL ALBERTA, CANADA

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Between 1986 and 1990, the life-history of a stunted perch population (mean length at age 5: 13.5 cm) was studied in Narrow Lake, Alberta and compared to that of the nearby 'normal' population of Baptiste Lake (mean length at age 5: 21.8 cm). Apart from growth rate, perch from the stunted and the 'normal' populations differed in most of the life-history traits examined. Average age of first sexual maturity, for example, was advanced by one and two years in stunted males (mature at 1.6 years) and females (mature at 2.8 years), respectively, compared to their normal conspecifics. At each spawning, the proportion of total body energy allocated to the gonads was significantly higher in both sexes of stunted perch (males: 4.0 % vs. 3.6 %; females: 26.0 % vs. 17.9 %). Also, relative fecundity of stunted perch (177 eggs/g body weight) was significantly higher than that of normal perch (108 eggs/g body weight). At the same time, energy densities of gonadal tissues (stunted:♀♀ 4.15 kJ, normal:♀♀ 4.00 kJ/g wet weight; stunted :♂♂ 3.11 kJ, normal :♂♂ 3.33 kJ/g wet weight) and dry weights of individual eggs (0.23 mg) were similar in both perch populations. Overall, life-time reproductive investment, calculated as the energy equivalent of the proportion of the total life-time production shed with the sex-products. was approximately 50 % (66 % in males, 44 % in females) higher in stunted than in normal perch. Hypotheses on the adaptive value of the life-history strategy of stunted perch from Narrow Lake are discussed.

EFFECTIVENESS OF STOCKING AND HARVEST REGULATIONS TO ENHANCE A WALLEYE POPULATION FOR BIOMANIPULATION

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A long term project to evaluate the potential for food web manipulation to improve water quality in Lake Mendota, Wisconsin began in 1987. Intensive walleye *Stizostedion vitreum* stocking and harvest regulations were used to enhance walleye biomass in this popular sport fishing lake. Over 60 million walleye fry and 2 4 million 50-mm walleye fingerlings were stocked during 1987-1992. In 1988 daily bag limits were reduced and a 381 mm minimum size limit was enacted. The size limit was increased to 457 mm in 1991. Mark-recapture population estimates were performed on small (<275 mm) walleyes biannually to evaluate success of the stocking program. Abundance estimates of walleyes >275 mm were computed annually and a creel survey monitored angler harvests. First year survival of stocked walleyes was variable but always <10 %. First year growth also varied but appeared to be positively correlated with survival. Individual based modeling simulations suggested that growth of stocked walleyes was sensitive to modest changes in size- or date-at-stocking. Angler response to walleye enhancement was intense and exploitation exceeded 50 % in 1989. Poor catch rates in 1990 and the 457mm size limit in 1991 reduced exploitation rates of legal age classes to <10 %. Together, stocking and regulations achieved a four fold increase in walleye density but the population of fish >275mm never exceeded 6 fish/ha. Yellow perch *Perca flavescens*, a primary walleye prey, decreased until 1991 when a strong year class was produced despite higher walleye density. Improved walleye stocking strategies and a better understanding of factors controlling perch recruitment are needed to make biomanipulation a reliable management tool on Lake Mendota.

FACTORS AFFECTING STOCK AND RECRUITMENT OF WALLEYE (*Stizostedion vitreum*) IN LAKE NIPISSING, ONTARIO, 1968 TO 1994

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Trawl netting data in conjunction with data from creel surveys and spring trap netting is used for fisheries management on Lake Nipissing. Numbers of young of year and yearling walleye, caught by the bottom trawling monitoring program (1977 to 1994), were correlated with year class strength as determined from samples taken in creel surveys and spring trap net monitoring programs. There was a better correlation with yearling than with young of year. Young walleye were also found to be correlated with young of year yellow perch, water levels at time of spawning and growing degree days above 5°C. A stock recruitment model is presented for Lake Nipissing.

ESTIMATION OF FISHING MORTALITY AND ABUNDANCE OF PIKE-PERCH IN LAKE VÕRTSJÄRV BY COHORT ANALYSIS

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Cohort Analysis (VPA) with the data on catch in number by age and year is used to estimate fishing mortality, abundance and biomass of fishable stock of the pike-perch in Lake Võrtsjärv, Estonia (270 km^2, mean depth 2.8 m). The catch rate of the fishery is rather low, fishing mortality (F) of the dominant age group aaged 4-10 was 0.21-0.63 during the years 1978-1990. The value of natural mortality (M) 0.3 was calculated by means of the Pauly (1980) equation. During the last 14 years great fluctuations in abundance did not appear, owing to strict regulation of fishery. Annuale catch was 2-2.5 kg/ha. But in fishery history the catches of pike-perch changed up to 80 times. About the reasons of the fluctuations in abundance are discussed. Annuale catch must be constitute 30-40 % from fishable stock (F=0.5).

POPULATION STRUCTURE AND ABUNDANCE OF PIKEPERCH *Stizostedion lucioperca* (L.) IN LAKE PEIPUS (ESTONIA)

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In Lake Peipus (area 3560 km^2; mean depth 7.1 m, maximum depth 15.3 m) fish productivity as well as catches (25-34 kg/ha) are high Till the 1990s the bulk of the catch of fish in the lake consisted of lake smelt, vendace and not valuable small fish (young perch, roach, ruffe and others). Thanks to the intensive use of Danish seines, which kill the fry of pikeperch in large amounts, the stocks of this fish were strongly supressed. According to the official fishery statistics, the mean annual catch of pikeperch was 18 t in 1958-1983. Today the number of Danish seines has been restricted and the mesh-size in the cod-end of the seine has been raised to 40 mm. As a result of this the abundance of pikeperch has increased and in 1991-1992 the annual catch of this fish exceeded 1000 t. At present pikeperch has become the most important commercial fish in the lake.
In 1993 and 1994 the population structure and abundance of pikeperch was investigated using fine-meshed (18-22 mm in the cod-end) trawl. In experimental catches the most abundant length group was 38-44 cm (standard length; age 4+) in August 1993, but 28-36 cm (3+) in 1994 at the same time. In 1993 the average total number of pikeperch per haul was 48, among them fishes with standard length 40 cm (the legal size) and more constituted 43 %. In 1994 the total number of pikeperches per haul was 129 and only about 3 % of them were larger than legal size.
The population of pikeperch has become younger about one year during the period of investigations.

FEEDING OF RUFFE (*Gymnocephalus cernuus*) IN LAKE VÔRTSJÄRV (ESTONIA)

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From May till November 1994 the diet of ruffe was investigated in the large (270 km^2) shallow (mean depth 2 8 m) eutrophic L. Vôrtsjärv. 187 fishes of the standard length 4.3-12 0 cm were examined. The prey items or their remains were counted, identified under the microscope and their reconstructed fresh weight was calculated according to the data of macrozoobenthos samples.
Young ruffes in the lake continue feeding on zooplankton until they are ca 4.5 cm long. The diet of larger ruffes (age 1+ and older) contains, in addition to zooplankters, chironomids, *Oligochaeta* cocoons, crustaceans, fish eggs, pieces of macrophytes and algae. In 1994 more than 95% of the food of larger ruffes was formed, regarding biomass, by chironomids (zoobenthos dominants in the lake). The main food objects among chironomids in the stomachs were the larvae and pupae of *Chironomus plumosus* that had the highest occurrence frequency (91%), mean number (72%) and biomass (98%). *Einfeldia carbonaria* (36%) and *Microchironomus tener* (33%), too, had a high occurrence frequency in the food of ruffe. Changes in the feeding of ruffe during summer were in accordance with the peculiarities of life cycle of chironomids. Differently from eel, ruffe continued to take food in late autumn when water temperature decreased to 2 - 0.2 °C. *Chironomidae* species, first at all *C. plumosus*, are the main prey items also for eel and bream in the lake, which can lead to a competition between them. However, they eat different chironomid instars (eel takes mainly large IV instar larvae and pupae of *C. plumosus*, ruffe and bream eat also large amounts of small III and II instar larvae of this species and other small-size chironomids). The population of ruffe in the lake takes more chironomids than do bream and eel together.

GROWTH, RECRUITMENT AND FISHING OF PIKEPERCH IN TWO DIFFERENT LAKES IN FINLAND

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The CPUE, total catch and growth data of pikeperch (*Stizostedion lucioperca*) from two Finnish lakes, Lake Lohjanjärvi and Pyhäselkä, were gathered for 19 years. Mesotrophic Lake Pyhäjärvi situates in eastern Finland while Lake Lohjanjärvi is an autrophic lake in southern part of Finland. There has been practically no pikeperch stockings in both lakes during the research period. Thus, the wild stocks were monitored in our study.
In Lake Pyhäselkä, during the 19-years research period there has developed three "good" year-classes which seemed to be for 4-5 years as a target of net-fishing. These summers 1978, 1980 and 1988 were warm and the new year-classes of perch was strong, too. The growth rate of pikeperch in Lake Lohjanjärvi is higher than in Lake Pyhäselkä.

The yearly variation in growth rate and recruitment was analysed in relation to the environmental factors (temperature) and to the changes in the whole fish community of the lakes. The hypothesis was that variation in the variables was higher in northern Lake Pyhäselkä than in Lake Lohjanjärvi.

BASIC CONDITIONS OF PERCH FRY PRODUCTION IN THE GULF OF BOTHNIA

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The long coastal zone around the Gulf of Bothnia provides recruitment areas for both warm and cold water fish. The low salinity makes fresh-water species common, perch (*Perca fluviatilis* L.) being one of the most abundant and widespred. Morphometric conditions and water temperature vary a lot between areas creating very different prerequisits for recruitment. Thus, there are sections that are exposed and deep with relatively cool and stable temperatures. In the archipelagoes, sheltered bays and inlets temperatures are also stable but much higher. On the other hand, there are sections influenced by upwelling of cold water creating unstable conditions.
A recruitment model for perch, calculating primarely the influence of temperature and day-length on recruitment, was used to estimate the the basic quality for production of fry in different coastal habitats. These estimates were compared with surveys of O+ fry in the autumn regarding growth, distribution and abundance. Habitats with different degrees of exposure from several sections of these costal areas were included. Comparisons were also made to data on abundance of fry of other species.
In the most exposed habitats and those influenced by upwelling the model predicted a very slow first year growth and no prospects for further survival, which was in agreement with the survey results. In the achipelago studied in SW Gulf of Bothnia high quality recruitment areas, as predicted, were extended much wider than in the exposed areas and in the north of the Gulf. In the latter areas only sheltered bays, estuaries and small freshwaters could provide conditions favourable for production of perch fry, in agreemnet of model predictions.

TEMPERATURE SELECTION OF RUFFE (*Gymnocephalus cernua*) IN LABORATORY AND NATURAL HABITAT

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Ruffe is considered to be a temperature generalist. Observations from lakes show that ruffe occupies wide thermal environment. In this work the temperature selection of ruffe is studied in horizontal thermo-gradient in laboratory and the results are compared with the thermal distribution of ruffe in lakes. The effect of fish size, season and illumination on selectedd temperature is analysed.

ASSESSMENTS OF THE QUANTITATIVE FEED REQUIREMENTS OF EUROPEAN PERCH *Perca fluviatilis* JUVENILES REARED IN INTENSIVE CONDITIONS

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ln order to determine the nutritional requirements of the European perch *Perca fluviatilis* in rearing conditions, the effects of feed supply on survival, growth, body composition and food utilization have been investigated in perch of 2.5 g (experiment l) and 20 g (experiment 2) mean body weight. Experiments were conducted at 20-22°C with weaned fish fed commercial trout pellets and held in recirculated systems at an initial densily of $3kg.m^{-3}$ and $9.2\ kg.m^{-3}$ in experiments 1 and 2 respectively. Daily feeding levels varied between l and 10 % b.w. in the first experiment and between 0.3 and 3% b.w in the second one. Survival was highly affected by the feeding level in 2.5 g fish, mainly due to the increase of cannibalism rate in food ration lower than the maintenance level, whereas no significant differences ($P<0.01$) in survival rate appeared in the larger fish groups. Based on second order polynomial regression analysis between feed supply and specific growth rate, calculated on tank biomass, daily feeding level was optimal at 4.4 % b.w in experiment 1 (SGR=1,4 $\%,d^{-1}$) and decreased to 2% b.w. in experiment 2 (SGR=0,6 $\%.d^{-1}$). Maximal growth rate was reached at a daily ration of 7% (SGR=1.66 $\%\ d^{-1}$) and 3% (SGR=0.9 $\%.d^{-1}$) in experiments 1 and 2 respectively. In the second experiment, the maximal daily ration corresponded also to the best food conversion ratio (1.4).

THE BY-CATCH OF PERCH BY TRAWL IN 1993 IN LAKE PÄIJÄNNE, FINLAND

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In 1993 there was seven professional trawling enterprises in Lake Päijänne. Their total trawling time was 1500 hours and catch about 120 tons, of which about l/6 was perch. Perch was unwanted species, because it had no commercial value and because perches damage valuable catch (whitefish, vendace) in the cod-end. Trawlers try to avoid perch schools with their echosounders; in some areas this was more successful than in others. The catch/ swept area was highest in June-July. Perch catch at one haul (av. 2 hours) ranged from 0 to 5 kg/ ha swept area; average ± sd was 0.4 ± 0.6 kg/ha swept

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PERCH POPULATIONS OF ACIDIFIED LAKES OF NORTH WESTERN RUSSIA

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Anthropogenically acidified small- and midlesized lakes with the water pH less than 5.0 are the genuine element of forest zone of Russia and are inhabited only by perch. In contrast to the vast majority of acidic lakes in Scandinavia and North America, the water aluminium concentrations in the North Western Russian lakes do not exceed 300 mkg/l. Presumably that is why the perch is able to spawn in the lakes with water pH as low as 4.2 -4.7. Decrease of the lake water pH usually leads to the decrease in the growth rate (as measured

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by the body length). This phenomenon may be presumably explained by two possible reasons. First, the change of the perch's feeding spectrum. Second, high body burden of the accumulated toxic compounds and subsequent alterations in the functioning of certain organs and biochemical processes.
To comparatively study the states of some perch populations affected by the acid stress it seems convenient and reasonable to use the Fulton's condition factor (FCF). Regression analysis of the relation of this index in fish from 24 lakes to environmental factors has been undertaken. There was no correlation between FCF and water color, total phosphorus content (as an index of a lake trophic state) and lake surface area. However, it was found that FCF is due to increase when the water pH decrease and the aluminum content increases. The possible reasons for the observed phenomenon are discussed.

SCALE MORPHOLOGY OF PERCH AS THE INDICATOR OF LAKE ACIDIFICATION

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Acidification of lakes negatively influences the fish fauna. Fish physiological, biochemical and morphological characteristics are changed under the acid impact. Russian acidic lakes with the water pH less than 5.0 are inhabited only by perch. The ultrastructure of scale of perch from neutral and acidic lakes in Darwin reserve have been investigated. The differences in the ultrastructure of scale foci in perch from neutral and acidic lakes have been found. As water pH and mineralization levels decrease, the well developed ridges on the foci surface reduce. In the lakes with the lowest water pH (4 4-4.6) values these ridges disappear fully. It seems important to note that such changes occur in the scales localized in the dorsal fin zone, i.e., in the region, where protective role of the surface relief is decreased, since the dorsal fin provides the main function of this type.

IMPACT OF THE PERCH POPULATION ON ZOOPLANKTON IN THE HUBENOV RESERVOIR

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The Hubenov reservoir is located in the watershed of the Jihlava river in the Czech Republic. The development of the icthyofauna was studied continuously from the filling of the reservoir in 1972 until 1985. The original fishstock represented by the salmonids was unable to prevent the propagation of perch and roach. The stock of salmonids rapidly decreased due to the natural mortality and the mortality induced by diseases in the year 1975. In the following years the fishstock was dominated by perch, pike and later also roach. The changes in the species structure and abundance of the ichthyofauna of the reservoir leading to a prevalence of the planktivorous fishes were reflected in the development of zooplankton. The stock of salmonids had no greater influence on the zooplankton. It was only with the development of the perch population that some changes were recorded in the qualitative and quantitative characteristics of zooplankton. The largest species of the water fleas - *Daphnia pulicaria* - disappeared from the reservoir and the proportion of water fleas

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larger than 950 μ (*Daphnia galeata*) out of the total biomass of all water fleas also diminished.
The changes in zooplankton brought about changes in water transparency and in chlorophyll a concentration.

DIFFERENTIATION OF THE PIKEPERCH *Stizostedion lucioperca* (L.) POPULATIONS FROM THE YUGOSLAV PART OF THE DANUBE

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In order to analyse the intra- and interpopulation homogeneity/heterogeneity of the pikeperch (*Stizostedion lucioperca*), we estimated the variability of morphological characters on the basis of a biometric analysis of 31 morphometric and 7 meristic characters in 274 specimens collected on four different sections along the Yugoslav sector of thr Danube, during 1986-1989. An ANOVA of morphological characters was performed for each sample and for males, females and juveniles respectively. The results were tested with the GT2-method for multiple unplanned comparison of means, or with the t-test where appropriate.
Comparison was also made with the results of some other authors for pikeperch samples from the Dnieper and the West Dvina, and we found that the differentiation between populations from three geographically distinct and isolated areas is much greater than between the four samples from the Danube, as expected.
According to our results of the variability analysis of morphological characters and known pikeperch habits (first of all having in mind the so-called "homing" effect - returning to the same spawning place from year to year), it can be concluded that the four samples from the Yugoslav part of the Danube most probably represent four distinct populations. The presence of reproductive isolation still has to be proved through experimental marking.

AGE DISTRIBUTION AND GROWTH OF THE PIKEPERCH *Stizostedion lucioperca* (L.) FROM THE YUGOSLAV PART OF THE DANUBE

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The age distribution of the pikeperch (*Stizostedion lucioperca*) was estimated according to the analysis of growth zones on scales in 333 specimens. The samples were collected on four different sections along the Yugoslav sector of the Danube, during 1986-1989. The analyses specimens were 0+-12+ years old, with total body lengths ranging from 73 mm to 960 mm and body weights (digestive tract included) from 3 g to 7 700 g.
Lewngth growth rate was analyzed according to the measured lengths of specimens of different ages and according to the back-calculated lengths in previous years. Back-calculation was done after the methods of Monastyrskij, von Bertalanffy and Walford, and the obtained empirical and theoretical values were compared. The greatest growth rate was accomplished during the 1st and 2nd uear of life. The inflection of the growth constant occurs during the 5th and 6th year, when there are no more sexually immature specimens.

There is no greater difference between growth rates in males and females. The growth of sexually immature specimens is slower in comparison with sexually mature specimens of the same age. Growth curves after von Bertalanffy were compared with results of some other authors for different waters.
Weight growth rate was calculated according to the empirical body weight values in specimens of different ages. Correlation and regression analysis on the length-weight relationship was also done, and consequently the condition factors were calculated.

PHENOLOGY OF PERCH CATCHES IN LAKE CONSTANCE

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The course of Lake Constance perch catches in the summer of 1994 has surprised commercial fishermen by suddenly turning from almost nil to satisfactory. Two explanations were put forward:
1. Although the fish were big enough for mesh size 32 mm well before catches picked up, they could not be caught with bottom-set nets because of their location;
2. They grew rapidly due to feeding on an abundant 1994 perch cohort and were caught as they entered the 32 mm selectivity curve.
By analysing daily catch statistics provided by commercial and recreational fishermen as well as growth patterns of perch obtained while monitoring the population, it is hoped it can be shown which is the better explanation.

PERCH (*Perca fluviatilis*) EFFECT UPON PELAGIC ZOOPLANKTON IN THE SPRING PERIOD

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Abundance, biomass and production of zooplankton had been monitored twice a week during March-July period in the Rimov Reservoir, Czech Republic. Food ration of 10-20 males and 10-20 females of a dominant year class of perch was established in the same intervals. Consumption of planktonic prey was low before and during the peak of spawning activity (late April). Fish food consumption generally followed the abundance of zooplankton during the whole period. Copepods dominated in the stomachs during copepod peak (early May) and were replaced by highly preferred *Daphnia* in subsequent periods. During this switch perch consumed almost all *Daphnia* production while later after establishing of a dense *Daphnia* population the consumption by perch (mostly larger sized individuals, carapax lenght >1 mm) dropped down to about 10 % of *Daphnia* production. In June some perch (mostly females) switched to feeding on littoral invertebrates such as *Polyphemus* and insect larvae, while the rest consumed pelagic plankton. Roach (*Rutilus*) and bream (*Abramus*) also present in the reservoir preyed on smaller size planktonic forms like *Bosmina* and small *Daphnia*.

QUALITY OF REPRODUCTIVE PRODUCTS OF THE PERCH (*Perca fluviatilis* L.) IN AN ACID AND A NEUTRAL LAKE

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Rearing experiments were carried out in an acid lake (pH 4.7-5.2) and a circumneutral lake (pH 6.6-6.9) both in native lake waters and by transferring the eggs between the lakes either immediately after fertilization, or after 3 and 20 h incubation in the native water. Incubation in the native water prior to transfer decreased the mortality of embryos from neutral lake population when incubated in the acid water. Mortality during embryonal development was markedly higher in the eggs from acid lake population, even when transferred to neutral water immediately after fertilization. The results confirmed a poorer quality of eggs produced by perch living in the acid lake. Cross-fertilization between perch from the acid and circumneutral lake indicated that milt quality was not affected by acid stress.

COVARIATION IN YEAR-CLASS STRENGTH OF PERCH (*Perca fluviatilis* L.) AND PIKEPERCH (*Stizostedion lucioperca* (L.))

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Covariation in the year-class strength of perch, *Perca fluviatilis* L., and pikeperch, *Stizostedion lucioperca* (L.), were studied among 10 populations in Baltic coastal areas and among 3 pikeperch populations in lakes. Within the two studied periods in 1974 -- 1981 and 1980 -- 1987 the covariations in the year-class strength were similar among populations and between species. When the variations in year-class strength in several populations were compared annually between species no statistically significant differences were found during the examined years in 1974 -- 1986. Despite of the covariations, correlation coefficients in year-class strength between populations were the lower the greater was the distance. Most (18 cases out of 35) of the correlation coefficients were statistically significant when the distance between populations was less than 300 km. Some rather high correlation coefficients were also found in distances between 300 and 900 km, but only one statistically significant between perch in Simo and perch in Taivassalo.

THE WINDERMERE PERCH AND PIKE PROJECT, 1940 - 1994

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In 1940, Windermere, a 14 km^2 lake in northern England with two relatively separate basins, had a fish population dominated by abundant small *Perca fluviatilis* fed on by *Esox lucius*. An experimental fishery for perch (by trapping in the spawning season) and pike (by gill-netting in winter) was started in 1941 and has continued since then (and is still continuing) as a study of the population biology of these two species and associated fish such as *Salvelinus alpinus*. Over 80 scientific papers by about 30 authors have been published. Recently, all the numerical data on the two species (catches, fishing effort, sexes, sizes, growth rates etc.) have been transferred to computer disks. Initially, the perch population fell rapidly; after intensive removal ended, numbers remained low until 1959. An epidemic of *Saprolegnia* again reduced the adult population in 1976, since when it has continued to be sparse. Modelling has revealed the importance of temperature, and predation on young perch by older perch and pike, in controlling recruitment, but the quantitative effects of the disease and predation on the population since 1976 have still to be successfully interpreted and modelled.

EXCEPTIONALLY BIG INDIVIDUALS IN PERCH POPULATIONS

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In Windermere, where there was a dense, slow-growing population of *Perca fluviatilis*, which had an $l\infty$ of about 180 mm, there co-existed a few individuals with an $l\infty$ of 463 mm Data from 137 of these exceptionally big perch showed that their early growth was identical to that of the majority of the fish, but, at an age that varied between from 1 to 8 and averaged 4 years, they accelerated for about four years and then followed a von Bertalanffy growth with an $l\infty$ of 463 mm. They thus had a 'double' growth curve that is revealed only if the growth of individual fish is studied. Acceleration tended to occur in certain calendar years and was correlated with strong year classes of young perch. Net-selection, length-weight relationships, seasonal cycle in gonad weight and opercular-body length relationship were the same as those of normal perch. The few available data suggested that the big perch were piscivorous, feeding mainly on small perch. Similar big perch have been caught in other British lakes; are they a widespread phenomenon in perch populations where most of the fish are slow-growing?

CHANGES OF PHOTOREACTION IN THE PERCH, *Perca fluviatilis*, DURING ITS EARLY ONTOGENY

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120 individuals of the perch hatched in laboratory were tested for light level preference in a long 130 cm tray where intensity of illumination gradually changed from 500 to 1 lx. Fish position along the photogradient and their motor activity were recorded every two days since hatching till the age of 24 days (SL=14.0 mm). During initial 10 days of observations (SL=6.0-9.5 mm) larvae preferred zones with high level of illumination (280-500 lx). In the following 7 days the preference for much lower illumination (10-85 lx) was observed. Further on, fish of about 14.0 mm body length became more photopositive again (preferred

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illumination increased to 160 lx). Motor activity was rather low and stable during the whole period of observations. Comparison of obtained results with data on vertical distribution and dispersion of the perch larvae in lakes (Disler, 1950; Coles, 1981) suggests that changes of photoreaction influence perch spatial distribution at their early ontogeny.

BIOLOGY OF THE PIKEPERCH IN THE BALTIC SEA

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In the Baltic Sea, there are considerable environmental gradients from north to south and from littoral areas to the open sea. These gradients include both abiotic parameters (e.g. salinity and temperature) and biotic parameters. Thus the Baltic Sea forms an extreme and variable environment for successful maintainance of a typical warm water species like pikeperch. It is forced to spawn entirely in shallow inlets, estuaries and bays where salinity is lower than in exposed areas and temperature during summer high. Pikeperch populations are heavily affected by human disturbances and exploitation. Pikeperch favour eutrophicated archipelagoes and bays where the temperature in spring and summer is considerably higher than elsewhere. Pikeperch has during recent decades enlarged its range and abundance as a consequence of increased turbidity of coastal waters and in years of high summer temperatures. Temperature is known to affect positively on the year-class strength. The species is heavily exploited all over the Baltic Sea, but the effects of harvest on populations are poorly known. In many Baltic areas it is economically the most important species. The ecological significance of pikeperch as a top predator is, however, poorly understood.

DENSITY, GROWTH AND PRODUCTION OF PERCH (*Perca fluviatilis*) IN A HEAVILY FISHED POPULATION

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This study was carried out in the oligotrophic lake Munksjøen in southeastern Norway. The lake is situated 570 m a.s.l., the surface area is 53 ha and maximum depth 10 m. The lake harbours perch, roach (*Rutilus rutilus*), pike (*Esox lucius*) and burbot (*Lota lota*). The water quality was poor due to acidification, with pH about 5.0 unntil summer 1991, when 23 tonnes of limestone powder were added. Afterwards pH > 6,0 has been maitained, except for snowmelt periods when pH has dropped to 5,8.
Before lime treatment, the recruitment was weak to all species, because of the poor water quality. To avoid over population and slow growth of perch after liming, the most numerous species perch and ruff, have been heavily fished with traps and gillnets every year since 1992. Attempts to depress the reqruitment of these species were also made by stocking 2-3 years old brown trout (*Salmo trutta*), assumed to be predatory. Density of perch was determined by marking and recapture, biomass and production were monitored for the period 1992-1994.

VISUAL FACTORS AFFECTING PREY RECOGNITION AND PREFERENCE BY LARVAL YELLOW PERCH *Perca flavescens*

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Larval perch are not indiscriminate feeders. Not only can they visually pick out prey from nonprey items, but they can select particular prey types from a mixture of many potential prey. Target detection and class assortment (e.g. size, shape) can be accomplished using only luminosity contrast and motion parameters. However, target recognition is a very different visual task which, while certainly dependent on luminosity contrast and motion, makes use of colour, pattern and textural cues as well. We have been examining the influence of prey colour on the ability of larval perch to select their preferred prey.
The tested visual task is the ability to discriminate between two size-matched copepod species, both of which are normal prey items for larval perch. In white light *Diaptomus sicilis* appears deep orange/red due to the presence of dense carotinoid vacuoles which effectively absorb all wavelenghts shorter than about 540 nm, while *Diaptomus minutus* is essentially colourless. Larval perch presented with a 50/50 mix under white light have no difficulty in discriminating between the two species as measured by consumption ratios based on gastric content analysis. These experiments also point out the existence of two preference groups within the population of tested larvae - one eating almost exclusively *D. sicilis* and the other mostly *D. minutus* - as well as a small number non-discriminate feeders. Assuming that colour is being used for this discrimination, we should be able to influence specific prey consumption by altering the illuminant. In red light there is no colour contrast, and negligible luminosity contrast, between the two prey species. In blue light there is also a loss of colour contrast, however the highly absorbant *D. sicilis* now appear black with maximal luminosity contrast. The expectation was that discrimination would be lost in red light with all larvae switching to *D. sicilis* in blue light. These expectations were met when fish were tested individually, but group testing still showed a large degree of selectivity. However, even the individual fish still showed evidence of prey preference. These results will be discussed in the context of visual search and feeding strategies.

THE STATUS OF SPECIES OF THE FAMILY *Percidae* IN THE WATERS OF THE CZECH REPUBLIC

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So far, the occurrence of seven percid species has been evidenced in the waters of the Czech Republic, belonging to the river systems of three seas (the Black, Baltic and North seas). *Perca fluviatilis*, *Gymnocephalus cernuus* and *Stizostedion lucioperca* are common. The occurrence of the remaining species is limited to the stream of the Morava River and its major tributary, the Dyje River (drainage area of the Danube; Black Sea river system). In the historical past, *Gymnocephalus schraetser*, *Zinqel zinqel* and *Zinqel streber* occurred in the Morava River. Water pollution and construction of weirs in the past caused that the species vanished from the waters in our territory. The gradual improvement in water quality in the Morava and Dyje rivers in recent years have caused that these species have returned to the territory of the Czech Republic. Recent evidence shows the occurrence of *G. schraetser*, *Z.*

zinqel and *Stizostedion volqense*, the latter being a species new for our ichthyofauna. In the territory of the Czech Republic the occurrence of these species is limited to stretches of the Morava and Dyje rivers, 20-30 km long, as the existing weirs prevent their incidental upstream migrations. The occurrence of the four species mentioned above, limited to the Black Sea river system, is evaluated as rare, and the species should be considered to be endangered as to their future existence.
S. lucioperca is a species of economic importance. It is reared in fishponds and commonly stocked into naturel waters. Its annual production in fishponds is up to 25 tonnes, and 150-200 tonnes are caught with hook and line annually. The annual bag of *P. fluviatilis*, obtained with hook and line, is 50-80 tonnes.

SIZE-SELECTIVE MORTALITY IN AN EXPLOITED PERCH POPULATION AND THE RECONSTRUCTION OF POTENTIAL GROWTH

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The purpose of the study was to assess the extent of size-selective mortality exerted on perch cohorts recruited to the commercial gillnet fishery in Lake IJssel. The size distribution of the individuals within a cohort (1985) was followed from fishery-independent trawlnet surveys before and after the winter gillnet fishery. Opercular bones were used to age the fish and to reconstruct their individual growth. Samples taken from the fish landed by the commercial fishermen were recorded for their size distributions, their age and their individual growth, using scales. The quantified modification of the cohort size distribution was compared with independent gillnet selectivity estimates. The reconstructed, potential growth of the 1985 cohort showed that the size reached after 5 summers could have been 26.9.cm, whereas mean length observed in the population was 25.3 cm. Correlations between size at age of recruitment to the fishery and size attained at an younger age became poor or even non-significant when the youngest age groups were taken into consideration. This finding stresses the large individual difference in growth history within a cohort. So in case of perch size-selective mortality can only be proven over relatively short growth trajectories.

EFFECTS OF PIKEPERCH NESTS STOCKING IN DANUBE RIVER SYSTEM IN YUGOSLAVIA

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In order to increase of ichthyoproduction and to improve of fishery on open waters of Pannonian part of Yugoslav Danube river system, pikeperch nests supplied with fertilized eggs were used. This management was carried out in the period 1988-1992 in the Danube and Tisa flooded areas by nests made of various materials (willow adventitious roots, hemp and jute) in density of 1-2 nests/ha. Spawning started mostly during first week of April. At first participated older individuals which abundantly laid large roe suitably located on the nest. Later on younger mature specimens took part by producing a smaller amount of tiny eggs less favorably settled on the nest. The spawn was finished at the end of April. Besides

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that, same time, physico-chemical parameters (temperature, pH, oxygen regime) and structure of fish community of water bodies were studied. The effects of this manipulation on population density, longitudinal and body mass growth of *Stizostedion lucioperca* were also evaluated.

SOME OBSERVATIONS ON FINAL OVARY MATURATION OF PERCH (*Perca fluviatilis*) IN CAPTIVITY

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Final ovary maturation of twenty eight perches hold in captivity have been studied over a two weeks period, by histological method.
The stages of oocytes maturity are described with an emphasis on the latest stages. The changes in the oocytes have been divided into seven stages (0 to VI).
- The 0 stage includes all the little oocytes which are in early development or in resting stage, characterised by: dark staining cytoplasm, large light nucleus with granular appearance, no granulosa layer, chorion, or yolk vesicles in the cytoplasm, simply a primary theca.
- The stages I to V include the oocytes which are in "developping-late" stages, i.e. whose diameter is increasing, cytoplasm is almost completely composed of yolk vesicles and lipid globules, chorion and granulosa layers well identified.
- The stage VI includes the hyalin oocytes (empty or undergoing autolysis). Their presence shows the evidence of pre-or/and post ovulatory degeneration of oocytes.
Frequency distribution of each maturity stage, at each date on which ovaries were sampled, has been drawn.
The diagram shows the presence of stage O oocytes in each ovary, with a relative abondance varying from 20 % to 60 % (average 41.1 %), which is the reserve stock.
Almost all the ovaries show stage V oocytes, more numerous at the end of the period.
Hyalin oocytes are numerous in some ovaries (frequency up to 21.9 %). They probably indicates the evidence of oocytes atresia prior ovulation because no perches have spawned.
The histological changes were related to gonad weight and gonadosomatic index variations.

DIETS OF EUROPEAN PERCIDS DURING THE PELAGIC STAGE OF LIFE IN EARLY ONTOGENY

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The diet composition of pelagic larvae and juveniles of perch (*Perca fluviatilis*), pike perch (*Stizostedion lucioperca*) and ruffe (*Gymnocephalus cernuus*) was investigated in a water supply reservoir (Rimov Reservoir, water area 210 ha, average depth 16 m) during a three year period. Nauplii, copepodites and adults of diaptomids and *Daphnia galeata* dominated subsequently the diet of perch and pike perch from the start of exogeneous feeding to a length of 30-40 mm. A significant diet overlap was found between both species at

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comparable developmental stages and lengths. Ruffe, although regularly found in the pelagic zone, fed to some extend on littoral prey. Chironomid larvae and littoral *Chydoridae* formed up to 40 % of the diet. The diet of investigated species is compared with the zooplankton composition and possible trophic relationships are discussed. Compared with the diets of dominant juvenile cyprinids, roach (*Rutilus rutilus*) and common bream (*Abramis brama*), an apparent competiton for *Daphnia* can be observed.

THE INFLUENCE OF THE MOLLUSC FILTRATOR *Dreissena polymorpha* ON GROWTH AND DEVELOPMENT OF JUVENILE PERCH *Perca fluviatilis* L.) UNDER EXPERIMENTAL CONDITIONS

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Two open aquatic ecosystems were created, in one of which the mollusc *Dreissena polymorpha* (zebra mussels) was introduced in the amount of 0.75 kg/sq. m of the bottom ground. During the experiment we determined: mass of the higher aquatic vegetation by species, composition and abundance of phyto-, bacterio- and zooplankton; character of passing through the larval stage in perch, rate of its growth and fattness. The abiotic factors were also observed: mineral composition of water (Ca, Mg, Na, K ions). Duration of the experiment was 119 days.

Differences in the gowth of the larvae were observed on day 12 from the beginning of the experiment. In the ecosystem with dreissena (F+Dr) on day 18-30 an increase in the variance of the body length was noted while the same in the ecosystem without dreissena (F) was noted only on day 24-36. On day 12 the growth rate in the treatment (F+Dr) decreased, and then gradually overgrown this index in the treatment (F) The character of changes of the fattness coefficient was similar. It is during this period of the experiment that an increased mortality of the weak juvenile perch in the treatment (F+Dr) was observed. That influenced the character of changes of the growth rate and fattness coefficient of the larvae.

A similar type of feeding of the larvae lasted till day 12. In the treatment (F) the role of Cladocera decreased by day 24 and chironomid larvae appeared in the ration. In the treatment (F+Dr) this occurred two weeks earlier. Here large individuals of perch shifted to feeding on fish.

Thus, the presence of the mollusc *Dreissena polymorpha* (0.75 kg/sq. m) in the experimental ecosystem on the ground facilitated an early shift of juvenile perch to benthic feeding, increased heterogenity of their size-mass characters and lead to emergence of predatory individuals.

SEASONAL PATTERNS OF PREDATION AND RESOURCE PARTITIONING IN A COMMUNITY OF AGE-0 PERCIDS

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In the hypertrophic, top-down manipulated Bautzen reservoir (Germany), perch (*Perca fluviatilis*), ruffe (*Gymnocephalus cernua*), and pikeperch (*Stizostedion lucioperca*) occur in high densities Their age groups O+ are the main zooplanktivorous predators. Due to the summer decline of large zooplankton species (daphnids) all age-0 percids are exposed to

increased competition for food. Consequently, regulation mechanisms to diminish the competition within the fish community are very common. They include resource partitioning along the dietary and spatial niche axis as well as interdependent predation and cannibalism of juvenile percids. This regulation in turn enables the development of a second population peak of daphnids in late summer and autumn. The sesonal patterns of the diet and the distribution of age-0 percids are documented and compared for two years with different composition of the fish community.

INTENSIVE CULTURE OF EUROPEAN PERCH (*PERCA FLUVIATILIS)* IN WARM WATER EFFLUENTS

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Intensive rearing of perch has been conducted since 1992 in the Tihange Aquaculture Research Centre (Belgium) in order to evaluate, on an actual production scale, the potentialities of using nuclear plants outflow to intensively culture perchs. Preliminary experiments evidenced that the optimum rearing temperature was 23°C. Maintaining this constant thermal regime all year round inhibits sexual maturation and minimizes the energetic investment in gonadic products, especially when considering the very high GSI in female perch (± 20 % in females). Weaning of perch fry is achieved through a progressive shift from natural (rotifers and *Artemia*) to artificial food. Weaned alevins (0.5 g) are stocked in tanks (2 m^2 and 0.5 m^3 then 4 m^2 and 1.5 m^3) at densities decreasing with increasing size and age: 8,000, 2,000 and 300 fish m^3, for 0.5-15, 15-50 and 50-200 g fish, respectively. The maximal biomass figure is 123.6 kg m^{-3} achieved with 15 g perch. Under this culture mode, weaned alevins fed exclusively with artificial diet (57 to 44 % protein) averaged 160 g after one year but their weight frequency distribution ranged from 20 to 350 g at that time, suggesting the need for frequent sorting in intensive perch culture. Although the survival rate observed during in our experiments (50 %) could be further improved through a more precise investigation upon pathological aspects (parasite, bacteria), these results already confirm the actual potentialities of mass rearing of perch.

RELATIONSHIPS BETWEEN GROWTH, CANNIBALISM AND SURVIVAL RATE IN INTENSIVELY CULTURED LARVAE AND ALEVINS OF PERCH (*Perca fluviatilis*)

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Cannibalism is a common phenomenon in wild or cultured populations of perch, especially during early life history stages (larvae, alevins) when individual growth shows a high variability. In high density rearing, up to 40 % of the overall mortality can be accounted for by this phenomenon though the functional mechanisms behind the emergence and intensity of cannibalism are still debated. In order to quantify the relationships between fish density, growth and cannibalism, rearing trials were conducted in 10 m^2 concrete ponds at stocking

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densities ranging from 500 to 4000 fish m^{-2}. Fish were reared at 23 °C and fed with mixed artificial and natural diets (*Artemia* and plankton). At the age of 44 days, cannibal fish represented from 0.5 to 6.5 % of the final population (associated with survival rates 38.6 of and 10.5 %, respectively). The number of cannibal fish is positively correlated (r^2=0.55) with the initial stocking density though the semi-log relationship indicates that increasing stocking density proportionally minimizes the relative intensity of cannibalism. A stepwise multiple regression model accounts for 93.8 % of the observed variation and further integrates SGR (power function) and relative availability of natural planktonic preys (Log function). These results evidence that cannibalism in perch is favoured under low availability of natural preys that apparently increases the specific growth rate and the size variability (e.g. cannibalism increased by 80 % when final size doubles). Predictive models of survival and growth based on density dependent variables are presented and discussed.

REGULATION AND CONTROL OF FISHERIES SELECTIVITY AS RELATED PERCID FISH

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Determination of fishing gear selectivity, regulation of mesh size, allowable fish size, by-catch of fishes of non-commercial size, control of fishing gear selectivity for percid fish were considered, based on our mathematical models and methods.

FORAGING PLASTICITY AND SELECTIVE FEEDING IN JUVENILE PERCIDS, *Perca fluviatilis* AND *Stizostedion lucioperca*

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Perch and pikeperch in their early ontogeny are typical particulate-feeders inhabiting predominantly still waters. While growing from larvae on they change their preference from microplankton to larger zooplankton and further to fish. Observed size-selectivity curves are monotonically increasing or bell-shaped depending on size composition of available prey. While living in water reservoirs juvenile percids encounter unusual local situations which significantly influence their foraging characteristics. Foraging on zooplankton drifting down-stream the dam the perch demonstarted higher selectivity and feeding rate at sites with higher water velocity. The lowest characteristics were observed in the still water upstream the dam. In the heterogeneous shallow-water zone foraging in dense vegetation patches the perch selected larger prey both among more and less profitable prey taxa. Potentially piscivorous pikeperch juveniles (30-50mm SL) encountering extremely dense (up to 60,000 ind. 1^{-1}) *Daphnia sp.* near the dam demonstrated "inverted size selection" (concaved or inverted bell-shaped curve). The result is analized as to both predator feeding mode and prey antipredator behaviour. Transformed environment of water reservoirs providing possibilities to study foraging of juvenile percids in wide range of situations allows insight into their behavioural potentialities and reveals the well-pronounced plasticity in their feeding.

DO ECOLOGICAL FLEXIBILITY AND FOOD DEMANDS INFLUENCE MASS ACTIVE MOVEMENT IN JUVENILE PERCIDS?

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The ruffe, *Gymnocephalus cernuus*, perch, *Perca fluviatilis*, and pikeperch, *Stizostedion lucioperca*, are typical open-water inhabitants at larval stages foraging on zooplankton. At this period of the ontogeny they are subject to different sorts of water currents which transport them down-stream the rivers and disperse over the lakes and reservoirs. When the fish concentration is high their directional movement is called "passive down-stream migration" (Pavlov,1979). Becoming juveniles these percids differ in their preferable biotops, diet and growth rates. It has been frequently observed that at the middle of its first summer pike-perch undertook mass active movement which in reservoirs led to the transport through the dam and mass mortality. These events were preceeded by declining in abundance of appropriate food (Mikheev, Pavlov, 1993). In case of the perch the mass active movement of juveniles was not so frequent and pronounced; in case of the ruffe it was not observed at all. We suggest that high food demands make the fast growing pike-perch juveniles the most vulnerable to shortage of appropriate food (large planktonic crustaceans and fish larvae). More omnivorous and slower growing perch and especially ruffe juveniles can meet their energetic demands, widening diet spectra without drastic increasing search area. It is particularly true for the ruffe which is ecologically more flexible than the perch (Bergman,1990).

LATE SIZE DIFFERENTIATION OF PERCH IN TWO RUSSIAN LAKES

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Well-known size differentation of perch during the first year of life. The size differentation is reverses or results in life history variability and ecological guilds formation. Individual growth curves of perch was studied on the base of back-calculated data from two small Russian lakes.
The late size differentiation of perch was revealed. The main ecological sources of skewness of size-frequency distribution are suggested the individuals interactions and resource partitioning, which delay or accelerate growth. This results support the idea that significant changes of growth and size differentation of fish may occur in any parts of ontogenesis including period after maturation.

SEASONAL PATTERNS OF ENERGY ALLOCATION IN PERCH (*Perca fluviatilis*)

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The allocation of energy to somatic and gonad growth and to locomotor activity during different seasons was studied in two perch populations in the Baltic Sea during I978-1990. One of them was exposed to thermal discharge in an artificial enclosure at a nuclear power plant.
The locomotory activity is high before and during the spawning in spring. Under natural conditions the start of this period is set by temperature but in heated water by day-length. In summer, perch gives priority to somatic growth. Its onset in May or June depends on temperature but also on the energetic state of the fish. Low temperature, in heated water short day-length, terminates the growth season in autumn. The gonad starts to grow in the same period in August irrespective of temperature. The female gonad is growing up to spawning, while the growth of the testes is finished in October.
Growth could be simulated by a bioenergetics model based on temperature and day-length. Except for the hyper-activity related to spawning, locomotor activity measured as gill net catches was well correlated to consumption values calculated by this model. The gonad growth rate seems to be independent of temperature.
The influence of size and age on the energy allocation and the reactions on an energetic stress in heated water are analyzed

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PARASITIC CILIATES OF PERCH *Perca fluviatilis* l. 1758 FROM VLASINSKO LAKE RESERVOIR (SERBIA, YUGOSLAVIA)

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In the sample of 83 specimens of the perch (*Perca fluviatilis* L. 1758) caugth on 8 localities at the Vlasinsko Lake reservoir, in April-October 1993, 25 infested specimens were found. They were infested with the following species of parasitic Ciliates: *Trichodinella epizootica*, *Apiosoma robustum*, *Apiosoma piscicolum* ssp. *perci*, *Ichtyophthirius multifiliis*, *Chilodonella cyprini* and *Chilodonella hexasticha*. The most intensive infestation with all quoted parasitic Ciliates was registered in April; only *Ichthyophthirius multifiliis* infested the perch intensively in July. *Trichodinella epizootica* and *Apiosoma robustum* revealed both the highest extensity and intensity of infestation. Regarding the localization of the parasitic species, *Trichodinella epizootica* and *Apiosoma robustum* had a mush stronger affinity for the gills than for the skin of the perch.

MOVEMENTS AND GROWTH OF THE ZANDER, *Stizostedion lucioperca*, IN LAKE HJÄLMAREN, CENTRAL SWEDEN

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Lake Hjälmaren is a shallow eutrophic lake with an intense commersial fishery. The zander is the most important species from an economic point of view. A total of 2 299 individuals with a total length of 22-39.5 cm were marked with Dart tags during late June-early August 1990. The fish were caught in commersial trap-nets, measured, marked and released immediately at the place of capture. In total 1 879 recaptures were recorded and the number of recaptured individuals was 885 (38.5%). 6 individuals were recaptured more than 20 times and one fish 39 times before it was caught and killed in a gill-net. These figures show

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that the fishing is intense and that the young zander tolerates to be captured in trap-nets and the handling before release quite well. The daily rate of growth was 0.14 mm on a yearly basis and the average growth rate during the summer was 0.7 mm per day. The zander showed a very stationary behaviour during the growth season and many individuals were captured repeatedly in the same trap-net, both during the season of tagging and during following seasons. In late autumn there was a migration from the shallow areas in the western part of the lake to deeper areas in the central part.

GROWTH RATES AND MORPHOLOGICAL CHARACTERS IN PERCH AS A FUNCTION OF DIFFERENT RESOURCE AVAILABILITIES

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The dynamics of Euroasian perch (*Perca fluviatilis*) can be positively or negatively affected by the amount of planktivorous fish present in the system, as functions of predatory and competitive interactions. In this study, eight lakes in northern Sweden, were sampled for fish and macro invertebrates during the summers of 1993 and 1994. These studied lakes had a humic gradient as well as productivity gradient. The growth rates of perch were higher in the lakes with a lower humic content than in the lakes with high humic content. Biomass of planktivorous fish and macro invertebrates were also higher in the lakes with low humic content. Furthermore, in the lakes with low humic content perch growth rates increased in the size interval where perch shift to piscivory, whereas the opposite was the case in the other four lakes. These results suggest that the differences in perch growth rates in the different lakes were due to different resource availabilities, probably interacting with humic content of the lakes. The mouth morphology of perch also differed between lake types. Mouth width was larger for small perch (<200 mm, TL) in lakes with high humic content than in lakes with lakes with low humic content, whereas the opposite were the case for large perch (>200 mm, TL). It is suggested that these differences in morphological characters of perch in the different lake types are a result of different selective pressure over the ontogeny.

DOWN-STREAM MOVEMENTS OF THE PERCH, *Perca fluviatilis*, FROM RESERVOIRS SITUATED AT DIFFERENT CLIMATIC ZONES

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Most important characteristics of down-stream movements of the perch, such as abundance, size and age composition, diurnal and seasonal patterns, were compared for arctic (Ust-Khantaiski) and temperate zone reservoirs (Ivankovski and Sheksninski). The only significant difference was related to seasonal dynamics of down-stream movements. Juvenile perch in arctic reservoir migrated later in season compared to fish from temperate zone reservoirs. 1+ and older perch demonstrated the peak of down-stream movement activity in the arctic reservoir at the beginning of winter, while in temperate zone reservoirs such a peak was observed in the middle of summer. The difference was primarily related to pecularities of thermic regime of reservoirs.

BEHAVIOUR OF PERCH, *Perca fluviatilis*, IN STREAMS WITH DIFFERENT LEVELS OF TURBULENCE

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The perch from riverine habitats when tested in experimental streams preferred areas with low level of turbulence. It differed from true reophilic fish such as grayling, chub and georgeon and was similar to crucian carp from a limnetic habitat. Prestarved for 2-6 days perch chose stream areas with higher level of turbulence as compared to satiated fish. The higher turbulence, the lower swimming performance and critical swimming speed for perch. It is related to enhanced energy costs for equilibrium maintenance while swimming against the water flow. The larger fish size, the higher turbulence level at which critical swimming speed began to decrease. Thus, turbulence significantly influences behaviour and spatial distribution of perch in a stream. Turbulence is one of the factors controlling perch distribution in a river.

PREY SELECTION AND SEASONAL PATTERNS IN FEEDING OF PIKEPERCH (*Stizostedion lucioperca* (L.)) IN LAKE VESIJÄRVI, SOUTHERN FINLAND

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Prey selection and seasonal patterns in feeding of pikeperch was studied and logistic regression was used to quantify the fractions of pikeperch feeding on different prey fish. The diet of the small pikeperch (< 500 g) consisted mainly of smelt (*Osmerus eperlanus* (L.)) whereas the large pikeperch mainly consumed perch (*Perca fluviatilis* (L.)). The pikeperch also fed on roach (*Rutilus rutilus* (L.)) and bleak (*Alburnus alburnus* (L.)) but the fractions of pther prey fish were small. Pikeperch are selective for perch whereas increase in the abundance of smelt or roach in the study area did not show in the feeding of pikeperch. The logistic regession analysiss was obsetved to be a suitable method to analyse feeding of predatory fishes in case they only take one or a few prey items at one instance.

CANNIBALISTIC CYCLES IN PERCH? THE TIMING OF COMPETITIVE AND PREDATORY PROCESSES

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Although the actual data is meagre, population cycles in single species populations of perch have been discussed in a number of papers. These cycles have generally been interpreted as cannibalism-driven cycles where new recruits are prevented to successfully enter the population by cannibalism from older individuals. It is only when the population size of older individuals has decreased that a successful recruitment will take place. Recent

modelling of size-structured consumer-resource models suggests that strong discrete reproduction pulses as is the case in many fish populations may have profound effects on the population dynamics and that recruits may drive adults to starvation death. In populations where recuits share a resource (zooplankton) with the cannibalistic adults as is the case in perch populations, it can be suggested that recruits under certain conditions may actually out compete the adults before recruits become susceptible to strong cannibalism mortality. As a consequence, recruits may take an active role in driving cycles also in cannibalistic populations. The above ideas are discussed in relationship to patterns observed in a perch population undergoing strong population fluctuations.

SETTLEMENT STRATEGY IN PERCH FRY - THE LARGEST INDIVIDUALS ARE THE FIRST ONES

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It is shown that after hatching the perch fry forms two groups - the larger individuals form the nearshore groups having predatory feeding pattern, the small ones form the pelagic groups feeding by plankton. The transit water flows in rivers or wind flows in lakes result in drift of pelagic groups. In the system "reservoi - river" the pelagic groups is carried out trough a dam and subsequently it drifts with a transit river flow. During the drift the fry is differentiated again according to its length. The largest individuals occupy the riverside while the small ones continue to drift downstream. Somewhat later (after 2 - 3 weeks) the nearshore groups starts to more against a water current along shoreline, in mass numbers entering into all tributaries and moving to their headwaters. During al this time the selection of small fishes continues, and these individuals are forcing out from riverside areas and drift again into the main channel of a river.

THE ROLE OF PERCID FISHES IN ECOSYSTEM OF EUTROPHICATING LAKE

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The ecological status of perch, pike-perch and ruffe is different. Pike-perch is a typical pelagical predator. Perch is a coastal facultative predator, young fishes are feeding on zooplankton and benthos and oldest ones - on fish. Ruffe is a small benthophagous fish, but young fishes may feed zooplankton and adults consumer egg and fingerlings of fish. All three species may appearence as prey in young age, and as cannibals in adult age, especially in the years of abundance generations.
In Lake Syam (South Karelia), taken as an example, common changes in food links of ecosystemin are considered during the process of eutrophication in the last 30 years. In this period, the trophical status of lake is increasing, zooplankton biomass has increased four times. Introduction and sharply increasing of smelt changes all food relations among fishes. All predators (escape pike) change their principal prey species (the cisco in the past and smelt - in present) and the annual rhythm of feeding. The most intensive period of feeding replaces from spring to autumn - the period of a smelt concentration. In the past small-sized perch and ruffe was representive about 50% in predacious ration, but at present - 10-

15% only. The plankton-feeding period of all percids has increased. At the same time the young of percids has consumered the larvae of smelt. The abundance and high availability of smelt during vegetation season result in increasing of annual ration and growth of predators.

THE ANALYSIS OF MORPHOLOGICAL VARIABILITY OF PERCH IN AREAL

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Using the multivariance analysis and Personal Computer the morphometric analysis of 14 populations of perch from the water of eastern Russia from the south (46°) up to norden (69°) boundary of distribution. It was indicated, that variability of plastic characters is high and connected more with ecological condition of habitats than with geographical latitude. On the contrary, meristic characters are connected with temperature and latitude of waterbody. Among considered plastic characters the most separating "weight" has pedunculus length, caudal fin, maximal heigth, head length and eye diameter; amomg meristic ones - number ray in dorsal fin, number of vertebra, number scales in 11 and gill rakers. A clear dividing all perch populations on two group (Baltic and Volga-Caspian basins) is demonstrated. Analysis of more 170 perch population from Europe and Asia has indicated that the clear clinical variability of D1 and vertebra is observed among perch population from Arctic region to Volga-Caspian basin. But as rule, the clear geographical trend is overlaping by ecological conditions, and as result a variability of meristic figures has a mosaic character.
Expert analysis of literature data allow us to discover rough errors in literature data among meristic characters and to revise the main characters in the whole area of perch.

PECULIARITIES OF FEEDING OF PERCH AND PIKE IN WATERBODIES OF PASVIK RIVER SYSTEM (KOLA PENINSULA)

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The food spectrum and feeding intensity of two predacious fish (perch and pike) was investigated in 7 waterbodies of Pasvik River system (the most northen bounder of their areal) with connection of food supply.
Duration of feeding season of the predadors in the waterbodies consists of 3-3,5 months (from June to September). Temperature and water level differs from year to year, accordingly food supply and feeding season divergies too. The food supply is limited and has a poor of number species. The basis of feeding of perch and pike consist of 3 species only: nine-spined stickleback, young of whitefish and perch. The stickleback has predominated in the perch food, and young of whitefish - in the pike food. The stickleback was a dominant prey species in upper waterbodies of Pasvik River, and whitefish - in lower part.

Size of stickleback in the food of two predators was 2,5-4,5 cm, and size of small whitefish was 3-10 cm in the perch food and 4-18 cm in pike food. The most intensive feeding period was in spring or autumn depending on the productivity of nine-spined stickleback or young whitefish.

GENETIC DIFFERENTIATION OF ENDANGERED DANUBIAN *Zingel zingel:* 1 ST RESULTS ON ISOZYME POLYMORPHISM AND CHROMOSOMAL MARKERS

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In the frame of French national project dealing with highly endangered, Rhone endemic percid *Zingel aspro*, we have started also studies on the genetic differentiation within also endangered 2 Danubian *Zingel* species, viz. *Z. zingel* and *Z. streber*. In this preliminary study we have investigated genetic markers of *Z. zingel* from 2 localities (Danube R., river km 1831 9 individuals, and lower Morava R., 8 individuals).
Examination of 19 presumptive enzymatic loci revealed 1) number of polymorphic loci to be higher (15.8%) in individuals from main coarse of Danube R. than that (5.3%) in those from Morava R., 2) number aleles per locus to be higher (1.26) in the former population but lower (1.05) in the latter. This comparison may indicate that significantly lower genetic variability of the latter population is related to the founder effect of formerly polluted Morava R. and recent penetration of this species to this locality. This finding suggest that these highly endangered percid species may be able to repopulate localities once polluted.
Karyotype analyses confirmed our earlier description of karyotype of *Zingel zingel.* Examination of location of nucleolar organizer regions (rDNA genes) by silver staining and CMA3 fluorescence, distribution of constitutive heterochromatin and locations of telomeric repeats by FISH (fluorescence in situ hybridization with telomeric probes) showed no observable differences between individuals of two populations. This finding may indicate karyotype uniformity within upper Danubian *Z. zingel* populations.

PISCIVOROUS EEL IN LAKE CONSTANCE: CAN THEY INFLUENCE YEAR-CLASS STRENGTH OF EUROPEAN PERCH?

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Research on predator-prey relationships in the littoral zone of Lake Constance showed that eel (*Anguilla anguilla* (L.)) was the most abundant predator in the shallow water zones up to 3 meters depth. From July on fish was the most important diet component. Perch (*Perca fluviatilis* (L.)), burbot (*Lota lota* (L.)) and bream (*Abramis brama* (L.)) were the most frequently consumed species. As 74 % of all identified fish the eels had consumed were

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perch, we tried to estimate the impact of eel predation on young-of-the-year perch. The consumption of the total eel population never exceeded the published estimates of young-of-the-year consumption by adult, cannibalistic perch, but an influence on weak year-classes seems possible Further reoligotrophication of the lake could lead to sinking benthic production, which could enhance the predation pressure of eel on perch.

PARASITES OF PIKE PERCH *Stizostedion lucioperca* (LINNAEUS 1758) FRY REARED IN TWO DIFFERENT TYPES OF NATURAL FOOD PONDS IN SOUTHERN FINLAND

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Pike perch fry (< 4 months old) reared in two different types of natural food ponds were examined for parasites in Rauma and at Porla, southern Finland, during June-August in 1990 and 1991. The ponds differed in size and drainage. The highest number of observed parasite species per sample was eleven at Porla and four in Rauma. Altogether four species of protozoan parasites were detected on the skin and/or gills: *Ichthyobodo necator, Ambiphrya ameiuri, Trichophrya piscium* and *Trichodina* sp. The two major species were *I. necator* and *A. ameiuri*. The intensity of *I. necator* infestation was mostly rather low. The infestation by *A. ameiuri* was very heavy at Porla in 1990. In July, the skin and particularly the fins were filled with this ciliate and the fins were frayed. Ten species of helminth parasites occurred at Porla: *Diplostomum* sp. (lens), *Diplostomum* sp. (vitreous humour), *Tylodelphys clavata, Bunodera lucioperae, Proteocephalus* sp., *Eubothrium* sp., *Raphidascaris acus, Argulus foliaceus, Piscicola geometra* and *Nematoda* sp. Only two helminth species, *Diplostomum* sp. in lens and *Diplostomum* sp. in vitreous humour, were found in the pike perch in Rauma. The composition of the parasite species and their influence on cultured pike perch in the natural food pond seemed to be connected to various environmental factors. Some indication was obtained for *Ambiphrya ameiuri* induced mortality. The results of this study indicate that the drainage of the pond between the growing seasons, minimizing the number of fish species in the pond and having sufficient nutrition are good methods for keeping the parasite load small.

THE COLLAPSE OF PERCH POPULATION IN A SMALL LAKE: RESPONSES IN THE FOOD CHAIN AND IN THE REST OF THE PERCH POPULATION

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In the Iso Valkjärvi Liming experiment, an almost total collapse of fish from the control basin of the lake took place in autumn 1992. According to the mark-recapture study of the next spring, more than 95 % of the perch population had died whereas the number of perch in the limed side remained at earlier levels. The most probable reason of the fish kill was so called "mixing zone phenomenon" i.e. interaction of acidity, Ca and Al chemistry in certain concentrations. In this case maybe also Fe and redox conditions affected because the sudden

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kill occurred during the autumn turnover.
Several biological responses were recorded. Later in the autumn, maximum densities of ciliates were recorded, suggesting an increased microbial activity in the decomposition of the dead fish biomass. Correspondingly, bacterial biomasses higher than earlier summer 1993. The response in crustacean zooplankton was surprising: against our expectations there was almost no planktonic cladocerans in the fishless side of the lake in summer 1993. This is explained by the rapid increase of *Chaoborus* larvae and corixids, which, in turn, resulted from the lack of predation by fish.
The remaining perch of the control basin started to grow wery rapidly. Instead of the normal length increase of 2-3 cm per year, they grew 5-7 cm in the summer 1993 and gained a ten fold higher weight increase than the perch of the limed basin of the lake. The mercury concentrations and radioactivity of the perch showed a 50 % decrease, probably due to the growth dilution. A behavioural change of the goldeneye was also recorded. The breeding individuals did not change their use of the both basins of L. Iso Valkjärvi, but the brood early increased the use the control basin after the perch crash.

ESTIMATION OF STATE OF FISH POPULATIONS IN CONDITIONS OF ANTROPOGENIC INFLUENCE

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On the basis of morphological and patalogo-anatomical characters the new method for expert estimation of the state of each speciment, population and all fish comminity was worked out. Index of Unfavourable State (IUS-index) has proposed, which indicate the state of fish as singular figure.
Intensive pollution of water bodies results in the same events as in the case of eutrophication (the asymmetry of gonads and deterioration of the quality of sex products), but moreover other specific impacts appear also as anomalies in fins, spine structure, vertebrae, kidney stones, accumulation of toxic substances in the fish body. The data of the 4 dominant fish species (including perch, *Perca fluviatilis*) from Pasvik River basin (Russian-Norwegian boundary near "Nikel-combinat") will be presented. IUS-index has increased with the fish age and during summer-autumn season, it has changed from water to water, depending of the level of pollution. Index is correlated with the concentration of heavy metalls in fish tissue, indicating the unfavourable state of populations.
On the basis IUS-index the three zones (zona of ecological crisis, ecological disaster and relative good conditions) are discowered in the Pasvik River basin, in which the fish populations indicate a different level defeat.

THE EFFECT OF WATER INTAKE FROM THE LENINGRAD NPP TO PERCID FISH INHABITING THE KOPOR BAY OF THE FINNISH GULF

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In the Kopor bay two species of cyclostomata and 50 fish species have been registered. Among them such percid fish as *Perca fluviatilis*, *Stizostedion lucioperca* and *Gymnocephalus cernua* are of commercial importance.
In connection with demand for cooling of condensers of the four blocks of the Leningrad NPP that comprises 180 m^3/sec, the part of fish enters with water into the water supply channel first and then falls on the safety gauzes of the turbines.
In 1981-1985 every week fish samples having fell on the safety gauzes were taken. Over five years 204 samples have been analysed. In average within one year about 600 million specimens of different species have been died, among them percid fish comprise 0,2 %. The losses of perch, pike perch and ruff comprised 838 000, 324 000 and 8 000 specimens, respectively.
Percid fish fal on the safety gauzes for the most part in autumn and winter. At the heart of the fish losses are this year's broods and yearlings with length of 40-100 mm. Mature species of percid fish having fell on the safety gauzes comprise 10-15 %.

WALLEYE EGG DEPOSITION AND SURVIVAL ON TWO REEFS IN WESTERN LAKE ERIE (OHIO: USA)

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Variation in egg survival is suspected to be a principal source of walleye (*Stizostedion vitreum vitreum*) recruitment variability in Lake Erie. We sampled walleye eggs at three depth contours (≤3m, 3-5m, >5m) on Toussaint and Niagara reefs in western Lake Erie. Eggs first appeared in samples from all depths; at both reefs on 8 April 1994 when the water temperature was 4.4 C. Fry were first observed on 26 April (148 thermal units) and viable eggs persisted in samples through 18 May. Significantly more eggs were collected per unit effort from Toussaint reef than Niagara reef (mean=3900 and 1700 respectively; $p<0.05$). More eggs were collected from sites <5m deep than from sites >5m on both reefs ($p<0.05$). Egg viability ranged from 41% to 74% (mean=56%) and did not differ significantly between depths or reefs. We estimated egg survival from the pre-organogenesis stage (≤ 28 thermal units) to the late embryonic stage (depicted by the formation of pectoral fin buds and caudal mesenchyme rays; >97 thermal units) for the pooled samples from each reef. Egg survival was calculated at 43% (s e.=0 15) for Toussaint reef and 30% (s.e.=0.10) for Niagara reef and did not differ significantly between reefs ($p=0.48$). Water temperature increased steadily during the incubation period and the western basin experienced few intense wind events during 1994 allowing for relatively high egg survival and thereby enhancing year class strength.

EVIDENCE FOR BIOTIC INTERACTIONS AMONG PERCIDS IN NEW YORK LAKES

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The population dynamics of walleye and yellow perch are hypothesized to be strongly affected by biotic interactions between the two species by the following mechanisms: abundant walleye populations decrease perch, resulting in high perch growth and decreased walleye growth (few prey and fast growth to in-vulnerable size); small walleye populations allow for strong perch recruitment resulting in slow perch growth and fast walleye growth (abundant prey of vulnerable sizes). If these mechanisms are important we expect a negative correlation between perch and walleye length at age. This was investigated using the New York State Data Base and long term data from Oneida Lake, Canadarago Lake and Silver Lake, New York. Size at age of walleye and perch was negatively correlated. Further, the trajectories of changing perch and walleye lengths as walleye were established in Canadarago and Silver Lakes follow the regression from the whole data set. This indicates strong biotic interaction between the two percid species in New York Lakes. Deviations from the regression occurred in very low productivity waters (in the Adirondacks, small size at age for both species) and in rivers (large size at age for both species).

MODELING EFFECTS OF ALTERNATE PREY TYPE ON WALLEYE AND YELLOW PERCH RECRUITMENT IN ONEIDA LAKE, NY., U.S.A

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Walleye and their primary forage yellow perch represent a tightly-coupled, predator-pray association in Oneida Lake, New York, USA. Growth, survival and potential recruitment of young-of-the year (YOY) walleye depend on size and abundance of YOY yellow perch, while YOY yellow perch potential recruitment is regulated by density-dependent growth and size-selective mortality by adult walleye. Before their disappearance from Oneida Lake in 1969, emergence of mayflies (*Hexagenia limbata)* in mid-June to early July buffered adult walleye predation on YOY perch, increasing perch survival, but causing density-dependent reductions in perch growth and recruitment through size-selective mortality. In the 1970's and early 1980's, absence of mayflies, and strong year classes of YOY white perch (*Morone americana*) which buffered YOY yellow perch from adult walleye predation in late summer and fall, were hypothesized to destabilize percid population dynamics. We configured an individual-based model of walleye and yellow perch using the 40-year Oneida Lake database to evaluate the different effects of alternate forage prey on percid recruitment strenght and variability. Model-simulated abundances, growth and survival rates, and diets of YOY's and adults agreed well with observed trends. Simulated increased abundances of walleye fish forage buffered predation onYOY perch and walleye. The model predicted that when mayflies are abundant, yellow perch recruitments are lower and walleye recruitments higher than under baseline conditions of no mayflies and low YOY white perch abundance because of increased walleye consumption. Major discrepancies remaining between modeled and observed dynamics include the stabilizing role of cannibalism and size-selective mortality on YOY perch.

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RELEASES OF FINGERLING ZANDER (*Stizostedion Lucioperca* L.) IN LAKES WITH NO ESTABLISHED ZANDER STOCK

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One-summer-old zander (*Stizostedion lucioperca* L.) fingerlings (6-8 cm) were in five successive years released in ten small and medium-sized (175-3600 ha) Finnish lakes with no permanent zander stock. Mean stocking density ranged from 10-40 ind/ha. In the following 5-7 years, data were collected to estimate the growth and survival rates of the fish and to assess the total yield and profitability of the releases in each lake. Catch samples were obtained from cooperating local fishermen. Fishing statistics were obtained by mailed fishing questionnaires. Reference data on growth and survival were collected from the two parent populations, which belong to the most abundant in Finland. Large annual and between-lake variation was found in the growth and survival rates of the released fish. In most year-classes, the stocked fish were smaller than one-year-old zander in the parent populations. In three lakes, subsequent growth rates were faster than in the parent populations. Similarities between the year-class pattern in the parent populations and the annual survival pattern of stocked fish suggest that common factors contribute to the variation in both cases.The year-class indices for the parent populations were, however, not correlated with summer mean temperatures or with the mean size of one-year-old fish, which in turn were intercorrelated. The yield of the releases varied in different lakes from 0.1 to 34 kg per thousand fingerlings (mean 11.5 kg). In two lakes, the estimated economic output exceeded the direct costs of the releases. An onset of natural reproduction was recorded in two lakes. In an attempt to explain the variable results, the quality of the stocking material, the limnological features of the lakes, as well as the differencies in the fish communities and in the fisheries are considered.

EFFECTS OF JOINT REARING ON DIET AND GROWTH OF ZANDER (*Stizostedion Lucioperca* L.) AND ASP (*Aspius aspius* L.) FRY IN NATURAL FOOD PONDS

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Zander and asp fry were reared in three natural food ponds during three successive summers. Every season one pond had a mixed stock of zander and asp, second pond only zander and third pond only asp. The fish species or species combination in each pond was changed every year. The ponds had 1 - 2 ha surface area, were located near each other and had same water source, a little eutrofic lake. Fish fry (ca. 40000 ind./ha) were stocked into the ponds in May. Fish samples were taken every second week until the ponds were emptied and the fish collected in the end of August. The water quality of the ponds was also monitored. The

length, weight and stomach contents of the sampled fish were analysed. In two ponds of three joint rearing resulted as highest production of fish. Joint rearing did not retard growth of neither zander or asp which indicates resource partioning of the fry of these two species. This resource partioning was also confirmed by stomach analyses, which showed that zander and asp used different food organisms especially in late summer.

RUFFE, NEWLY INTRODUCED INTO LAKE CONSTANCE: POPULATION DYNAMICS AND POSSIBLE EFFECTS ON COREGONIDS

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In 1987 ruffe (*Gymnocephalus cernua*) was recorded for the first time in Lake Constance. Since then its population increased dramatically. This species is now (1994) found in high numbers throughout the lake (540 km^2) in shore areas as well as in depths up to 100 m. In autumn 1994, ruffe population consisted of fish of an age of 0+ to 3+. Maximum body length was 15.5 cm. At the end of the first year the fish attain a body length of around 7.5 cm. At the end of the second year around 10.5 cm.
During the vegetation period ruffe are bottom feeders, preying mainly on chironomids and detritus. However, during the coregonid spawning season in December ruffe switch to coregonid eggs as a main prey. In December 1993 in the stomachs of all ruffe investigated coregonid eggs were found in high numbers. The maximum was 320 eggs in the stomach of a ruffe with 15.5 cm body length and 62 g body weight. In Dec. 1994, when the number of coregonids spawning was presumed to be smaller than in 1993 (and the ruffe population bigger?), in ruffe stomachs coregonid eggs were found in smaller numbers.
Due to this egg predation negative impacts on the natural reproduction of nearshore spawning coregonids (*Coregonus lavaretus*, local name "Gangfisch") are to be expected. If during the vegetation period interactions with the commercially also very important perch (*Perca fluviatilis*) exist, is so far unknown.

OOCYTE FINAL MATURATION AND OVULATION IN PERCH, *Perca fluviatilis*

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Fragments of prespawning perch ovaries were incubated *in vitro* in medium 199 in the presence of 1 μg/ml 17α-hydroxy-20β-dihydroprogesterone. The transition from meiotic prophase (with intact germinal vesicle) to mature eggs has been described both macroscopically and histologically (using serial sections of paraffin-embedded oocytes). The oocyte maturation was normally followed by ovulation. The latter process is typical to other vertebrates (not peculiar as described by Koshelev, 1984). The typical pattern of egg clutch is not the result of altered ovulation mechanism but achieved due to local stickness of ovulated eggs.

THE RATE OF EMBRYONIC DEVELOPMENT IN PERCH AND RUFFE AT DIFFERENT TEMPERATURES

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The duration of one mitotic cycle during the period of synchronous cleavage divisions (τ_o, a relative unit of embryological time introduced by Dettlaff & Dettlaff, 1961) has been determined at various temperatures (4-19 °C). The relative rate of development ($1/\tau_o$) in perch and ruffe is rather similar; it is compared with that of other fish species.

FEASIBILITY OF CONTROLLING COARSE FISH POPULATIONS THROUGH PIKEPERCH (*Stizostedion lucioperca*) STOCKING IN LAKE KÖYLIÖNJÄRVI, SOUTHWEST FINLAND

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Lake Köyliönjärvi is shallow and very eutrophic lake where the fish community is dominated by small cyprinids and smelt. Mass removal of unwanted fish by means of winter seine net has been performed in 1992, 1993 and 1994. Mass removal is now ending and it is planned to be replaced by pikeperch enhancement. Estimates of available forage fish and of predator consumption rates are thus needed to compute stock sizes that will maintain a balanced predator-prey community. We used here a bioenergetics model of walleye (*Stizostedion vitreum vitreum*) to calculate consumption rates from the growth rate, fish size and ambient temperature. Growth of pikeperch in Lake Köyliönjärvi was very fast compared to other Finnish lakes. Model calculations revealed that during its five years in lake (age 5+) pikeperch with a final weight of 2.1 kg consumed 9.9 kg fish with an energy content of 4.18 kJ/g, implying a growth conversion efficiency 21 %. On the basis of population analysis the total annual mortality was very high, 65 %. With average stocking density of 20 000 age 0+ fish, the total population biomass of age 1+ - 5+ pikeperch was 1000 kg (0.8 kg/ha) and their annual food consumption 4000 kg (3.3 kg/ha). In autumn 1994 the catchable fish stock of Lake Köyliönjärvi was estimated to be 40 000 kg (33 kg/ha). Thus food consumption of the pikeperch population alone was still insufficient to control production of its prey fishes. Suitable combinations of intensified stocking programme and fishing restrictions are needed to multiply the pikeperch population and its predator effect.

USE OF HOT BRANDING IN MARKING ONE-SUMMER OLD PIKE-PERCH JUVENILES

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The hot branding methods used for adult fish are generally considered too harsh for marking juveniles. The use of a very thin electrically heated metal (nichrome) wire to press a mark on the scales of the fish is a fairly gentle procedure compared with the traditional method of branding. The thin metal filament can easily be shaped to form code symbols.
Some ten thousands of one summer old pike-perch juveniles (mean weight 2,5-5,5 g) were

marked with this branding method in years 1986-1994. They were stocked into two lakes in southern part of Finland. No mortality or physiological responses were observed caused by marking and the marks were readily identified on all adult fish in control groups three or four years after application.
This kind of hot branding method is very cheap and rapid. Branding instruments cost about 500 FIM and one person can mark 500 - 1000 fish per hour. The method is suitable for pike-perch whose scales are fairly small and firmly attached. The marks are retained throughout the life of fish.

INTENSIVE REARING OF *Stizostedion lucioperca* LARVAE

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The success of intensive rearing of *Stizostedion lucioperca* is a prerequisite for a further development of Pike-perch production and aquaculture. Through successive trials in conical bottom tanks (50 l; water temperature: 23 °C) we found that:
commercial artificial foods (microparticules) are accepted and ingested by larvae but assimilation is poor; highly digestible feeds must be used.
- there is a critical phase with high mortality rate (90 % in 48 h) when the digestive tract goes through a " metamorphosis" (at 150 day-degree at 23 °C), and change from a linear to a Z shape, with stomach differenciation.
- feeding and lighting rhythms play an important role.
- using a "feeding ring" on the surface of water, problems with gas bladder non-inflation are avoided.
For now, the main problems are the poor growth and low survival rates. New feeds will tested.

DEVELOPMENT OF THE PERCH POPULATION IN THE HYPERTROPHIC BAUTZEN RESERVOIR: RESULTS OF A BIOMANIPULATION EXPERIMENT

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As known for other man-made lakes perch was by far the dominant species within the first ten years (1976-1984) in Bautzen reservoir with high abundances up to an age of seven years. Age diversity of perch in this period was low and growth was very moderate. Up to the age of seven ys. more than 90 % of the individuals were planktivores. In 1980 a biomanipulation experiment was started by enhancement of the piscivorous fish stock, especially by stocking of pike-perch, in order to diminish the feeding pressure on the zooplankton. When in 1984 a sharp decline of the perch population of mainly seven and eight years old individuals occurred, a new outstanding year-class grew up for the first time since seven years. Feeding pressure of pike-perch and now of the perch itself which had markedly changed its feeding mode since this time let to a strongly decline of the high 0-group abundance until the end of the first year. Rich year-classes in several years later on arose. Under the regime of biomanipulation growth from the I-group onwards as well as size and age diversity of perch increased considerably. Recruitment of perch since 1986 was

essentially better than of roach. Together with the well developing ruffe and a stable pike-perch population the fish stock in the hypertrophic reservoir is changed by biomanipulation from a roach dominated one since the middle of the eighties to a percid community.

THE COMMERCIAL UTILIZATION OF SMALL PERCH (*Perca fluviatilis*) IN FINNISH INLAND FISHERIES

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Perch (*Perca fluviatilis*) is one of the most common fish species harvested by recreational fishermen in Finnish inland waters. In 1992, the total catch was 13 740 tons with less than 2 % harvested by the commercial fisheries. However, there is a large potential to utilize perch stocks more effectively than today.
The most important reasons for the underutilization of small-sized perch are minor markets for unprocessed perch and technically awkward and costly processing methods. Perch stocks are widely spread in inland waters and gathering of fish is difficult and expensive; the seasonal variations in perch catches are also high. However, the development of the processing industry requires a stabile and large enough volume of fish.
The commercial utilization of small perch was studied by interviewing 89 Finnish fish processors. Perch was utilized by 20 processors: the product groups were prepared products (6 processors), fishmeat (5), fillets (5), preserved fish (4) and smoked products (3). The main reason (55 processors) not to use perch was an uneven supply and wearisome and expensive prosessing methods.

FECUNDITY OF THE PERCH FROM SOME WATER BASINS OF RUSSIA

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Indexes of fecundity of perch from Seliger lake (Central Russian Plain), the Syamozero lake (Karelia), the Uglich reservoir (Upper Volga) and the Volga delta are discussed.
The average individual fecundity of the perch females from the Volga delta fluctuated from 60.5 to 69.1 thousands eggs by years (mean values 65.3 thous.), in Seliger perch from 22 to 29 thous. (mean values is 25.7 thous.), from Uglich reservoir in range 14.7 - 16.4 thous. (mean values is 15.5 thous.).
The average body masses of fishes are correspondingly 314, 76 and 153 gr.
On age, sizes and body mass increasing the definitive mass of ripe eggs and values of the gonado-somatic index increase, but values of relative fecunditry index (number of eggs per 1 gr. of body mass) decrease.
High reproductive capacity of perch inhabiting the Volga delta corresponds to optimal termal and trophic conditions for this perch population

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FATNESS AND GROWTH OF PERCH FROM SOME WATER BASINS OF RUSSIA

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The rate of growth and the level of fat accumulation in the perch from water basins in north and south parts of area are compared.
Speciments from the Volga delta are characterized by the most rapid growth both linear and weight and the lowest fat contents in muscles and around inner organs (up to 1 % in muscles in unit of wet weight and up to 0,7 % in absolute unit for cavity fat -in % of total body weight).
Specimens from north Karelia (Vyalozero) from example are characterized by the slow growth and the greatest fat content (up to 2 % of wet weight in muscles and up to 2 % for cavity fat from total body weight).
Under optimal temperature and food conditions of Volga delta metabolism of perch is characterized by high food conversion to growth; in the north part of the area low temperature and low food rations result low food conversion to growth and predominate lipids and reproductive metabolism; high fat reserves provide energetic metabolism and development of gonads during period of low feeding activities.

MORPHOLOGY OF THE EURASIAN PERCH (*Perca fluviatilis* Linnaeus, 1758): MULTIVARIATE APPROACH

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The morphology of the Eurasian perch (*Perca fluviatilis* L.) taken from three sites, the Danube (river), Stari Begej (channel), and Gruzansko Lake (reservoir), was analyzed by multivariate statistical methods. It was evident that the formation of morphological features differed in examined samples, since the mode and amount in characters that changed in a particular month stages of fingerling and age classes of older perch were not the same, nor the dynamics of the morphology formation, untill the adulthood. Even then, perch from a particular sample differed. Allometry was not observed, suggesting that even if it appeared, it had a short duration and was of small importance. The main morphological stanzas that were identified in the life history of the perch were: younger and older fingerlings (YOY) and young juveniles (1+) as the one stanza, preadults (2+ & 3+) as the second stanza, and adults (4+) as the third one. Thus delimited divisions of the life history coincided rather well with the main feeding periods in the life history of the perch, and were apparently related to growth, since the slowly growing perch lagged behind in the development of morphological features, as well as in the shift to piscivorous feeding.

THE SUCCESSFUL COLONISATION OF BRITISH CANALS BY AN ALIEN PERCID, ZANDER (*Stizostedion lucioperca*)

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Zander are not indigenous to the U.K. In 1963, they were introduced into an isolated system of eutrophic, slow flowing rivers and drainage channels in East Anglia in an attempt to enhance the fishery. Illegal transfer resulted in the introduction of zander into an interconnecting network of navigation canals in the Midlands in 1976. In this situation, anglers allege that colonisation by zander has a deleterious effect on indigenous fish stocks. As the majority of British anglers value native fish for recreation purposes, and not for consumption, the commercial value of these canals as fisheries has declined. Quantitative fish population surveys on a partly colonised canal have demonstrated that the zander-colonised region contained a significantly (ANOVA, $P=< 0.01$) lower biomass of indigenous fish (11.9 S.E. 1.5 g m^{-2}) when compared to the zander-free (23.5 S.E. 2.2 g m^{-2}), but otherwise ecologically similar, adjacent area. Zander have now colonised ca. 150 km of British canals and appear to be extending their range. Zander biomass continues to be in the range of 1.0 - 2.0 g m^{-2}, despite annual removal programmes aimed at protecting the abundance of indigenous fish. This removal has resulted in a truncated population structure, consisting mainly of fast-growing zander aged I to IV. Dietary studies suggest that piscivory causes the observed decline in prey abundance following the introduction of zander into these waters. Canals offer a route by which zander may colonise many rivers, which may result in further problems.

GERMAN EXPERIENCE IN PROPAGATION AND FINGERLING REARING PIKE-PERCH (*Stizostedion lucioperca*)

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The pike-perch (*Stizostedion lucioperca*) is reckoned among the freshwater fish species of high market value in Germany. Fingerling rearing is aimed at introducing this species into suitable waters without pike-perch populations or increasing pike-perch stocks, esp. for angling.
Spawners should be reared in ponds with favourable nutritional conditions (e.g. stocked with small feed fish, as a rule cyprinid species). Fish at an age of 4 to 6 years are best suited for reproduction.
Several methods of propagation are used. The simplest procedure is pike-perch spawning in ponds which often does not require any preparation. Semi-artificial reproduction may be induced after hypophysation in basins covered with brushes. The sticky eggs attached to the spawning substratum can be incubated in troughs, net cages or mist chambers. Good results are obtained by stripping mature fish and artificial insemination of the eggs. Sperm is collected with a pipette.
Egg adhesiveness is removed by using alkaline protease, however, talkum or starch are suitable, too. Eggs are incubated in Zug jars at an incubation temperature of about 16 to 18 ° C, hatching rate averages 90 %.
Larvae are siphoned to holding tanks where they are fed on boiled egg yolk, yeast, small

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zooplankton and *Artemia nauplii* for about four days. Then the fry is transferred to ponds. It is advisable to use well prepared nursing ponds for advanced fry rearing. Within 4 to 5 weeks the fish can reach up to 5 cm body length at water temperatures above 20 °C. Survival rate is about 50 %. For producing one-summer-old pike-perch fingerlings in polyculture (e.g. with carp) the proper feed supply in the pond is very important. Adequate number of feed fish is a pre-requisite for the harvest of large pike-perch fingerlings in autumn which are well suited for a successful stocking in natural waters.

PERCH POPULATION MONITORING IN LAKE ZÜRICH BY COUNTING AND MEASURING EGGSTRANDS

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From 1987 till 1994 eggstrands of the perch (*Perca fluviatilis* L.) deposited on fir branches at four locations in lake Zürich (Switzerland) were counted and measured.
The abundance of eggstrands was strongly correlated with the annual yield of professional fishermen.The number of eggstrands in one year can therefore be used as an indicator for the expected yield in this year.
The size distribution of the eggstrands was divided in three peaks in each year. Each peak is likely to be caused by one age class. This allows to estimate the minimal size and the annual mortality of each age class.
High proportions of unfertilized eggstrands in some years may be caused by the small year class strength of the youngest cohorte of adult males.

ADAPTATION OF PERCH *Perca fluviatilis* TO TEMPERATURE AND LIGHT CYCLES

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Influences of season and fish age on the final temperature preferendum, the upper lethal temperature and the diel pattern of locomotor activity were studied in laboratory for perch *Perca fluviatilis* L. of Rybinsk reservoir. The upper lethal temperature changed slightly during the year within of 1-3°C. Its age fluctuations were of the same order: 33°C for juveniles of 2 weeks old, 35°C for yearlings and 32°C for adults. On the contrary, the final thermopreferendum in a complex manner depended on season and age. In summer young fish preferred 26°C and adults preferred 23°C. In winter the most of tested yearlings continued to select "summer" temperatures of 25-26°C and only 7 % of them preferred "winter" level of 5°C. A half of older perch selected 24-25°C while others preferred 6-7°C. All fish of 4 years and older always selected 7-8°C in winter. The perch exhibited a typical diel rhythm of locomotor activity with a period of increased activity in light hours and two peaks at dawn and dusk. However these peaks were distinct well in late autumn, early spring and sometimes in winter. The period of increased activity of young perch coincided with the photoperiod duration all over the year varying from 9 hours in winter to 19 hours in summer.

In adult perch this period also followed the day length, but in summer, when the photoperiod exceeded 16 hours, fish became night-active and reduced the duration of activity to 9 hours. In the end of summer a change to day-activity accured again. The energetic base of perch reactions to temperature and light is discussed.

BIOLOGICAL CHARACTERISTICS OF BROOD STOCKS PERCH *Perca fluviatilis* UNDER THERMOPHOTOPERIODIC PROGRAMS

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Some biological characteristics of perch *Perca fluviatilis* brood stock undergone thermo-photoperiodic programs were studied in laboratory. The aims were to alter the spawning season and to examine the reproductive aptitude of fish holded at 22°C during one year in a recirculating system.
After 7 months, male perch released sperm when their flanks were pressed. On contrary, females did not spawn. However, gonadosomatic index (GSI) of both sexes evolved clearly: 0.5 to 2.9 % (males) and 0.7 to 10.8 % (females). Besidely, hepatosomatic index (HSI) regressed more in females (2.1 to 1.2 %) than in males (1.7 to 1.4 %). Positive correlations between liver and body weight and between gonads and body weight were almost identics ($r^2 = 0.92$). Factor conditions (K) calculated with and without gonads were more importants in females than in males.
While, brood stock maintained at 22°C and constant photoperiod of 14L:10D during the experiment did not present significative evolution of GSI and HSI. The relationships between gonads and body weight and between liver and body weight were $r^2 = 0.65$ and $r^2 = 0.68$, respectively. Whatever sexes, K did not modify and was still higher in females.
On the other hand, three females of six were spawned in a lot kept under variations of natural season.
The rearing of perch during one year under such artificial conditions did not inhibit the reproductive aptitude of perch.

ZOOTECHNICAL PERFORMANCES AND BODY COMPOSITION OF *Perca fluviatilis* PELLETED DIET IN A FLOATING CAGE

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Mass rearing performances and body composition of perch *Perca fluviatilis*, pelleted diet in floating cages placed in a pond are studied during two months (July to September 1993). Two large cages (12 m^3 with 380 fish each) and 4 small ones (4 m^3 with 190 fish each) are used. The average weight of perch is 24,8 g. Two feeding ratio are proposed: 3 and 4 % of body weight. Physico-chemical parameters are regulary recorded.
Final rates of survival are 78.6 and 70.0 %, weight increases are the same (23 and 24 g) and conversion factors are 3.0 and 4.1, for the 3 and 4 % rations, respectively. Perch are mainly feeding on artificial diet, but they also consume the natural food entering the cages, as observed by stomach contents. Water temperature is decreasing from 22.5 to 16.0°C.

The gonado-somatic indexes increase, particularly for males in September. However, the hepato-somatic indexes are slightly reducing. The feeding rates have no direct influence in the body composition. In comparison with perch reared in tanks with recyrculating water at 22.0 °C, the fish in cage have a higher protein and a smaller lipids and calorific content. Triglycerids and phospholipids evolve reversely and according to the rearing system.

PRODUCTION, FOOD CONSUMPTION AND PREDATION IMPACT OF JUVENILE PERCIDS IN TWO GERMAN ESTUARIES

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From 1987 to 1989 production, food consumption and predation impact of the juveniles of ruffe, pikeperch and perch were quantified in the Barther Bodden - a typical estuarine water of the southern Baltic Sea. From 1991 to 1993 the role of juvenile percids in the fish community of the Elbe estuary (southern North Sea) was analysed.
Monthly, juvenile percids were caught nearshore and offshore using bongo and ring net, drop trap and lift net, otter trawl, popnet, beach seine and framed gape stow net to obtain all length groups quantitatively. The catching efficiencies of the different gears were investigated.
Average annual net production of juvenile percids was around 1.6 g m^{-2} (wet weight) and 0.1 g m^{-2} in the Barther Bodden and the Elbe estuary, respectively. Food consumption of percids increased from spring to summer. Maximum daily rations were estimated between May and August. During the later season a decrease of daily ration was being observed.
Food analysis was carried out on a total of more than 2400 individuals. Remarkable seasonal and spatial differences in food composition of juvenile percids were observed in both estuaries. Juveniles of ruffe were the most important percids in the food web of the Elbe estuary. Ruffe mainly consumed zooplankton, especially calanoid copepods and mysids in the Elbe estuary. In the Barther Bodden chironomids, polychaetes and ostracods were important food components of ruffe as well. Juvenile pikeperches were typical piscivorous fishes in both estuaries. In addition shrimps, mysids and gammarids represented main food items of the pikeperch. Juveniles of perch were important zooplanktivorous, zoobenthivorous and piscivorous fishes both in littoral and pelagial regions of the Barther Bodden.
Especially greater zooplankton species like cladocerans and calanoids were prefered by juvenile percids. During summer the relative importance of rotifers increased within the zooplankton community as an effect of predation on greater bodied zooplankton species.

BEHAVIOURAL ASPECTS IN CREATING TRAPS FOR PERCHES FOR PROLONGED TRAP NET FISHERY

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There is a growing demand on perch in the fish market. Perch is mainly fished during the spawning time and with gill nets in the summertime. The perch are known of their low activity during cold seasons. They also tend to hide in shadowed areas among vegetation or under bridges. The possibilities to enhance the catches by ethological gear design are discussed. By considering the behavioural characteristics of the species it is possible to develop better fishing gear for perches. The advantage of trap nets is their ability to keep fish alive and unharmed for longer periods than gill nets. The objective is towards less work consuming fishery with less seasonal fluctuation and with high quality of fish.

PERCIDS IN SINGLE SPECIES, SIMPLE AND COMPEX FISH ASSEMBLAGES IN SCOTLAND

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Following the last glaciation, 13,15,000 years ago, the fish fauna of northern Britain was impoverished and colonisation was slow until 1790, but up to 15 species have been introduced by man since that time. Perch, *Perca fluviatilis* L., were probably introduced by clerics and by 1790 perch were widely distributed throughout Scotland. Sport and commercial fisheries in Scotland have been dominated by salmonids and consequently research on perch was limited until recently. The perch is widely distributed in Scotland and their is potential competition for food with salmonids.
Three case studies of perch in different fish assemblages are given. The first is from Loch Lomond which has the most diverse fish fauna in Scotland with up to 15 species. In a simple predator-prey association with pike *Esox lucius* L., in two Deeside lochs, Kinord and Davan, and in single species lochs, Sand and Lower lochs in north east Scotland. Despite the wide range in community type, the biomass, production and growth of perch was consistent, and perch populations were largely self-regulating through cannibalism of young.
The ruffe, *Gymnocephalus cernuus* (L.), is a recent addition to the Scottish fish fauna, being introduced as a bait fish to Loch Lomond by anglers. Since 1982 it has become abundant in the loch and has a considerable impact on a rare whitefish species the powan, *Coregonus lavaretus* (L.), being a main predator of eggs.
The possibilities for extending the sport fishery for perch and the consequences of further introductions are discussed.

SELECTIVITY OF GILLNET FOR PIKEPERCH: EFFECT OF MESH SIZE AND DIAMETER OF NETTING FILAMENT

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The gillnet selectivity of pikeperch (*Stizostedion lucioperca*) was studied in Lake Pyhäselkä, eastern Finland, during 1992-1995. Trial fishing was conducted using gillnets prepared of grey nylon (polyamide) monofilament netting. Experimental gillnet series contained nets of six mesh size (30, 35, 40, 45, 50, 55 mm, knot-to-knot mesh size) each measuring ca. 30 m in length and 3 m in high. There were two diameters (0.15 mm and 0.20 mm) in thickness of netting filament.

The shape of selection curve in each mesh size was sharp indicating the high selectivity for gillnets in pikeperch fishing. The total size distribution of catches were narrow due to the population structure of pikeperch in the study lake: the main target of gill-netting was only one year-class (1988). During study period the fish grew and mesh size, giving the most abundant catches, increased from year to year.
There were significant differences between catches in two thickness of netting filament. The thinner diameter netting gave averagely douple catches when comparing to the thicker one. However, against the hypothesis, the low diameter nettinig didn't caught more undersized pikeperch than the thicker type of netting.

PERCH, PIKEPERCH OR RUFFE LARVAE?

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At the size of 16-18 mm first dorsal fin has started to develop and the rays in the anal and second dorsal fin can be counted making in rather easy to identify perch (*Perca fluviatilis*), pikeperch (*Stizostedion lucioperca*) and ruffe (*Gymnocephalus cernuus*). The mouth and the jaws already differ slightly earlier between the percids. At the yolk sac stage the number of myotoms from yolk to anus is characteristic for the species. Between the yolk sac stage and the differentiation of jaws and unpaired fins the identification of the percid larvae is most difficult and laborious counting of myotoms. Ruffe has only 14 to 16 preanal myotoms while perch and pikeperch at least 18. The amount of postanal myotoms is also higher in perch (24-26) and pikeperch (27-30) than in ruffe (22-24).

THE STRATEGIES OF THE EARLY STAGES OF PERCH TO SURVIVE

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Perch (*Perca fluviatilis*) spawn in lakes, rivers, estuaries and even in brackish water of the archipelago areas in the Baltie Sea. Egg masses are found mainly in very shallow water areas After hatching perch larvae move out into the pelagic. A gradual shift back to inshore has been noticed in several areas. The timing of the return to littoral areas seems to vary depending the lake, although it has said to be connected to the ontogeny of perch. In rivers and estuaries 0+ juvenile perch migrate downstream/seawards. The reasons for all these habitat changes of the early stages of perch are discussed. How does the habitat choice contribute to the year class variation?

EFFECT OF WATER SALINITY ON THE EMBRYOLOGICAL DEVELOPMENT OF PERCH (*Perca fluviatilis*) AND RUFFE (*Gymnocephalus cernua*)

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Series of fertilization and hatching experiments were performed at salinities ranging from 0 to 16 % under laboratory conditions. All works were carried on in thermochamber, enabling to keep temperature permanently at 14 °C. Rate of survival was estimated twice per day during all the period of embryological development using binocular microscope to uncover all dead eggs, which were immediately removed. Perch were obtained from the Pärnu Bay, Estonia. Ruffe were obtained from the same place and, additionally, from the Lake Vörtsjärv. Remarkable decrease of salinity tolerance was followed in ruffe population, living in freshwater. Tables with the survival rate of embryos correspondingly to salinities and stages of development will be presented.
Experiments on the fertilization success of perch and roach throughout wide scale of salinities were performed. Eggs were fertilized artificially and fertilization success was estimated during the stage of cleavage.

MODELLING IMPACTS OF JUVENILE PERCH UPON MAIN ECOSYSTEM COMPONENTS

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Effets of perch larvae and yearlings on plankton and benthos community structure and biomass were studied in ecosystem model experiments performed in 16 cubic m outdoor mesocosms. A mathematical model of the mesocosms including shift of the fish feeding spectrum with aging was also developed. The impacts of perch given below were predicted by the model and verified in experiments. Primary effects of perch larvae consisted mainly in reduction of biomass and abundance of large crustaceans, both predatory and herbivorous. The secondary effects included a great increase in phytoplankton biomass, causing stimulation of the small-bodied cladocerans and rotifers. All these effects lead to a dramatic change in composition and size-structure of the whole plankton community. Benthos was slightly enhanced. After larvae gradually shifted to feeding on zoobenthos a stimulation of zooplankton and a decline in phytoplankton and zoobenthos were observed. The effects of perch yearlings on plankton and benthos were in essence those of the aged larvae, but of greater magnitude. A comparison is made of perch and a mollusc zebraa mussel concerning their impacts on the model ecosystem of mesocosms.

CANNIBALISM AMONG INTENSIVE CULTURED PERCH *Perca fluviatilis* POPULATIONS

Vlavonou, R., Masson, G. and Moreteau, J-C.

Experiments were performed to quantify the effects of cannibalism among cultured perch populations in laboratory. Two length classes of perch (preys and potential predators) were considered. For the first experiment, perch of class 1 measured 15-20 mm of total length and those of class 2 had 25-40 mm. Three groups of perch were constitued. Two groups are graded fish, coming from each length class. The third group is made by mixing fry of class 1 and those of class 2. During the experiment, they were fed enriched living *Artemia salina* or artificial feed after several days of weaning or fasting. Perch of the second experiment were larger and weaned several weeks ago. Mean weight of class 1 is 11-20 g and >100 g for class

2. Two groups made by mixing perch of the two classes were given artificial Salmonid food or fasting. Each class of graded perch were examined during their culture to note the impact of the phenomenon.
It appeared among reared perch populations at larval and fry stages, even if food of good quality is available. It affects more the mixed populations. Gradation reduces it at those stages but not seems to eliminate it. During the second experiment, there was no recorded case of cannibalism in graded populations. It is minor in mixed populations.
For intensive perch culture, cannibalism should be taken into account until weaned fingerling stage Culture of juveniles of the same cohort until market size may be done without mortalities due to cannibalism.
For intensive perch culture, cannibalism should be taken into account until weaned fingerling stage. Culture of juveniles of the same cohort until market size may be done without mortalities due to cannibalism.

USE OF *Artemia salina* AS UNIQUE STARTING FOOD FOR CULTURED PERCH *Perca fluviatilis* LARVAE

Vlavonou, R., Masson, G. and Moreteau, J-C.

Larvae of Perch (*Perca fluviatilis*) were reared for 29-31 days. Experiments were performed in laboratory to test the use of *Artemia salina* nauplii and 3 different starting feeding days: 1, 2 or 3 days after hatching. The experimental design was a set of 9 tanks with a circulating water coming from a coldwater tap at a flow of about 4 liters per hour. Water was heated and temperature maintained at 21 °C throughout the experimental period. Perch larvae were maintained in total darkness until their first feeding. After 14 days of feeding, there was no statistic difference between the 3 groups of larvae either for the survival rates or for growth parameters: mean total length of 12.2±1.5mm and 12.6±5.8mg for the mean weight. Larvae survived at 85.3%. At day 29, they reached 19.8±2.8mm for 67.7±34.7mg with a survival rate for this period of 79.7%. Cannibalism was observed intensively since day 15, (TL 12 mm against smallers). *Artemia salina* of specific strains may be used successfully to start intensive Perch larvae culture. The starting feeding day advised is the second day after hatching.

THE FISH COMMUNITY STRUCTURE AND THE SIGNIFICANCE OF PERCH IN VARIOUS HABITATS OF LAKE PURUVESI

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This paper describes the species composition and relative abundance of the fish community in various habitats in Lake Puruvesi based upon results of experimental fishing (six methods) in 1992. Perch (*Perca fluviatilis*), whitefish (*Coregonus lavaretus*) and roach (*Rutilus rutilus*) were the most important species forming 80 % of the total catch. Perch occured in equal densities in the littoral zone and in the pelagic zone. Roach was absend

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from the deep pelagic zone while whitefish preferred the pelagic. Vendace (*Coregonus albula*), which was the most numerous spieces in the pelagic fish community in the 1970's when the stock was at a high level, occured mainly in the deep pelagic zone. According to the gillnet catches perch is more active in the early summer and in the autumn than in the middle of the summer, when perch seems to move to shallow pelagic areas (3-10 m depth), where it is caught with active gear.

THE ROLE OF SPECIAL SENSES IN FEEDING BEHAVIOUR OF THE WALLEYE, *Stizostedion vitreum*

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Most juvenile fishes are considered to be predominantly visual feeders, including the walleye. Juveniles are diurnal, but become crepuscular and nocturnal as adults. Retinal anatomy changes during growth froma non-tapetal "diurnal" type to a highly light-sensitive and tapetal "crepuscular" type. Whether differently-adapted visual systems, found in the same animal as "juvenile" and "adult", are equally important in pray detection was studied by examining feeding behavior of individual fish in total darkness.
A light-tight testing chamber was built into which zooplankton prey could be introduced. Individual, separately housed young fish were pre-conditioned to this apparatus, and were additionally acclimated 5 minutes prior to each feeding trial. After feeding on a pre-counted number of pray for 10 minutes, the fish was removed. Rinse water and tank water were strained, and remaining prey were counted.
It was found that the proportion of prey consumed in the dark increased with growth of the fish. An apparent detection threshold was reached after 60% of the available prey were eaten. If light was used to illuminate the chamber following dark feeding trial, the walleyes would consume all remaining prey. Initial data using both scanning electron microscopy and ablation of the neuromast suggest that the lateral line in the walleye develops over the first season of growth, eventually contributing an important component of the animal's prey detection ability.

INTERTROPHIC EFFECTS ON ZOOPLANKTON COMMUNITY STRUCTURE.

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Fish predation changes the composition and size structure of zooplankton communities which in turn influence phytoplankton biomass. To study the effects of a top predator on lower trophic levels, we compared the zooplankton communities in two lakes inhabiting perch (*Perca fluviatilis*) only and two lakes inhabiting both perch and pike (*Esox lucius*). The lakes with pike had a lower abundance of perch than the lakes without pike. We measured zooplankton abundance and composition and phytoplankton biomass.
The total biomass of zooplankton was higher in the lakes lacking pike but the biomass of larger zooplankton primarily the cladoceran *Holopedium gibberum* was higher in the lakes with pike than in lakes without pike. In lakes with high perch densities (no pike) small cladocerans were dominating. This indicate a higher predation pressure in lakes lacking pike compared to lakes with pike. No effect of pike could be seen on phytoplankton abundance.

COMPARISON OF DIFFERENT METHODS TO QUANTIFY PELAGIC EARLY LIFE STAGES OF PERCH, PIKEPERCH AND RUFFE

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In two eutrophic systems different methods were employed to quantify and study horizontal and vertical distributions of larval and juvenile perch (*Perca fluviatilis*), pikeperch (*Stizostedion lucioperca*) and ruffe (*Gymnocephalus cernua*). A natural lake (Wallersee, Austria; 6.1 km^2, mean depth = 12 m) and a man-made reservoir (Rimov, Czech Republic, 2.1 km^2, mean depth = 16 m) were sampled in spring of 1994. Two different netting techniques, a push-net system and a large, towed ichthyoplankton net were used in Wallersee at the end of May. A week later the same netting techniques were used in the Rimov reservoir (in addition to echosounding by means of a Biosonics scientific echosounding equipment). Different depth strata were sampled, day and night catches performed and a longitudinal transect compared in the reservoir. Overall effectiveness of sampling gear, size selectivity and resulting distribution patterns were compared among methods and sampling sites

THE FOOD OF FIRST FEEDERS OF PERCH (*Perca fluviatilis*) IN THE GULF OF BOTHNIA, THE BALTIC

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The feeding of perch larvae was studied in three coastal and archipelago areas and one river estuary in the Gulf of Bothnia in years 1988-91. The gut contents were compared to parallel plankton samples to determine the food resources and eventual food selection of the larvae. The feeding of yolk sac larvae was studied in relation to the size of the yolk sac. In the three coastal and archipelago study areas it could be seen that larvae under the size of 6 mm did'nt prey, or were preying on easily digesting *Protozoans* impossible to find when examining the guts later under the microscope, but bigger larvae started preying despite of having about 70 % of the yolk sac left. If they were having more of the yolk sac left, no prey items were found in the guts. In the river estuary larvae under the size of 6.2 mm couldn't be found. The food of perch larvae consisted mainly of *Rotatoria* and *Copepoda*, *Cladocerans* were less consumed. The diet of the larvae in the coastal and archipelago areas differed a little from that in the river estuary. In the coastal and archipelago areas the *Rotatorians* of the genus *Synchaeta* are very common, and first feeding perch larvae were preying on them if they were available. In the river estuary *Synchaeta* was scarce or missing, and perch larvae started feeding on various small-sized *Rotatorians* and *Copepoda*. Generally the very abundant *Rotatorian Keratella cochlearis* was strongly avoided everywhere except in one pond connected to the sea by a ditch, where even the larvae sized 6 mm were preying mainly on it.

AN ANNOTATED BIBLIOGRAPHY OF THE RUFFE *Gymnocephalus cernuus* (L.)

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For many years, the ruffe *Gymnocephalus cernuus* has been considered to have little or no value for commercial or recreational fisheries throughout its natural range in Europe. As a result it has been relatively neglected by fish biologists and its literature is sparse and little reviewed or collated. However, recent expansions in the range of the ruffe, including an accidental introduction to North America, have raised concerns over the potential negative effects of this species on established commercial fisheries and on the conservation of rarer fish species. This paper presents an annotated bibliography for the ruffe of over 125 papers produced by a late 1994 and early 1995 search of the literature. Sources searched included Aquatic Sciences and Fisheries Abstracts on CD-ROM; BIOSIS Previews, CAB Abstracts, Zoological Record online; and various printed sources in the library of the Institute of Freshwater Ecology. The usefulness of this comprehensive bibliography is enhanced by key field identifications, e.g. taxonomy, growth, feeding, reproduction and interactions, for each paper. Areas of particular neglect which should be given priority in fiuture research are highlighted.

RECENT INTRODUCTIONS OF THE RUFFE *Gymnocephalus cernuus* TO THREE *Coregonus* LAKES OF THE U.K.

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Although a native of the U.K. fish fauna, the distribution of the ruffe *Gymnocephalus cernuus* was until recently largely restricted to lowland England. During the last two decades, however, it has been introduced (probably as discarded or escaped live-bait by anglers) to numerous lakes and rivers of the U K., increasing its geographical range to include water bodies in northern England, Wales and Scotland. This expansion has given cause for concern on conservation grounds because it has included introductions to three lakes containing nationally rare *Coregonus* species. This paper documents the known history of these introductions to Bassenthwaite Lake in England (containing *Coregonus albula*), Llyn Tegid in Wales (containing *Coregonus lavaretus*) and Loch Lomond in Scotland (containing *Coregonus lavaretus*), briefly describes the present population and community ecology of ruffe, and discusses the implications of these arrivals for the continued survival of the *Coregonus* populations.

FEEDING MODES OF PIKEPERCH AND PERCH AND THEIR ROLE IN THE COASTAL FISH COMMUNITIES

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Both species are, besides roach and herring, most dominant regarding abundance and biomass in coastal waters of the Southern Baltic. At the same time they are the key-

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predators, who influence the structure of the fish community. In the first summer of their life after a short period of zooplankton feeding they start feeding fish larvae and mysids later on 0+ and small sized fishes.
Pikeperch feeds more selektive, preferring small and slender species (in oligohaline areas: smelt, roach, ruffe, perch; in mesohaline areas: herring, gobies, shrimps).
Perch is more opportunistic in the choice of prey species and is able to switch between fish and evertebrates.
Cannibalism is regularly observed for both species. In the oligohaline areas perch is vulnerable to predation by pikeperch. In addition competition occurs between them in respect of size and species of the prey.
The role of pikeperch and perch in the fish community is also influenced by heavy fishing pressure on both predators.

CHANGES IN THE STATUS OF SMALL WATER BODIES AS SPAWNING PLACES FOR PERCH IN THE QUARK

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Introduction: Since the 1960´s there has been a drastic decline in the stocks of perch and many freshwater fishes in the coastal areas of the Northern Quark, because of destruction of spawning places and nursery areas.
Methods: Data concerning 90 fladas, 97 glo-lakes, 74 lakes and 20 brooks in the central Quark (Korsnäs-Oravais) were in 1989 collected by interviews with fishermen and from field studies.
The spawning areas were screened in the following order:
1. Current status of fish migration.
2. Human impact since about 1950 i.e. dredgings and drainage.
3. Perch as a present or previous spawning species.
Results:
1. Migratory hindrance occurred in 0 % of the fladas, 21 % of the glo-lakes, 540 % of the lakes and 5 % of the brooks.
2. Forr antropogenic changes the percentages are 21 %, 52 %, 46 % and 95 % respectively.
3. Perch was reported from all fladas but had disappeared from 32 % of the glo-lakes, 51 % of the lakes and from 55 % of the brooks.
The disappearence was mostly due to migratory hindrance as dams etc., but could also be attributed to antropogenic changes. Many other species sensitive to acidity have decreased or disappeared.
A study on 20 brooks, 11 fladas and glo-lakes and 10 lakes in the spring of 1985 revealed that 13 of the brooks had a pH-value below 5,0.
Enhancing fish migration and preventing further antropogenic changes seem to be the primary management methods.