Theme Session G

Comparative study of climate impact on coastal and continental shelf ecosystems in the ICES area: assessment and management

ICES CM2009/G:01

Integrated analyses of coastal ecosystems—addressing temporal trends in Baltic fish and zoobenthos

L. Bergström, A. Gårdmark, and J. Olsson

Understanding long-term ecosystem changes and ecological regime shifts, identified as structural changes across multiple trophic levels over large geographical scales, is central in marine environmental and fishery management. To date, documentation is available for several marine open ecosystems, including the Baltic Sea, where regime shifts have been observed, most prominently for the late 1980s. Similar studies for coastal areas are, however, more rarely performed, in particular because of the difficulties in scaling up data from structurally complex coastal areas to a more general pattern. Nevertheless, common drivers of ecosystem change in coastal areas, such as climate, fishing pressure, and eutrophication, may be anticipated. A crucial question for management is whether these common drivers act locally or regionally. This is particularly important as the coastal zone and open sea are often governed under different jurisdictions, yet the areas share the same water bodies and migrations between them (e.g. for many fish species) are common. In this study, we explore long-term changes in coastal fish and zoobenthos assemblages from different sites along the Swedish coast, addressing the occurrence of common long-term trends, with a particular focus on the relationship of observed temporal changes to potential drivers in the open sea vs. those on a local scale.

Keywords: integrated ecosystem analysis, coastal zone, long-term changes, regime shift, fish, zoobenthos.

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ICES CM 2009/G:02

Developments in the shallow coastal ecosystem of the Väike Strait (Baltic Sea): a comparative study with different modelling scenarios

Ülo Suursaar, Robert Aps, Tiit Kullas, Georg Martin, and Mikk Otsmann

The Väike Strait in the West Estonian Archipelago has been closed by a 3-km-long road dam since 1896, forming two separate bays. Conditions in the northern part are mainly governed by the more saline Baltic Proper; in the S-part, relatively nutrient-rich Gulf of Riga waters prevail. In recent decades, ecological conditions have deteriorated in the area, and acceleration of accumulation and eutrophication have been observed. Reproduction areas of whitefish and herring have been disturbed. According to widespread opinion, as no water exchange occurs through the strait, the existence of the dam is the reason for these adverse changes. In the past, it has been suggested that some bridged openings could be constructed. The aims of the study are to analyse the ongoing changes in the area, and to decide whether reopening of the strait would help to restore conditions. The study is based on monitoring and special measurements data in the area. The possible influence of openings were analysed using high-resolution two-dimensional hydrodynamic modelling. Changes in renewal times of water masses were calculated and matter fluxes were studied. The results suggest that most of the past changes probably occurred as a result of natural and large-scale causes, such as isostatic land uplift, regional increase in water temperature, sedimentation, and overall eutrophication of the sea. They cannot be turned back merely by reopening the strait. On the other hand, anticipated manifestations of climate change, such as sea-level rise, increase in temperature, and storminess, will increasingly affect the ecosystem.

Keywords: water exchange, climate change, trends, eutrophication, modelling.

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ICES CM 2009/G:03

Climate-induced synchronous regime shifts along environmental and diversity gradients in Baltic Sea subsystems

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Marine ecosystems are currently under strong atmospheric and anthropogenic pressure. Besides natural and human-induced changes in climate, major anthropogenic drivers such as overfishing and eutrophication are significantly affecting ecosystem structure and function. Recently, studies have demonstrated the existence of ecosystem regime shifts which have been explained mainly as a result of multiple causes (e.g. climatic regime shifts, overexploitation, or a combination of both). The occurrence of ecosystem regime shifts has important management implications as they can cause significant losses of ecological and economic resources. Also the Baltic Sea, the largest brackish water body in the world ocean, and its subsystems are strongly affected by atmospheric and anthropogenic drivers. In recent years, climate-induced changes in temperature and salinity, eutrophication, and high fishing pressure have had severe impacts on the entire Baltic. To assess changes in the structure and function of the ecosystem and to evaluate the relative effects of the different external forcing factors we performed principal component and regime shift analyses as well as generalized additive modelling using large datasets of hydro-climatic, nutrient, phyto/zooplankton, and fisheries variables. We investigated ecosystem structure and function during the period 1979–2006 in seven Baltic subsystems, each representing different environmental conditions and foodweb structures. This meta-analytic approach allowed us to study the importance of global (i.e. climatic) relative to local (e.g. fisheries and eutrophication) forcings. It further allowed us to investigate whether ecosystems with different environmental and structural settings respond in common or idiosyncratic ways to external forcing.

Keywords: regime shifts, foodweb, climate, eutrophication.

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ICES CM 2009/G:04

Cod populations in the eastern Baltic Sea and the White Sea: the environmental extremeness as a factor of two unique reproduction strategies formationE. M. Karasiova

Two large populations of cod in the Northeast Atlantic Ocean—the Eastern Baltic cod (*Gadus morhua callarias*) and the White Sea cod (*Gadus morhua maris-albi*)—inhabit the intracontinental seas, where reproduction conditions are close to the extremes for the species as a whole. Some aspects of their reproductive strategy are considered here with reference to the determining influence of the extreme environmental conditions. A unique feature of the White Sea cod is the coincidence of its reproductive peak with the hydrological winter season and low water temperatures. The biological reason for this adaptation is avoidance of a summer decline in surface salinity leading to a decrease in the buoyancy of the eggs. As a result of adaptation to maturation and reproduction at extreme temperature conditions, the White Sea cod has reduced the costs of energy-consuming functions such as fecundity and growth rate. The reproductive strategy of the Baltic cod is affected by the combined impact of salinity and oxygen content variability and the reproductive volume is the integral index of this. The duration of the Eastern Baltic cod spawning season and the shift of the mass spawning period from spring to summer after the prolonged absence of the North Sea water inflows are highly significant because of the association of reproduction with the restricted near-bottom water volume. As a result, it is thought that salinity is the general factor that, to a significant extent, controls the reproduction and egg survival of the two populations considered.

Keywords: cod of the Baltic and White Sea, environmental extremeness, reproduction strategy.

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ICES CM 2009/G:05

Impact of climate variability on northern hemisphere marine ecosystems: regime shifts and teleconnection patterns

Jürgen Alheit *et al.*

Understanding the role of natural variability occurring over a variety of scales is essential if we are to effectively manage marine ecosystems and their living resources in the wake of predicted global change. Evidence has been accumulated that climate variability can cause ecosystem regime shifts. These shifts can re-organize marine communities and trophodynamic relationships and induce changes in the mix of dominating species. Examples of regime shifts in the Atlantic (Baltic, North Sea, Mediterranean) and Pacific (Japan/East Sea, Oyashio/Kuroshio System) are described here, based on long-term time-series of atmospheric, hydrographic, and ecosystem variables. The focus is on the pelagic realm, including phytoplankton, zooplankton, and small pelagic fish such as sardines, anchovies, sprat, and saury. Often, aquatic ecosystems separated by thousands of kilometres react synchronously to the same climate signal, as did northeast European shelf seas and lakes in association with the increase in the North Atlantic Oscillation index and northwest Pacific ecosystems in association with the weakening of the East Asian winter monsoon, all in the late 1980s. This Atlantic–Pacific teleconnection pattern seems to be mediated by the dynamics of the Arctic Oscillation and the Siberian High. Management implications are discussed.

Keywords: climate variability, ecosystem regime shifts, teleconnections.

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ICES CM 2009/G:06

Dynamics and regimes of the Baltic Proper foodweb, linking time-series analysis with modelling

S. Niiranen, M. T. Tomczak, T. Blenckner, and O. Hjerne

The impact of external forcing on past foodweb dynamics, and more specifically the mechanisms behind the latest regime shift in the open Baltic Proper ecosystem, are studied by means of statistical analysis and foodweb modelling. Time-series analyses are employed to test specific response mechanisms of individual key functional groups, as well as changes in prey and predators interactions in relation to variation in abiotic drivers. The relative strengths of bottom–up and top–down dynamics, together with potential thresholds determining the direction of the control, are specified accordingly. A time-dynamic Ecopath with the Ecosim foodweb model is calibrated for the period studied (1974–2006), using information produced by the time-series analysis. Different combinations of external forcing are introduced into the model and the combinations of forces and processes capable of displaying the late 1980s regime shift are identified. The change over time in the foodweb structure and dynamics is presented and the relative ecosystem effect of age group-specific fishing pressure imposed on Baltic cod (*Gadus morhua*), sprat (*Sprattus sprattus*), and herring (*Clupea harengus membras*) is evaluated under different combinations of environmental drivers. All in all this study stresses that both fishery and climate impact the Baltic Sea foodweb structure and dynamics. Furthermore, the relative strength of each external driver is discussed, providing a basis for future projections on ecosystem dynamics and ecosystem-based management options.

Keywords: foodweb, Baltic Proper, regime shift, environmental change.

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ICES CM 2009/G:07

Ecological effects of climate change on Narragansett Bay, RI

D. Christopher Melrose, Mark S. Berman, and Candace Oviatt

Narragansett Bay is an estuary within the United States Northeastern continental shelf large marine ecosystem (LME). Because of its transitional location between two temperature-driven biogeographical provinces, it provides a useful case study on the impacts of climate change. Narragansett Bay has undergone changes in productivity coincident with increasing temperature. The bay's productivity cycle was traditionally dominated by a winter/spring bloom, which has been reduced or absent since the 1970s. Localized episodic summer blooms are now the dominant annual feature. Parts of the bay demonstrate decreased productivity and increased water clarity. This trend is not evident in upper Narragansett Bay where anthropogenic nutrients have led to eutrophication. Narragansett Bay has also demonstrated a major change in fish populations, with demersal species being replaced with pelagics and species favouring warmer habitats. Summer hypoxic events have become common in upper portions of Narragansett Bay because of increased temperature and organic matter loading from phytoplankton blooms supported by anthropogenic nutrient sources. Benthic pelagic coupling has also been affected by warming, which has enhanced water column respiration and grazing rates and decreased the fraction of organic matter delivered to the sediments and the benthos. This may alter the amount of organic matter and nutrients exported to the surrounding LME, and impact fish stocks that spend some portion of their life cycle within the bay.

Keywords: climate change, Narragansett Bay, productivity.

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ICES CM 2009/G:08

Managing marine ecosystem goods and services in a changing climate: a case study on the Tasmanian east coast lobster fishery

Stewart Frusher, Gretta Pecl, Caleb Gardner, Marcus Haward, Alistair Hobday, Sarah Jennings, Melissa Nursey-Bray, André Punt, Hilary Revill, and Ingrid van Putten

Climate change adaptation research requires multidisciplinary studies to underpin the policy required to manage both biophysical and human systems. In marine domains, climate-induced changes in water temperature and ocean currents can change the productivity of resources which in turn alters the spatiotemporal distribution of users (e.g. fishers) with social and economic flow-on effects to communities. This presentation, based on results from the recently completed National Coastal Vulnerability Case Study on the rock lobster fishery of eastern Tasmania in Australia, demonstrates the importance of considering the links between biophysical and human systems and the interactions in terms of assessing potential impacts and adaptation options. This fishery, located in a region predicted to be the fastest warming in the southern hemisphere, provides early warning signals for consideration in fisheries globally. Direct impacts relate to forecast changes in growth and recruitment whereas indirect impacts, already in full swing, affect ecosystem services through major changes in ecosystem resilience. Although climate change adaption is often viewed by managers and industry as a future decision because incremental changes appear small, climate-related impacts are already affecting this fishery. Current resource assessments and the evaluation of future management strategies need to account for climate change impacts to produce the best long-term outcomes for the fishery.

Keywords: climate change, multidisciplinary approach, ecosystem resilience.

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ICES CM 2009:G:09

Ecosystem responses to recent climate variability: comparison of four northern hemisphere regions

Ken Drinkwater, Franz Mueter, Kevin Friedland, George Hunt, Jon Hare, Cecilie Broms, Webjørn Melle, and Maureen Taylor

Results of comparative studies examining the ecosystem responses to recent climate changes in four high-latitude regions of the northern hemisphere are presented. The regions include two in the Pacific (Bering Sea and Gulf of Alaska) and two in the Atlantic (Georges Bank/Gulf of Maine and the Barents/Norwegian Seas). Air temperature, heat fluxes, and windforcing over the four regions are examined and their effects on the physical oceanography of the regions are compared and contrasted, including changes in ocean temperatures, salinities, stratification, and circulation. The relative roles of advection and air–sea fluxes in controlling the physical variability will also be discussed. In addition, changes in seasonal sea-ice cover are compared between those regions where it occurs. The responses of phytoplankton and zooplankton to the physical changes are then discussed. Phytoplankton production is found to increase with increasing temperature in the Bering Sea, Barents Sea, and the Gulf of Maine regions but not in the Gulf of Alaska or Norwegian Sea. The responses of the higher trophic levels include distributional shifts and changes in production, which are species dependent. Evidence of both bottom–up and top–down control is provided. The implication of these results for developing ecosystem responses to future climate scenarios is also discussed.

Keywords: ecosystem comparisons, Atlantic, Pacific, physical oceanography, biological oceanography, fish.

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ICES CM 2009/G:10

Impact of climate variability on pelagic foodwebs in European shelf systems, with a focus on trophic relations between zooplankton and small pelagic fish

Jürgen Alheit

Marine ecosystems around Europe are exposed to the forcing of several climatic phenomena, such as the North Atlantic Oscillation (NAO), the Atlantic Multidecadal Oscillation (AMO), and global warming. The interdependence between these different climate indicators and their individual as well as their combined impacts on marine ecosystems are poorly understood. At present, a fascinating natural climate experiment involving zooplankton and small pelagic schooling fish such as sardines, sardinellas, anchovies, and sprats is going on in waters surrounding Europe, which has been largely ignored, despite its acute and future commercial importance for the European fishing industry. Numerous observations over the last 20 years demonstrate clearly that small pelagic fish populations in all shelf seas surrounding Europe from the North African upwelling and the Black Sea in the south up to the Baltic Sea and southern Norwegian coasts in the north are shifting their distributional borders northwards with concomitant dramatic changes in abundance and recruitment. Spectacular examples are the invasion of the North Sea by anchovies and sardines since the 1990s which have established spawning populations in this northern shelf sea and the unprecedented increase in abundance of sardinellas in the western as well as in the eastern Mediterranean. At the same time, large-scale northward movements of copepod assemblages, the main food source of small pelagics, have been observed in the Northeast Atlantic. All these dramatic changes in distribution and abundance of small pelagics and copepods seem to be primarily associated with recurrent climatic events or periods, oscillations, such as NAO and AMO, and, maybe second, with global warming. Concomitant changes in the distribution and abundance of zooplankton and small pelagic fish in northern and southern European marine ecosystems that are thought to be climate induced are compared in this presentation and mechanisms for causal relationships are suggested.

Keywords: climate variability, pelagic foodwebs, small pelagic fish, NAO, AMO.

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ICES CM 2009/G:11

Recent climatic changes in the southeast Bay of Biscay affecting pelagic and coastal ecosystems

V. Valencia, A. Borja, A. Fontán, N. Goikoetxea, and J. Sáenz

Throughout the last decade several regime shifts and anomaly patterns for different oceano-meteorological indices (ENSO, NAO, EA, etc.) have been described because of unusual values and/or related to persistent accumulated anomalies. For the inner (southeastern) Bay of Biscay, the prevalence of positive values of the East Atlantic pattern since 1998 has affected the transport and subsequent properties of the upper water masses. The mesoscale effect, related mainly to the intensification of the British Isles low atmospheric pressure centre, also drives moisture transport, storm frequency and intensity, etc. As a consequence of the shift in the EA pattern, several structural factors of the coastal and pelagic ecosystems have displayed seasonal and/or annual anomaly patterns in recent years. For instance, assessment of the recruitment of the Bay of Biscay anchovy, as well as the assessment of benthic communities (macroalgae, barnacles, etc.) based on climatic and oceanographic variables also demonstrate responses to these anomaly patterns. Factors such as the turbulence–stability and upwelling–downwelling dualities; saline stratification and coastal fertilization by precipitation and continental run-off; and other coupled oceano-meteorological variables are considered. The patterns observed are representative of the response, in terms of local and seasonal or annual anomalies in the coastal and pelagic ecosystems, to shifts in some mesoscale or large-scale climatic indices such as the EA pattern.

Keywords: oceano-meteorological coupling, pelagic ecosystem, East Atlantic pattern, Bay of Biscay.

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ICES CM 2009/G:12

Impact of climate change on the ecological state of the Curonian and Vistula Lagoons of the Baltic Sea

Sergey Aleksandrov and Olga Dmitrieva

Coastal lagoons are vulnerable to direct impacts from natural environmental and anthropogenic factors. Analysis of long-term changes in chemical and biological parameters in lagoons could help to demonstrate the relationship between global and local changes (e.g. impact of climate change). The Curonian and Vistula Lagoons are the largest coastal lagoons in the Baltic Sea. Eutrophication is one of the most important problems. Multiple reductions in nutrient loading from the watershed area in the 1990s because of the economic crisis did not result in considerable improvement of the ecological situation. On the basis of comparison with hydrological and chemical parameters the main abiotic factors that influence the level of biological production and the trophic state of lagoons are indicated. Water temperature appears the key environmental factor determining the seasonal and long-term variability of the level of biological production and the trophic status. More intensive summer warming-up of the water in the 1990s–2000s combined with freshwater conditions, slow flow velocity, and high concentrations of nutrients creates conditions for ”hyperblooms” of cyanobacteria. In the coastal zone, periodic accumulation and decomposition of algae result in oxygen deficit and death of fish. It is likely that climate warming in the 1990s–2000s caused ongoing eutrophication of the Curonian Lagoon despite a significant reduction of external nutrient loading as a result of a decrease in fertilizer application and industrial production. Therefore, the warming up of the water resulting from global climatic changes represents a risk for coastal water bodies, as this stimulates cyanobacteria ”hyperblooms”. Biological productivity and

the trophic state of the Vistula Lagoon do not attain potentially possible levels because hydrodynamic activity and brackish water prevent water "blooming".

Keywords: biological production, eutrophication, climate change, water temperature, hyperbloom of cyanobacteria, Curonian and Vistula Lagoons.

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ICES CM 2009/G:13

Ecosystem changes and possible management solutions in the shallow areas of the eastern Baltic Sea—preliminary results of the Latvian KALME programme

Anda Ikauniece, Juris Aigars, Baiba Kalveka, Vadims Jermakovs, and Iveta Jurgensone

Launched in 2006 the Latvian national research programme KALME is addressing the observed consequences and possible projections of climate change in marine ecosystems. The current study tries to answer "What will happen and what should we do?" using the IPCC regional forecast, which indicates the certain rise of air temperature in the area and keeping in mind that recommendations for ecosystem management are between the deliverables of KALME. Preliminary results indicate that a switch of nutrient fluxes is likely to occur in the thermally stratified Gulf of Riga, with longer seasonal anoxic conditions. In the relatively shallow gulf these changes could lead to considerable restructuring of the ecosystem as the nitrogen limitation expands. Increased nitrogen fixation and more intense cyanobacteria blooms could be one of the effects. Higher water temperature in the upper layers of the Baltic Proper would enhance the set of the thermocline in spring and decrease the nutrient availability for phytoplankton. Structural changes in the phytoplankton community could lead to suppressed zooplankton development because of declining food conditions in spring when most zooplankton are herbivores. The strengthening of thermal stratification would induce a further reduction in the already low oxygen concentrations and continue the restructuring of the benthic communities when the consumers of the organic matter are replaced by mobile species. Further effects would be visible in both pelagic and benthic foodwebs as the growth of larval and juvenile fish is affected. Management recommendations for Latvian marine areas considering all ecosystem compartments are discussed and certain activities as future adaptation measures are suggested.

Keywords: Baltic Sea, ecosystem processes, biodiversity, forecasts, management.

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ICES CM 2009/G:14

Comparative integrated ecosystem assessments of the North Sea and Baltic Sea

Rabea Diekmann, Andrew Kenny, and Christian Möllmann

Integrated ecosystem assessments (IEAs) can be undertaken using multivariate statistical analyses of spatial and time-series data representing all biotic and abiotic components of an ecosystem. Hence IEAs can deliver information on the state and historical development of the ecosystem as well as the relative importance of external drivers such as climate, fisheries, and eutrophication in changing ecosystem structure and function. The integrated analysis of ecosystem component data provides a crucial objective background when developing the ecosystem approach to management of exploited marine resources. Comparative IEAs of ecosystems which differ fundamentally in physical oceanography, species composition, and biodiversity, for example, may furthermore provide general insights into the effects that climate change may be exerting on marine ecosystems relative to direct anthropogenic influences. Here we undertake a comparative analysis of the state and development of the North Sea and Baltic Sea ecosystems by using principal component and discontinuity analyses. Simultaneous ecological structural changes (i.e. "regime shifts") were observed in both systems, with the most pronounced shift identified in the late 1980s. In a

comparative approach we want to disentangle common and system-specific drivers, identify whether ecosystem changes are initiated by persistent forcing or episodic events (including those caused by some human activities), and what proportion of the biological variance is caused by direct physical forcing and what is driven by non-linear internal dynamics and feedback loops.

Keywords: integrated ecosystem assessment, regime shifts, ecosystem state, resilience, climate change.

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ICES CM 2009 /G:15

Cod and climate

Brian J. Rothschild, Changsheng Chen, Song Hu, Robert C. Beardsley, Yue Jiao, and Emily F. Keiley

Substantial changes in cod populations in the Northwest Atlantic Ocean appear to be related to changes in ocean physics. In order to examine this problem, we reconstructed the surface heat flux over the Gulf of Maine/Georges Bank region from 1978 to present using a high-resolution mesoscale meteorological model with data assimilation. The net annual flux indicates that global warming has led to a warming trend near the coast and over Georges Bank, Nantucket Shoal, and Nova Scotia shelf. A simple heat balance box model suggests that the average water temperature in the Gulf of Maine bounded by 200-m isobath increased dramatically in the past 30 years because of climate-induced local warming. This result contrasts with long-term sea surface water temperature measurements from NOAA buoys in the Gulf of Maine, which demonstrate a cooling trend off Georges Bank over the past 30 years. An analysis was made to link the Gulf of Maine to the upstream Labrador Sea and Arctic Ocean. The cooling trend is coherent with decreasing ice coverage in the Arctic Ocean. Our analysis is that the impact of the Arctic Ocean and Labrador Sea climates on the Gulf of Maine has significantly increased. This upstream effect is much stronger than the change of heat flux caused by the climate-induced local weather change. This index should be taken into account in the study of the interannual and long-term variability of fishery stocks over the Scotian and New England shelves. The evidence to support our argument will be presented in this paper.

Keywords: cod stocks, Gulf of Maine, Scotian Shelf, temperature response.

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ICES CM 2009/G:16 Poster

Baltic foodweb model as a tool for holistic exploration of Baltic Sea system dynamics and integrated assessment

M. Tomczak, O. Hjerne S. Niiranen, and T. Blenckner

The new version of the NEST Ecopath/Ecosim model covers the area of the central Baltic Sea (ICES SD 25-29 excl. GoR) and contains 28 functional groups from primary producers to top predators including fishing. The model has been created based on different databases and literature sources. The most important Baltic fish species—cod, sprat, and herring—are split into multi-stanza groups that represent major ontogenetic changes and shifts in fish diets. Mesozooplankton is represented by four functional groups divided according to their importance as fish food items. Fisheries are represented by three fleets targeting the main fish species. The mass-balanced model describes the state of the ecosystem in the mid-1970s and year 1974 is chosen as a baseline for the temporal Ecosim simulation. To fit and drive the Ecosim model, time-series of biomasses, fishing mortalities, and environmental drivers (temperature and cod reproductive volume) have been used. The NEST Ecopath/Ecosim model is able to reproduce Baltic Proper foodweb dynamics and regime shifts within the fitting period chosen (1974–2006). Large-scale environmental drivers and high fishing pressure explain most of variance in fish stock and intermediate trophic level dynamics as well as

cascading effects on key mesozooplankton groups. Simple model estimates and ecosystem state indicators have been investigated and present an additional tool for integrated assessment of the Baltic Sea.

Keywords: Baltic Sea, foodweb, assessment tool, integrated assessment, regime shift, Ecosim.

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ICES CM 2009/G:17 Poster

Environmental variability on the distribution, abundances, and growth rates of the larvae of bullet tuna

A. Pérez-Torres, F. Alemany, and P. Reglero

Small tuna species, such as bullet tuna (*Auxis rochei*), play a key role in coastal marine ecosystems, because they can have a major impact in small pelagic fish stocks. At their larval stages they can interact, as competitors or prey/predators, with other tuna larvae, as those of *Thunnus thynnus* or *T. alalunga*. It is a well-known fact that environmentally driven variations in larval survivorship rates, potentially induced by climate changes, can result in large fluctuations in population abundances. Therefore, studies providing information on the ecology of small tuna species larvae are useful to assess both the impact of climate changes on the dynamics of small pelagic fish and other tuna stocks. Here we provide a review of the available information on this species over all ICES areas, focusing on the distribution, abundance, and growth rates of the larvae. Because water temperature may be of crucial importance in larval stage dynamics we assess/explore the relationship between temperature and distribution patterns and growth of bullet tuna larvae using data obtained within the framework of ichthyoplankton surveys directed to tuna larvae sampling carried out during the last decade off the Balearic islands, recognized as one of the main spawning grounds of tuna species in the Mediterranean. These relationships are compared with other tuna species and other ICES areas where information is available. Our findings highlight the role that temperature plays in these early stages of development and the impact that increasing temperature may have on the distribution and growth of these species, and hence in recruitment success.

Keywords: tuna, coastal ecosystem, bullet tuna, distribution, growth, larvae.

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ICES CM 2009/G:18 Poster

Galician and Porcupine Bank *Nephrops* fishery systems: a comparison from a climate-induced changes perspective

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Nephrops norvegicus is a valuable resource of the bottom–demersal ecosystems in the Celtic–Biscay shelf and Iberian coastal large marine areas, of which Porcupine Bank and Galician shelf and upper slope (northwest Spain) are representative, respectively. The catch per unit effort (cpue) of *Nephrops* fisheries of these areas, considered as an abundance index of populations, decreased in the Porcupine Bank Spanish bottom fishery and dramatically fell in the Galician fishery. The causes for that decline are not known. In this study, the upwelling, North Atlantic Oscillation and Atlantic Multidecadal Oscillation indices series were used as proxies to explore and interpret the variability of the cpue time-series of the two *Nephrops* populations from the two areas.

Keywords: *Nephrops*, fishery, upwelling, northwestern Spain, Porcupine Bank, North Atlantic Oscillation, Atlantic Multidecadal Oscillation, time-series analysis.

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ICES CM 2009/ G Poster

Linking fisheries to climate variability on Georges Bank

David Kowalske

The move towards ecosystem-based fishery management challenges fishery scientists to fully understand the variability found in the multispecies complex on Georges Bank. Understanding how climate variability affects this ecosystem will lead to a more complete understanding of the physical and biological processes found on Georges Bank. To investigate this link, Georges Bank sea surface temperature data from the National Oceanographic Data Center were compiled from 1970 to 2007. These data are compared with surface temperature measurements compiled from the National Data Buoy Center for buoy 44011 located on Georges Bank. Neural networks completed these temporally incomplete datasets, allowing a monthly climatology to be constructed. Similar trends were seen over both time-series. These data will be used as a proxy for changes in the hydrographic environment on Georges Bank. A gradual warming trend from 1999 to 2007 is described and will be compared with trends in commercially important species in terms of biomass. Changes in species assemblages from the National Marine Fisheries Service spring trawl survey will also be computed. This information will be used to support the hypothesis that increases in temperature on Georges Bank has led to a regime shift that will continue to inhibit recovery of important groundfish stocks.

Keywords: Georges Bank, ecosystem management, community structure, neural networks.

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