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Report of the Study Group on Regional Scale Ecology of Small Pelagics (SGRESP)

23–26 February 2004
Nantes, France

International Council for the Exploration of the Sea

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1 INTRODUCTION

1.1 Background information

Study Group on Regional Scale Ecology of Small Pelagics (SGRESP) was established for 3 years (2004–2006) at ICES ASC meeting in September 2003. The Study Group was established with the purpose of i) integrating various survey data together as well as with meteo, satellite, fishery and/or ecosystem model outputs and ii) feeding in the assessment WG with synthetic understanding of how the spatial dynamics of the biological cycle and the stock dynamics are related to the ecosystem thus increasing ICES ability to use ecological information in assessment, prediction and management of small pelagics. The Study Group was recognised as essential for ICES to make progress in the understanding of environmental forcing on life history, spatial and population dynamics of pelagic fish to provide alternative basis to management on stocks recognised to fluctuate under environmental forcing. Widened participation for this group was to be sought including scientists from population surveying, assessment working groups, GLOBEC/SPACC and academic science.

1.2 Terms of references

A **Study Group on Regional Scale Ecology of Small Pelagics** [SGRESP] will be established (Chair: Pierre Petitgas, France) and will meet in Nantes, France, from 23–26 February 2004 to:

a) assemble existing data on life history stages (adult, egg, larvae, juvenile) of pelagic fish (horse mackerel, mackerel, sardine, anchovy, herring and sprat) in ICES waters, regionally;
b) characterise habitats of life cycle stages (spawning, nursery, feeding grounds), their inter-annual changes, their inter-species overlap;
c) review existing relationships with physical and biological environmental indicators;
d) produce and deliver assessment Working Groups with integrated environmental and ecological information relevant to the evaluation and prediction processes;
e) consider a scientific plan to set up a working group on environmental forcing on small pelagics as well as propose a framework articulating the group with existing LRC groups on surveys methods and fish ecology and ACFM groups on assessment;
f) evaluate applicability of GLOBEC/SPACC findings to small pelagic stocks in ICES waters and establish contact between the SG work and GLOBEC/SPACC research.

1.3 Participation

A complete list of the participants who met at IFREMER, Nantes, France from the 23–26 February inclusive can be found in Appendix 3.

Contrasting stock situations were available to the group which allowed for general and comparative approaches. Stocks available to the group were: Atlanto-scandian herring (Norwegian spring spawning herring), North East Atlantic mackerel, Baltic sprat, Sardine and anchovy around the Iberian Peninsula and in Biscay.

The work of the group for this initial meeting consisted of presentations and discussions, leading to the development of a conceptual scientific framework. This was translated into schematic diagrams and summary descriptions by stock and area.

2 EXECUTIVE SUMMARY

The major outcome of the meeting was the recognised importance of the role of adults in a population to maintain habitat occupation, migration routes and transmission of "knowledge" between generations. Therefore environmental impact on a population was redefined as an interaction between climate ecosystem and population structure rather than a direct forcing on a particular biological process. As a consequence, it was understood that fishing can modify the interaction between a population and the environment as a change in population demography would result in modifying the occupation of habitats and the link between generations (Figure 1).

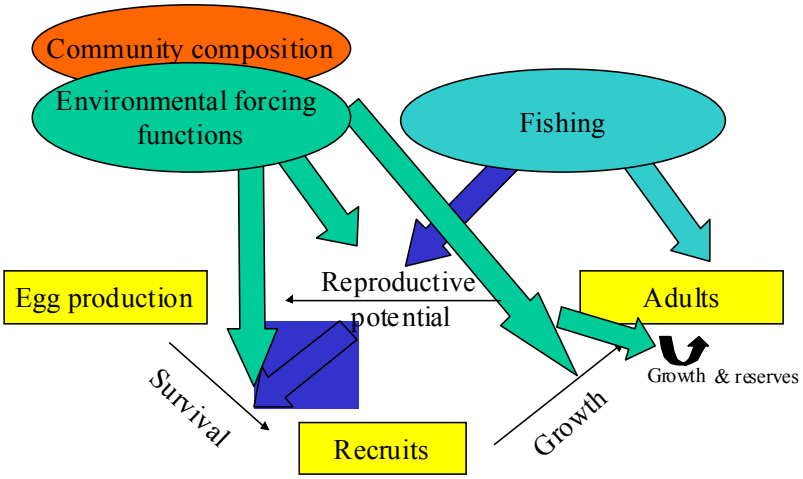


Figure 1. Schematic diagram of the interaction between a population life cycle and the ecosystem.

Before attempting an understanding of the interaction between environment and populations it is important to understand how a population functions. The pelagic fish populations considered by the group offered a wide range of variation in population parameters (short/long lived, high/low recruitment variability, large/small biomass, pelagic/demersal spawning) and historical situations. They also offered a wide range of variation for the scale at which to consider the environment-population interaction. For instance, the space-time spawning windows were small for anchovy in Biscay (a few spawning grounds during a few months depending on a few hydro-climate regimes) while they were large for NEA mackerel (extensive spawning locations during a large part of the year). All populations showed specific spawning locations repeatedly year after year except sardine which seemed to have no specific spawning locations. Adult fish were recognised to play a crucial role in leading spawning in space and time in all stocks: demographic organisation of spawning was acknowledged, population behaviour varied when demography was balanced or biased towards the young. This led the group to formulate the "Follow mum and dad" hypothesis as an important mechanism in population maintenance. Population variation was not only considered as dependent on recruitment but also on the interaction of the adult fish with the ecosystem. IBM models of larval survival will not be enough for understanding population variability: Models for the adults will also be necessary although the knowledge required is complex.

SGRESP was envisaged as a forum for regional scale data integration of different types of data allowing building a general picture of population life cycle. It was also planned to facilitate implement and develop tools for testing usefulness of short-term predictions in present ICES management context. The long-term objective of the group was to built a scientific framework proposing a novel point of view based on the consideration of the spatial patterns of life cycles (spawning, movements, recruitment, multispecies context). The group was recognised as a regional scale European contribution of ICES to GLOBEC/SPACC program by SPACC executive committee. The group's contribution was original in that it considered other species than anchovy and sardine in areas that were not under the influence of large scale upwelling systems. Most participants to the group were also participants to assessment Working Groups of ICES/ACFM allowing direct linkage with applicability.

The following short-term actions were found necessary:

- Inventory and collation of data with an appropriate format, internationally, at regional scale and on a long-term basis on fish and ecosystems relevant for analysing spawning and growth
- Identify and collate environmental data at general/meso/local scales relevant for characterising history and extreme events in the hydro-climate (e.g., retention areas, currents, inflows, upwelling), in the zooplankton (e.g., Continuous Plankton Recorder), in the multispecies assemblages.
- Identify and collate data and tools relevant for analysing the tele-connections between areas concerning larvae/juveniles (e.g., otolith growth, circulation model) as well as spawning/feeding migrations (e.g., otolith age-0 growth, tagging)
- Analyse pattern in processes, e.g., stage-specific egg mortality in recruitment and test for their importance

3 PROGRESS ON THE TERMS OF REFERENCE

3.1 ToRs a) and b)

Assemble existing data on life history stages (adult, egg, larvae, juvenile) of pelagic fish (horse mackerel, mackerel, sardine, anchovy, herring and sprat) in ICES waters, regionally.; Characterise habitats of life cycle stages (spawning, nursery, feeding grounds), their inter-annual changes, their inter-species overlap.

This was answered by documenting each stock (ID card), drawing synthetic schemes of the life cycle in space as well as synthetic schemes of hycro-climate events potentially effecting particular stages of the stock life cycle. The ID card contained a review of the following characteristics: life history traits, spawning, adult growth, nursery, feeding, adult and juvenile migrations, long-term trends, nowadays characteristics, potential environmental influences. The hydro-climate schemes concerned macro-scale events. Inter-annual variations in terms of intensity, location and time that will potentially affect biological processes are to be found in the meso-scale events related to the macro-scale processes drawn on the diagrams.

3.1.1 Norwegian spring spawning herring (NSS herring)

Life history traits. The oldest herring aged in IMR database is 25 years. The age and length where 50% is mature varies from 4–7 year and 28–31 cm respectively (Engelhard and Heino, 2004). It is a determinate 1-batch spawner.

Wintering. Wintering has occurred in the open ocean to the east of Iceland (prior to the stock decline in the late 1960s) and off northern Norway, and in fjords at the west and north coast of Norway. Since the late 1980s wintering has occurred in Vestfjorden, northern Norway. At present a large proportion of the stock contributed by recruits of the 1998–1999 year classes have started to winter in the open ocean off the northern Norwegian coast. During the wintering the herring is dispersed in layers both during day and night-time, deeper during day than night. Two different layers, with recruits in the upper and adult in the deeper layer, may occur. Co-occurring species in the area are cod, saithe, blue whiting, killing whales.

Spawning. Time**:** Spawning occurs during February-April. There are two major spawning waves, the repeat spawners first, and secondly the recruit spawners (Slotte *et al.* 2000). Habitat: They spawn at bottom, substrates like coarse sand, shell sand, gravel, stones and rocks, at depths 30–250 m. The spawning grounds are located around the Norwegian coast from 58º–70ºN. The selection of spawning grounds is affected by the size and structure of the stock. The extension of the spawning area increases with stock size. Schooling behaviour: During the spawning season they occur in dispersed layers close to surface during night, dense layers close to bottom or dense schools closer to the surface during periods of daylight (Slotte 2001). Spawning occurs during night; usually one may observe a mixture of mature and spent fish in a dispersed layer close to surface, a layer at the bottom spawning and interaction between the two groups. Co-occurring species: cod, saithe, haddock and killing whales.

Feeding. Time: April-August with May-June being the main period. During the wintering period (September-January) and spawning season (February-April) herring does not feed. Feeding starts immediately after spawning. Habitat: Feeding occurs all over the Norwegian Sea at high stock levels and closer to the Norwegian coast during low stock levels. The feeding seems to occur in a clockwise manner starting in the south going west, north and east, ending up in wintering areas in northern Norway (Misund *et al.* 1998). Predation mode: snapping/filtering. Prey species: Calanus copepods. Schooling behaviour: During the feeding season herring form schools of different sizes due to splitting and joining processes. Co-occurring species: blue whiting and mackerel, various mesopelagic fish, whales.

Migrations. It is believed that the recruits must learn from the adults the migration route to wintering, spawning and feeding grounds (Slotte 2000). Changes in migration pattern usually take place during recruitment of strong year classes. There is a tendency for a year class to spawn farther south as it grows to be older (Slotte 1999b, 2000). Reduced condition may cause a reduced migration distance compared with previous years. By modelling the size specific costs of migrating (Slotte 1999a), and the benefits of larval survival farther south due to a drift through warmer temperatures, it has been demonstrated that it is optimal to spawn farther south with increasing size and condition (Slotte and Fiksen 2000).

Larval drift and nursery areas. The hatched larvae drift northwards along the coast. Some larvae drift into fjord nurseries, but the major part of the larvae ends up in the Barents Sea nursery area (Holst and Slotte 1998). As 0–3 group they occur both as layers and schools. The main co-occurring species in the Barents Sea nursery area are cod, saithe, haddock, capelin, various whales and seals. Herring is known to feed on capelin larvae, having a negative influence on capelin recruitment. The immature herring leaves the fjord and Barents Sea nursery areas to join the adults in the Norwegian Sea to feed during summer before the first spawning at ca. 28 cm length and ages 2–8 depending on growth.

Long term trends. The stock size has varied from almost 20 million tonnes down to levels around 100 000 tonnes in the late 1960s and up to more then 10 million tonnes again in the late 1990s (Toresen and Østvedt 2000). At the same time the use of wintering-, spawning- and feeding areas have changed as mentioned above (Dragesund *et al.* 1997).

Nowadays characteristics. A tendency towards a more northern distribution in the Norwegian Sea has been observed in recent year. Two different wintering areas are utilised, one in the open sea off northern Norway (1998–99 year classes) and one in Vestfjorden. The spawning has also moved more towards the north.

Potential environmental influence. Inflow of Atlantic water into the Norwegian Sea and Barents Sea (NAO-index) seems to influence both the condition and hence fecundity of adult fish as well as the survival of larvae (Toresen and Østvedt 2000, Fiksen and Slotte 2002, Sætre *et al.* 2002). There is a very good correlation between environmental changes locally at spawning grounds and nursery areas and the large-scale variations in Atlantic water inflow. The survival of larva is also influenced by changes in currents, some years retention areas may be stronger. It has been demonstrated that the tendency of retention may increase larval survival, i.e., the larvae stay for a longer period in warmer water, drifting slower towards the north (Sætre *et al.* 2002). The environmental conditions also affect the condition of the fish, which again may cause reduced fecundity (Oskarson *et al.* 2002). The strong year classes have occurred in periods of good condition and high temperatures.

References

Dragesund, O., Johannessen, A., and Ulltang, Ø. 1997. Variation in migration and abundance of Norwegian spring spawning herring (*Clupea harengus* L.). Sarsia 82: 97–105.

Engelhard, G. H. and Heino, M. 2004. Maturity changes in Norwegian spring-spawning herring before, during, and after a major population collapse. Fisheries Research 66: 299–310.

Fiksen, Ø. and Slotte, A. 2002. Stock-environment recruitment models for Norwegian spring spawning herring. Canadian Journal of Fisheries and Aquatic Science 59: 211–217.

Holst, J. C. and Slotte, A. 1998. Effects of juvenile nursery on geographic spawning distribution in Norwegian spring spawning herring (*Clupea harengus* L.). ICES Journal of Marine Science 55: 987–996.

Misund, O. A., Vilhjálmsson, H., Jakupsstovu, S. H. I., Røttingen, I., Belikov, S., Asthorsson, O., Blindheim, J., Jónsson, J., Krysov, A., Malmberg, S. A. and Sveinbjørnsson, S. (1998). Distribution, migration and abundance of Norwegian spring spawning herring in relation to the temperature and zooplankton biomass in the Norwegian Sea as recorded by coordinated surveys in spring and summer 1996. Sarsia 83: 117–127.

Oskarsson, G. J., Kjesbu, O. S., and Slotte, A. 2002. Predictions of realised fecundity and spawning time in Norwegian spring spawning herring (*Clupea harengus* L.). Journal of Sea Research 48: 59–79.

Slotte, A.1999a. Differential utilisation of energy during wintering and spawning migration in Norwegian spring spawning herring (*Clupea harengus* L.). Journal of Fish Biology 54: 338–355.

Slotte, A. 1999b. Effects of fish length and condition on spawning migration in Norwegian spring spawning herring (*Clupea harengus* L.). Sarsia 84: 111–127.

Slotte, A. 2001. Factors Influencing Location and Time of Spawning in Norwegian Spring Spawning Herring: An Evaluation of Different Hypotheses. *In:* F. Funk, J. Blackburn, D. Hay, A. J. Paul, R. Stephenson, R. Toresen, and D. Witherell (Eds.), Herring: Expectations for a New Millennium. University of Alaska Sea Grant, AK-SG-01–04, Fairbanks, pp. 255–278.

Slotte, A. and Fiksen, Ø. 2000. State-dependent spawning migration in Norwegian spring spawning herring (*Clupea harengus* L.). Journal of Fish Biology 56: 138–162.

Slotte, A, Johannessen, A., and Kjesbu, O. S. 2000. Effects of fish size on spawning time in Norwegian spring spawning herring (*Clupea harengus* L.). Journal of Fish Biology 56: 295–310.

Sætre, R., Toresen, R., and Anker-Nilssen, T. 2002. Factors affecting the recruitment variability of the Norwegian spring-spawning herring (*Clupea harengus* L.). ICES Journal of Marine Science 59: 725–736.

Toresen, R., and Østvedt, O. J. 2000. Variation in abundance of Norwegian spring spawning herring (*Clupea harengus*, Clupeidae) throughout the 20th century and the influence of climatic fluctuations. Fish and Fish. 1: 231–256.

Toresen, R. and Østvedt, O. J. 2002. Stock structure of Norwegian spring-spawning herring: historical background and recent apprehension. ICES Mar. Sci. Symp. 215: 532–542.

Supporting Figures::Figure 1 to Figure 4.

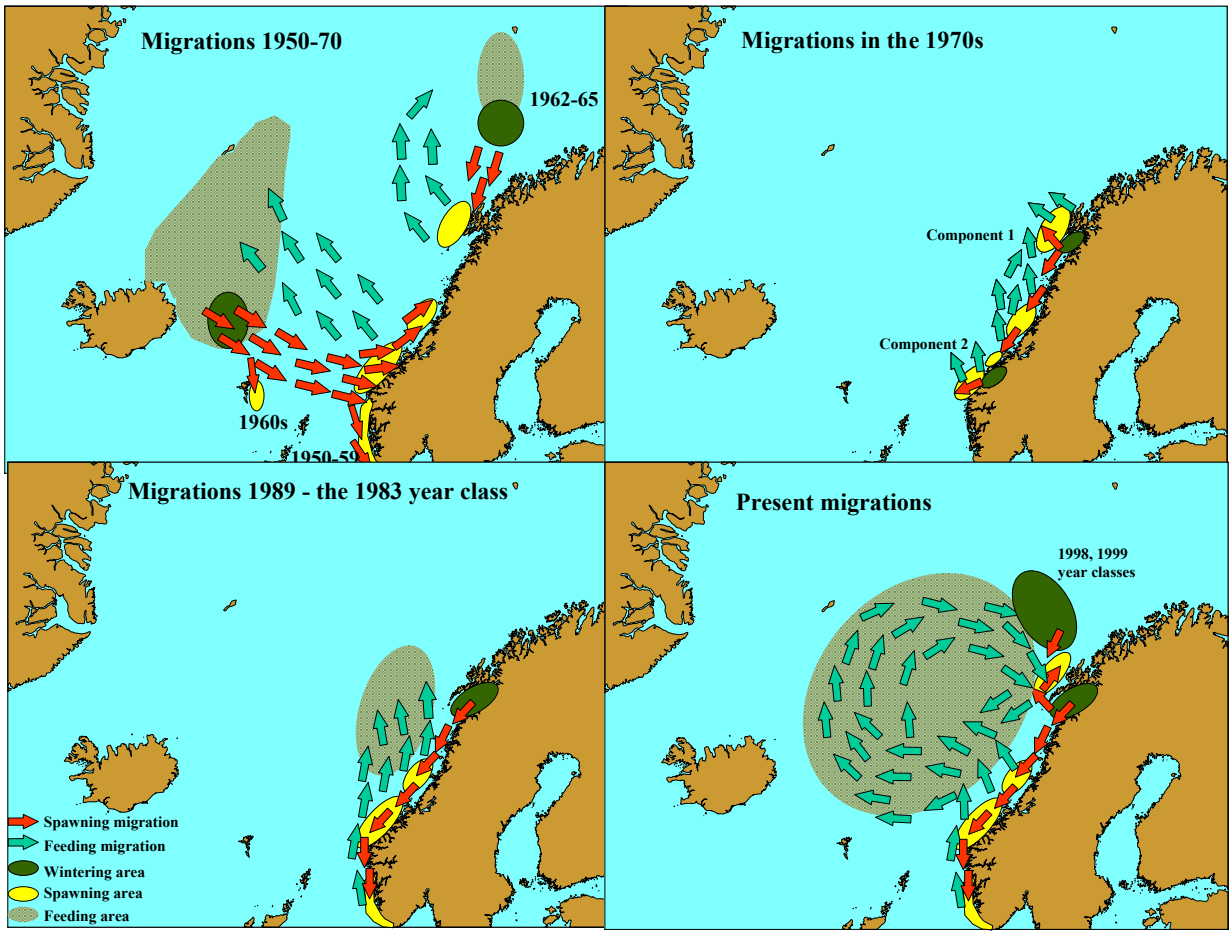


Figure 2. Schematic overview of historic changes in the adult NSS herring seasonal migration pattern.

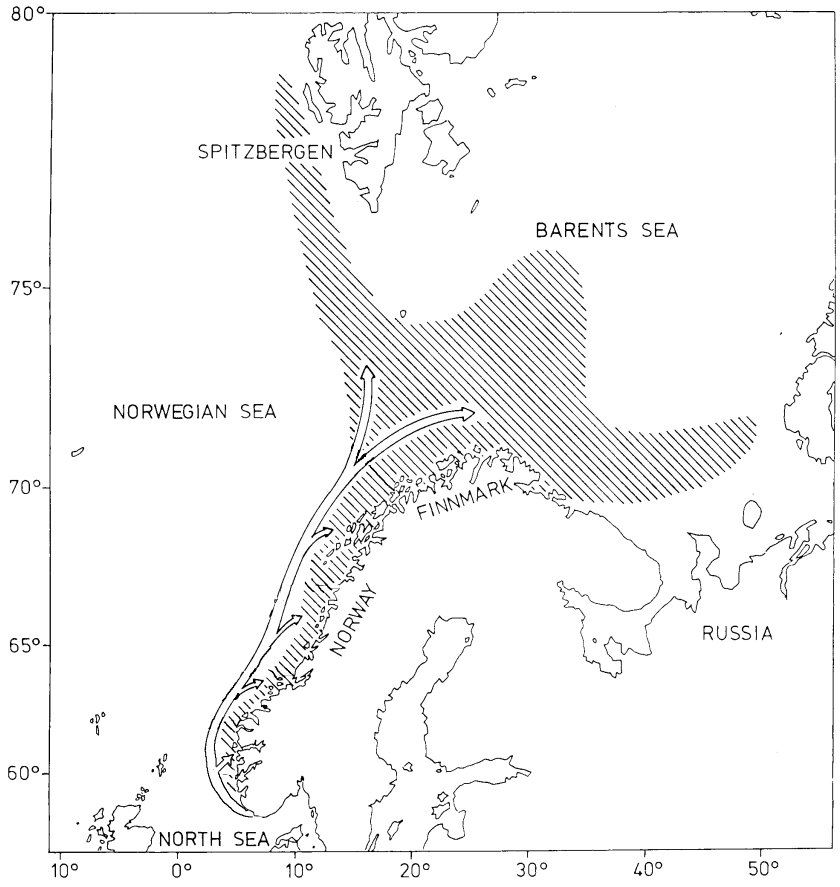


Figure 3. Drift routes of NSS herring larvae and adjacent nursery areas (hatched areas) for immature herring (0–3 year olds).

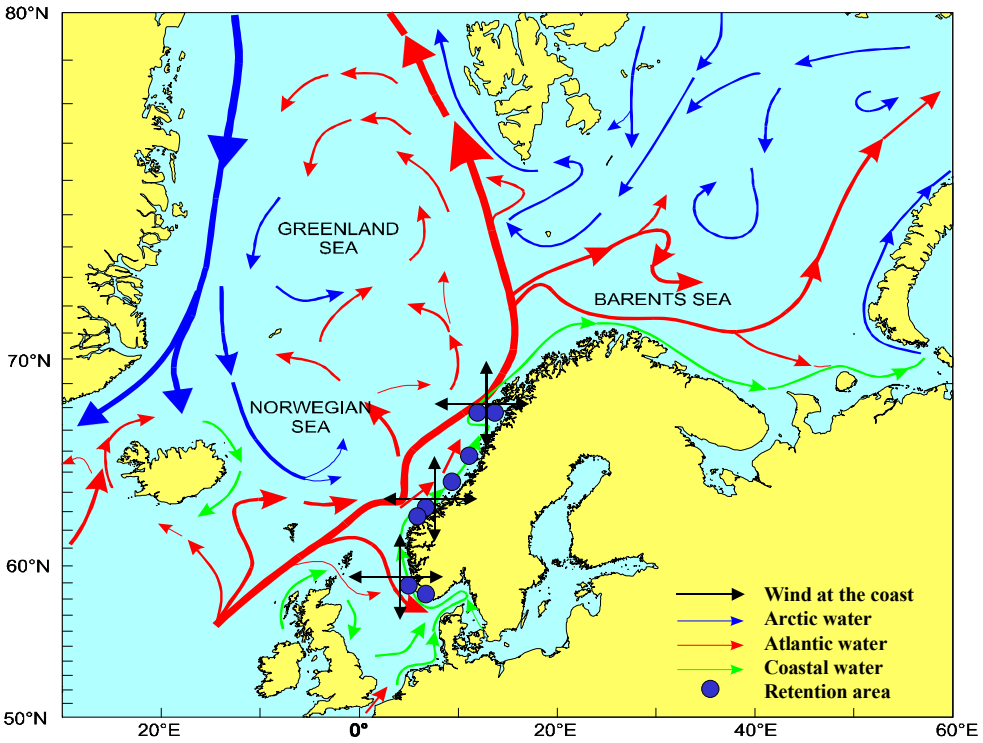


Figure 4. Physical forces on NSS herring.

- The survival of eggs at bottom on the spawning grounds along the Norwegian coast are influenced by the characteristics (t and s) of the cold and less salt coastal water and mixing of warmer and saltier Atlantic water.
- The larval survival is influenced also by the characteristics (t and s) of the cold and less salt coastal water and mixing of warmer and saltier Atlantic water. Higher survival in warmer periods. The survival increases with retention, i.e., reduced drift speed northwards towards the Barents Sea nursery, several retention areas are located related to the shelf along the coast. The survival of larvae is also influenced by wind, i.e., directions and speed. In general northerly winds causes advection to the west out of the main drift route towards the Barents Sea, which is believed to be a deadly option. On the other hand, wind from the south/south-west causes the larva to drift into fjords, which is believed to be good, i.e., herring from fjord nurseries grow faster than those in the Barents Sea. Winds from east and west have a more complex influence on the larvae, not fully understood.
- The 0–3 group in the Barents Sea is influenced by the inflow of warm Atlantic water and cold Arctic water, i.e., better growth and survival during warm periods. Herring in the fjord nurseries may be influenced by river outflow from ice-melting, but this has not been studied.
- Adult herring distribution, growth and condition during the feeding season, and hence migration and reproductive potential during the spawning season, is influenced by the flow of Atlantic water/Arctic water into the main feeding area in the Norwegian Sea.

3.1.2 North East Atlantic mackerel (NEA mackerel)

Life history traits: life span = 15+ yrs; mature at 3 years; determinate multiple batch spawner

spawning.

time: January to May (southern area) March-July (western area);

habitat: closely associated with shelf edge from 37–60°N, longitudinal extent is greatest between 46 and 55°N and can extend 3–4° west of 200m contour, most commonly at peak spawning in April/May. Potential spawning area is believed to be largely identical to the actual area occupied.

schooling behaviour: Schools in large deep schools prior to spawning. Largely dispersed or in high small schools during spawning season. Remains as small high schools until aggregation in overwintering area in the northern North Sea, in October, when it starts to form very large schools in 225m water at western edge of Norwegian Deeps.

co-occurring species; During spawning, co-occurs with horse mackerel (which spawns later by one month) and blue whiting (generally found over water deeper than 200m). Also possibly sardine and anchovy in Iberian area and Biscay, and herring in areas north of 54°N.

adult growth:

summer/autumn; migrates to Norwegian and possibly N North Sea at start of Q3. Feeding is believed to be continuous until overwintering aggregation in October

habitat: deep water areas of Norwegian and North Seas (approx 60–65°N, 4°E-2°W), probably strongly associated with *Calanus*

co-occurring species. AS Herring, blue whiting, horse mackerel

nursery:

time; Not fully known, probably arrive in nursery areas in August/September. Are found there for first two winters until age 2. Possibly recruit to adult stock at 2 or 3 yrs at around spawning time

habitat; Generally demersal in shelf areas adjacent to coast lines. From south to north, juvenile fish aggregate in the following areas:

- Spanish/Portuguese border
- Biscay (between 45 and 48°N)

- Celtic Sea/Cornwall – mostly second winter
- West of Ireland (historic - but still some second winter fish)
- NW Ireland
- West of the Hebrides (historic)
- North edge of North Sea (recent and intermittent – mostly first winter fish)

Nursery areas are mostly away from adult feeding areas.

The status of Cantabrian Sea as a nursery is unknown. There are definitely some juveniles there, but juvenile distributions are inferred from bottom trawl surveys. The gear used in the Cantabrian Sea is selective against pelagics and so data are unreliable.

co-occurring species: herring, possibly horse mackerel and many demersal species

feeding regime: predation mode – able to filter or particulate feeding, probably mainly particulate; prey species: predominantly *Calanus*, but with other crustaceans, fish larvae and small adult fish

adult migration: Overwinter in North Sea (Viking Bank area) from October to February. Migrate to spawning area. Believed to turn north at start of spawning and will spawn and migrate until spent – June to July. Move to Norwegian Sea (approx 60–65^{o}N, 4^{o}E-2^{o}W) – July August.

Scale: Cantabrian to Norwegian Seas

juv migration: After end of larval drift are believed to actively migrate to nursery areas (above).

Tagging data suggest juveniles then generally stay in the same area until recruitment. However, some evidence of movement of second winter fish out of N. North Sea to west of Scotland, from NW to W or SW of Ireland and into Celtic Sea and Cornwall area.

long-term trend: Fishery, and hence study is post World War II. This stock was only identified and exploited in the mid 1970s. At that time, spawning and post spawning migration was very similar in timing and space. However, overwintering was west of Ireland, fish left North Sea in September. This departure time shifted gradually to the current pattern from 1975 to 1990, and has been relatively stable since. There is some evidence of changes in recruit distribution. In the 1980s, key areas were west of Ireland, and west of the Hebrides. Both these areas are not heavily occupied now, with NW Ireland and the N North Sea becoming more important.

nowadays characteristics: Large healthy stock fished at around 0.2 F. Generally good stable recruitment with rare (c. once ever 15 years) low years. Very wide spread spawning in time and space (Gibraltar to Cape Wrath – January to July). Dramatic recent change in pre-spawning migration (track and time), reversion would have significant management implications

potential env. influence: Considerable evidence that migration and distribution is modulated by temperature. Adult fish seem to avoid water cooler than 8.5C, and pre-spawning migration seems to start when water reaches this temperature in the overwintering areas. Timing and area choice for feeding migration and areas would suggest strong links to *Calanus*. No real evidence from IBM studies for transport modulation of recruitment. About 50% of the variability in the historical recruitment series may be explained by an index of wind induced turbulence.

Supporting references

Augustin, N. H., Borchers, D. L., Clarke, E. D., Buckland, S. T. and Walsh, M. 1998. Spatiotemporal modelling for the annual egg production method of stock assessment using generalized additive models. *Can. J. Fish. Aquat. Sci*., 55: 2608–2621.

Bakken, E; and Westgaard, T. (1986). Intermixture of the North Sea and western mackerel ICES-CM-1986/H:65.

Bartsch, J. and Coombs, S. (Submitted) An individual-based model of the early life-history of mackerel (*Scomber scombrus*) in the eastern North Atlantic simulating transport, growth and mortality. Ecological Modelling 138: 127–141.

Beare, D. J. and Reid, D. G., 2002. Investigating spatio-temporal change in spawning activity by Atlantic mackerel between 1977 and 1998 using generalized additive models. *ICES Journal of Marine Science*, 59: 711–724.

Beare, D. J., Imrie, C., Mosqueira, I., Korre, A., McAllister, M., and Reid, D. G. (2002). Comparing the performance of Traditional, Generalized Additive Model and Geostatistical Estimators of Mackerel Annual Egg Production along the Western Continental Shelf., pp. 1–18. ICES Working Document, Copenhagen.

Beare, D. J., Burns, F., Jones, E.G., Peach, K. J., and Reid, D. G. (2003). The ongoing invasion of the northern North Sea by fish species with southern biogeographic affinities. ICES CM 2003/Q:24.

Belikov, S. V., Jakupsstovu, S. H., Shamrai, E; Thomsen, B. (1998) Migration of mackerel during summer in the Norwegian Sea. ICES-CM-1998/AA:8.

Bez, N. and Rivoirard, J., 2000. On the role of sea surface temperature on the spatial distribution of early stages of mackerel using inertiograms. ICES Journal of Marine Science, 57: 383–392.

Bez, N. and Rivoirard, J. 2001. Transitive geostatistics to characterize spatial aggregations with diffuse limits: an application on mackerel ichtyoplankton. Fisheries Research, 50: 41–58.

Borja, A., Uriarte, A., and Egaña, J. (2002) Environmental factors and recruitment of mackerel, *Scomber Scombrus* L. 1758, along the north-east Atlantic coasts of Europe. Fish. Oceanogr. 11:116–127.

Cunningham, C. L. 2002. Improved Management of North East Atlantic Mackerel, Using Bayesian Modelling Methodologies. PhD Thesis, University of London, United Kingdom.

Dawson, W. A. 1983. A Preliminary Analysis of Mackerel (*Scomber scombrus* L.) Otolith (L_1) measurements. ICES C.M. 1983/H:29.

Dawson, W. A. 1986. Mackerel (*Scomber scombrus L.*) Otolith L_1 Measurements as a Method of Stock Separation. ICES C.M. 1986/H:24.

Eltink, A. T. G. W. (1987). Changes in age-size distribution and sex ratio during spawning and migration of Western mackerel (*Scomber scombrus* L.). J. CONS. CIEM., vol. 44, no. 1, pp. 10–22.

Eltink, A. and Gerritsen, J. (1982). Growth, spawning and migration of western mackerel. ICES-CM-1982/H:31.

Hamre, J. (1978). Biology, exploitation, and management of the Northeast Atlantic mackerel. *In:* The assessment and management of pelagic fish stocks. 1980, pp. 212–242, Rapp. P.-V. Reun. CIEM., Vol. 177.

Holst, J. C, and Iversen, S. A. (1992). Distribution of Norwegian spring-spawning herring and mackerel in the Norwegian Sea in late summer, 1991. ICES-CM-1992/H:13.

Imrie, C. E., Korre, A. and Reid, D. G. (2003). The use of geostatistical simulation for the estimation of the total annual egg production of Atlantic mackerel (*Scombrus scombrus*) with associated confidence intervals. ICES CM 2003/X:11.

Iversen, S. A. D., Skogen, M., Svendsen, E. (2002). Availability of horse mackerel (*Trachurus trachurus*) in the north-eastern North Sea, predicted by the transport of Atlantic water. Fisheries Oceanography. Vol. 11, no. 4, pp. 245–250.

Iversen, S. A., Skagen, D. W. (1989) Migration of western mackerel to the North Sea 1973–1988. ICES-CM-1989/H:20.

Lockwood, S. J., Nichols, J. H., and Dawson, W. A. 1981a. The mackerel (*Scomber scombrus*) spawning in the Bay of Biscay, Celtic Sea and west of Ireland. Rapp. P.-v. Reun. Cons. Int. Expor. Mer, 178, 171–173.

Lockwood, S. J. 1988. The mackerel – its biology, assessment and the management of a fishery. Fishing News Books Ltd, Farnham, UK.

Lockwood, S. J., Nichols, J. H. and Coombs, S. H. (1977). The development rates of mackerel (*Scomber scoumbrus*, L.) eggs over a range of temperature. ICES, Copenhagen.

Lockwood, S. J., Nichols, J. H., and Dawson, W. A. (1981). The estimation of a mackerel (*Scomber scombrus* L.) spawning stock size by plankton survey. Journal of Plankton Research 3, 217–233.

Lucio, P. and Martin, I. 1989. Biological aspects of horse mackerel (*Trachurus trachurus* L. 1758) in the Bay of Biscay in 1987 and 1988. ICES CM 1989/H:28.

Mosqueira, I. 2004. Bayesian and Geostatistical Methods for the Estimation of Spawning Stock Biomass from Pelagic Egg Surveys. PhD Thesis, University of London, United Kingdom.

Murray, T., LeDuc, S., and Ingham, M. (1983). Impact of climatic factors on early life stages of Atlantic mackerel, *Scomber scombrus*, L. An application of meteorological data to a fishery problem. J. CLIM. APPL. METEOROL., vol. 22, pp. 57–68.

Nesbø, C. L., Rueness, E. K., Iversen, S. A., Skagen, D. W., and Jakobsen, K. S. 2000. Phylogeography and population history of Atlantic mackerel (*Scomber scombrus* L.): a genealogical approach reveals genetic structuring among the eastern Atlantic stocks. Proc. R. Soc. Lond. B. 267: 281–292.

Nottestad, L., Giske, J., Holst, J. C., and Huse, G. (1999). A length-based hypothesis for feeding migrations in pelagic fish Can. J. Fish. Aquat. Sci. suppl. 1999.

Rankine, P. A. and Walsh, M. (1982). Tracing the migrations of Minch mackerel. SCOTT. FISH. BULL., no. 47, pp. 8–13.

Reid, D. G. 2001. SEFOS – shelf edge fisheries and oceanography studies: and overview. Fish. Res. 50: 1–15.

Reid, D. G., Walsh, M., and. Turrell, W. R (2001) Hydrography and mackerel distribution on the shelf edge west of the Norwegian deeps. Fisheries Research 50: 141–150.

Reid, D.G., Turrell, W. R., Walsh, M., and Corten, A. (1997) Cross-shelf processes north of Scotland in relation to the southerly migration of western mackerel. ICES J. Mar. Sci. Vol. 54, 168–178.

Reid, D. G., Eltink, A., and Kelly, C. (2003) Inferences on the changes in pattern in the prespawning migration of the western mackerel (*Scomber scombrus*) from commercial vessel data. ICES CM 2003/Q:19.

Sentiabrov, E. V., Bochkov, Yu. A., and Morozova, G. N. The long-term forecast of mackerel fishing conditions. Rybn. Khoz. (Mosc.). no. 2, pp. 28–30.

Sentyabov, E. V. and Plekhanova, N. V. (2000). Rapid variations of the Norwegian Sea water heat content during 1995–1999 and their influence on condition of the feeding plankton. ICES-CM-2000/M:33.

Simmonds, E. J., Beare, D. J., and Reid, D. G. (2003). Sensitivity of the current ICA assessment of western mackerel and short term prediction to the sampling error in the egg survey parameters. ICES CM 2003/X:10.

Uriarte, A., Alvarez, P., Iversen, S., Molloy, J., Villamor, B., Martins, M. M., and Myklevoll, S. (2001). Spatial pattern of migration and recruitment of Northeast Atlantic mackerel. ICES CM 2001/O:17.

Uriarte, A., and Lucio, P. (2001). Migration of adult mackerel along the Atlantic European shelf edge from a tagging experiment in the south of the Bay of Biscay in 1994. Fisheries Research. Vol. 50, no. 1–2, pp. 129–139.

Walsh, M., Skogen, M., Reid, D. G., Svendsen, E., and Mcmillan, J. A. (1996). The relationship between the location of western mackerel spawning, larval drift and recruit distributions: A modelling study. ICES-CM-1996/S:33.

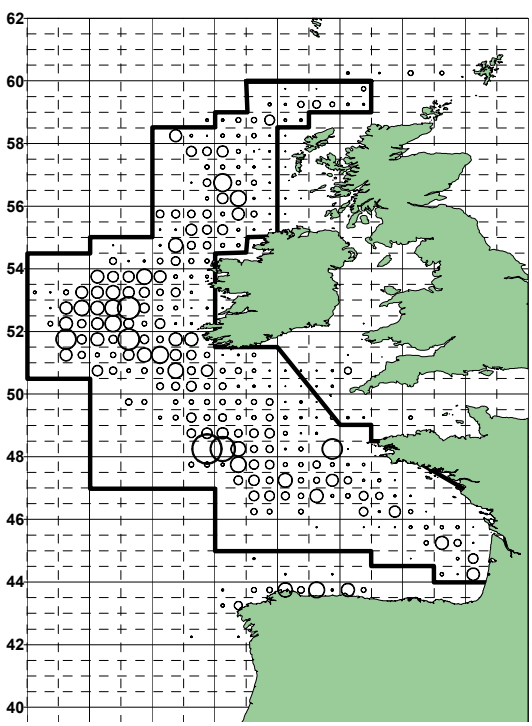
Walsh, M, and Martin, J. H. A. (1986) Recent changes in the distribution and migrations of the western mackerel stock in relation to hydrographic changes. ICES CM 1986/H:17.

Walsh, M., Reid, D. G., and Turrell, W. R. (1995) Understanding mackerel migration off Scotland: Tracking with echosounders and commercial data, and including environmental correlates and behaviour. ICES J. Mar. Sci. Vol. 52, 925–939.

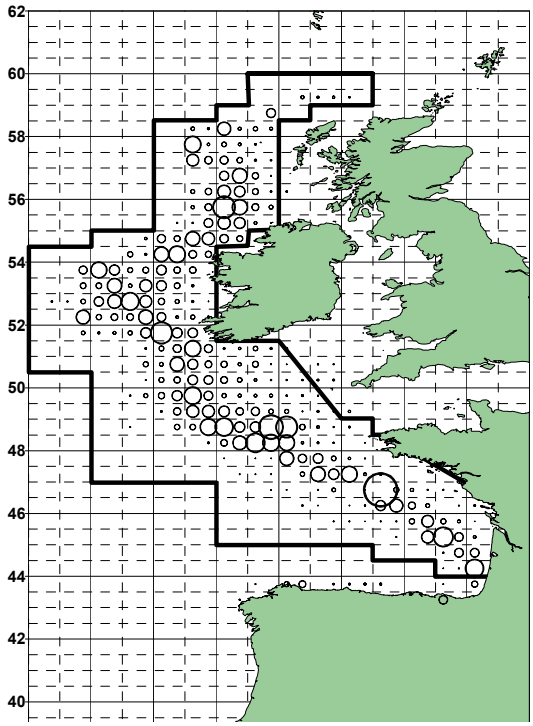
Walsh, M., Hopkins, P., Witthames, P. R., Greer-Walker, M., and Watson, J. 1990. Estimation of total atresia in the Western mackerel stock, 1989. ICES CM 1990/H:31.

Uriarte, A., Alvarez, P. Iversen, S., Molloy, J., Villamor, B., Manuel, M. and Myklevoll, S. 2001. Spatial pattern of migration and recruitment of North East Atlantic mackerel. ICES C.M. 2001/O: 17.

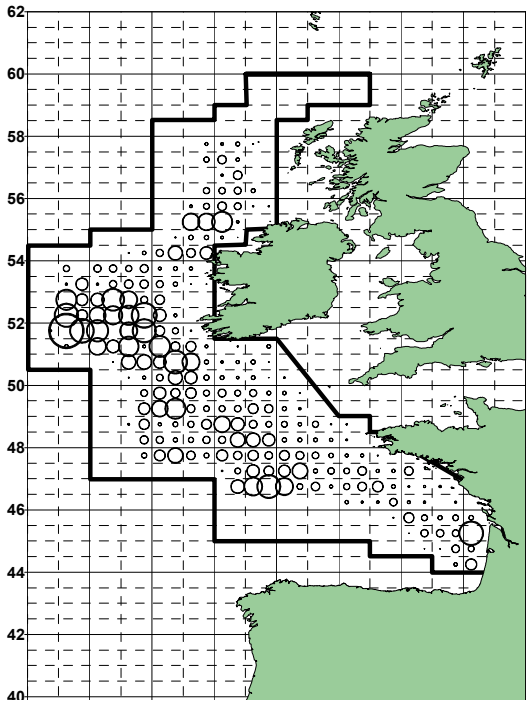
Supporting figures: Figure 5 to Figure 8.



2001



1998



1995

Figure 5. Distribution of spawning for the full survey season in 2001, 1998 and 1995. In 2001: note the wide spread west of the shelf break in Biscay, at Porcupine and west of the Hebrides. In 1998: note the tighter distribution at the shelf break, but still spread out at Porcupine. In 1995: note that again, like 2001 there is a wide spread west of the shelf break in Biscay and at Porcupine but less so west of the Hebrides.

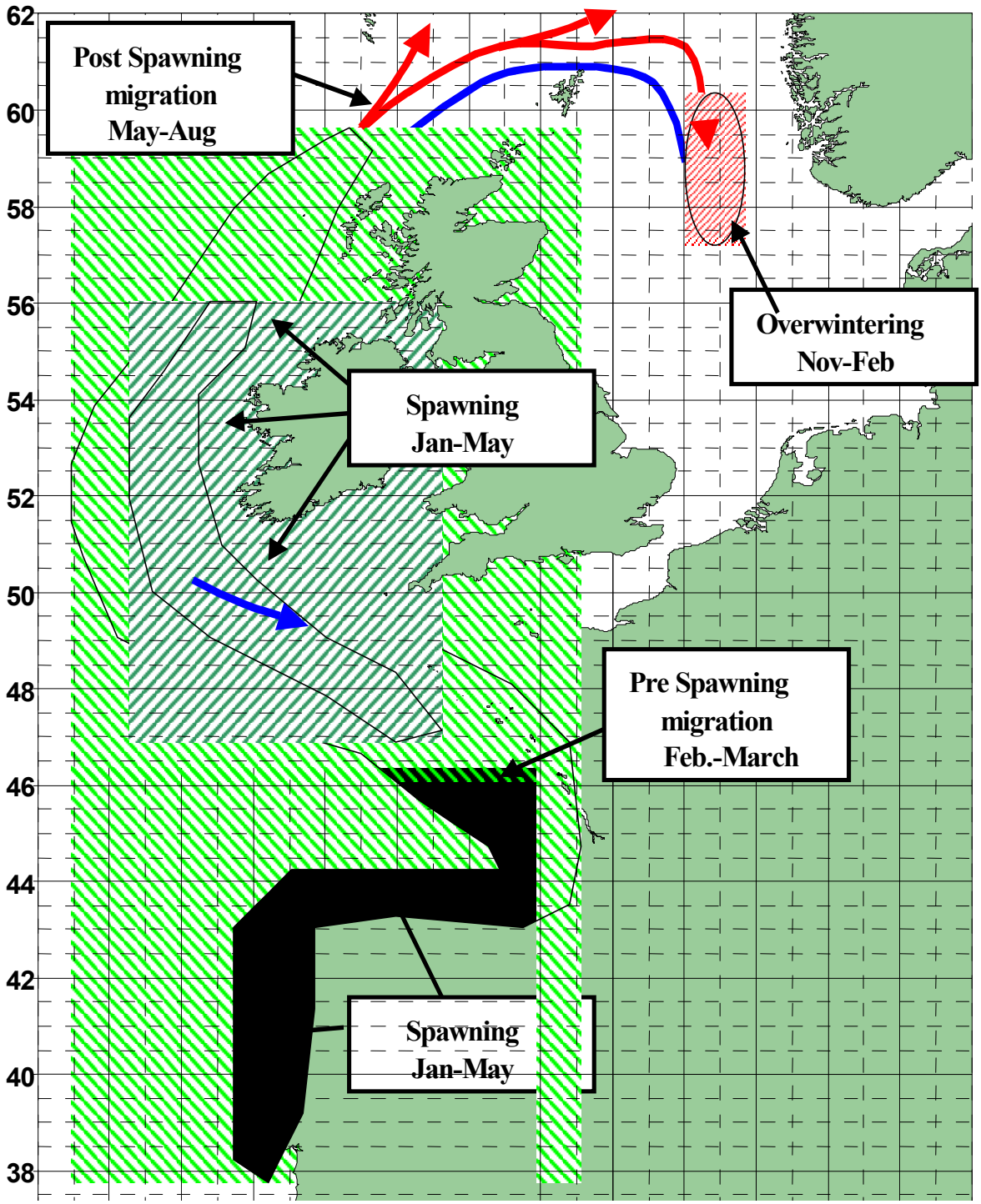


Figure 6. Migrations of adults of NEA mackerel.

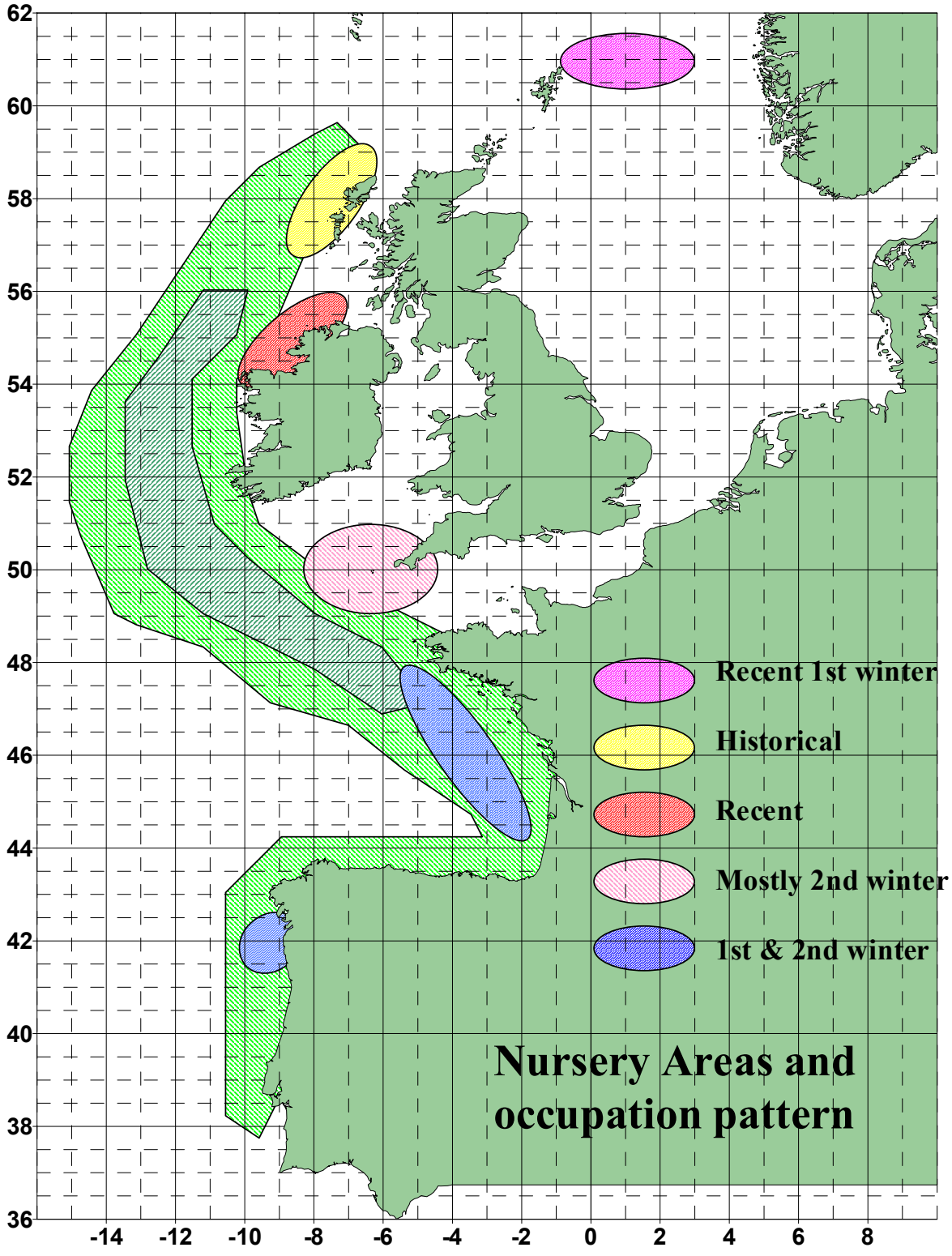


Figure 7. Migrations of juveniles of NEA mackerel.

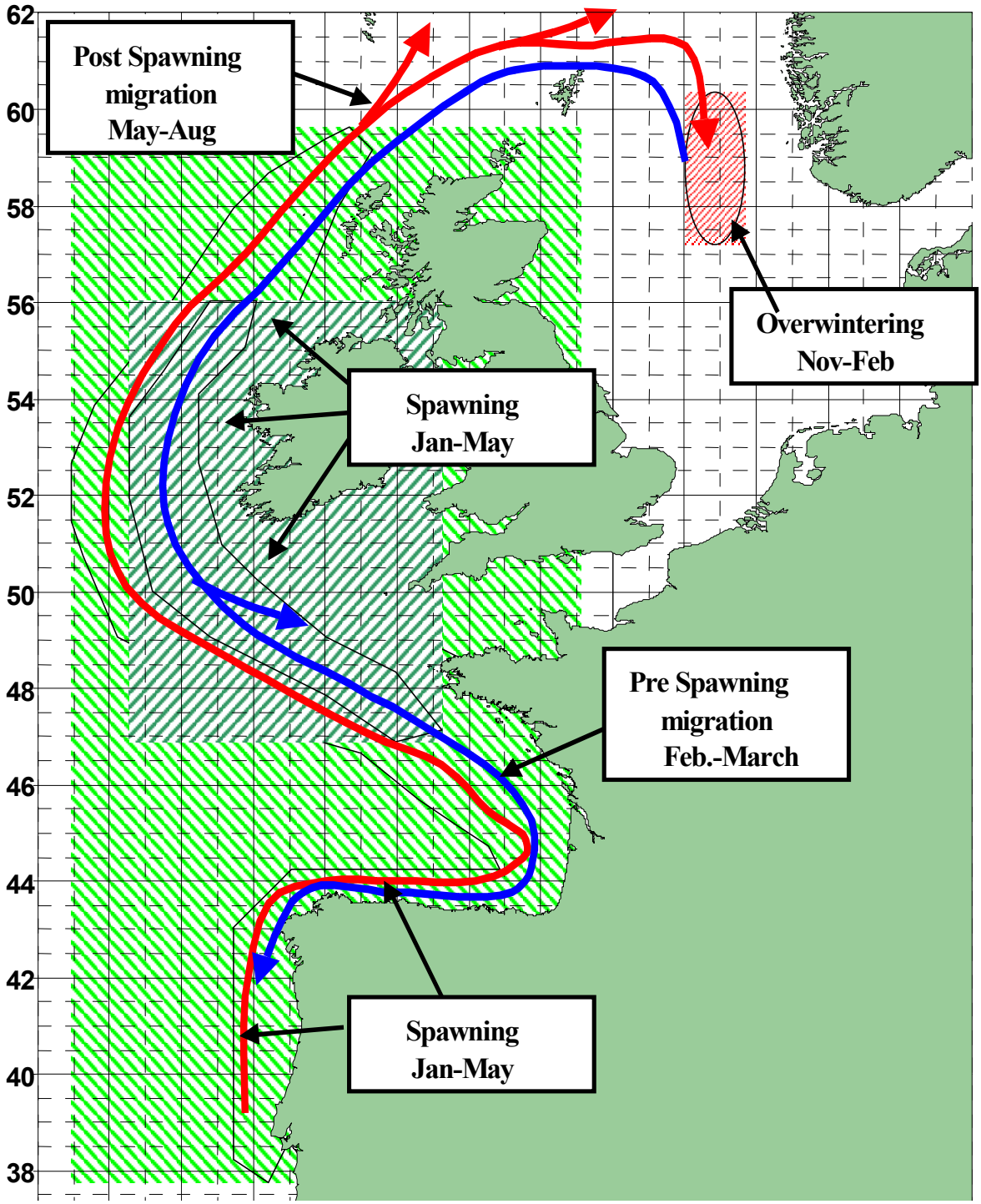


Figure 8.Tentative characterisation of NEA mackerel occupied are with potential physical processes impacting NEA mackerel.

3.1.3 Baltic sprat

life history traits: life span = 7y; matu = 1–2y; indeterminate multiple batch spawner

spawning: time: spring (March-August, depending to some degree on temperature); habitat: deep basins (Bornholm Basin, Gdansk Deep, Gotland Basin); schooling behaviour: feeding schools in the halocline during day; dispersed in surface waters at night; co-occurring species: herring, cod during day

adult growth: time: summer/autumn; habitat: coastal areas; co-occurring species: juvenile herring

nursery: early juveniles (April-September): coastal areas

feeding regime: predation mode: (filter/snapping) depending on the size of prey; prey species: copepods *Pseudocalanus* sp., *Acartia* spp., *Temora longicornis*

adult migration: fourth/first quarter overwintering and pre-spawning migration into deep basins; third quarter migration to coastal feeding grounds (see map);

juv. migration: end of larval drift to nursery areas dependent on the wind driven current situation (coastal vs. basins)

long-term trend: period of extremely high stock sizes in the 1990s due to a release in predation pressure by the collapsed cod stock and high (although variable) recruitment

potential env. influence: *Recruitment* positively influenced by increased temperatures (high NAO) during the 1990s and associated increase in *Acartia* spp. abundance (main larval food); reduced growth (eventually affecting recruitment) since late 1990s due to decrease in abundance of *Pseudocalanus* sp. (main adult food in winter/spring) and strong competition due to the high stock size.

Rough description of migrations: Central Baltic sprat moves for overwintering and pre-spawning feeding into the deep basins, i.e., Bornholm Basin, Gdansk Deep and Gotland Basin (November-December). Spawning takes place in the deep basins between March and August, afterwards sprat is leaving the deep areas for coastal feeding (June-August). Eggs and larvae drift out of the deep basins into coastal nursery areas depending on the wind-driven currents, but mainly in north-easterly direction.

Supporting References

Aro, E. 1989. A review of fish migration patterns in the Baltic. Rapp. P.-v. Réun. Cons. int. Explor. Mer, 190: 72–96.

Köster, F. W., Hinrichsen, H.-H., Schnack, D., St. John, M. A., MacKenzie, B. R., Tomkiewicz, J., Möllmann, C., Kraus, G., Plikshs, M., Makarchouk, A. and Eero, A. 2003. Recruitment of Baltic cod and sprat stocks: identification of critical life stages and incorporation of environmental variability into stock-recruitment relationships. Sci. Mar., 67 (suppl. 1): 129–154.

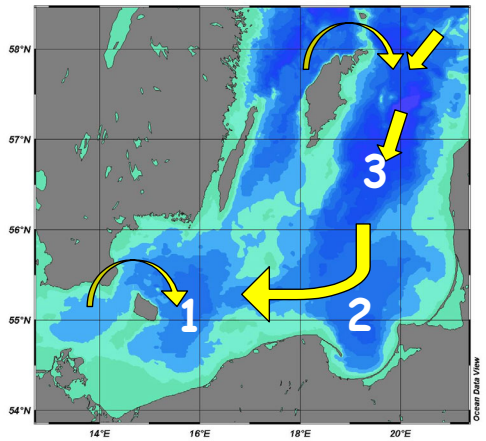
Köster, F. W., Möllmann, C., Neuenfeldt, S., Vinther, M., St. John, M. A., Tomkiewicz, J., Voss, R., Hinrichsen, H. H., Kraus, G. and Schnack, D. 2003. Fish stock development in the Central Baltic Sea (1976–2000) in relation to variability in the physical environment. ICES Mar. Sci. Symp., 219: 294–306.

MacKenzie B. R. and F. W. Köster. 2004. Fish production and climate: sprat in the Baltic Sea. Ecology, 85: 784–794.

Parmanne, R., Rechlin, O. and Sjøstrand, B. 1994. Status and future of herring and sprat stocks in the Baltic Sea. Dana, 10: 29–59.

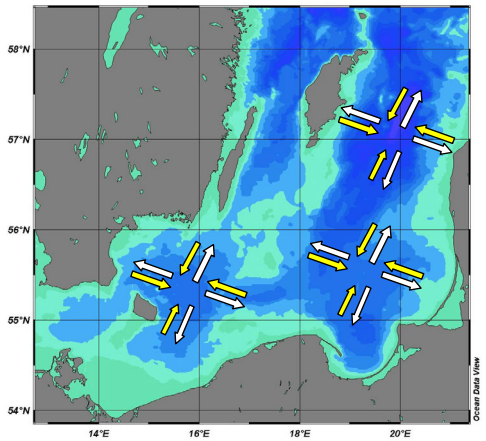
Supporting figures: Figure 9.

Winter feeding migration
(among basins)



(blue areas comprise roughly spawning areas;
1-Bornholm Basin, 2-Gdansk Deep, 3-Gotland Basin; adapted from Aro et al., 1989)

Spawning and feeding migration
(into and out of deep basins)



(Schematic of in and out basin migration for spawning [yellow; March-July] and post-spawning coastal feeding [white; June-August)

Figure 9. Schematic diagram of Baltic sprat migrations.

3.1.4 Iberia and Biscay sardine

Life history traits: life span = 8–10y; matu = 1–2y; indeterminate multiple batch spawner (batch fecundity 300–400 eggs g^{-1});); metamorphose at 4–5 cm.

Spawning: Time: Some mature sardine and eggs can be found all year around, but the main period is between October and June, with a latitudinal gradient in the duration and peak of the season (longer duration and earlier peak in the south). First time spawners are believed to have a narrower spawning season. Habitat: Spawning occurs along the shelf (with no clearly defined spawning grounds) and close to the bottom during dusk. Areas of permanent upwelling and offshore transport (like the northwestern Iberian corner) are generally avoided. Schooling behaviour: spawning close to the bottom during dusk. Co-occurring species: Spawning coincides with that of mackerel and horse mackerel off Iberia and mackerel, horse mackerel and anchovy in Biscay.

Adult growth (from Portuguese data): Time: Size/weight gain mainly occurs between late spring and early autumn; Size growth is mainly limited to the first 2–3 years of life, while in weight continues throughout life; Condition factor is highest in early autumn, when fat contents (up to 20%) are highest; Lowest condition and fat contents (down to 2–3%) are observed in late winter; Habitat: Adults are mainly distributed within the inner and mid-shelf with occasional excursions to the outer shelf; Co-occurring species: In these areas they co-occur with mackerel, sprat, horse mackerel, anchovy, bogue, Japanese mackerel (the first two with a more northerly distribution and the last two with a more southerly one).

Nursery (from Portuguese data): Time: summer, strong year-classes being usually detected in autumn acoustic surveys (age-0); Habitat: in these surveys age-0 fish are detected in the inner shelf of Portugal (off the Ria of Aveiro and off Lisbon) and the Gulf of Cadiz (well localised areas)..; inner shelf, well localised, retention areas?; Co-occurring species: off western Portugal sardine nursery areas may coincide with those of horse mackerel.

Feeding regime: Sardine feeding takes place throughout the year. Predation mode: Sardine can both filter and particulate feed depending on prey size. Experiments in laboratory conditions have recently demonstrated that particulate/filter feeding are associated to distinct behaviours (looser school organisation, faster swimming, more frequent change of direction and more energy expenditure during the former). Prey species: Phytoplankton and micro-zooplankton dominate in terms of numbers and volume respectively and there are indications that the size range of preys is inversely related to sardine size (finer gill rackers in bigger/older fish). Experiments in laboratory conditions have recently demonstrated that fish eggs are highly appreciated by sardine.

Adult migration: Seasonal movements are often reported by fishermen, but this empirical knowledge has never been sufficiently compiled/verified to provide a description at a regional scale. Length and age range in IXa and VIIIc and the comparison of numbers at age from commercial and survey data in the 1980s provide some indirect evidence of northward movements in the Iberian Peninsula a long life. The scale of these movements remains unknown, as well as the potential fluxes of sardine across the current stock boundaries (Gibraltar in the south and inner Bay of Biscay in the north).

Juvenile migration: Unknown and generally assumed to be minor.

Long-term trend: Sardine has been exploited off Iberia throughout the 20th century, with catches fluctuating between 100 – 250 Ktonnes. Analytical assessment (performed for the period 1977-today) indicates that the Iberian stock oscillates between high and low cycles of SSB. Stronger, more frequent and more widespread recruitments were observed in the 1980s than in the 1990s. The spawning area has contracted during the 1990s, mainly due to a reduction of spawning activity off northern Portugal, Galicia and off north of Spain (Cantabrian coast).

Nowadays characteristics: Off Iberia, moderate recovery after historically low SSB in 2000, mainly due to the strong recruitment in 2000 off northern Portugal (that in following years has expanded its distribution to the north); Spawning area has recently expanded again in northern Portugal and western Galicia; Recent recruitments (after 2001) are considered to be low.

Potential env. influence: Poleward current intensity, wind strength and direction, upwelling, river outflow, Mediterranean water outflow and the mesoscale features created from the interaction of the above seem to affect sardine dynamics.

Supporting references

Bode, A., Carrera, P., Lens, S. (2003). The pelagic foodweb in the upwelling ecosystem of Galicia (NW Spain) during spring: natural abundance of stable carbon and nitrogen isotopes. ICES J Mar Sci, 60: 11–22

Borges, M. F., Santos, A. M. P., Crato, N., Mendes, H., Mota, B. (2003). Sardine regime shifts off Portugal: a time series analysis of catches and wind conditions. Sci Mar 67: 235–244.

Carrera, P. and Porteiro, C. (2001). Stock dynamic of the Iberian sardine (*Sardina pilchardus*, W.) and its implication on the fishery off Galicia (NW Spain). Sci Mar 67 (1): 245–258.

Chícharo, M. A, Esteves E., Santos A. M. P., dos Santos A., Peliz, A., Ré, P. (2003). Are sardine larvae caught off northern Portugal in winter starving? An approach examining nutritional conditions. Mar Ecol Prog Ser 257: 303–309.

Santos, A. M. P., Peliz, A., Dubert, J., Oliveira, P. B., Angelico, M. M. , Ré, P. (2004) Impact of a winter upwelling event on the distribution and transport of sardine eggs and larvae off western Iberia: a retention mechanism. Cont Shelf Res. 24: 149–165.

Silva, A. (2003) Morphometric variation among sardine (*Sardina pilchardus*) populations from the north-eastern Atlantic and the western Mediterranean. ICES J Mar Sci. 60: 1352–1360.

Stratoudakis, Y., Bernal, M., Borchers, D., Borges, F. (2003). Changes in the distribution of sardine eggs and larvae off Portugal, 1985–2000. Fish Oceanogr. 12: 49–60.

Supporting figures: Figure 10 to Figure 12.

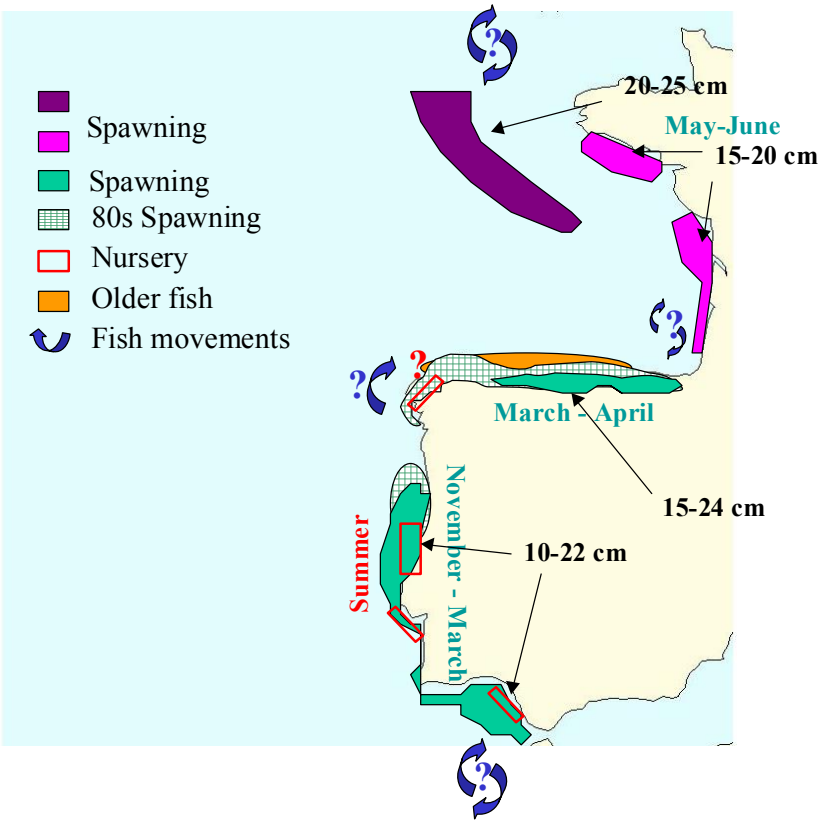


Figure 10. Schematic life cycle of sardine around Iberia and in Biscay.

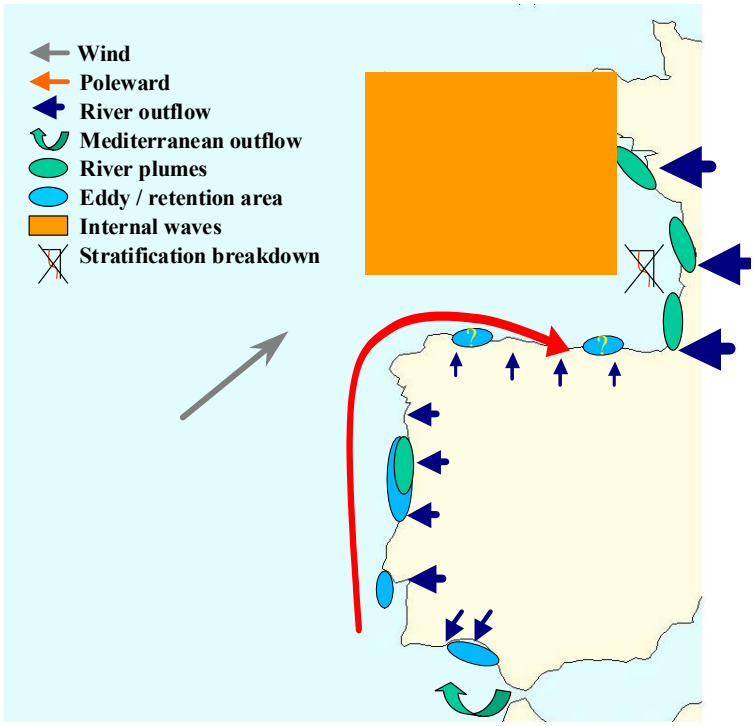


Figure 11. Physical processes around Iberia and in Biscay in a cyclonic situation (SW winds). Poleward current is activated and interacts with river plumes in Portugal to generate retention areas. River plumes in France are packed along the coast. Thermal stratification is broken down on the French shelf.

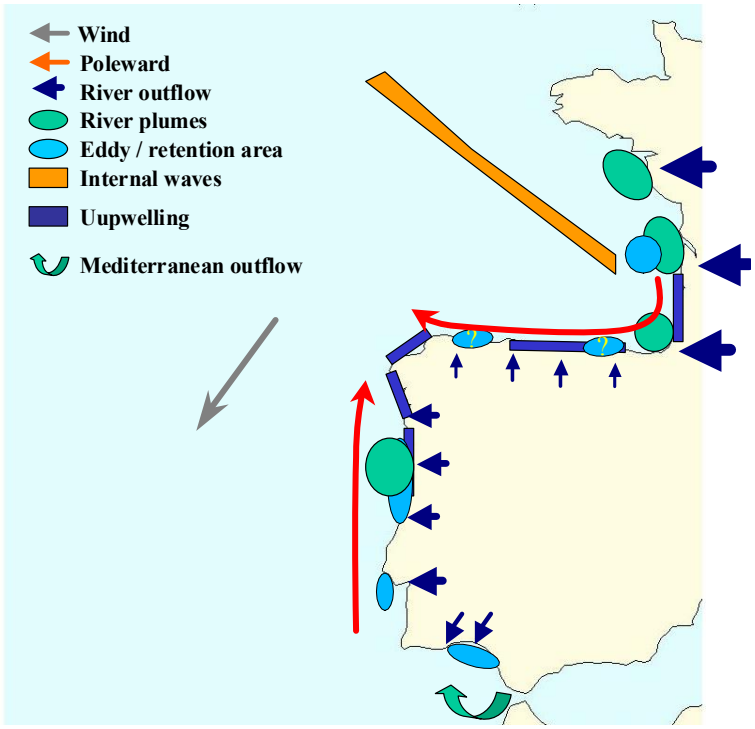


Figure 12. Physical processes under anticyclonic situation (NNE winds). Many local upwelling events are activated along the coasts. River plumes are spread across the shelves. The Poleward current is stopped. Circulation on the Northern coast of Spain is reversed to the West. Meeting of the two currents around Galicia generates a flow going outside the shelf.

3.1.5 Bay of Biscay anchovy

life history traits: life span = 3y; matu = 1y; indeterminate multiple batch spawner.

spawning: time: spring (May-July); habitat: presently realised: river plumes Adour, Gironde, Shelf edge SE (see map); schooling behaviour: small soft schools aligned 10 to 25 m above the bottom during day; often vertically separated when cohabitant with horse-mackerel; small dense schools at the surface at night; co-occurring species: sardine and horse mackerel, sprat, mackerel

adult growth: time: summer/autumn; habitat: presently northern part of Biscay; co-occurring species: sardine, sprat, horse mackerel

nursery: early juveniles (August / September): mainly south of 46°00N, far offshore and also very close to the coast; schooling behaviour: small dense schools at the surface with high potential to desegregate; co-occurring species; juveniles horse mackerel (offshore), juveniles sardine mackerel (shelf and inshore).

late juveniles (November / December): recruiting in coastal areas over the shelf from the Spanish coast to the French coast mostly south of 47°N

feeding regime: predation mode: (filter / snapping) depending on the size of preys; prey species: copepods

adult migration: First quarter pre-spawning migration south of 46°; second quarter spawning mid south (Adour, Gironde, shelf break); third quarter migration to the north for feeding grounds and back (see map); fourth quarter in the North of Biscay (South Brittany)

juv. migration: At the end of larval drift and after metamorphosis they recruit to coastal areas over the shelf (some being also adult feeding grounds)

long-term trend: reduction of distribution area along Spanish northern coast, reduction of spring catches in the south, disappearance of autumn catches in the south, development of an autumn fishery in North Biscay.

nowadays characteristics: one major spawning ground (Gironde) and secondary ones in front of the Adourand along the shelf edges. one major spawning ground (Gironde); number of spawning grounds depending on stock demography; large inter-annual recruitment fluctuations with no temporal correlation; importance of the Gironde area in the stock dynamics.

potential env. influence: Recruitment positively influenced by second quarter coastal upwelling along French and Spanish coasts in the SE corner of Biscay (46°N; 4°W) under NE wind condition and negatively influenced by third quarter water column stratification breakdown under W-SW storms. There is evidence that larval growth is enhanced when larval drift stays on the French shelf.

Supporting references

Allain, G., Petitgas, P., and Lazure, P. 2001. The influence of mesoscale ocean processes on anchovy (*Engraulis encrasicolus*) recruitment in the Bay of Biscay estimated with a three-dimensional hydrodynamic model. *Fisheries Oceanography* 10: 151–163.

Allain, G., Petitgas, P., Grellier, P., and Lazure, P. 2003. The selection process from larval to juvenile stages of anchovy (*Engraulis encrasicolus*) in the bay of Biscay investigated by lagrangian simulations and comparative otolith growth. *Fisheries Oceanography* 12: 407–418.

Borja, A., Uriarte, A., Egaña, J., Motos, L., and Valencia, V. 1998. Relationships between anchovy (*Engraulis encrasicolus*) recruitment and environment in the Bay of Biscay. *Fisheries Oceanography* 7: 375–380.

Cendrero, 0., Cort, J., and Cardenas, E. 1981. Revisión de algunos datos sobre la biología de la anchoa, *Engraulis encrasicholus* (L.) del Mar Cantábrico. Bol. Inst. Espa. Oceano., 311: 118–123.

Cort, J., Cendrero, O., Iribar, X. 1976. La anchoa, *Engraulis encrasicholus* (L.), del Cantábrico. Bol. Inst. Espa. Oceano., 220: 3–34.

Junquera, S. 1984. Pêche de l'anchois (*Engraulis encrasicolus*) dans le Golfe de Gascogne et sur le littoral atlantique de Galics depuis 1920. *Rev. Trav. Inst. Pêches marit.* 48: 133–142.

Massé, J. 1996. Acoustic observations in the Bay of Biscay: schooling, vertical distribution, species assemblages and behaviour. Sci. Mar. 60 (supl.2): 227–234.

Motos, L. 1996. Reproductive biology and fecundity of the Bay of Biscay Anchovy Population (*Engraulis encrasicholus* L.) Sci. Mar. 60 (supl.2): 195–207.

Motos, L., Uriarte A., and Valencia, V. 1996. The spawning environment of the Bay of Biscay anchovy (*Engraulis encrasicolus*, L.). Scientia Marina 60: 117–140

Uriarte, A., Prouzet, P., and Villamor, B. 1996. Bay of Biscay and Ibero Atlantic anchovy populations and their fisheries. *Scientia Marina* 60: 237–255.

Uriarte, A., Sagarminaga, Y., Scalabrin, C., Valencia, V., Cermeño, P., de Miguel, E., Gomez Sanchez, J. A., and Jimenez, M. 2001. Ecology of anchovy juveniles in the Bay of Biscay 4 months after peak spawning: Do they form part of the plankton?. ICES CM 2001/W:20.

Vaz, S. and Petitgas, P. 2002. Study of the Bay of Biscay anchovy population dynamics using spatialised age-specific matrix models. ICES CM 2002/O:07.

Supporting figures: Figure 11 to Figure 16.

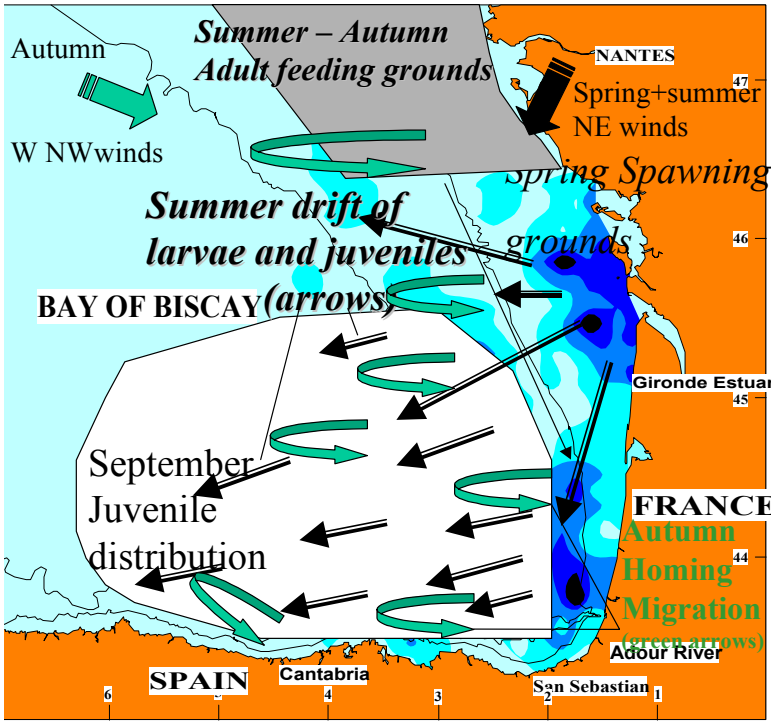


Figure 13. Present day life cycle of anchovy in Biscay.

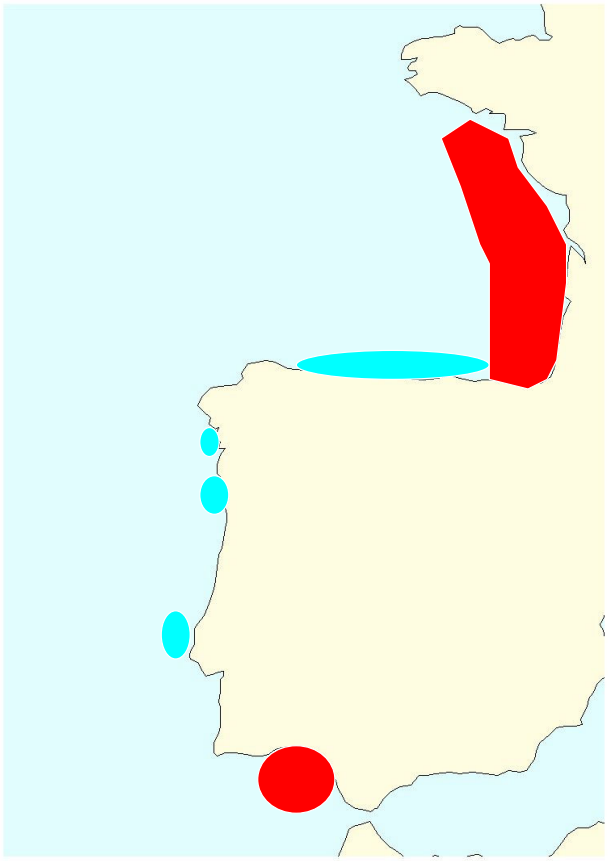


Figure 14. Present situation of anchovy populations. Red: present day fisheries and main "populations"; blue: residual "populations" with sporadic fisheries

Spatial evolution of the fishery:

- a : Spring fishery first half of XXth century (up to 1960). mostly spanish.
- b : Spring fishery (1966-1975). mostly spanish.
- c : Spring Spanish fishery since mid-eighties
- d : Summer-Autum French fishery since mid-eighties

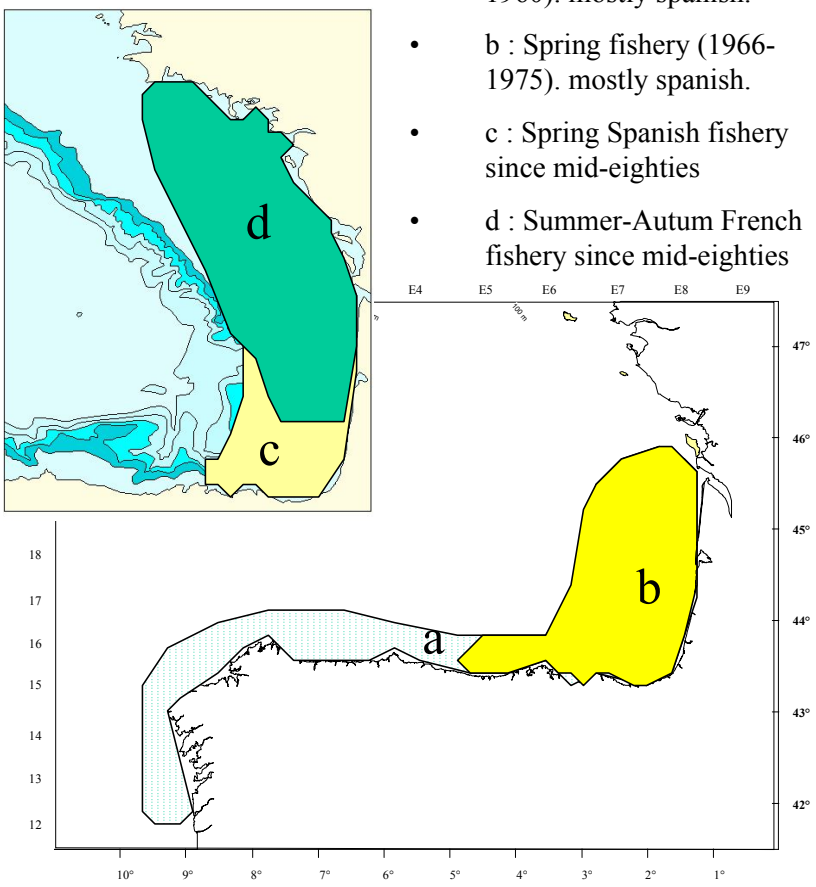


Figure 15. Long-term evolution of anchovy fishery in space and seasons.

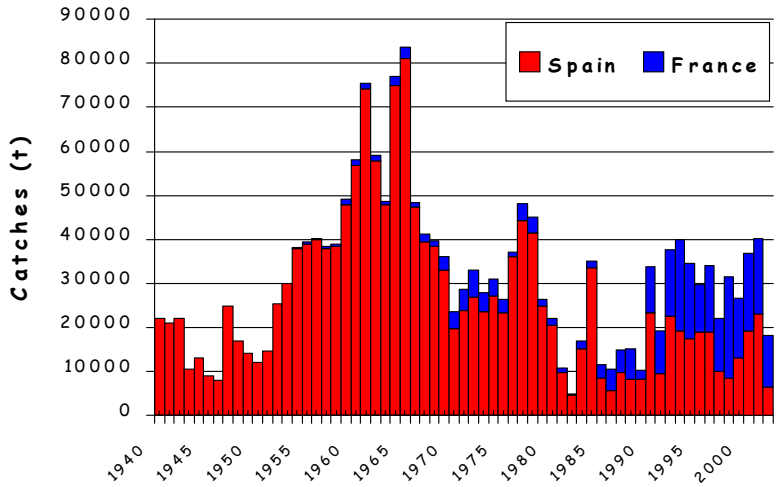


Figure 16. Long-term evolution of anchovy landings in Biscay (ICES Divisions VIIIc,b,a).

3.2 ToR c):

Review existing relationships with physical and biological environmental indicators

Presentations evidenced a link between recruitment or stock biomass and environmental parameters for NSS herring (inflow of Atlantic water in the Barents Sea), NEA mackerel (spring wind induced turbulence), Baltic sprat (spring salinity dependent on climate [NAO], salinity and oxygen dependent on inflow of North Sea water to the Eastern Baltic, larval retention in the Bornholm Basin dependent on atmospheric forcing), Biscay anchovy (spring upwelling and water column stratification), South African anchovy (upwelling and jet current intensity and spawning location) and, sardine (winter northerly winds inducing upwelling; although process studies, i.e., SURVIVAL project, did not validate the mechanistic hypothesis underlying the relationship). Correlation was observed to "work" over a period of time only, meaning that the interaction of the population with the environment had changed. Examples were: Baltic sprat for which a retention index in Bornholm was correlated with recruitment in the 1990s but not in the 1980s; South Africa anchovy for which in recent years, recruitment variation was explained if a new parameter, i.e., the spawning location, was added to previous indicators of upwelling; Biscay anchovy for which in recent years recruitment variation was explained if a new parameter, i.e., water column stratification breakdown, was added to previous indicators of upwelling. For NEA mackerel a larval IBM was developed (European Union program SEAMAR) which took into account larval growth and mortality depending on temperature and zooplankton production as well as larval drift. Results of the IBM model failed to predict historical lows in the recruitment series. To explain changes in the dependence of recruitment to particular mechanisms it was hypothesised that in different environmental regimes, the relative importance of different parameters was changed. It was concluded that the incorporation of adult behaviour was essential, as it was understood to be part of the reason for the changes in the linkage with the environment.

Supporting references

NSS herring:

Sætre, R., Toresen, R., Anker-Nilssen, T. 2002. Factors affecting the recruitment variability of the Norwegian spring-spawning herring (*Clupea harengus* L.). ICES Journal of Marine Science 59: 725–736.

Toresen, R. And Østvedt, O. J. 2000. Variation In Abundance Of Norwegian Spring Spawning Herring (*Clupea Harengus*, Clupeidae) Throughout The 20th Century And The Influence Of Climatic Fluctuations. Fish And Fish. 1: 231–256.

NEA Mackerel:

Bartsch, J., Reid, D. G., and Coombs, S. Prediction of mackerel recruitment with an Individual-based Model and comparison to field data. Submitted to Fisheries Oceanography.

Bartsch J., Coombs S. 2001. An individual-based growth and transport model of the early life-history stages of mackerel (*Scomber scombrus*) in the eastern North Atlantic. Ecological Modelling 138: 127–141

Borja A., Uriarte, A., and Egaña, J. 2002. Environmental factors and recruitment of mackerel, *Scomber scombrus* L. 1758, along the north-east Atlantic coast of Europe. Fisheries Oceanography 11: 116–127.

Sardine off Portugal:

Borges, M., Santos, A., Crato, N. *et al.* 2003. Sardine regime shifts off Portugal: a time series analysis of catches and wind conditions. Scientia Marina 67: 235–244.

Santos, A., Peliz, A., Dubert, J., Oliveira, P. *et al.* 2004. Impact of a winter upwelling event on the distribution and transport of sardine eggs and larvae off western Iberia: a retention mechanism. Continental Shelf Research, 24: 149–165.

Biscay anchovy:

Allain, G., Petitgas, P., and Lazure, P. 2001. The influence of mesoscale ocean processes on anchovy (*Engraulis encrasicolus*) recruitment in the Bay of Biscay estimated with a three-dimensional hydrodynamic model. Fisheries Oceanography 10: 151–163.

Borja, A., Uriarte, A., Egaña, J., Motos, L., and Valencia, V. 1998. Relationships between anchovy (*Engraulis encrasicolus*) recruitment and environment in the Bay of Biscay. Fisheries Oceanography 7: 375–380.

South African anchovy:

Huggett, J., Freon, P., Mullon, C. *et al.* 2003. Modelling the transport success of anchovy *Engraulis encrasicolus* eggs and larvae in the southern Benguela: the effect of spatio-temporal spawning patterns. Marine Ecology Progress Series 250: 247–262.

Miller, D., Field, J. 2002. Predicting anchovy recruitment in the southern Benguela ecosystem: developing an expert system using classification trees. South African Journal of Science 98 (9–10): 465–472.

Roy, C., Weeks, S., Rouault, M. *et al.* 2001. Extreme oceanographic events recorded in the Southern Benguela during the 1999–2000 summer season. South African Journal of Science 97 (11–12) Part 1: 465–471.

Baltic Sprat:

Köster, F. W., Möllmann, C., Neuenfeldt, S., Vinther, M., St. John, M. A., Tomkiewicz, J., Voss, R., Hinrichsen, H. H., Kraus, G., and Schnack, D. 2003. Fish stock development in the Central Baltic Sea (1976–2000) in relation to variability in the physical environment. ICES Mar. Sci. Symp., 219: 294–306.

MacKenzie, B. R. and Köster, F. W. 2004. Fish production and climate: sprat in the Baltic Sea. Ecology, 85: 784–794.

Möllmann, C., Kornilovs, G., Fetter, M. *et al.* 2003. The marine copepod, *Pseudocalanus elongatus*, as a mediator between climate variability and fisheries in the central Baltic Sea. Fisheries Oceanography 12(4/5): 360–368.

3.3 ToR d)

Produce and deliver assessment Working Groups with integrated environmental and ecological information relevant to the evaluation and prediction processes.

Most participants to the group were also members of assessment Working Groups of ICES/ACFM allowing direct linkage with applicability. Two products were considered: short-term recruitment prediction and medium-term interaction status between population and environment regime. The recruitment prediction relates the short term population forecast while the medium-term status of the population-environment interaction relates to suggesting alternative management options.

Use of correlative relationship between recruitment and environment for short-term recruitment prediction was discussed. GLOBEC special contribution #6 (Barange Ed., 2003) provided a framework to simulation-test the utility of using a recruitment-environment relationship with a low R-square of 50%. Applications were presented on anchovy in South Africa and Biscay which showed risk decrease or harvest increase as a consequence of using a recruitment-environment relationship. But breakdown or change in the recruitment-environment relationships were considered to jeopardise the utility of such relationships for prediction. Also noise in the correlation should be lower than that in the recruitment series for the correlation to be useful. The number of years for which the correlation exists depending on the level of noise in the relationship was also listed as an important parameter for the relationship to be useful in the assessment process.

It was felt that the group could propose in the future a list of indicators for diagnostic and health of stocks, relating to their spatial occupation, reproductive potential and demography. The intension would be to improve the understanding of long-term population dynamics and to devise qualitative/semi-quantitative indicators of stock state other than abundance at age.

3.4 ToR e)

Consider a scientific plan to set up a working group on environmental forcing on small pelagics as well as propose a framework articulating the group with existing LRC groups on surveys methods and fish ecology and ACFM groups on assessment.

Most of the meeting discussions related to this ToR. A major characteristic of the group's activity was the spatial pattern analysis of the life cycles. A major outcome of the group's activity was an understanding of the importance of adult behaviour in the maintenance or change of these patterns. The working hypothesis is that the spatial pattern of the life cycle specifies the interaction between the population and its environment. SGRESP focus is to understand how the spatial dynamics of the biological life cycle relates to population dynamics and that of the ecosystem and ultimately increase ICES ability to use ecological information in population prediction, assessment and management processes.

The regional scale was considered to be appropriate for implementing the scientific approach of the group. The group will integrate various data sources at regional scale. Work will be carried out within the framework of ICES and GLOBEC data policy. Particular attention will be paid to inform and communicate between group members and data produces on research activity intended to be carried out nationally using the international data.

Within ICES, groups with activity relevant for SGRESP are listed to be:

WGRP – Working Group on Recruitment Processes (Oceanography Committee);
SGGOOS – ICES-IOC Steering Group on GOOS (OCC);
PGHERS – Planning Group for Herring Surveys (Living Resources Committee);
WGMEGS – Working Group on Mackerel and Horse Mackerel Egg Surveys (LRC);
WGBIFS – Baltic International Fish Survey Working Group (LRC)
SGGROMAT – Study Group on Growth Maturity and Condition in Stock Projections (LRC);
SGSBSA – Study Group on the Estimation of Spawning Stock Biomass of Sardine and Anchovy (LRC);
WGMHSA – Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (ACFM);
WGNPBW – Northern Pelagic and Blue Whiting Fisheries Working Group (ACFM);
WGBFAS – Baltic Fisheries Assessment Working Group (ACFM).

Within SPACC, activity relevant for SGRESP was found to be:

Long-term variation in populations;
Use of environmental indices in population dynamics;
Reproductive habitats.

The group endorsed the aims of SGRESP and was willing to formulate at the end of the activity of the SG a scientific proposition to be continued.

3.5 ToR f)

Evaluate applicability of GLOBEC/SPACC findings to small pelagic stocks in ICES waters and establish contact between the Study Group work and GLOBEC/SPACC research.

Contacts had been made prior to the meeting. GLOBEC/SPACC representatives participated to the meeting. SPACC executive committee supported SGRESP as a regional scale European group (see letter attached). This ToR was answered by applying SPACC's general comparative approach and by discussing the complementarity of SGRESP with SPACC case studies. Some members of SGRESP also participate to SPACC facilitating complementarity and communication between groups.

An important aspect of SPACC is the comparative approach across regions worldwide. The group compared stocks for their recruitment dynamics across the last 3 decades to test for patterns. Estimates of recruitment (age-0 or age-1 depending on the stocks) were taken from the ACFM relevant assessment working group reports and the recruitment dynamics was compared across stocks.

Table 1. Statistics of the recruitment series for the different stocks considered (millions of 0 group fish, except for sprat which are age 1 fishes in year y+1). HM = horse mackerel (the stock limit between southern and western HM considered by the assessment WG is VIIIc/VIIIb -inner Biscay- while the HOMSIR project evidenced the limit to be Galicia). For NSS herring, ICES divisions IV, VIId and IIIa were considered; for sprat Baltic divisions 22–32 were considered.

	anchovy	sardine	HM_west	HM_south	Mackerel	Herring	Baltic sprat
Average	15,932	8,014	4,948	1,241	4,379	40,623	75,874
StD	8,171	4,245	9,605	486	1,539	26,802	60,705
CV	51%	53%	194%	39%	35%	66%	80%
Max	28,652	19,613	44,985	2,628	7,599	97,680	254,994
Min	3,457	3,519	372	595	1,057	2,732	10,389
Range	25,195	16,093	44,613	2,033	6,542	94,948	244,604

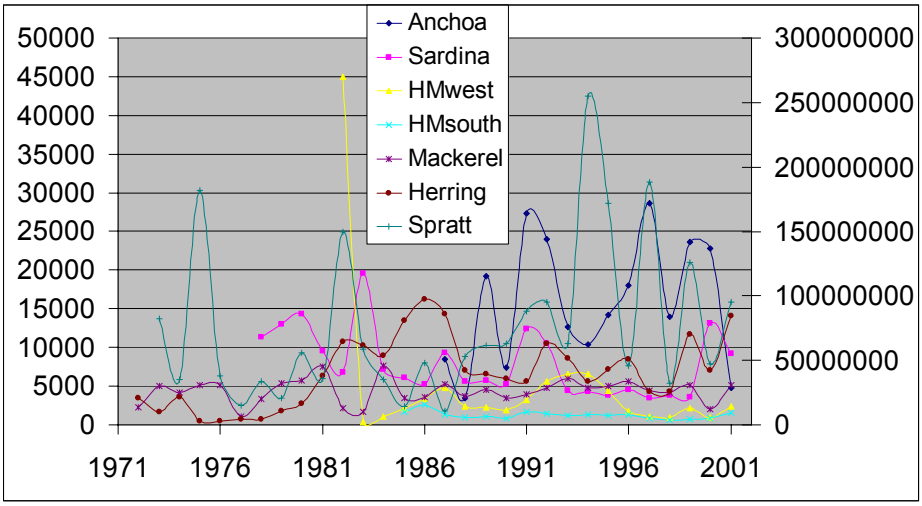


Figure 17. Recruitment series for the different stock considered. (age-1 for sprat; age-0 otherwise. in thousands of fish for herring and sprat; in millions of fish otherwise).

Stocks showed contrasting recruitment dynamics (Table 1 and Figure 17). Western Horse Mackerel (HM west) showed stable recruitment and occasional massive recruitment. Recruitment dynamics of HM west was found to be low with exceptional years separated in time or to be mostly good and with exceptional years. No consensus was found. NEA mackerel showed stable recruitment. HM west and NEA mackerel have similar spawning grounds though HM west would tend to spawn a few weeks later than NEA mackerel. The important difference in the recruitment dynamics of these stocks contrasted with their apparently similar spawning behaviour. Discussion pointed out that spawning behaviour of adults and vertical distribution of the icthyoplancton could be less similar than previously thought. In particular, HM west is an indeterminate batch spawner while NEA mackerel is a determinate spawner. Herring showed important recruitments since the 1980s (rebuilding of the stock since its collapse in the 70s) with high interannual variability. Sardine showed stable low recruitments in the late 1980s and 1990s in comparison to the 70s and to recent years. Sprat and anchovy showed high inter-annual variations in recruitment.

Table 2. Linear correlation coefficients between recruitment series of the different stocks.

1972–2001	**Correlation**	Sardine	HMwest	HMsouth	Mackerel	NSS_Herring	Baltic_Sprat
	Anchovy	0.208	-0.210	-0.072	-0.147	-0.279	0.189
	Sardine		-0.064	0.192	-0.247	-0.152	***-0.351***
	HMwest			0.325	-0.291	0.140	0.302
	HMsouth				0.016	***0.661***	-0.135
	Mackerel					0.044	0.039
	NSS_herring						-0.041

There was no obvious correlation pattern in the recruitment series between stocks (Table 2) except for two situations (in which the probability for the correlation to be due to randomness was low): Baltic sprat and Iberian sardine had negatively correlated recruitment; Southern horse-mackerel and NSS herring had positively correlated recruitment. No working hypothesis was formulated.

Within SPACC, most of the stocks under consideration are sardine and anchovy in large upwelling areas. The group is highly complementary to SPACC both on the research themes but also on the stocks considered. Stocks considered in SGRESP include not only sardine and anchovy but also mackerel, herring and sprat. The sardine and anchovy stocks considered in SGRESP are not located in large scale upwelling regions but in areas dominated by meso-scale processes and their interaction with the general circulation.

SPACC's activity on spawning habitat related to the distribution of eggs. SGRESP has the potential to integrate survey data on spawning adult fish (e.g., acoustics) with egg surveys as well as with juvenile surveys (e.g., bottom trawl).

4 RECOMMENDATIONS

4.1 Recommendations

To develop SGRESP activity, the group recommends the following.

a) Particularly for plankton, but also for fish, collected material (e.g., plankton sample, otoliths,...) should not be thrown away without query to SGRESP about potential interest. Data archaeology will be essential for construction of long-term and ecosystem-based comprehensive time series.
b) Comprehensive long-term and ecosystem-based data need be assembled at regional scale, shared and exploited among group members. ICES and GLOBEC data policy will regulate data sharing and exploitation.
c) A SPACC/ICES workshop on small pelagics in SW Europe is suggested with the idea of enhancing comprehensive assemblage and analysis of different types of data (physics, plankton, landings, surveys, model outputs) at regional scale in a long-term perspective (20–50 years).
d) A Theme session at ICES ASC in 2005 is suggested (Co-Chaired by J. Alheit and D. Reid) on the importance of old adults in population dynamics, particularly for migration.

4.2 Theme Session proposal 2005

ICES ASC 2005 Theme Session (SGRESP)

Title: Large scale changes in the migration of small pelagic fish and the factors modulating such changes.

Conveners: J. Alheit (Germany), D. Reid (UK)

Description: This session aims to bring together studies on observed changes in migration patterns. These could include; track, timing, distance or speed. Papers are invited on any documented changes in such migrations, but particularly where potential explanatory phenomena have been identified. These could include:

- Environmental change e.g., upwelling and other oceanic events (e.g., ENSO), or climate change e.g., NAO, current changes etc. These may include both physical (e.g., temperature) and biological (e.g., food availability) factors
- Population structure: For example stock abundance and demography (age structure) as well as population parameters such as condition factor, maturity ogives etc. The role of experienced adult fish in modulating migrations would be of particular interest
- Anthropogenic factors: This is principally aimed at the impact of fishing activity, particularly before and after stock collapses, but can include the direct result of fishing activity on migration paths and timings.

4.3 Next meeting and ToRs

The Study Group on Regional Scale Ecology of Small Pelagic Fish [SGRESP] (Chair: P. Petitgas, France) will meet at the end of February 2005 either in Plymouth, UK (GLOBEC IPO) or Galway, Ireland with the following terms of reference:

a) Identify gaps in the data inventory and continue to assemble data on life history stages (adult, egg, larva, juvenile) of pelagic fish (mackerel, sardine, anchovy, sprat, herring, and horse mackerel) in ICES waters at regional scale and in a long-term perspective.
b) Continue to characterise habitats of life cycle stages (spawning, nursery, feeding and wintering grounds) with particular attention to physical meso-scale processes and multi-species context, evidence inter-annual changes and reconstruct long-term history of the spatial pattern of populations.
c) Assemble long-term series of environmental indices using survey data, meteorological data and model outputs at basin-scale and meso-scale in order to reconstruct long-term history of environmental changes at different scales.
d) Review and update adult fish behaviour in relation with oceanographic and ecosystem features and characterise how adult fish migration, feeding and spawning impact the environment-population interaction.

e) Identify situations which have potential impact on the assessment, projection or management processes: update the relevant assessment working groups and survey planning groups with the information through working documents and provide these groups with quantitative information on fishery-ecosystem interactions.

SGRESP will report by 31 March 2005 for the attention of the Living Resources Committee, ACFM, and ACE.

Supporting Information

Priority:	The work of the Group is essential if ICES is to progress the understanding of environmental forcing on life history, spatial and population dynamics of pelagic fish to provide alternative basis to management on stocks recognised to fluctuate under environmental forcing.
Scientific Justification:	Present Study Groups and Planning Groups of LRC consider survey methods and tools for a variety of surveys on small pelagics in ICES areas (eggs, larvae, acoustics, aerial). On the other hand, assessment WGs of ACFM cannot deal with data integration although they consider that small pelagic stocks fluctuate under environmental forcing. The purpose of the SG is i) to integrate various survey data together as well as with meteo, satellite, fishery and/or ecosystem model outputs and ii) feed in the assessment WG with synthetic understanding of how the spatial dynamics of the biological cycle and the stock dynamics are related to the ecosystem thus increasing ICES ability to use ecological information in assessment and prediction of small pelagics. The SG will work on different case studies in the ICES waters.
Relation to Action Plan:	This group responds to Goal 1 Understand the physical, chemical, and biological functioning of marine ecosystems, in particular action numbers 1.2.2 Changes in spatio-temporal distributions in relation with environmental change, 1.6 assess and predict impact of climate variability and 1.7 play an active role in collaborations between ICES and other international research such as GLOBEC. This group is also related to Goal 4 Advise on the sustainable use of living marine resources, in particular action number 4.11 Develop the scientific basis for an ecosystem approach to management.
Resource Requirements:	No specific resource requirements beyond the need for members to prepare for and participate in the meeting.
Participants:	These would include scientists working in WG MHSA, scientists performing egg and acoustic surveys as well as scientists in population modelling, environmental change and scientists participating to GLOBEC/SPACC.
Secretariat Facilities:	None specific
Financial	None specific
Linkages To Advisory Committees:	link with ACFM through WG MHSA
Linkages To other Committees or Groups:	The Group will deliver products to the WG MHSA It will take data from PG on egg, aerial and acoustic surveys
Linkages to other Organisations:	widened participation for this group will be sought, including GLOBEC/SPACC and relevant academic science
Cost:	National expenses

APPENDIX 1: LETTER FROM SPACC EXECUTIVE COMMITTEE

GLOBAL OCEAN ECOSYSTEM DYNAMICS

GLOBEC International Project Office
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Prospect Place
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United Kingdom

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Alternative Fax: +44 1752 633101
E-mail: globec@pml.ac.uk
http://www1.npm.ac.uk/globec/

GLOBEC
GLOBAL CHANGE IGBP
SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH

Dr Pierre Petitgas and Dr Leonie Dransfeld
Co-Chairs ICES/SPACC SG RESP
C/O IFREMER
Laboratoire Ecologie Halieutique
BP 21105
F- 44311 cedex 03
Nantes
France

16 February 2004

Dear Pierre and Leonie,
Cc Lorenzo Motos

I write to you on behalf of the Executive Committee of the Small Pelagic Fish and Climate Change Programme (GLOBEC-SPACC), to recognise the formation of the **ICES/SPACC Study Group on Regional scale Ecology of Small Pelagics**, under the ICES Living Resources Committee.

The Executive Committee of SPACC takes note that the purpose of the SG is:

i) to integrate various survey data together as well as with meteorological, satellite, fishery and/or ecosystem model outputs and

ii) to feed in the assessment WG with synthetic understanding of how the spatial dynamics of the biological cycle and the stock dynamics are related to the ecosystem thus increasing ICES ability to use ecological information in assessment and prediction of small pelagics.

This purpose is in line with SPACC's goal to "understand and ultimately forecast how changes in ocean climate will alter the productivity of small pelagic fish populations"[1].

SPACC has identified seven main geographical areas of activity: the four Eastern boundary Currents (Humboldt, California, Canary and Benguela), the Bay of Biscay, the Baltic Sea, and the Sea of Japan/ Yellow Sea region. This does not limit the geographical extent of SPACC's work, but highlights our core research regions. We note that the ICES SG will cover two of these core regions, and would potentially link other SPACC activity in the Mediterranean, North and Celtic Seas. The role of the ICES SG in coordinating research in these regions is appreciated and strongly supported.

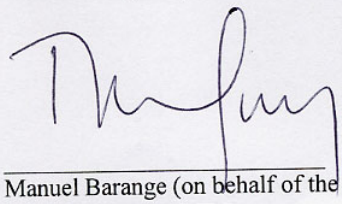
Dr Lorenzo Motos will be your official contact in the SPACC Executive Committee, although any other member of the committee will be happy to play an advisory role. As you know the GLOBEC International Project Office acts as the coordinating office for SPACC, and will be available for support as and when needed. The three main networking mechanisms of the IPO, namely the GLOBEC Newsletter, GLOBEC Report Series and GLOBEC webpage, are available to the ICES-SG. Do not hesitate to contact me should you want to use these tools.

[1] Hunter, J.R. and J. Alheit (eds.) 1997. International GLOBEC Small Pelagic Fishes and Climate Change program. Implementation Plan. GLOBEC Report 11: 36p.

IPO Co-sponsored by
Natural Environmental Research Council
NSF
PERC University of Plymouth

Finally, the SPACC Executive Committee would like to thank you for your timely initiative. SPACC, like the rest of GLOBEC, intends to continue activities until December 2009. Your participation in the integration and synthesis of SPACC in the coming years will be most welcome. We look forward to seeing results from your research in the near future. Please pass on our support to the rest of the Study Group at your first meeting in Nantes, 23-26 February 2004.

With best regards,



Manuel Barange (on behalf of the SPACC Executive)
Director GLOBEC IPO
Member of the SPACC Executive Committee

SPACC Executive:

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Carl van der Lingen (South Africa) - vdlingen@mcm.wcape.gov.za

APPENDIX 2: INVENTORY OF SURVEY DATA

Portuguese surveys:

- Ichtyoplankton Surveys of IPIMAR (coordinated by ICES for triennialnnual mackerel egg surveys, contracted by EC for sardine)
- Spring Pelagic acoustic surveys of IPIMAR (Pelasses series coordinated by ICES and contracted by EC)
- Autumn Pelagic acoustic surveys of IPIMAR
- Bottom trawl surveys of IPIMAR (IBTS series coordinated by ICES and contracted by EC)

Assembly of hydrological and icthyoplankton data from egg surveys of IPIMAR, IEO and AZTI within EC program SARDYN (2002–2004) and within ICES SG-SBSA. Similar assembly performed between IPIMAR, IEO, AZTI and IFREMER within EC program PELASSES (2000–2002) relative to egg and acoustic surveys.

Data are available in the following data base:
files at IPIMAR

Data are available by SG members in the following way:

Contact person for data request:
Yorgos Stradoudakis (SGRESP member) who will transfer request: yorgos@ipimar.pt

Ichtyoplancton surveys

Country :	Portugal								
acronym :									
Type of survey :	Ichtyo	adults	eggs	larvaes	plankton	genetics			
months :	various								
Areas	IXa								
target species :	various								
	1	2	3	4	5	6	7	8	9
secondary species :	sardine	mackerel	horse macker	anchovy					

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) ex. **SUc** or **VEs** or **SUc+VEs***									
parameter	**X**	**T°**	**Sal**	**Fluo**	**Oxy**	**Months**	**Survey**	**Coverage**	**Species**	
1984										
1985	x					8+11	CICLOS	Portugal	sardine	
1986	x					1+3+5	CICLOS	Portugal	sardine	
1987	x					4	EPOCAS	Portugal	sardine	
1988	x					3	DEPM	Portugal	sardine	
1989										
1990	x					11	FAR	Portugal	sardine	
1991	x					3+11	FAR	Portugal	sardine	
1992	x					3+11	FAR	Portugal	sardine	
1993	x					3	FAR	Portugal	sardine	
1994										
1995	x	SUs				1+2+3	AEPM	IXa	mack+hmack+sard	
1996										
1997	x	SUs				3	DEPM	IXa	sardine	
1998	x	VEs				1+2+3	AEPM	IXa	mack+hmack+sard	
1999	x	VEs				1	DEPM	IXa	sardine	
2000										
2001	x	VEs	VEs			1+2+3	AEPM	IXa	mack+hmack	
2002	x	SUc+VEs	SUc+VEs	SUc		1	DEPM	IXa	sardine	
2003										
2004	x	SUc+VEs	SUc+VEs	SUc		1+2+3	AEPM	IXa	mack+hmack	

Spring acoustic surveys

Country :	Portugal						
acronym :							
Type of survey :	Acoustics	adults	eggs	larvaes	plankton	genetics	
months :	March						
Areas	IXa						
target species :	**sardine**						
	1	2	3	4	5	6	
secondary species :	anchovy	snipefish					

environmental parameter	**X**	**T°**	**Sal**	**Fluo**	**Oxy**	**Eggs**	**…**
		*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations*					
1981							
1982	x						
1983							
1984							
1985							
1986	x						
1987							
1988	x						
1989							
1990							
1991							
1992							
1993							
1994							
1995							
1996	x						
1997	x						
1998	x						
1999	x						
2000	x	**SUc+BOs**	**SUc+BOs**	**SUc+BOs**		**CALVET (night)**	
2001	x	**SUc+BOs**	**SUc+BOs**	**SUc+BOs**		**CALVET (night)**	
2002	x	**SUc**	**SUc**	**SUc**			
2003	x	**SUc**	**SUc**	**SUc**		**WP2 (night-vertical strata)**	
2004	x	**SUc**	**SUc**	**SUc**		**WP2 (night-vertical strata)**	

Autumn acoustic surveys

Country :	Portugal						
acronym :							
Type of survey :	Acoustics	adults	eggs	larvaes	plankton	genetics	
months :	November						
Areas	IXa						
target species :	**sardine**						
	1	2	3	4	5	6	
secondary species :	anchovy	snipefish					

environmental parameter	**X**	**T°**	**Sal**	**Fluo**	**Oxy**	**Comment**	**…**
		*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / statior*					
1983							
1984	x					**excluding CADIZ**	
1985	x					**excluding CADIZ**	
1986	x					**excluding CADIZ**	
1987	x					**excluding CADIZ**	
1988							
1989							
1990							
1991							
1992	x						
1993							
1994							
1995							
1996							
1997	x						
1998	x						
1999	x						
2000	x	**SUc**	**SUc**	**SUc**			
2001	x	**SUc**	**SUc**	**SUc**			
2002	x	**SUc**	**SUc**	**SUc**		**incomplete survey**	
2003	x	**SUc**	**SUc**	**SUc**		**incomplete survey**	
2004							

Spanish surveys in Biscay

- pelagic acoustics (IEO) on sardine anchovy mackerel horse mackerel blue whiting (with hydro, Cufes eggs, zooplankton) (PELASSES series coordinated by ICES and contracted by EC) and on juvenile anchovy (AZTI);
- egg surveys (IEO and AZTI) (sardine, anchovy, mackerel) (contracted by EC and coordinated by ICES for the triennial mackerel egg survey);
- bottom trawl (IEO) (potential for juvenile fish, e.g., mackerel) (IBTS series coordinated by ICES and contracted by EC).

Egg surveys of AZTI (contracted by EC for anchovy and coordinated by ICES for triennialnnual mackerel egg surveys)

BIOMAN Egg Surveys on Anchovy (1989-2003)				
data are available in the following data base :				
In AZTI data bases				
they are accessible by SG members by the following way :				
Data accessible upon request with restrictions depending on intended				
use and interest for exploitation of the data by the producers and owners.				
You must ask data to the owner who is :				
name	María Santos			
e.mail	asantos@pas.azti.es			
phone	34 943 004800			

Country :	SPAIN							
acronym :	BIOMAN							
Type of survey :	**EGGS Survey**	Cufes		**pelagic trawl**	**hydrology**	**vertical plankton stations**	**Purse seine ha**	
months :	05 & 06							
Areas	Bay of Biscay							
target species :	**anchovy**							
	1	2	3	4	5	6	7	
secondary species :	**sardine**	**horse macke**	**mackerel**					
environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) ex. **SUc** or **VEs** c*							
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**	**CUFES**	**BONGO**
1975								
1976								
1977								
1978								
1979								
1980								
1981								
1982								
1983								
1984								
1985								
1986								
1987								
1988								
1989	**X**	**BO**	**BO**					
1990	**X**	**BO**	**BO**					
1991	**X**	**BO**	**BO**					
1992	**X**	**BO**	**BO**					
1993								
1994	**X**	**BO**	**BO**	**VEs**				
1995	**X**	**BO**	**BO**	**VEs**				
1996	**X**	**BO**	**BO**	**VEs**				
1997	**X**	**BO**	**BO**	**VEs**				
1998	**X**	**BO**	**BO**	**VEs**			**X**	**X**
1999	**X**	**BO**	**BO**	**VEs**			**X**	
2000	**X**	**BO**	**BO**	**VEs**	**VEs**		**X**	
2001	**X**	**BO**	**BO**	**VEs**	**VEs**		**X**	**X**
2002	**X**	**BO**	**BO**	**VEs**	**VEs**		**X**	
2003	**X**	**BO**	**BO**	**VEs**	**VEs**		**X**	
2004	**X**	**BO**	**BO**	**VEs**	**VEs**		**X**	**X**

comments :

Acoustic Surveys on Anchovy Juveniles (JUVESU 1998-1999 and JUVENA 2003 onwards)

data are available in the following data base :
In AZTI acoustic data for 2003 onward
In AZTI data bases: CTD and Biological and length samples
In IFREMER acoustic data for 1998 and 1999

they are accessible by SG members by the following way :

Data accessible upon request with restrictions depending on intended use and the interest for exploitation of the data by the producers and owners.
JUVESU partners have agreed a Plan of Exploitation of results (TIP) which is currently on course concerning the acoustic data and ecological and biological information obtained in the JUVESU surveys.
JUVENA survey was entirely funded by the Departamento de Agricultura y Pesca del Gobierno Vasco (Basque

You must ask data to the owner who is :

name GUILLERMO BOYRA
CARLA SCALABRIN (Acoustic data 1998 & 1999)
e.mail gboyra@pas.azti.es
phone 34 943 004800

Country : SPAIN
acronym : JUVESU+JUVENA
Type of survey : **Acoustic** **Purse seine hauls** **hydrology**
months : 09 - 10
Areas Bay of Biscay
target species : **juvenile anchovy**

	1	2	3	4	5	6
secondary species :	**sardine**	**horse macke**	**mackerel**			

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) ex.*						
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**	**CUFES**
1997							
1998	**X**	**VEs**	**VEs**	**VEs**			
1999	**X**	**VEs**	**VEs**	**VEs**			
2000							
2001							
2002							
2003	**X**	**BO**	**BO**	**VEs**			
2004	**X**	**BO**	**BO**	**VEs**			

comments :

Ichtyoplancton surveys of IEO

Data are available in the following data base:
files at IEO in various formats
Data are available by SG members in the following way:
on request with ICES data policy
Contact person for data request:
name: C. Porteiro, IEO - Vigo
e-mail: carmela.porteiro@vi.ieo.es

Country :	E					
acronym :	SAREVA / ICTIOEVA / ICTIONORTE / BIOMAN					
Type of survey :	Ictioplankton	CalVET		hydrology		
months :	03,04(**)					
Areas	Bay of Biscay	Galicia				
target species :	sardine					
	1	2	3	4	5	
secondary species :	horse mackerel	mackerel	Blue whiting	anchovy	Sprat	

environmental parameter	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / static*					
	X	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**
1987						
1988	X	VEs	?			
1989						
1990	X	VEs	VEs			
1991	X	VEs	VEs			
1992	X	VEs	VEs			
1993						
1994						
1995						
1996						
1997	X	BO	BO	BO	*	
1998						
1999	X	BO	BO	BO	*	
2000						
2001						
2002	X	BO	BO	BO	*	VEs
2003						
2004						

* Samples for integrated zooplancton
** Bioman is made in May (91,92)

Country :	E					
acronym :	CAREVA / JUREVA/ OTHER					
Type of survey :	Ictioplankton	BONGO		hydrology		
months :	03,04					
Areas	Bay of Biscay	Galicia				
target species :	sardine					
	1	2	3	4	5	
secondary species :	horse mackerel	mackerel	Blue whiting	anchovy	Sprat	

environmental parameter	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / static*					
	X	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**
1991						
1992						
1993	X	VEs	VEs		*	
1994	X	VEs	VEs		*	
1995	X	VEs	VEs		*	
1996						
1997	X	BO	BO	BO	*	
1998						
1999						
2000	X	BO	BO	BO	*	VEs
2001	X	BO	BO	BO	*	VEs
2002						
2003						
2004						

* Samples for integrated zooplancton

Spring acoustic surveys of IEO

Data are available in the following data base:
files at IEO in various formats
Data are available by SG members in the following way:
on request with ICES data policy
Contact person for data request:
name: C. Porteiro, IEO - Vigo
e-mail: carmela.porteiro@vi.ieo.es

Country :	E					
acronym :	SARACUS / PELACUS					
Type of survey :	Acoustics	Cufes	pelagic trawl	hydrology	vertical plank	
months :	03,04 (*)					
Areas	Bay of Biscay	Galicia				
target species :	sardine					
	1	2	3	4	5	
secondary species :	horse mackerel	mackerel	Blue whiting	anchovy	Sprat	

environmental parameter	X	T°	Sal	Fluo	Zoo	OPC
		*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / static*				
1982						
1983	X	VEs	VEs			
1984	X	VEs	VEs			
1985	X	VEs	VEs			
1986	X	VEs	VEs			
1987	X	VEs	VEs			
1988	X	VEs	VEs			
1989						
1990	X	VEs	VEs			
1991	X	VEs	VEs			
1992	X	VEs	VEs			
1993	X	VEs	VEs			
1994	X	VEs	VEs			
1995	X	VEs	VEs	VEs		
1996	X	VEs	VEs	VEs		
1997	X	BO	BO	BO		
1998	X	BO	BO	BO		
1999	X	BO	BO	BO		
2000	X	BO	BO	BO	VEs	
2001	X	BO	BO	BO	VEs	
2002	X	BO	BO	BO	VEs	VEs
2003	X	BO	BO	BO	VEs	VEs
2004	X	BO	BO	BO	VEs	VEs
comments :	(*)	1983,1984 and 1985 took place in August				
	(*)	1987 took place in February				
	(*)	1995 took place in May				

French surveys in Biscay and Celtic Sea:

- spring pelagic acoustics on adults of anchovy sardine horse mackerel mackerel blue whiting (with hydro, Cufes eggs, zooplankton) (PELASSES series coordinated by ICES and contracted by EC)
- autumn pelagic acoustics on juvenile anchovy (with hydro, zooplankton)
- ichtyoplancton surveys (larvae, hydro, zooplankton) covering all Biscay French shelf (historical) and targeting anchovy larvae on a major spawning ground (Gironde) (recent)
- bottom trawl (potential for juvenile fish, e.g., mackerel) in Biscay and Celtic Sea (IBTS series coordinated by ICES and contracted by EC)

Spring Pelagic acoustic surveys in Biscay (Pelasses series coordinated by ICES and contracted by EC)

Data are available in the following data base:
access files
Data are available by SG members in the following way:
ICES data policy; at present availability jeopardised by technical reasons (e.g., standardisation of series)
You must ask data to the following person:
name: Jacques Massé, IFREMER - Nantes
e-mail: jacques.masse@ifremer.fr

Country :	F					
acronym :	PEL					
Type of survey :	Acoustics	Cufes	pelagic trawl	hydrology	vertical plankto	
months :	04, 05 or 06					
Areas	Bay of Biscay					
target species :	**anchovy**					
	1	2	3	4	5	
secondary species :	sardine	sprat	horse macker	mackerel		

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or s*					
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**
1975						
1976						
1977						
1978						
1979						
1980						
1981						
1982						
1983	**X**	**SUc**				
1984	**X**	**SUc**				
1985	**X**	**SUc**				
1986	**X**	**SUc**				
1987	**X**	**SUc**				
1988						
1989	**X**	**BO**	**BO**			
1990	**X**	**BO**	**BO**			
1991	**X**	**BO**	**BO**			
1992	**X**	**BO**	**BO**			
1993	**X**	**BO**	**BO**			
1994	**X**	**BO**	**BO**			
1995						
1996						
1997	**X**	**BO**	**BO**			
1998	**X**	**BO**	**BO**			
1999						
2000	**X**	**BO**	**BO**	**BO**	**VEs**	
2001	**X**	**BO**	**BO**	**BO**	**VEs**	
2002	**X**	**BO**	**BO**	**BO**	**VEs**	
2003	**X**	**BO**	**BO**	**BO**	**VEs**	
2004	**X**	**BO**	**BO**	**BO**	**VEs**	**VEs**

comments :

Historic hydrology and ichtyoplancton surveys (national program)

Data are available in the following data base:
files at IFREMER-Nantes
Data are available by SG members in the following way:
on request but for joint analysis only
Contact person for data request:
name: Chief lab. Fisheries Ecology, IFREMER-Nantes
e-mail: jacques.bertrand@ifremer.fr

Country :	FR						
acronym :							
Type of survey :	hydrology (stations) and ichtyoplancton (eggs + larvae oblique towed hauls Hensen net						
months :	2, 5, 7, 9	4 surveys per year					
Areas	Biscay entire French shelf						
target species :	**all species (sardine, anchovy, sprat : in files ; other species : on paper)**						
	1	2	3	4	5	6	
secondary species :							

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) ex.*						
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**	**…**
1966							
1967	**xxxx**	**VE s**	**SU s**				
1968	**xxxx**	**VE s**	**SU s**				
1969	**xxxx**	**VE s**	**SU s**				
1970	**xxxx**	**VE s**	**SU s**				
1971	**xxxx**	**VE s**	**SU s**				
1972	**xxxx**	**VE s**	**SU s**				
1973	**xxxx**	**VE s**	**SU s**				
1974							

comments :

Recent ichtyoplancton surveys directed on anchovy larvae (national programs)

Data are available in the following data base:
files at IFREMER-Nantes (ichtyo and hydro), Univ. La Rochelle (microzoo), Univ.Bordeaux (mesozoo), Crema LaRochelle (nutrients and phyto)
Data are available by SG members in the following way:
on request at IFREMER provided there is joint analysis with laboratories who collected the data
Contact person for data request:
name: Chief lab. Fisheries Ecology, IFREMER-Nantes
e-mail: jacques.bertrand@ifremer.fr

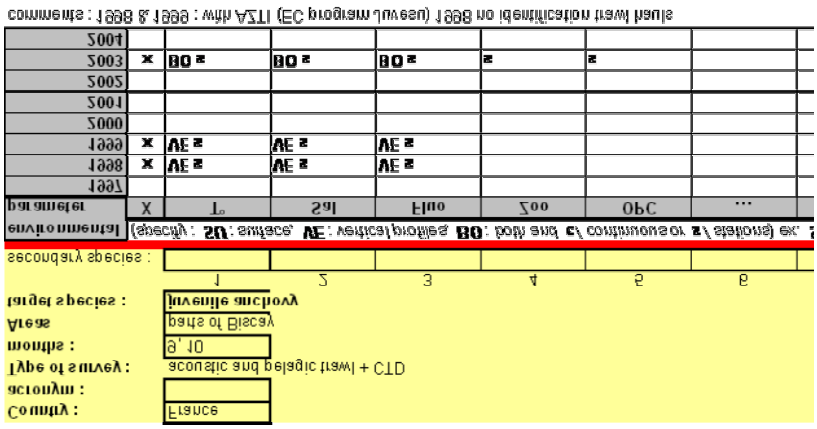
Country :	France					
acronym :						
Type of survey :	ichtyoplankton					
months :	5, 6, 7					
Areas	part of Biscay (Gironde)					
target species :	**anchovy**					
	1	2	3	4	5	
secondary species :	sardine	sprat				

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or*					
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**
1993						
1994	**x**	**VEs**	**VEs**	**VEs**	**s**	
1995						
1996						
1997	**x**	**VEs**	**VEs**	**VEs**	**s**	
1998	**x**	**VEs**	**VEs**	**VEs**	**s**	
1999	**xxx**	**VEs**	**VEs**	**VEs**	**s**	
2000	**+**	**VEs**	**VEs**	**VEs**	**s**	
2001	**+**	**VEs**	**VEs**	**VEs**	**s**	
2002	**+**	**VEs**	**VEs**	**VEs**	**s**	
2003	**+**	**VEs**	**VEs**	**VEs**	**s**	
2004	**x +**	**VEs**	**VEs**	**VEs**	**s**	**s**

comments : **+** oportunistic ichtyoplancton sampling combined with acoustic survey
x ichtyoplancton surveys

Autumn juvenile anchovy acoustic surveys

Data are available in the following data base:
files at IFREMER-Nantes, lab. Fisheries Ecology
Data are available by SG members in the following way:
on request with ICES data policy for 1998 and 1999 (EC program Juvesu)
national data for 2003: access on request only for joint analysis
Contact person for data request:
name: Chief lab. Fisheries Ecology, IFREMER-Nantes
e-mail: jacques.bertrand@ifremer.fr



Bottom trawl survey (IBTS series coordinated by ICES and contracted by EC)

Data are available in the following data base:
files at IFREMER-Nantes and Lorient. See DATRAS project
Data are available by SG members in the following way:
on request with ICES data policy
Contact person for data request:
name: J.C. Mahé, IFREMER-Nantes
e-mail: jean.claude.mahe@ifremer.fr

In Biscay

Country :	F						
acronym :	EVOHE						
Type of survey :	bottom trawl						
months :	04, 05 or 06						
Areas	Bay of Biscay						
target species :	**demersal**						
	1	2	3	4	5	6	
secondary species :	anchovy	sardine	sprat	horse macker	mackerel		
environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) ex*						
parameter	**X**	**T°**	**Sal**				**...**
1986							
1987	**X**						
1988	**X**						
1989	**X**						
1990	**X**						
1991							
1992	**X**						
1993							
1994	**X**	**VEs**	**VEs**				
1995	**X**	**VEs**	**VEs**				
1996	**X**	**VEs**	**VEs**				
1997	**X**	**VEs**	**VEs**				
1998	**X**	**VEs**	**VEs**				
1999	**X**	**VEs**	**VEs**				
2000	**X**	**VEs**	**VEs**				
2001	**X**	**VEs**	**VEs**				
2002	**X**	**VEs**	**VEs**				
2003	**X**	**VEs**	**VEs**				
2004							

comments :

In Celtic Sea

Country :	F						
acronym :	EVOHE						
Type of survey :	bottom trawl						
months :	9, 10, 11						
Areas	Celtic sea						
target species :	**demersal**						
	1	2	3	4	5	6	
secondary species :	anchovy	sardine	sprat	horse macker	mackerel		
environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) ex*						
parameter	**X**	**T°**	**Sal**				**...**
1989							
1990	**X**						
1991							
1992	**X**						
1993							
1994							
1995							
1996							
1997	**X**	**VEs**	**VEs**				
1998	**X**	**VEs**	**VEs**				
1999	**X**	**VEs**	**VEs**				
2000	**X**	**VEs**	**VEs**				
2001	**X**	**VEs**	**VEs**				
2002	**X**	**VEs**	**VEs**				
2003	**X**	**VEs**	**VEs**				
2004							

comments :

NEA mackerel surveys

- triennial international egg surveys (coordinated by ICES and contracted by EC)
- bottom trawl surveys (IBTS series) potential for juvenile fish
- national Norwegian acoustic surveys on adult fish

NEA mackerel international triennial egg surveys (coordinated by ICES and contracted by EC)

data are available in the following data base :
ICES egg survey database - held by D Reid FRS Aberdeen (XL spreads)
1998 survey has been analysed for all other fish species - eggs and larvae
Under INDICES project - similar potential work for 1992 and 1995 has been carried out but requires Data Archaeology
they are accessible by SG members by the following way :
email request

You must ask data to the owner who is :

name	Through WGMEGS chair - for permissions from national owners
e.mail	reiddg@marlab.ac.uk
phone	44 1224 295363

Country :	INT						
acronym :	NA						
Type of survey :	Vertical Oblique Integrated Icthyoplankton						
months :	March to July						
Areas	Western Shelf and beyond 44-60N						
target species :	**Mackerel and horse mackerel**						
	1	2	3	4	5	6	
secondary species :	usually none						

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) e*						
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**	**…**
1975							
1976							
1977	**x**	**SUs**	**SUs ?**				
1978							
1979							
1980	**x**	**SUs**	**SUs ?**				
1981							
1982							
1983	**x**	**SUs**	**SUs ?**				
1984							
1985							
1986	**x**	**SUs**	**SUs ?**				
1987							
1988							
1989	**x**	**SUs**	**SUs ?**				
1990							
1991							
1992	**x**	**SUs**	**SUs ?**				
1993							
1994							
1995	**x**	**SUs**	**SUs ?**				
1996							
1997							
1998	**x**	**SUs**	**SUs ?**				
1999							
2000							
2001	**x**	**SUs**	**Sus**				
2002							
2003							
2004	**x**	**SUs**	**Sus**				

comments :

Recruit data base extracted from ICES coordinated IBTS series and held by D. Reid, FRS Aberdeen

data are available in the following data base :
WGMHSA mac recruit database - held by D Reid FRS Aberdeen (XL spreads)
Database is partial in many years up to and including 200˙TS data is also partial for many included surveys

they are accessible by SG members by the following way :
email request
Database is derived from national BT surveys - permission from contributors through D Reid

You must ask data to the owner who is :

name	Represented by D Reid
e.mail	reiddg@marlab.ac.uk
phone	44 1224 295363

Country :	Int						
acronym :	NA						
Type of survey :	Bottom trawl surveys CPUE						
months :	September to March						
Areas	Western Shelf 35-62N + N N Sea						
target species :	**Mackerel**						
	1	2	3	4	5	6	
secondary species :	IBTS - all species						

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) e*						
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**	**…**
1975							
1976							
1977							
1978							
1979							
1980							
1981	x						
1982	x						
1983	x						
1984	x						
1985	x						
1986	x	**SUs ?**	**SUs ?**				
1987	x	**SUs ?**	**SUs ?**				
1988	x	**SUs ?**	**SUs ?**				
1989	x	**SUs ?**	**SUs ?**				
1990	x	**SUs ?**	**SUs ?**				
1991	x	**SUs ?**	**SUs ?**				
1992	x	**SUs ?**	**SUs ?**				
1993	x	**SUs ?**	**SUs ?**				
1994	x	**SUs ?**	**SUs ?**				
1995	x	**SUs ?**	**SUs ?**				
1996	x	**SUs ?**	**SUs ?**				
1997	x	**SUs ?**	**SUs ?**				
1998	x	**SUs ?**	**SUs ?**				
1999	x	**SUs ?**	**SUs ?**				
2000	x	**SUs ?**	**SUs ?**				
2001	x	**SUs ?**	**SUs ?**				
2002	x	**SUs ?**	**SUs ?**				
2003							
2004							

comments :

Norwegian Summer / Autumn Pelagic acoustic surveys on adults (IMR)

data are available in the following data base :
IMR.database

they are accessible by SG members by the following way :

You must ask data to the owner who is :
name
e.mail
phone

Country :	Norway						
acronym :	PEL						
Type of survey :	Acoustic			Pelagic trawl	CTD		
months :	10, 11						
Areas	ICES Area Iva (Northern North Sea)						
target species :	**Mackerel**						
	1	2	3	4	5	6	
secondary species :	North Sea her						

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) e*					
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**	**…**
1996	x	VEs	VEs				
1997	X	VEs	VEs				
1998	X	VEs	VEs				
1999	x	VEs	VEs				
2000	X	VEs	VEs		VEs		
2001	X	VEs	VEs		VEs		
2002	X	VEs	VEs		VEs		
2003	X	VEs	VEs		VEs		

comments :

Country :	Norway						
acronym :	PEL						
Type of survey :	Acoustic/trawl			Pelagic trawl	CTD		
months :	10, 11						
Areas	Norwegian Sea						
target species :	**Mackerel**						
	1	2	3	4	5	6	
secondary species :	NSS herring	Blue whiting					

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) ex.*					
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**	**…**
2002	X	VEs	VEs				
2003	X	VEs	VEs				

comments :

Norwegian surveys on NSS herring

- acoustic surveys on wintering adult fish
- acoustic surveys on spawning fish
- acoustic surveys on O-group (coastal in Fjords and in Barents Sea)
- larval surveys

data are available in the following data base :
IMR.database

they are accessible by SG members by the following way :

You must ask data to the owner who is :
name
e.mail
phone

Acoustic surveys on wintering adult fish

Country :	Norway						
acronym :	PEL						
Type of survey :	Acoustic		Pelagic trawl				
months :	11, 12						
Areas	Vestfjorden, Norway						
target species :	**NSS herring adult**						
	1	2	3	4	5	6	
secondary species :	Cod	Saithe					

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) e*						
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**	**…**
1988							
1989							
1990							
1990							
1991							
1992	**X**						
1993	**X**						
1994	**X**						
1995	**X**						
1996	**X**						
1997	**x**						
1998	**X**						
1999	**x**						
2000	**x**						
2001	**x**						
2002	**x**						
2003	**x**						

comments: in 1992-93 and 1997 the whole spawning area was not surveyed (no total estimate) : there is dat

Country :	Norway						
acronym :	PEL						
Type of survey :	Acoustic		Pelagic trawl				
months :	1,						
Areas	Vestfjorden, Norway						
target species :	**NSS herring adult**						
	1	2	3	4	5	6	
secondary species :	Cod	Saithe					

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) e*						
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**	**…**
1988							
1989							
1990							
1990							
1991	**X**						
1992	**x**						
1993	**x**						
1994	**X**						
1995	**X**						
1996	**X**						
1997							
1998	**X**						
1999	**x**						
2000							
2001							
2002							
2003							

comments: in 1992-93 and 1997 the whole spawning area was not surveyed (no total estimate) : there is dat

Acoustic surveys on spawning adult fish

Country :	Norway						
acronym :	PEL						
Type of survey :	Acoustic	Cufes	Pelagic trawl	CTD			
months :	2, 3						
Areas	The Norwegian coast						
target species :	**NSS herring adult**						
	1	2	3	4	5	6	
secondary species :	Cod	Saithe					

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) e*						
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**	**…**
1988	**X**	**VEs**	**VEs**				
1989	**X**	**VEs**	**VEs**				
1990	**x**	**VEs**	**VEs**				
1990	**X**	**VEs**	**VEs**				
1991	**X**	**VEs**	**VEs**				
1992							
1993							
1994	**X**	**VEs**	**VEs**				
1995	**X**	**VEs**	**VEs**				
1996	**X**	**VEs**	**VEs**				
1997							
1998	**X**	**VEs**	**VEs**				
1999	**x**	**VEs**	**VEs**				
2000	**x**	**VEs**	**VEs**				
2001	**x**	**VEs**	**VEs**				
2002	**x**	**VEs**	**VEs**				
2003	**X**	**VEs**	**VEs**				

Acoustic surveys on feeding adult fish

Country :	Norway						
acronym :	PEL						
Type of survey :	Acoustic		Pelagic trawl	CTD	Mochness	WP2	
months :	5, 6						
Areas	Norwegian sea						
target species :	**NSS herring adult**						
	1	2	3	4	5	6	
secondary species :	Blue whiting	Mackerel					

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) e*						
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**	**…**
1988							
1989							
1990							
1990							
1991							
1992							
1993							
1994							
1995							
1996	**X**	**VEs**	**VEs**		**Ves+Vec**		
1997	**x**	**VEs**	**VEs**		**Ves+Vec**		
1998	**X**	**VEs**	**VEs**		**Ves+Vec**		
1999	**x**	**VEs**	**VEs**		**Ves+Vec**		
2000	**x**	**VEs**	**VEs**		**Ves+Vec**		
2001	**x**	**VEs**	**VEs**		**Ves+Vec**		
2002	**x**	**VEs**	**VEs**		**Ves+Vec**		
2003	**X**	**VEs**	**VEs**		**Ves+Vec**		

comments: This is a joint survey with Iceland, Faores and EU vessels.

Larval surveys

Country :	Norway						
acronym :	PEL						
Type of survey :	Larvae	Cufes	Gulf-III	T-80 net	WP2		CTD
months :	3, 4						
Areas	Norwegian coast						
target species :	**NSS herring larvae**						
	1	2	3	4	5	6	
secondary species :	North Sea her						

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) e*						
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**	**…**
1975							
1976							
1977							
1978							
1979							
1980							
1981	x	VEs	VEs		VEs		
1982	x	VEs	VEs		VEs		
1983	X	VEs	VEs		VEs		
1984	X	VEs	VEs		VEs		
1985	X	VEs	VEs		VEs		
1986	X	VEs	VEs		VEs		
1987	X	VEs	VEs		VEs		
1988	x	VEs	VEs		VEs		
1989	X	VEs	VEs		VEs		
1990	X	VEs	VEs		VEs		
1991	X	VEs	VEs		VEs		
1992	X	VEs	VEs		VEs		
1993	X	VEs	VEs		VEs		
1994	X	VEs	VEs		VEs		
1995	x	VEs	VEs		VEs		
1996	x	VEs	VEs		VEs		
1997	X	VEs	VEs		VEs		
1998	X	VEs	VEs		VEs		
1999	x	VEs	VEs		VEs		
2000	X	VEs	VEs		VEs		
2001	X	VEs	VEs		VEs		
2002	X	VEs	VEs		VEs		
2003	X	VEs	VEs		VEs		
2004	X	VEs	VEs		VEs		

comments : Gulf-III is used to collect larvae durin day and T-80 net during night. WP2 is used to collect zoop

O-group surveys in Fjords and in the Barents Sea

Country :	Norway						
acronym :	PEL						
Type of survey :	Acoustic		Pelagic trawl	CTD			
months :	10, 11, 12						
Areas	Norwegian fjords						
target species :	**NSS herring 0-3 group**						
	1	2	3	4	5	6	
secondary species :	North Sea her	Sprat					

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) e*						
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**	**…**
1975	x	VEs	VEs				
1976	x	VEs	VEs				
1977	x	VEs	VEs				
1978	x	VEs	VEs				
1979	x	VEs	VEs				
1980	x	VEs	VEs				
1981	x	VEs	VEs				
1982	x	VEs	VEs				
1983	X	VEs	VEs				
1984	X	VEs	VEs				
1985	X	VEs	VEs				
1986	X	VEs	VEs				
1987	X	VEs	VEs				
1988	x	VEs	VEs				
1989	X	VEs	VEs				
1990	X	VEs	VEs				
1991	X	VEs	VEs				
1992	X	VEs	VEs				
1993	X	VEs	VEs				
1994	X	VEs	VEs				
1995	x	VEs	VEs				
1996	x	VEs	VEs				
1997	X	VEs	VEs				
1998	X	VEs	VEs				
1999	x	VEs	VEs				
2000	X	VEs	VEs				
2001	X	VEs	VEs				
2002	X	VEs	VEs				
2003	X	VEs	VEs				
2004	X	VEs	VEs				

comments :

Country :	Norway						
acronym :	PEL						
Type of survey :	Acoustic			Pelagic trawl	CTD		
months :	5, 6						
Areas	Barents Sea						
target species :	**NSS herring**						
	1	2	3	4	5	6	
secondary species :	Capelin	Cod					

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations) e*						
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**	**…**
1990							
1991	x	VEs	VEs				
1992	x	VEs	VEs				
1993	x	VEs	VEs				
1994	x	VEs	VEs				
1995	x	VEs	VEs				
1996	x	VEs	VEs				
1997	x	VEs	VEs				
1998	x	VEs	VEs				
1999	x	VEs	VEs				
2000	x	VEs	VEs				
2001	x	VEs	VEs				
2002	x	VEs	VEs				
2003	x	VEs	VEs				

comments: in 1997 there is data, but thee whole wintering area was not surveyed due to bad weather.

Country :	Norway						
acronym :	PEL						
Type of survey :	Trawl-index	Cufes		Pelagic trawl	CTD		
months :	8, 9						
Areas	The Barents Sea						
target species :	**NSS herring 0-3 group**						
	1	2	3	4	5	6	
secondary species :	Capelin	Cod	Haddock	Saithe	Polar cod	Red fish	

environmental	*(specify : **SU** : surface, **VE** : vertical profiles, **BO** : both and **c** / continuous or **s** / stations)*						
parameter	**X**	**T°**	**Sal**	**Fluo**	**Zoo**	**OPC**	**…**
1965	x	VEs	VEs				
1966	x	VEs	VEs				
1967	x	VEs	VEs				
1968	x	VEs	VEs				
1969	x	VEs	VEs				
1970	x	VEs	VEs				
1971	x	VEs	VEs				
1972	x	VEs	VEs				
1973	x	VEs	VEs				
1974	x	VEs	VEs				
1975	X	VEs	VEs				
1976	X	VEs	VEs				
1977	X	VEs	VEs				
1978	X	VEs	VEs				
1979	x	VEs	VEs				
1980	X	VEs	VEs				
1981	x	VEs	VEs				
1982	x	VEs	VEs				
1983	x	VEs	VEs				
1984	x	VEs	VEs				
1985	x	VEs	VEs				
1986	x	VEs	VEs				
1987	x	VEs	VEs				
1988	X	VEs	VEs				
1989	X	VEs	VEs				
1990	X	VEs	VEs				
1991	X	VEs	VEs				
1992	x	VEs	VEs				
1993	X	VEs	VEs				
1994	X	VEs	VEs				
1995	X	VEs	VEs				
1996	X	VEs	VEs				
1997	X	VEs	VEs				
1998	X	VEs	VEs				
1999	x	VEs	VEs				
2000	x	VEs	VEs				
2001	x	VEs	VEs				
2002	x	VEs	VEs				
2003	X	VEs	VEs				

comments : This survey carries out 0.5 nm min trawl hauls at 0, 20, 40, 60 m depth at specified locations ca

(Central) Baltic sprat surveys

- International Baltic acoustic surveys
- National ichtyoplankton surveys
- GLOBEC-Germany process oriented surveys

Data-overview Central Baltic

"regular" SURVEYS

- target species: **herring & sprat**
- survey: Baltic International Acoustic Survey
- objective: stock evaluation for *Tuning*
- life-stages: juveniles, adults
- season: 1) autumn (October/November)
  2) spring (May)
- years: 1) 1991-2003
  2) fragmentary; 1980s since late 1990s
- partners: Sweden, Russia, Poland, Germany, Denmark, Estonia, Latvia
- databases: 1) BAD1-aggregated for ICES-rectangles (complete)
  BAD2-original data (incomplete)
  user-rights not totally clear
  2) in preparation (IOR Rostock & Globec-Germany)

Data-overview Central Baltic

ENVIRONMENT

- meteorological: ?, available from various institutes
- physical data: 1) parallel to acoustic survey
  2) ICES-hydrographic database
  3) hydrodynamic model
  - 3d eddy-resolving hydrodynamic model (Lehmann 1995)
  - entire Baltic
  - 5 km horizontally, 41 layers vertically
  - forced by wind data und hydrographic measurements
  - runs from 1979-2003
- mesozooplankton: - survey data from the LATVIAN INSTITUTE FOR FISHERIES RESEARCH, Riga
  - seasonal 1959-2003 (with gaps)
  - variable number of stations (Judai net 200µm)
  - copepods identified to stages, others to species

Data-overview Central Baltic

"scientific" SURVEYS

- target species: **sprat**, herring
- survey: IfM Kiel "ichthyoplankton surveys
- objective: recruitment studies
- life-stages: eggs, larvae
- season: different months during spawning season
- area: mainly Bornholm Basin
- years: 1987-2003
- environment: hydrography (mesasurements & model), partly mesozooplankton

- target species: **sprat**, herring
- survey: LATFRI "ichthyoplankton surveys
- objective: stock observation
- life-stages: eggs, larvae
- season: seasonal
- area: mainly Gdansk Deep & Gotland Basin
- years: 1960-2003
- environment: hydrography, mesozooplankton

Data-overview Central Baltic

"scientific" SURVEYS

- target species: **sprat**, herring
- survey: GLOBEC-GERMANY project

- objective: recruitment studies of fish and copepods
- life-stages: eggs, larvae, juveniles (netsampling), juveniles, adults (acoustic/trawl surveys)
- season: monthly/bi-monthly
- area: Bornholm Basin
- years: 2002-2003
- environment: hydrography (measurements [stations, continuously) & model), nutrients, phytoplankton, micro-, meso-, macrozooplankton)-> on station grid

Data-overview Central Baltic

ASSESSMENT

• ICES WG: Baltic Fisheries Assessment WG (WGBFAS)
• ICES SGs: - SG on Multispecies Assessments in the Baltic (SGMAB)
- Baltic International Fish Survey Working Group (WGBIFS) - SG on Fish and Fisheries Issues in support of the Baltic Sea Regional Project (SGBFFI)
• useful information for WG: - environment/recruitment
- environment/growth

APPENDIX 3: LIST OF PARTICIPANTS

The group met at IFREMER in Nantes, 23–26 February inclusive with the following participants:

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