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Coastal Fish Monitoring In Baltic Reference Areas 2000

Helsinki 2001

DOCUMENTATION PAGE

Published by

Finnish Game and Fisheries Research Institute

Date of Publication

September 2001

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Title of Publication

Coastal Fish Monitoring in Baltic Reference Areas 2000

Type of Publication

Annual Report

Commissioned by

Date of Research Contract

Title and Number of Project

Composition of fish communities in Baltic Coastal reference areas (204 033)

Abstract

The fifth annual report on monitoring of Baltic coastal fish presents the development and dissimilarity over time compared to the first year's catches of the fish communities in six international reference areas; Kvädöfjärden at the Swedish coast of the Baltic Proper, Hiiumaa in the Estonian Sea of Straits, Brunskär in the Archipelago Sea, Finbo at north-western Åland, Holmöarna in the northern Quark and Råneå in the Bothnian Bay, and one regional reference area, Curonian Lagoon in Lithuania. Year-class strength of female perch and the development of reproduction indexes of viviparous blenny are also discussed.

Dissimilarity patterns of the fish communities were not found tobe similar among the reference areas. A significant increase of the dissimilarity index was found at Brunskär reference area and a significant decrease was found at Holmöarna reference area. The increase at Brunskär indicated enhanced eutrophication and the decrease in Holmöarna was caused by strong year-classes in the beginning of the monitoring period. Instable fish communities appeared at Curonian Lagoon and Råneå reference areas, the former probably as a result of improved control of anthropogenic effluent to the lagoon and the latter probably as a result of natural environmental variations such as temperature, currents and weather conditions.

Year-class strength showed a similar annual variation pattern in the south-western archipelago of Finland, Åland archipelago and northern Quark. The pattern deviated at the other areas, except that year-class 1988 was strong in all areas. Indications of improved reproduction of viviparous blenny were found in Kvädöfjärden, Finbo and Holmöarna reference area.

Key words

Coastal monitoring, fish community, eutrophication, perch, roach, viviparous blenny

Series (key title and no.)

Kala- ja riistaraportteja 229

ISBN

951-776-337-9

ISSN

1238-3325

Pages

14 p + appendix

Language

English

Price

Confidentiality

Distributed by

Finnish Game and Fisheries Research Institute, Antti Lappalainen, P.O. Box 6, FIN-00721 Helsinki
tel. +358 02057511

Provincial Government of Åland, Fisheries Division, Kaj Ådjers, Box 60, FIN-22101 Mariehamn
tel.+358 25297

Publisher

Finnish Game and Fisheries Research Institute, P.O. Box 6, FIN-00721 Helsinki

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Contents

1. Introduction

Monitoring of coastal fish is carried out in six Baltic reference areas within an internationally established system covering Sweden, Finland, Åland and Estonia (Fig. 1). This system of international reference areas is supplemented by monitoring in the regional reference area in the Kursiu Marios in Lithuania. The methods have been adopted by HELCOM to be used in the whole Baltic Sea. The objectives of the integrated monitoring programme design for coastal fish have been presented by Neuman and Sandström (1996 a, b).

The monitoring in reference areas is co-ordinated by COBRA (The Coordination Organ for Baltic Reference Areas), with a secretariat at the Provincial Government of Åland. Members of COBRA are appointed by the participating institutes, the Estonian Marine Institute, the Fisheries Division at the Provincial Government of Åland, the Finnish Game and Fisheries Research Institute, the Lithuanian Academy of Sciences, Institute of Ecology and the Swedish National Board of Fisheries, Institute of Coastal Research.

Results from the monitoring programme, including fish community development, stock development of perch (*Perca fluviatilis*) and roach *(Rutilus rutilus*), year-class strength of perch and reproduction success of viviparous blenny (*Zoarces viviparus*) are summarized in annual reports.

2. Study areas

The reference areas are located to Kursiu Marios in Lithuania, Kvädöfjärden in the Archipelago of Gryt at the Swedish east coast of the Baltic Proper, to Hiiumaa in the Sea of Straits in western Estonia, to Brunskär in the southern Archipelago Sea in south-western Finland, to Finbo in north-western Åland, to Holmöarna in the Northern Quark and to the bay of Råneå in the northernmost Bothnian Bay (Fig. 1). Detailed maps of the reference areas are presented in Ådjers et al. (1997). General geographic and biotic characteristics of the areas have been described in Ådjers et. al (1996).

The fishing areas at Kursiu Marios, Kvädöfjärden, Hiiumaa and Holmöarna consist of two subareas (sections). The sections differ from each other both geographically and environmentally. Different environmental prerequisites prevail and hence the species composition might differ between the sections. One section at Kvädöfjärden, Hiiumaa and Holmöarna is located in the inner archipelago and the other section in the middle or/and the outer archipelago. Kursiu Marios consists of one section located in the northern part and the other section in the central part of the lagoon. The section in the central part is close to the river mouth of Nemunas. The river Nemunas carries large amounts of human discharges into the lagoon.

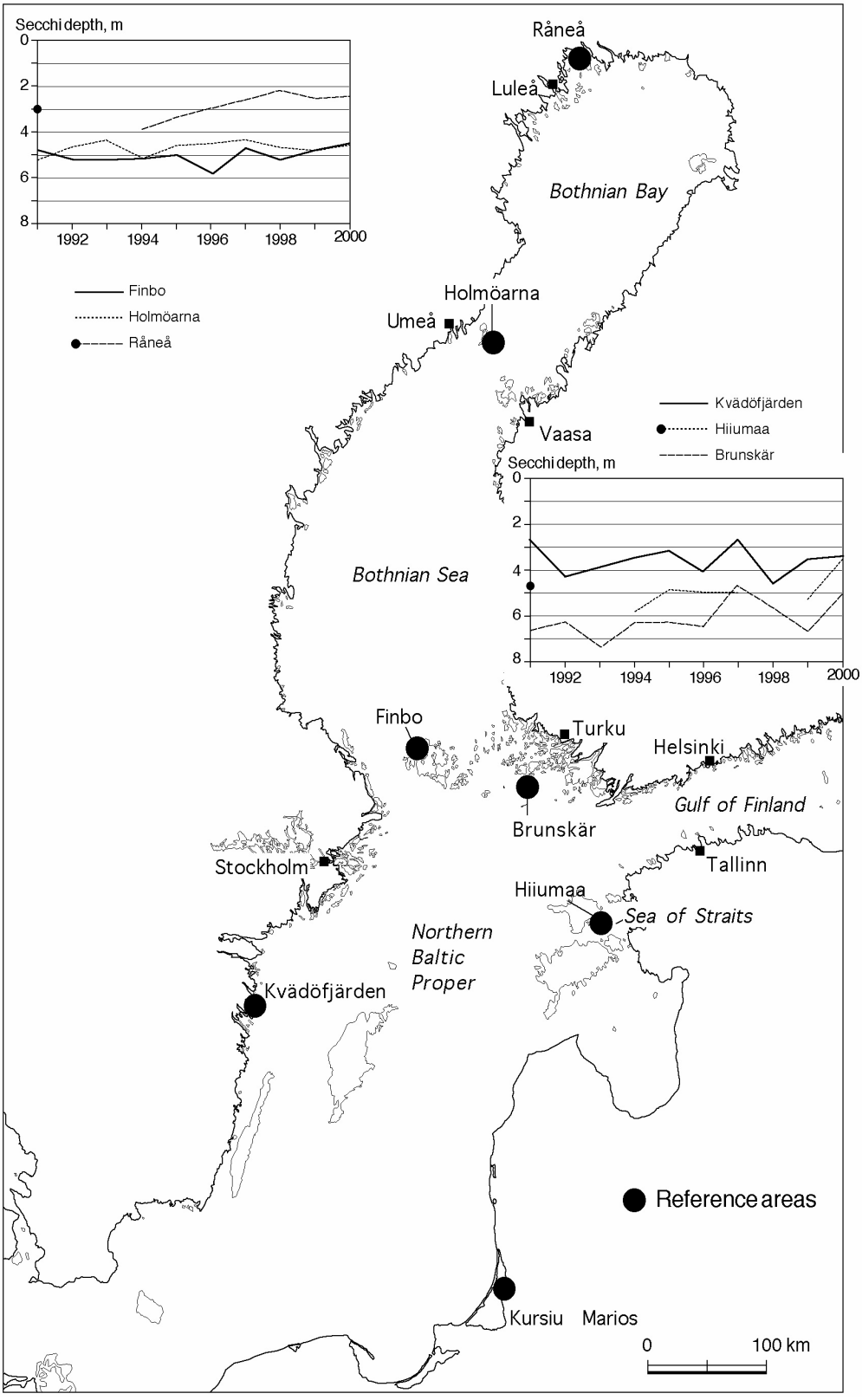

Figure 1. International reference areas (●) in the Baltic Sea with Secchi disk depths.

3. Material and methods

The fish-monitoring methods, which are available as HELCOM guidelines for monitoring of coastal fish in the Baltic Sea, are described in Neuman et al. (1997). More detailed descriptions of the monitoring methods and the monitoring of viviparous blenny appeared in Ådjers et al. (1997, 1998).

Secchi disk depth is determined during the monitoring in August and is used as a general indicator of eutrophication in the area. The Secchi disk depths showed significantly decreasing trends in Råneå and Brunskär reference areas (Fig. 1) despite deviating values in 1999 in both areas. No trends appeared in the other areas.

Trends in the development of the Secchi depth and abundance of perch, roach and other common species were analysed by Mann-Kendall nonparametric trend analysis with 95 % confidence level. Six observations per year (one for each fishing night) were included in the Secchi depth trend analyses. The observations for trend analyses in species abundance were obtained from each station and fishing night. The total number of observations varied between 30 and 54 per year and area.

Temporal development of the fish stocks is presented as catch-per-unit-effort (CPUE) in terms of numbers. The development of fish communities is based on analyses of community dissimilarity compared to the first year of catch. A fish community stable over time was indicated by dissimilarity indexes close to zero and a community changing over time was indicated by increased values. Community dissimilarity was analysed by Euclidean distance (Collins et al., 2000). All species found were included in the analyses, except species such as black goby, deep-snouted pipefish, eel, greater sandeel, straight-nosed pipefish and three-spined stickleback, which were insufficiently caught by the nets used. Linear regression was used to determine if the dissimilarity slope was significant with 95 % confidence level. The monitoring period varied between 7 – 14 years depending on the area.

Operculum bones of female perch were sampled for age and growth analyses. Sampling was carried out by taking 50 samples from each 2.5 cm length group starting from fish with a length of 12.6 cm and 25 samples or all fish caught from length groups >27.5 cm. After age determination, length-at-age data were combined with the length distribution data to produce an age distribution for the total catch. Year-class strength was calculated by summarising the CPUE of the individual cohorts during ages 3 – 6 over the whole sampling period.

The English names of the fish species together with the scientific names are listed in appendix.

4. Results

4.1. The development of fish communities

Kursiu Marios

The fish community found since 1994 at Kursiu Marios was made up of 22 species 19 of which were freshwater species. Four species, perch, roach, ruffe and silver bream dominated the catches (Fig. 2). Other abundant species were bleak, bream, pikeperch and vimba bream. Species found occasionally were asp, burbot, chub, crucian carp, gudgeon, ide, smelt, tench, whitefish, goldfish and ziege. The cyprinid community comprised as many as 13 species. Large proportions of roach and other cyprinids compared to perch indicated an environment with suitable recruiting and feeding areas favouring cyprinids more than perch, but that may also indicate a fish community affected by eutrophication. A few individuals of flounder, sprat and twaite shad represented the marine fish community.

Significant increasing trends of the stocks have been found for perch, silver bream and ruffe at both sections. A significant increasing trend at the northern part and a significant decreasing trend at the central part of the lagoon were found for roach. Vimba bream showed no significant trends.

The dissimilarity analysis showed that the fish community was strongly variable over time. The dissimilarities during the monitoring period were distant compared to the first year of catch (Fig. 3). During the last years Lithuania has regulated land based effluents to the lagoon in order to diminish the human impact on the environment (Dubra, 1994; Stankevicius, 1998). This caused altering conditions for the fish community, which in turn resulted in variations of the fish community structure. The changing fish community is also confirmed by the increasing trends in abundance of important species.

Kvädöfjärden

A total of 21 species, 17 freshwater and four marine species, have been caught at Kvädöfjärden since 1987. Species of the freshwater community dominated the catches. Perch and roach were most abundant, but silver bream, ruffe and rudd were also caught in large numbers (Fig. 2). Freshwater species found regularly were crucian carp, ide and pike. Bream has regularly been found since 1993 and pikeperch since 1992. Species found only occasionally were bleak, burbot, rainbow trout, smelt, tench, whitefish and vimba bream. The cyprinid community was well represented with nine species. The abundance of cyprinids was high compared to perch. The proportion of marine species was low, about 0.1 – 2 % in terms of numbers. The marine species mainly consisted of Baltic herring, but a few individuals of flounder, sprat and cod were caught.

A significant increasing trend for perch at the inner part of the archipelago and a decreasing trend for roach at the outer part of the archipelago were found. Silver bream, ruffe and rudd showed no significant trends. The community has been relatively stable over time, but it appeared that the community composition slowly

changed to become more different compared to that of the first year (Fig. 3). The slope was not significant.

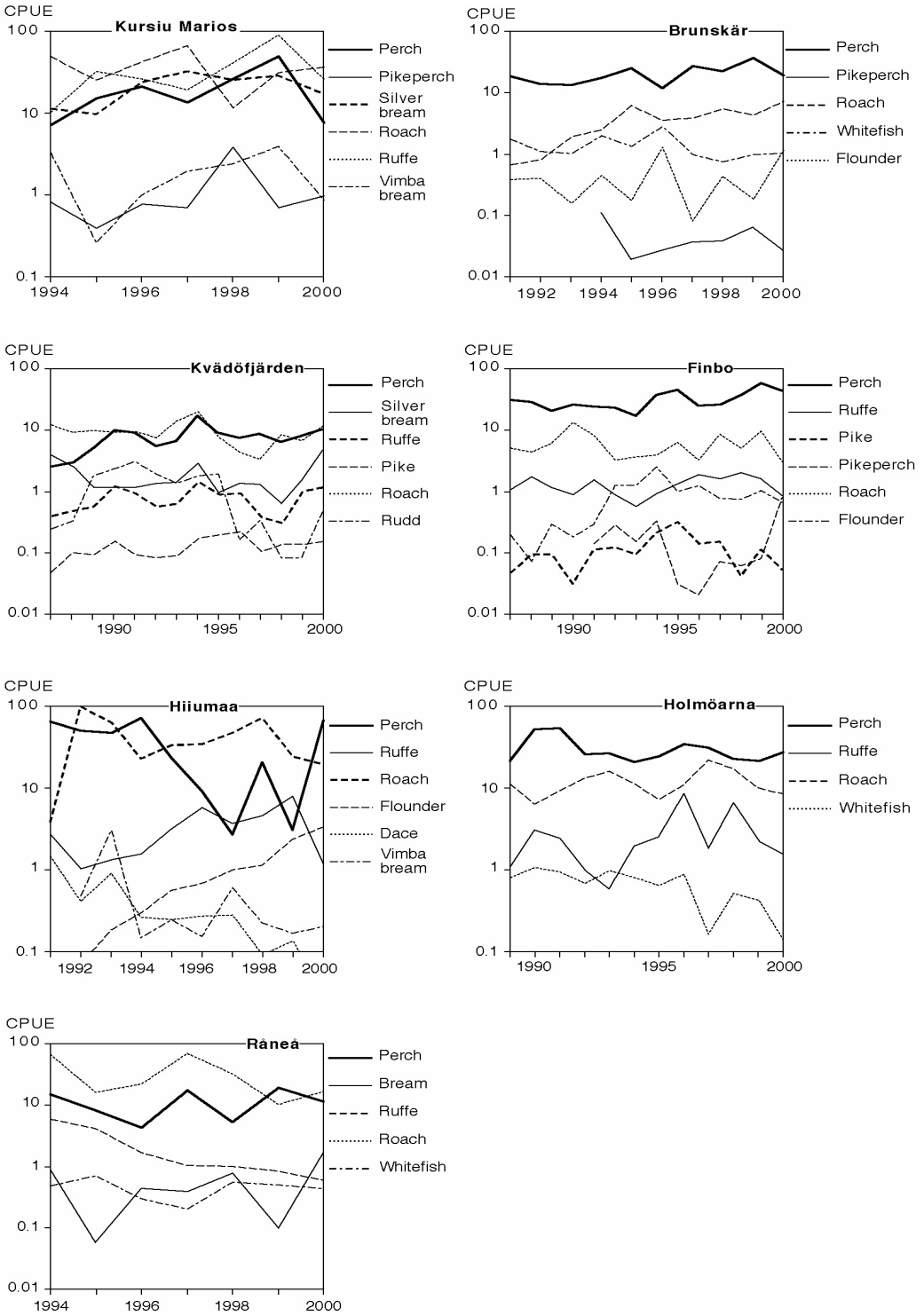

Figure 2. Catches of abundant species at Baltic Sea reference areas.

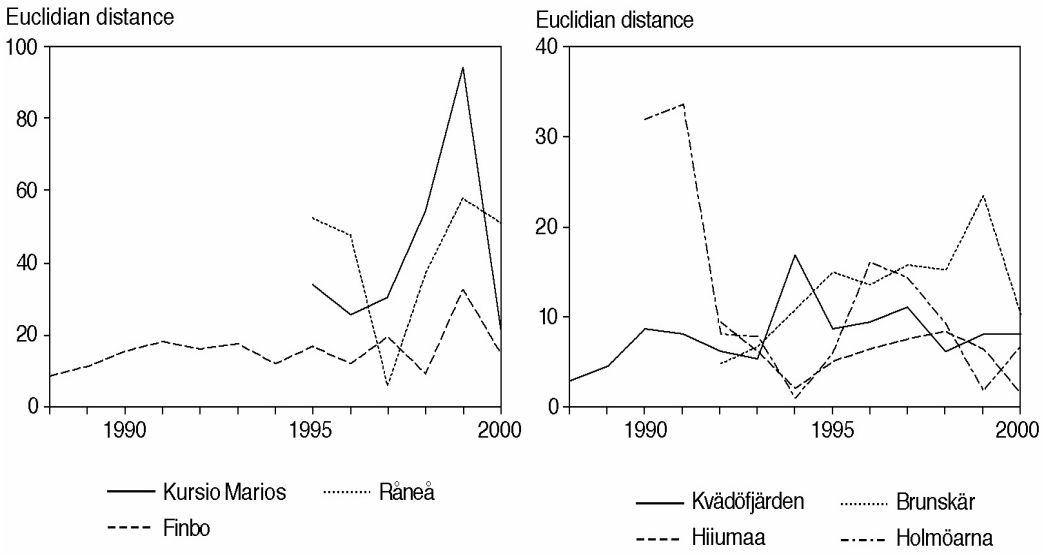

Figure 3. Dissimilarity index (Euclidean distance) of fish communities at Baltic Sea reference areas.

Hiiumaa

The fish community at Hiiumaa was made up of fourteen freshwater species and six marine species. Perch and roach dominated the catches (Fig. 2). Ruffe and Baltic herring were also abundant. Freshwater species found regularly were bleak, dace, ide, pike, pikeperch, silver bream and vimba bream. Burbot, gudgeon, rudd and smelt were found occasionally. The proportion of marine species in terms of numbers has varied between 0.5 and 18 %. The strong variation was caused by the highly variable catches of Baltic herring. Flounder was relatively common. Other marine species caught were sprat, turbot, twaite shad and viviparous blenny.

The perch stock has been strongly exploited since the middle of 1990's (Ojaveer, 1999). The catches have decreased significantly at both sections during the monitoring period. The catches were small during the period 1995 – 1999. The stock recovered in year 2000, but it consisted mainly of small and consequently young fish. This proved that the recruitment of perch is still sufficient and that a recovery of the adult stock is also possible. To achieve a sustainable recovery of the stock, it is necessary to regulate the professional fishing of perch. The roach stock has probably not suffered from the exploitation of perch, since no significant trends were proved. It may be noted that the ruffe stock increased during the years when the perch stock was small (Fig. 2). The catches of flounder have markedly increased during the monitoring period.

The dissimilarity of the fish community compared to the catches of first year has been relatively stable, despite the variations of the perch catches (Fig. 3).

Brunskär

The whole fish community was made up of 17 species at Brunskär, 11 of which were freshwater species. The freshwater species made up 50 – 90 % of the whole fish community. Perch dominated the catches (Fig. 2). Roach was also abundant. Regularly appearing freshwater species were ide, pikeperch, smelt and whitefish. Other species found were crucian carp, pike, rudd, ruffe and silver bream. The proportion of roach and other cyprinids compared to perch was low. The large proportion of marine species consisted mainly of large catches of Baltic herring, but flounder was also relatively common. Other marine species found were longspined bullhead, sprat, turbot and viviparous blenny.

The catches of both perch and roach have significantly increased during the monitoring period. No significant trend was proved for flounder.

The slope of the change in the fish community composition increased significantly at Brunskär compared to the first years' catches (Fig. 3). This dissimilarity was mainly caused by the increasing catches of perch and roach, which may indicate increasing nutrient availability in the area. The Secchi disk depths have decreased significantly during the same period, which may also indicate increasing eutrophication (Fig. 1).

Finbo

The fish community at Finbo was diverse with fifteen freshwater and eight marine species. Perch dominated the catches of freshwater species, followed by roach (Fig. 2). Regularly found freshwater species were pike, ruffe, smelt and whitefish. Bream, ide, pikeperch and silver bream were found regularly since 1991. Species caught occasionally were burbot, rainbow trout, rudd, salmon and trout. The proportions of roach and other cyprinids were low compared to perch. The low share of cyprinids was probably due to frequent upwellings of cold water, which is not favoured by cyprinids. The contribution of other cyprinids than roach has increased since 1991, which together with the appearance of pikeperch may indicate increased eutrophication. The proportion of fish from the marine community was large, which was probably explained by the upwellings of cold water already mentioned. Marine species are favoured by cold water. Baltic herring dominated the catches but flounder was also common. Other species found were cod, four-horned sculpin, longspined bullhead, sprat, turbot and viviparous blenny.

The perch catches have significantly increased during the monitoring period. This is probably the result of several strong year-classes, but it could also indicate better nutrient availability. No significant trends were found for roach or ruffe. The catches of flounder were low until 1991, but in 1992 the catches were about tenfold larger. The catches of flounder have remained on a higher level since then. The increase could not be proved significant due to large variations of the catches within the years.

The fish community composition compared to the first years' catches has been relatively stable during the monitoring period, except during the last years, when large variations appeared (Fig. 3). The dissimilarity slope showed no significant trend.

Holmöarna

The fish community was made up of 14 species, 11 of which was freshwater species. Perch dominated the catches, followed by roach (Fig. 2). Ruffe and whitefish were also abundant. Other freshwater species frequently caught were bleak and pike. Burbot, crucian carp, dace, grayling and ide were found occasionally. The share of

other cyprinids than roach was low, which probably merely indicated lack of reproduction and feeding areas rather than oligotrophic conditions. The only marine species caught in notable numbers was Baltic herring. A few individuals of sprat and viviparous blenny were noted.

The perch catches have significantly decreased. That was probably explained by large variations of the year-class strengths. The strong year-class of 1988 resulted in large catches in 1990 and 1991. Similar strong year-classes have not appeared at Holmöarna since then and combined with the gradual disappearance of fish from year-class 1988 a significant decreasing trend was detected. The ruffe catches have increased at the outer part of the archipelago during the monitoring period. No significant trends were found for roach. The catches of whitefish have decreased according to Figure 2. The decrease was statistically not significant due to large variations among the stations.

The dissimilarity of the fish community was distant the two years following the starting year (Fig. 3). The distance was mainly caused by large catches of perch. These catches consisted to a large extent of the strong year-class in 1988. The dissimilarity has since then moved closer to the first years' catches. The approach of the dissimilarity index to the catches of first year was proved significant.

Råneå

The fish community was almost exclusively made up of freshwater species. The catches of the dominating species roach and perch showed strong annual variations (Fig. 2). Species caught regularly were bleak, bream, dace, ide, pike, ruffe and whitefish. Species found occasionally were Arctic char, burbot, pikeperch, rainbow trout and vendace. The proportion of roach was larger than the proportion of perch. Baltic herring was the only marine species found. No significant trends were found for perch, roach, ruffe or bream.

The catches of the dominating species perch and roach caused strong variations and large distances of the dissimilarity indexes during 1995 – 2000 compared to the catches in 1994 (Fig. 3). The catches of roach and perch were probably more affected by environmental conditions such as temperature, currents and weather conditions than by stock size, thus causing these strong annual variations. No significant trends could be noted.

4.2. Year-class strength of female perch

Year-class strength has been shown to vary according to a common pattern in areas with low anthropogenic influence in the Baltic Sea (Böhling et. al. 1991). Analysis based on CPUE data, where fish of ages 3 - 6 years are included, showed a common annual pattern for the areas located around the Bothnian Sea, Finbo, Brunskär and Holmöarna (Fig. 4). A strong year-class appeared in 1988 followed by several weak or normal year-classes. The year-class of 1994 was again strong at the areas. Since the analysis was based on catch-per-unit effort it is possible to compare the level of the year-class strength between the areas. The level at Finbo was generally higher than at the other areas, indicating that the year-classes have been more or less strong during the whole period. Only in 1993 can it be regarded as weak. Strong year-classes are expected to produce large stocks, which was confirmed by the significantly increased perch catches during the period 1987 – 2000 (Fig. 2). Age data from a sufficiently long period is lacking to reveal this kind of year-class strengths from Råneå.

The southern areas Kursiu Marios, Kvädöfjärden and Hiiumaa deviated to some extent from the pattern observed in the northern areas, except that year 1988 produced a strong year-class in these areas also. Kursiu Marios was relatively similar to the northern areas, but year-class 1993 was strong in contrast to the northern areas. Kvädöfjärden deviated by a strong year-class in 1992 and a relatively weak one in 1994.

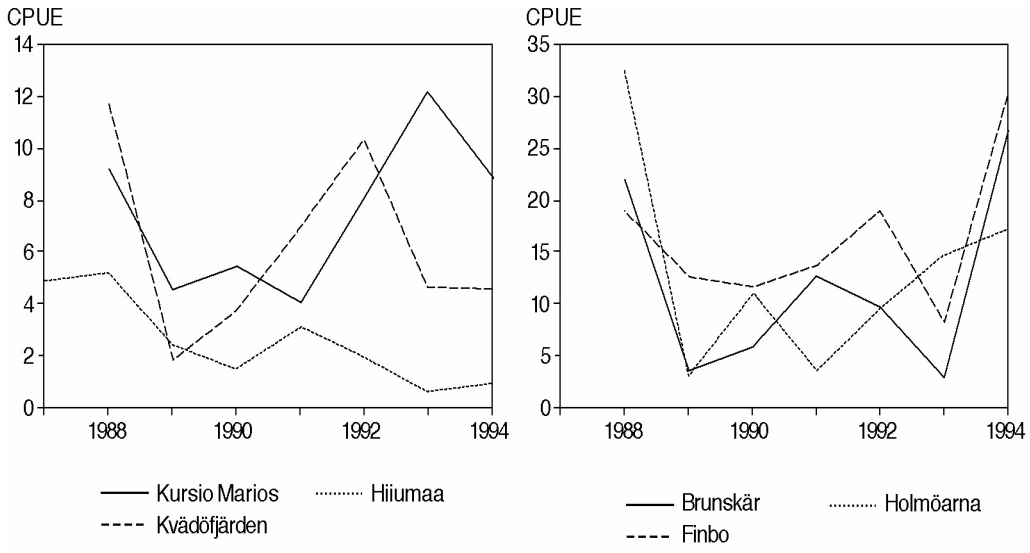

Figure 4. Year-class strength of female perch.

4.3. The viviparous blenny

Catch-per-unit-effort and reproduction indexes, such as the proportion of retarded fry and proportion of late dead fry, showed similar annual variations over a larger geographical area (Fig. 5). Kvädöfjärden deviated in several parameters from the common pattern. The proportion of malformed fry was high compared with the other areas in 1998 and the proportion of females with late dead fry and the proportion of late dead fry were higher than in other areas in Kvädöfjärden in 1997. It was also indicated that proportion of retarded fry, proportion of females with late dead fry and proportion of late dead fry decreased with time (Fig. 5).

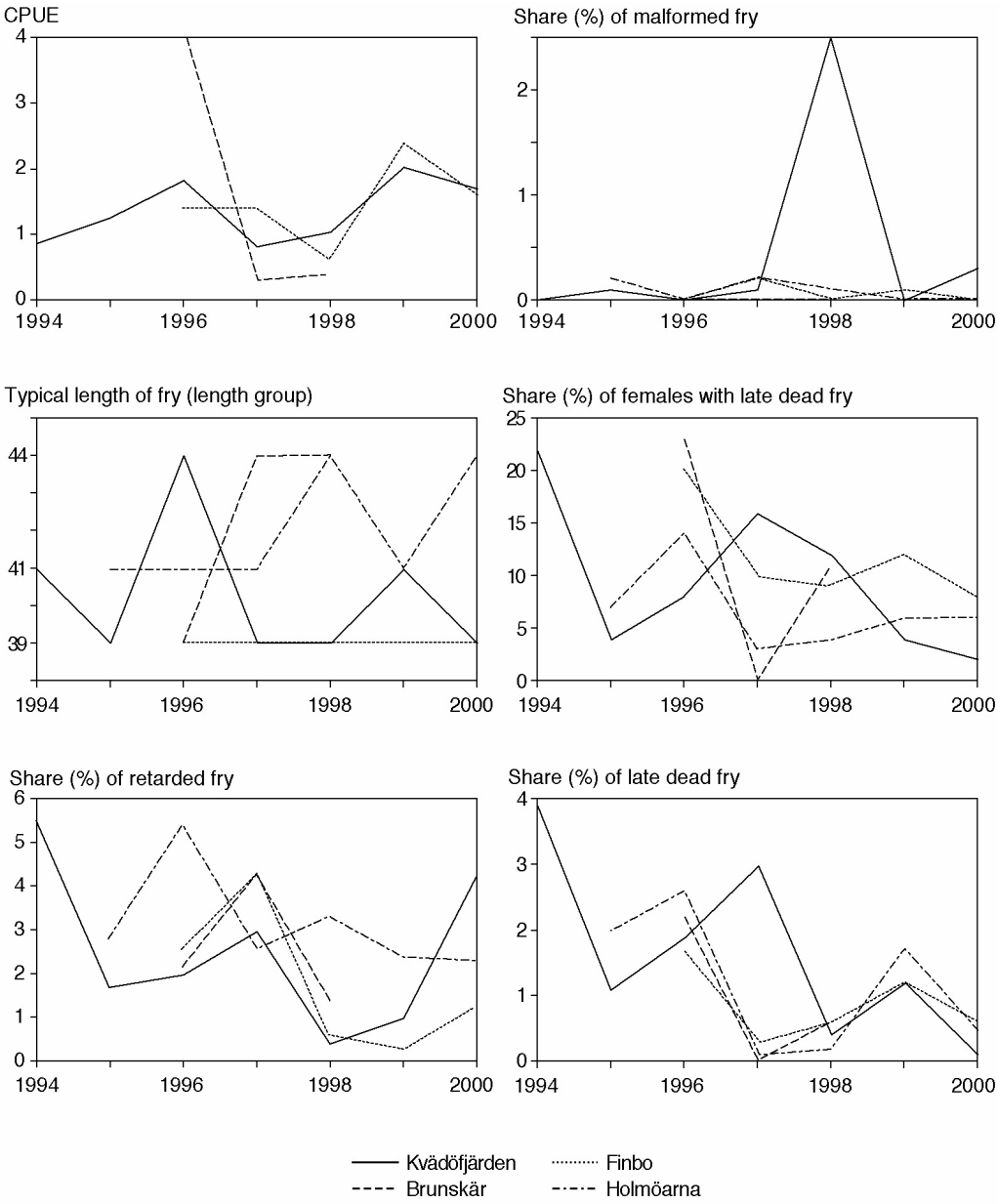

Figure 5. Catch-per-unit-effort and reproduction indexes of viviparous blenny.

5. Conclusions

The fish stock development along the Baltic Sea coast did not show any consistent pattern. In south-western Finland, the Åland archipelago and the Archipelago Sea, the perch stocks increased, probably due to strong year-classes and increased eutrophication. Changes in other fish stocks were explained by overexploitation (perch in Hiiumaa), reduced anthropogenic pollution (several species at Kursiu Marios) and natural variations of year-class strengths (perch at Holmöarna).

Fish community dissimilarity indexes, i.e. changes of community composition and structure over time, did not show any consistency among the reference areas in the Baltic Sea. At Brunskär the fish community has changed significantly over time probably due to increased eutrophication. A significant decrease of the dissimilarity index at Holmöarna could be explained by variation in year-class strengths among years. Strong variations in dissimilarity indexes between years at Kursiu Marios and at Råneå were suggested to be effects of altered environmental conditions.

Andersson et al. (2000) reported a strong decrease in the stock and reproduction of perch and other common species at the Kalmarsund area at the south-eastern coast of Sweden during the 1990's. With the exception of the overexploitation of the perch stock at Hiiumaa, drastic changes in fish stocks have not been found in the monitoring areas presented in this report.

Year-class strength of perch varied simultaneously in the south-western archipelago of Finland, Åland archipelago and northern Quark. Year-class strength in areas in the northern Baltic Sea deviated from the pattern, with the exception that year-class 1988 was strong in all areas. Improvements in reproduction indexes of viviparous blenny were indicated at Kvädöfjärden, Finbo and Holmöarna, possibly as a result of improved environmental conditions.

Acknowledgements

The fieldwork requires the efforts of many persons and co-operation partners. We thank the Finnish Forest and Park Service for co-operation and financial contribution to the monitoring in Brunskär reference area and the Hiiumaa Islets State Landscape Reserve for successful co-operation in Hiiumaa reference area. We are also grateful to all employees in the participating institutes who have contributed to the reference system and to the fishermen taking part in the fieldwork.

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Appendix. List of English and scientific names of fish species occurring in the report.

English	Scientific
Arctic char	Salvelinus alpinus
Asp	Aspius aspius
Baltic herring	Clupea harengus
Black goby	Gobius niger
Bleak	Alburnus alburnus
Bream	Abramis brama
Burbot	Lota lota
Chub	Leuciscus cephalus
Cod	Gadus morhua
Crucian carp	Carassius carassius
Dace	Leuciscus leuciscus
Deep-snouted pipefish	Syngnathus typhle
Eel	Anguilla anguilla
Flounder	Platichthys flesus
Four-horned sculpin	Myoxocephalus quadricornis
Goldfish	Carassius auratus
Grayling	Thymallus thymallus
Greater sandeel	Hyperoplus lanceolatus
Gudgeon	Gobio gobio
Ide	Leuciscus idus
Longspined bullhead	Taurulus bubalis
Perch	Perca fluviatilis
Pike	Esox lucius
Pikeperch	Stizostedion lucioperca
Rainbow trout	Oncorhynchus mykiss
Roach	Rutilus rutilus
Ruffe	Gymnocephalus cernuus
Rudd	Scardinius erythrophthalmus
Salmon	Salmo salar
Silver bream	Blicca bjoerkna
Smelt	Osmerus eperlanus
Sprat	Sprattus sprattus
Straight-nosed pipefish	Nerophis ophidion
Tench	Tinca tinca
Three-spined stickleback	Gasterosteus aculeatus
Trout	Salmo trutta
Turbot	Psetta maxima
Twaite shad	Alosa fallax
Vendace	Coregonus albula
Whitefish	Coregonus lavaretus
Vimba bream	Vimba vimba
Viviparous blenny	Zoarces viviparus
Ziege	Pelecus cultratus