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The structure and dynamics of fish communities in the Latvian coastal zone (Pape - Pērkone), Baltic Sea

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Abstract

The fish biodiversity in the Baltic Sea coastal area was analysed in 1998 - 2002. Different ecological groups – marine, diadromous and freshwater – were captured in survey gillnets and beach seine catches. The coastal fish communities revealed a strong seasonal variation. The water temperature increase early in the spring caused migration of juveniles and adult marine fishes from depths to the nursery, spawning and feeding grounds located in the coastal waters. In summer mostly diadromous and freshwater fish species migrated from the adjacent freshwater basins to the sea coastal feeding grounds. In 1998-2002 fish communities comprised representatives of various ecological types. The available information from the monitoring combined with the fisheries data could facilitate an ecologically-focused management of the coastal zone ecosystem.

Key words: Baltic Sea, coastal zone, diversity, fish community, seasonal dynamics.

Introduction

The marine coastal zone plays an important role for many fish and bird species. Some fish species live permanently in the coastal zone and are to varying degrees restricted to specific habitats, whereas other species may be present only as juveniles, migrate seasonally to the coastal zone or just pass through on their way between marine and fresh waters. Environmental conditions in the coastal waters of open sea depend on several hydrodynamic factors the most important being wind direction and velocity, wave height, light and frequent temperature changes (Beyst et al. 2001). Wind-influenced circulation of water masses occurs in coastal zone, creating changes in water temperature and also the structure of coastal fish communities. Wind direction and velocity causes changes in the abundance of certain fish species especially in the warmwater season. Strong land-wind causes a drift of warm waters from the coastal area to the open sea. Warm water masses are replaced with cold waters from greater depths (upwelling effect). The influence of water temperature on coastal fish community structure in brackish waters has been described previously in Scandinavia (Pihl, Rosenberg 1982; Thorman, Wiederholm 1986; Pihl, Wennhage 2002).

The coastal area of Pape – Pērkone is one of four HELCOM Baltic Sea Protected Areas in Latvian territorial waters. Shallow marine waters are generally considered to be important nursery areas, environments where juvenile fishes will experience enhanced survival and growth (Rozas, Odum 1998). The sea bottom in the study area is covered by *Furcellaria lumbricalis* (Korolev, Fetter 2000) and plays an important role in spawning and fry survival of Baltic herring. Rocky and soft bottoms in near shore shallow waters are the main spawning habitat for turbot and several non-commercial fish species.

Representatives of different ecological guilds (marine, freshwater and diadromous species) are present in the coastal brackish water zone. The coastal areas and fish communities inhabiting them are exposed to anthropogenic pollution risks that can directly affect the food resources, distribution, growth and survival of fish populations. Commercial fishery in coastal as well as open sea areas can also alter the population structure of target species – herring, cod, turbot and flounder.

The health and integrity of different water ecosystems based on fish communities are monitored in different countries. Studies in the river basins of Illinois (Karr 1981; Karr 1986) and lagoons in the Atlantic Ocean in Portugal (Pombo et al. 2002) show that fish are suitable indicators of the ecological state. Monitoring of shallow water fish communities are being carried out in Sweden, eastern and western coast of Baltic Sea (Hansson 1984; Pihl, Wennhage 2002) as well as in the North Sea (Beyst et al. 2001) and various estuaries of Europe (Whitfield, Elliot 2002).

The aim of this study was to investigate the seasonal dynamics and structure of the coastal fish community of the Pape – Pērkone area for the time period from 1998 to 2002. The abundance and distribution of different fish species in different life stages were studied in two depth zones (0 to 2 m and 3 to 5 m).

Materials and methods

Scientific surveys were carried out at two coastal sites in the Liepaja district – Pape (56° 09' N, 21° 02' E) and Jūrmalciems (56° 18' N, 20° 59' E; Fig. 1). These study sites were chosen because the study area is a relatively pristine environment with little influence from anthropogenic disturbances but nevertheless in potential threat of oil pollution from the Butinge oil terminal in Lithuanian waters.

Samples were taken twice a year – in spring (May) and summer (July). Two fishing methods were applied to capture a maximum number of species, at different life stages. In shallow depths (0 to 2 m), fishes were sampled using beach seine with a mesh-size 5 to 10 mm (5 mm in cod-end and 10 mm in wings); the total catch area was approximately 4000 m^2. Details of the sampling methodology are given in Vitinsh (1989). Samples were taken at 5 stations at each site during daylight. The caught fish were preserved in 80 % ethanol and analysed later in laboratory. The number of individuals in each species were determined and fish length and weight were measured. In total, 97 samples were collected from 1998 to 2002. In fish community surveys at medium depth (3 to 5 m), fish were caught using gillnet sets. Two monofilament survey nets (150 m long, 3 m high) with 5 different mesh-sizes (25, 30, 38, 50, 60 mm) and one polyfilament survey net (210 m long, 1.8 m high) with 7 different mesh-sizes (17, 22, 25, 30, 33, 38, 50 mm) were used. Polyfilament survey nets were chosen according to guidelines for coastal fish monitoring (Neuman et al.1997), nets with mesh size 38 and 50 mm were added to catch adult large-size fishes. We used monofilament gillnets to catch fishes more effectively in the 4 to 5 m depth. Fishing was performed between 18:00 - 06:00 in three stations at each site. All fishe were identified to species, weighed (g) and measured for total length after capture.

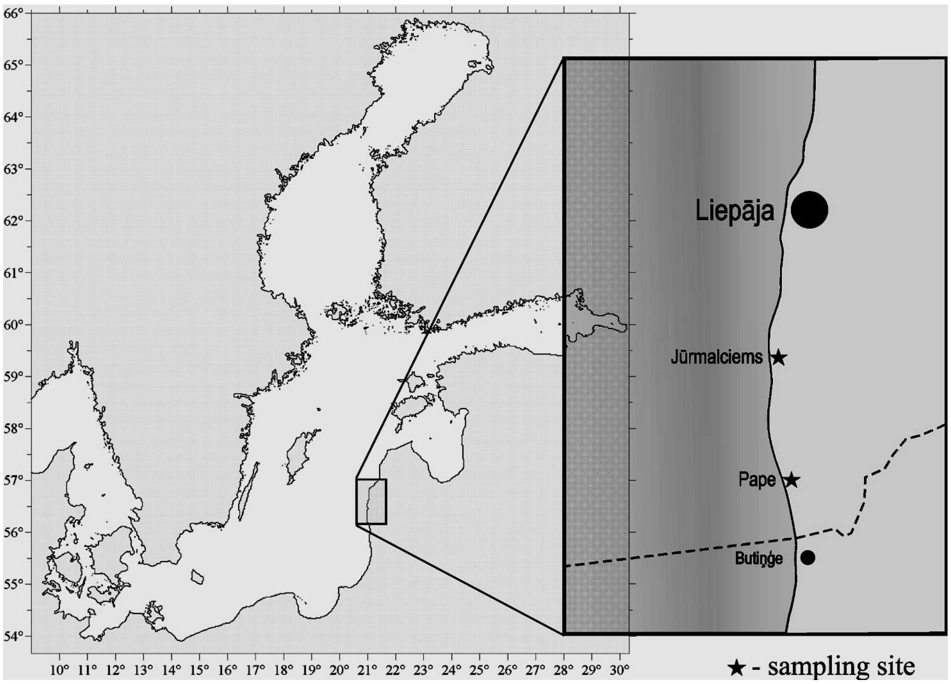

Fig. 1. Location of the survey area. Sampling site in open part of Baltic Sea. Sampling was conducted in two sampling sites in the 0 - 2 m and 3 - 5 m depth.

In total, 57 samples were collected from 1998 to 2002.

Water temperature at the bottom and surface were recorded during each sampling.

Further, all fish species were denoted to one of four ecological guilds (benthic marine; pelagic marine; freshwater and diadromous species) to analyze the functional ecology of the fish assemblages in different seasons. Certain fish species were considered as 'residents' (they were present in more than 50 % of the total number of sampling stations) or 'migrants' (most abundant during a certain period). All other species were recorded 'sporadically' (Clark et al. 1996). Temporal variation in the number of dominant fish species was investigated with a one-way ANOVA using Statgraphics Plus software. The Shannon-Wiener biodiversity index was calculated to analyse temporal and spatial variability of species diversity (Odum 1986).

Results

Fish community structure

In time period from 1998 to 2002 a total of 31 fish species belonging to 19 families were recorded (Table 1). Twenty eight of them are common in the Latvian coastal waters (Winkler 2000), two fish species [black goby (*Gobius niger*) and sabrefish (*Pelecus cultratus*)] can be considered as rare, and one species – twaite shad (*Alosa fallax*) – as very rare. Furthermore, the latter two species are included in the Red Data Book of Latvia, 3rd category.

Table 1. List of fish species caught in the Pape-Jūrmalciems area in 1998 - 2002 with beach seine and gillnets. The table represents the occurrence of different life stages of caught fishes and the assignment of fish species to different occurrence groups and ecological guilds according to Winkler et. al. 2000. A, adult fish; J, juvenile fish; L, fish larvae; B, common species; R, rare species; V, very rare species; M, marine fish; D, diadromous fish; F, freshwater fish

Taxon/Family	Scientific name	Common name	Life stage	Occurrence	Ecological guild
Ammodytidae	*Ammodytes tobianus*	Sandeel	A, J, L	C	M
Ammodytidae	*Hyperoplus lanceolatus*	Greater sandeel	A, J	C	M
Anguillidae	*Anguilla anguilla*	Eel	A	C	D
Belonidae	*Belone belone*	Garfish	A, J	C	M
Clupeidae	*Alosa fallax*	Twaite shad	A	V	D
Clupeidae	*Clupea harengus membras*	Herring	A, J, L	C	M
Clupeidae	*Sprattus sprattus*	Sprat	A, J, L	C	M
Coregonidae	*Coregonus lavaretus*	Whitefish	A, J	C	D
Cottidae	*Myoxocephalus scorpius*	Bullrout	A	C	M
Cyclopteridae	*Cyclopterus lumpus*	Lumpsucker	A	C	M
Cyprinidae	*Abramis brama*	Bream	A, J	C	F
Cyprinidae	*Alburnus alburnus*	Bleak	A	C	F
Cyprinidae	*Blicca bjoerkna*	White bream	A, J	C	F
Cyprinidae	*Leuciscus leuciscus*	Dace	J	C	F
Cyprinidae	*Pelecus cultratus*	Sabrefish	A	R	D
Cyprinidae	*Rutilus rutilus*	Roach	A, J	C	F
Cyprinidae	*Vimba vimba*	Vimba	A, J	C	D
Esocidae	*Esox lucius*	Pike	A	C	F
Gadidae	*Gadus morhua callarias*	Cod	A	C	M
Gasterosteidae	*Gasterosteus aculatus*	Three-spined stickleback	A	C	F
Gasterosteidae	*Pungitius pungitius*	Nine-spined stickleback	A	C	F
Gobiidae	*Pomatoschistus minutus*	Sand goby	A, J, L	C	M
Gobiidae	*Gobius niger*	Black goby	A	R	M
Osmeridae	*Osmerus eperlanus*	Smelt	A, J, L	C	D
Percidae	*Perca fluviatilis*	Perch	A, J	C	F
Percidae	*Stizostedion lucioperca*	Pike-perch	A, J	C	D
Pleuronectidae	*Platichthys flesus trachurus*	Flounder	A, J	C	M
Salmonidae	*Salmo trutta*	Sea trout	A, J	C	D
Scophthalmidae	*Psetta maxima*	Turbot	A, J	C	M
Syngnathidae	*Neophis ophidion*	Straight-nosed pipefish	A	C	M
Zoarcidae	*Zoarces viviparus*	Eelpout	A, J	C	M

Juveniles and small-sized adult fishes dominated in beach seine catches, whereas larger-sized adult fishes dominated in gillnet catches.

Juveniles of marine pelagic and benthic fish dominated (93 % of total number) in beach seine catches in Pape and Jūrmalciems in the shallow depth (0 to 2 m) in spring (Fig. 2A). They were mainly juveniles of clupeids and flatfishes. A small number of diadromous smelt (*Osmerus eperlanus*) and juveniles of freshwater roach (*Rutilus rutilus*) and bream (*Abramis brama*) were also present. Adult marine benthic fishes such as sandeel (*Ammodytes tobianus*), flounder (*Platichthys flesus*), and greater sandeel (*Hyperoplus lanceolatus*) were more abundant in the coastal zone in Pape whereas smelt were more frequent in Jūrmalciems. Bleak (*Alburnus alburnus*) and three-spined stickleback (*Gasterosteus aculeatus*) were representatives of freshwater species (Fig. 2B).

A marine fish community dominated (94 %) in the medium depth (3 to 5 m) in spring at both sites. Flounder, herring (*Clupea harengus*) and turbot (*Psetta maxima*) were most abundant, and freshwater and diadromous fishes occurred in small numbers (Fig. 2C).

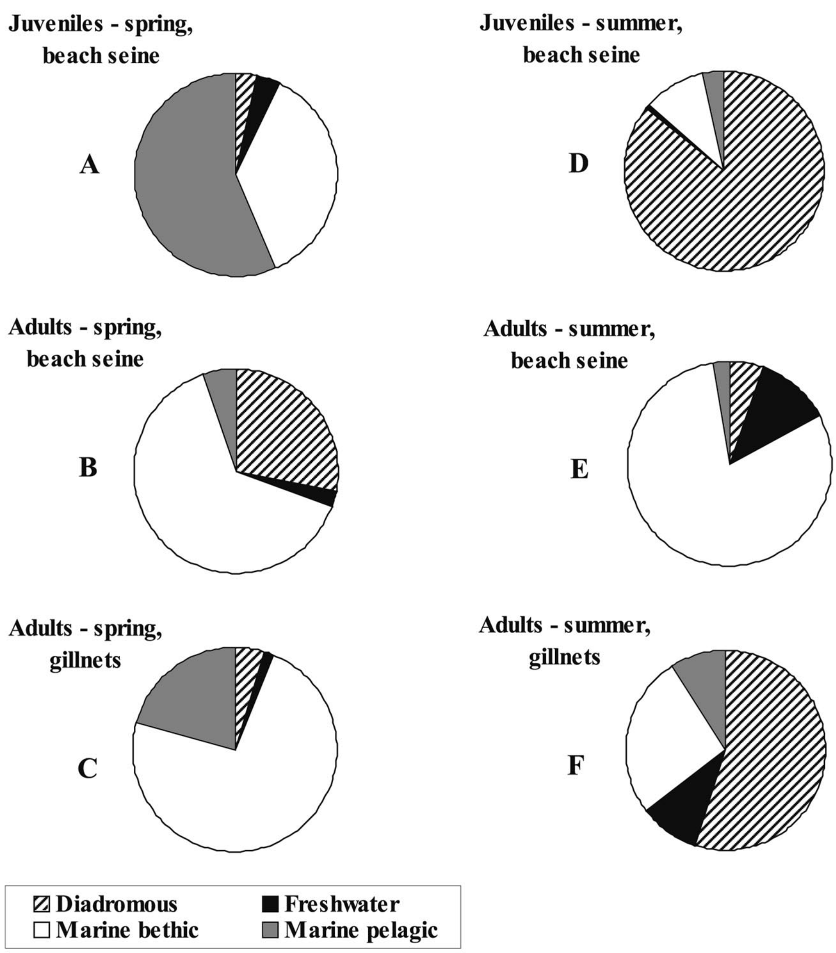

Fig. 2. Percentage of juveniles and adult fishes in ecological guilds in beach seine and gillnet catches. The figure shows comparison of the number of fishe of different ecological guilds and life stages between spring and summer in the survey area.

In summer, in the shallow depth, the proportion of diadromous fishes, mainly juveniles of smelt, increased significantly (86 %), particularly in Jūrmalciems (Fig. 2D). Juveniles of marine benthic species (flounder, turbot and sandeel) were widely distributed but were caught in less number than smelt. The proportion of young freshwater fishes was slightly higher in Pape. The number of adult fishes was lower in summer than in spring. In summer at both sites samples were dominated by marine benthic species such as sandeel, flounder and sand goby (*Pomatoschistus minutus* Fig. 2E).

A similar pattern in species composition was observed in summer in the medium depth, where diadromous fishes, especially vimba (*Vimba vimba*) were the most abundant ecological guild (55 %) in the fish community in Pape. The proportion of freshwater fishes also increased in July, but did not exceed 10 % of the total number (Fig. 2F). The fish community in Jūrmalciems also consisted mainly of diadromous and marine fish (60 and 30 % respectively). The proportion of freshwater fishes there was similar to that in Pape.

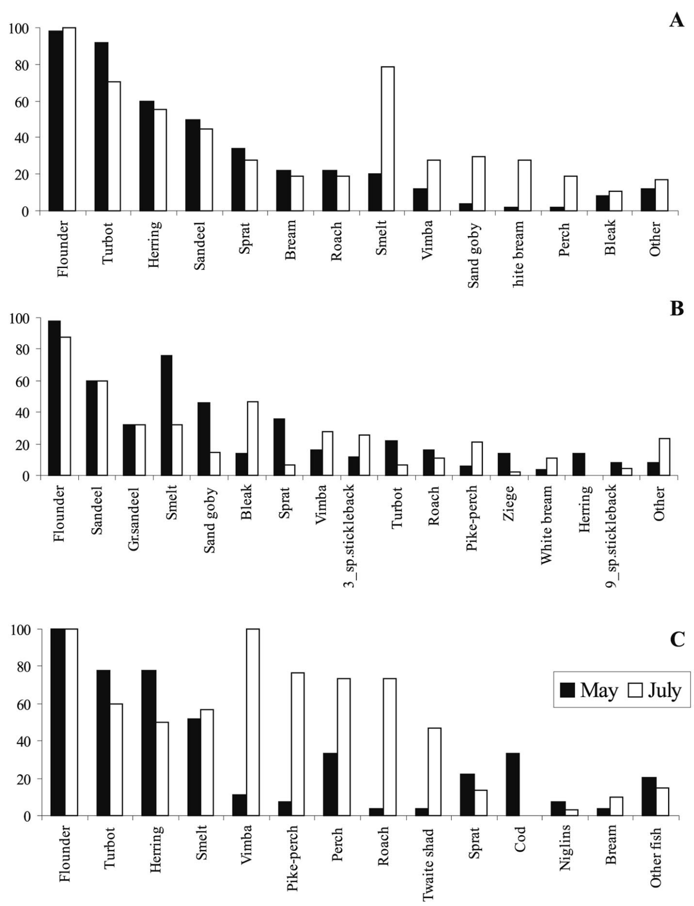

Fig. 3. Fish species occurrence by season. The figure shows the relative occurrence of fish species in sampling stations in May and July. A, juvenile fishes in beach seine; B, adult fishes in beach seine; C, adult fishes in gillnets.

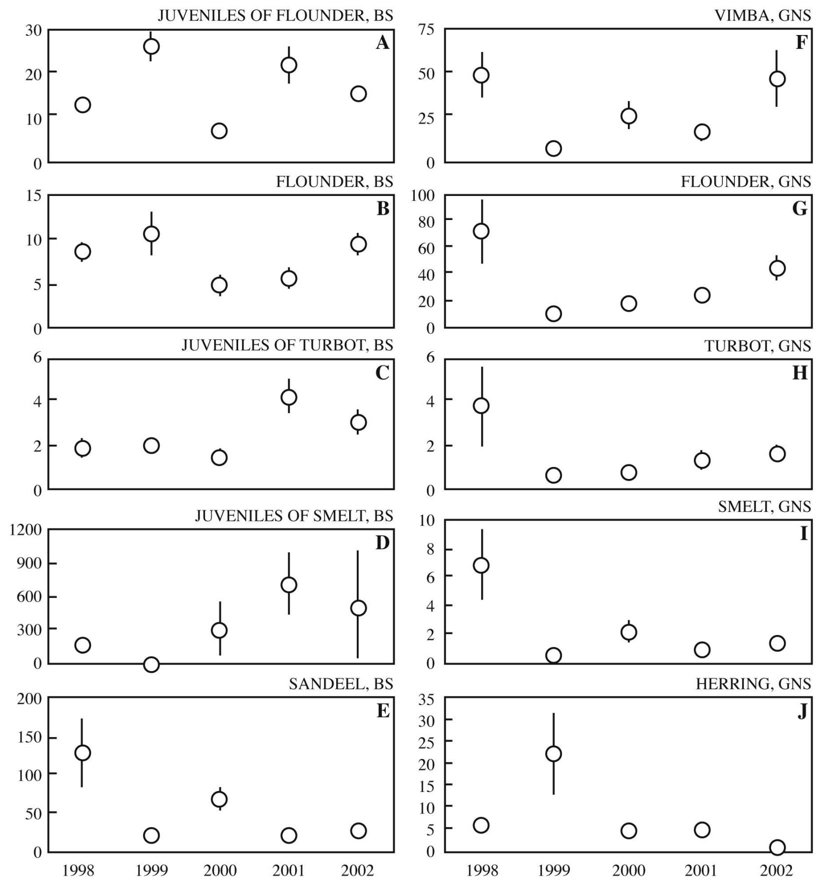

Fig. 4. Density and CPUE (catch per unit effort) of resident species in sampling stations by year. The figure shows the density of resident fishes in beach seine catches (number of fish per sampling station) and CPUE of resident fishes in gillnet catches. BS, beach seine; GNS, gillnets. Values are the means ±SD.

Fish species distribution, density and CPUE in the shallow depth zone

In the shallow depth up to 2 m, six fish species occurred most frequently and were represented by juveniles of flounder, turbot, herring, sandeel and adult flounder, sandeel, great sandeel and sand goby (Fig. 3A, B). These benthic and pelagic fishes occurred in the surf zone more or less throughout both seasons. They were present in 50 to 95 % of all sampling stations depending on time and can be considered as 'resident' species (according to the terminology of Clark; Beyst et al. 2001). The mean number of juvenile flounder was variable without an obvious trend (Fig. 4A). The density of adult flounder was lower, but they were evenly distributed (Fig. 4B). Juveniles of turbot were resident inhabitants of the surf zone with numbers varying between one to four individuals per sampling station. From 2001 on there was slight increase of turbot juvenile number (Fig. 4C). Herring juveniles numbered 20 to 80 individuals per station, however in several stations they were in high numbers. The distribution of sandeel and great sandeel also aggregated in patches. They occurred in approximately 40 to 60 % of all sampling stations and variation of density was high (Fig. 3; Fig. 4E). The abundance of adult sand goby was high in spring, whereas the number of juveniles increased in summer.

Epibenthic smelt and bleak were classified as 'migrants' (most abundant during a certain period of the year and at several stations). The greatest concentrations of smelt juveniles and fry were encountered in summer (Fig. 4D), but there was sure patchiness observed in their distribution. Bleak was more common in freshwater, but occurred in low numbers also in the surf zone in summer. All of the other species were recorded sporadically.

The Shannon-Wiener biodiversity index in 1998 - 2002 varied between 0.99 to 1.36 and without a tendency. The highest biodiversity index was in 2002 (Fig. 5A), and generally the values were higher in spring.

Fish species distribution, density and CPUE in the medium depth zone

Four fish species – flounder, turbot, herring and smelt – were classified as resident species in the depth from 3 to 5 m. There was a common pattern observed in flounder and turbot CPUE (number of individuals per sampling station) dynamics. They were most abundant in 1998 (70 and 4 individuals per station), but unevenly distributed between depths (Fig. 4G, H). In 1999 their numbers significantly decreased (10 and 1 individuals respectively), but in subsequent years the abundance of both species increased again reaching 45 and 2 individuals per sampling station. In 2002 the distribution between depths was more even.

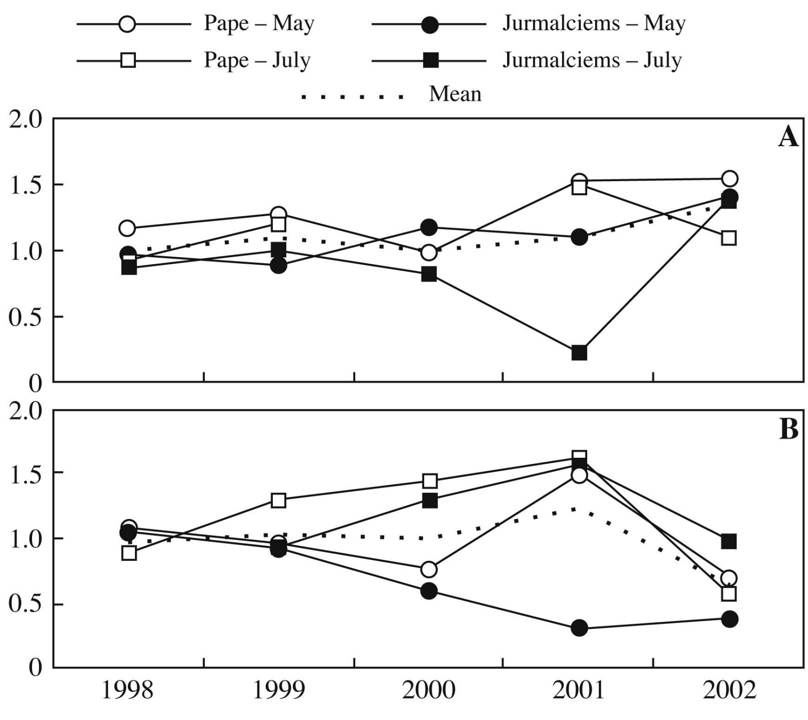

Fig. 5. Shannon-Wiener biological diversity index. Mean annual values by year. A, shallow depth (0 - 2 m); B, medium depth (3 - 5 m).

Baltic herring was very abundant in 1999 – around 20 individuals per station – with a patchy distribution. In later years the CPUE of herring declined (less than 10 individuals per station) and the variability was low (Fig. 4J). Although smelt were resident, their CPUE was low (several individuals per station) and they occurred in equal numbers in samples (Fig. 4I).

Vimba, pike-perch (*Stizostedion lucioperca*), perch (*Perca fluviatilis*) and roach can be considered as migrants and appear in the coastal waters mainly in summer. In Pape-Jūrmalciems coastal waters vimba occurred in great numbers in summer. The highest numbers and variability were recorded in 1998 and 2002 (around 50 individuals per sampling station; Fig. 4F). In time period from 1999 to 2001, vimba was less abundant, with numbers varying from 10 to 25 fishes per station. The perch CPUE in Pape – Jūrmalciems coastal zone was low through the whole period of investigation. A slight increase in perch numbers was observed in summer 2002.

Shannon-Wiener biodiversity varied from 0.66 to 1.24. Generally the values were higher in Pape than in Jūrmalciems. There were also seasonal differences, as biodiversity was lower in spring (Fig. 5B).

Discussion

The environmental conditions in the coastal brackish waters of the study area apparently were more suitable for benthic marine fishes. These species were recorded more consistently and in greater numbers in different seasons through the whole period of study. Other ecological guilds may use the surf and medium depth zones as a transient area when they migrate from the estuary to the open sea and back. Some species may infrequently enter the surf zone to feed, since only adult individuals were found. Coastal waters provide food resources and diversity for different trophic levels.

The fish community structure in coastal waters is dynamic and varies according to season and temperature changes. The period of favourable conditions is relatively short from 4 to 5 months. Pihl and Rosenberg (1982) estimated that 90 % of the annual production is related to warm spring-summer months.

The size and structure of research catches in the coastal zone up to 5 m proved to be dependent on several environmental variables as well as catchability of the sampling gears used. Although no sampling was performed during extreme weather conditions, hydrodynamic variables such as wind speed and direction and wave height are considered to influence the community structure.

A relatively high number of fishes was observed in spring, when water temperature reached 7 to 11 °C. As the temperature in the 40-60 m water layer in May is usually low, about 3-4 °C (E. Jula, unpublished data, 2003), marine pelagic and benthic fish species migrate to warm near-shore waters from the open sea. The pelagic species complex was represented by adult spring-spawning herring and probably by autumn-spawning herring juveniles. The benthic fishes were represented by juveniles of sandeel and flounder that migrate to shallow coastal waters after spending winter at greater depths. Adult flounder in spring perform a feeding migration from Gotland Deep to Irbe Straight along the shore (Vitinsh 1976). Only three (turbot, flounder and herring) of the observed ten fish species were recorded yearly in surveys at a medium depth and they were dominant in numbers. The explanation could be that herring and turbot migrate in spring to coastal areas to spawn (Korolov et al. 1993). The deeper waters of Pape-Jūrmalciems coastal area play important role in turbot spawning (Ustups 1997). However, the specific selectivity of gillnets used in surveys, do not permit to estimate the actual density of adult turbot. Other fish species were found more inconsistently.

In summer, when the water temperature reached 17 to 21 ºC, there were significant differences in fish community structure between shallow and medium depth zones. juveniles and larvae of smelt dominated on depths not greater than 2 m. Another widely encountered ecological group in this area was flatfish juveniles. Shallow waters during the whole season are inhabited by one- and two-year-old flatfishes, but in the case of early spawning also by 0-group fishes. Although the density of flounder juveniles was not as great as in Irbe Straight (main flounder nursery ground; Vitinsh 1976), individuals of different age groups were widely distributed on the sandy bottom of the Pape-Jūrmalciems coastal zone. The density of turbot juveniles was low, but they were equally distributed along the shore in the survey area. Another resident of the shallow surf zone is sandeel, which spends most of the daylight time buried in sand, and feeds aggregated in shoals during night in the water column (Plikšs, Aleksejevs 1998). Adult smelt also inhabit coastal waters (almost year round) though most of the year, and they migrate to the lower reaches of rivers to spawn only in spring (Gaumiga 1967). Of the freshwater species perch, bream (*Abramis brama*), juveniles of white bream (*Blicca bjoercna*), and bleak were present in the coastal zone in summer. Diadromous fishes were represented by juveniles of vimba.

The number of species at a medium depth was greater in summer than in spring. The species turbot, perch, flounder, vimba and pike-perch encountered in every survey were twice as much as in spring. Vimba and flounder dominated the fish community. In 2000, twaite shad, a rare species in Latvian waters, occurred in significant numbers in coastal waters of Pape and Jūrmalciems. Apparently, this was due to appearance of several strong year classes in Curonian Bay, resulting in expansion of its distribution area (Kesminas et al. 1998).

In summer, the Pape-Jūrmalciems coastal area apparently is significant feeding ground for many fish species. Some of them – pike-perch, smelt, twaite shad and vimba – migrate from Curonian Lagoon. Other migrants are freshwater species like perch, roach, white bream and bream that migrate to coastal waters from the lakes Pape and Liepaja. The abundance of freshwater fishes increased in 2001, like caused by a storm washout of the sluice that regulated water level in Lake Pape, which enabled freshwater fish to migrate unrestrictedly to the Baltic Sea.

There were no significant changes in the number of species and individuals in the coastal zone during the survey period. The variability of biological diversity index showed a seasonal pattern depending on the feeding migrations of juveniles and adult fishes. In the shallow zone in summer, the number of species slightly increased, but the biological diversity decreased due to the occurrence of juvenile and adult smelt in high abundance. The highest variability of biological diversity was in 2001, when in summer in Jūrmalciems smelt juveniles contributed 97 % of total number of fish, causing the lowest biological diversity index (0.23) recorded.

In medium depths, in contrast to the shallow depth zone, biological diversity was higher in summer. In spring flounder was dominant species. As its dominance decreased in summer and freshwater species appeared in the same time, the biological diversity increased. The lowest Shannon-Wiener biological diversity index was observed in 2002 in Pape, 0.31 in spring, and 0.37 in summer. These low values were caused by a strong dominance of specific fish species – flounder in spring (84 % of total numbers) and vimba in summer (83 %). Generally, Shannon-Wiener biodiversity depended on the biology of the species. Flounder occur in high numbers in the coastal zone in spring during feeding migrations (Vitinsh 1976). Coastal waters are the main feeding grounds of vimba and juveniles of smelt in summer (E. Urtans, unpublished data).

The present study shows that the juvenile fish stay in the coastal waters during the spring and summer seasons, and that coastal habitats provide feeding conditions for different ecological guilds of fishes. During in the adult life cycle, marine flounder, turbot, herring and diadromous smelt utilize different shallow habitats permanently as feeding grounds. Turbot and herring also spawn in the coastal areas. Adult and juvenile diadromous vimba, pike-perch and smelt (juvenile), as well as freshwater species such as perch, roach, and bream were considered as migrants. These fishes migrated from the adjacent water basins to the coastal waters mainly in summer and feeding grounds were utilized for a shorter time.

The study also showed that coastal fish communities are dynamic with complex structure and that fish production of the coastal zone is related to the fluctuating levels of recruitment and stock abundance in the main distribution areas. The monitoring, which focuses on the fish community structure, species distribution, habitat borders and abundance indices could be used to determine the habitats in need of protection and to evaluate the impact of anthropogenic influences (Karr 1981).

References

Beyst B., Hostens K., Mees J. 2001. Factors influencing fish and macrocrustacean communities in the surf zone of sandy beaches in Belgium: temporal variation. *J. Sea Res.* 46: 281–294.

Clark B.M., Benneth B.A., Lamberth S.J. 1996. Temporal variations in surf zone fish assemblages from False Bay, South Africa. *Marine Ecol. Progr. Ser.* 131: 35–47.

Gaumiga R. 1967. Role of Daugava in recruitment of spring spawning fishes. *Fish. Res. Baltic Sea* 3: 197–204. (in Russian)

Hansson S. 1984. Competition as a factor regulating the geographical distribution of fish species in a Baltic archipelago: a neutral model analysis. *J. Biogeography* 11: 367–381.

Karr J.R. 1981. Assessment of biotic integrity using fish communities. *Fisheries* 6: 21–27.

Karr J.R., Fausch K.D., Angermeier P.L., Yant P.R., Schlosser I.J. 1986. *Assessing Biological Integrity in Running Waters. A Method and Its Rationale*. Illinois Natural History Survey Special Publication 5. 28 p.

Kesminas V., Repecka R., Balkuviene G., Virbickas T., Stakenas S., Šriupkuviene N., Motiejūnas S. 1998. Monitoring of fish communities, population parameters and heavy metals in Lithuania. *Proc. Latvian Acad. Sci., Sect. B* 52: 85–93.

Korolov A., Kuznetsova T., Drozdecky V. 1993. Features of the Baltic herring's spawning grounds in the Eastern Baltic. *ICES CM* 1993/J: 23.

Korolev A., Fetter M. 2000. The mapping of biocenoses in the coastal zone of Latvia. *ICES CM* 2000/T: 11.

Neuman E., Sandstrom O., Thoresson T. 1997. *Guidelines for coastal fish monitoring*. National Board of fisheries, Oregrund. 44 p.

Odum E.P.1986. *Basic Ecology 2*. Mir, Moscow. 376 p. (in Russian)

Pihl L., Rosenberg R. 1982. Production, abundance, and biomass of mobile epibenthic marine

fauna in shallow waters, western Sweden. *J. Exp. Mar. Biol. Ecol.* 57:273–301.
Pihl L., Wennhage H. 2002. Structure and diversity of fish assemblages on rocky and soft bottom shores on Swedish west coast. *J. Fish Biol.* 61: 148–166.
Plikšs M., Aleksejevs E. 1998. *Zivis (Fish)*. Gandrs. Rīga. 304.
Ustups D. 1997. Akmeņplekste (Turbot). *Latvijas Zivsaimniecības Gadagrāmata 1996/97*. Zivju fonds, Rīga, 105–109.
Pombo L., Elliott M., Rebelo J.E. 2002. Changes in the fish fauna of the Ria de Aveiro estuarine lagoon (Portugal) during the twentieth century. *J. Fish Biol.* 61: 167–181.
Rozas L.P., Odum W.E. 1998. Occupation of submerged aquatic vegetation by fishes: testing the roles of food and refuge. *Oecologia* 77: 101–106.
Thorman S., Wiederholm A.M. 1986. Food, habitat and time niches in a coastal fish species assemblage in a brackish water bay in the Bothnian Sea, Sweden. *J. Exp. Marine Biol. Ecol.* 95: 57–86.
Vitinsh M. 1976. Some distribution and migration patterns of flounder (*Platichthys flesus*) in East and Northeast Baltic Sea. *Fisherei-Forshung* 14: 39–48. (in Russian)
Vitinsh M. 1989. Methods and results of surveys of the juvenile flounder and turbot in Easter Baltic in 1986 and 1987. *Fisherei-Forshung* 27: 59–61. (in Russian)
Whitfield A.K., Elliot M. 2002. Fishes as indicators of environmental and ecological changes within estuaries: a review of progress and some suggestions for the future. *J. Fish Biol.* 61: 229–250.
Winkler H.M., Skora K., Repecka R., Pliks M., Neelov A., Urho L., Gushin A., Jespersen H. 2000. Checklist and status of fish species in Baltic Sea. *ICES CM* 2000/Mini: 11.

Zivju sabiedrību sastāvs un tā izmaiņas Baltijas jūras Latvijas piekrastē (Pape – Pērkone)

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Kopsavilkums

Zivju sabiedrību daudzveidība Baltijas jūras piekrastē tika analizēta laikā no 1998. līdz 2002. gadam. Piekrastes zivju mazuļu vadiņa un tīklu lomos konstatēti dažādu (jūras, ceļotājzivju un saldūdens zivju) ekoloģisko grupu pārstāvji. Piekrastes zivju sabiedrībās ir novērojamas izteiktas sezonālās svārstības. Agri pavasarī, ūdens masām uzsilstot, notiek mazuļu un pieaugušo jūras zivju migrācijas no atklātās jūras dziļākiem rajoniem uz piekrastes seklajiem ūdeņiem, kur notiek zivju barošanās, nārsts un kas ir mazuļu uzturēšanās rajoni. Vasaras periodā barošanās migrācijas no netāliem saldūdens baseiniem uz piekrastes ūdeņiem veic galvenokārt ceļotājzivis un saldūdens zivis. Zivju sabiedrības laika posmā no 1998. līdz 2002. gadam novērotas dažādas ekoloģiskās grupas. Pamatojoties uz zivju monitoringa datiem, var noteikt aizsargājamās dzīvotnes, kā arī aprēķināt saimnieciskās darbības rezultātā ihtiofaunai nodarīto zaudējumu vērtību.