

## Theme Session F

### How does fishing alter the sensitivity of marine populations and ecosystems to climate?

---

#### ICES CM 2009/F:01

---

##### How does fishing alter the sensitivity of marine populations and ecosystems to climate?—An introduction

Benjamin Planque and Miguel Bernal

The effects of climate and fishing on marine populations and ecosystems have conventionally been considered separately and it has often been suggested that they should be disentangled from each other. However, exploitation not only modifies the abundance of targeted or bycatch species but can also affect demographic structure, stock structure, geographical and migration patterns, species composition, and trophic pathways. As a result, climate and exploitation interact in their effects and evidence has accumulated to demonstrate that fishing pressure can have direct consequences on the way in which climate signal propagates through populations and ecosystems. In September 2006, a workshop was hosted in the Berlin Museum of Natural History under the auspices of the international programme GLOBEC. A specific topic of this workshop was to examine the sensitivity of marine ecosystems to climate and human exploitation. Theme Session F of the ICES 2009 Annual Science Conference follows some of the ideas presented in the original GLOBEC workshop. In the present contribution, we summarize the conclusion from that GLOBEC workshop and review some of the recent findings obtained since then as an introduction to the state-of-the-art research related to this theme session, and to promote debate within the session. We conclude that our understanding of climate–fishing interactions is still in its infancy. This calls for increasing efforts in studying the interactions between the effects of climate and fishing, in particular in a context of global climate change and globalized fisheries.

Keywords: none.

Contact author: Benjamin Planque, Institute of Marine Research, Tromsø, Norway [e-mail: benjamin.planque@imr.no].

---

#### ICES CM 2009/F:02

---

##### Modelling the competition for food by flatfish species in the North Sea under different temperature regimes and fishing pressures

S. Van der Zon, R. Van Hal, R. Hille Ris Lambers, T. Van Kooten, N. Hintzen, and A. D. Rijnsdorp

A clear increase in average water temperature has been observed in recent decades in the North Sea. Simultaneously, numbers of small demersal fish species such as scaldfish (*Arnoglossus laterna*) and solenette (*Buglossidium luteum*) have increased strongly in regions which were previously considered to be outside their temperature range. These species compete for resources with exploited flatfish populations, such as plaice (*Pleuronectes platessa*), which can potentially lead to reduced availability of valuable flatfish resources. We develop a stage-structured model to study how the competition between these groups plays out under different scenarios of harvesting and climate change.

Keywords: foodweb model, competition, temperature, fisheries, flatfish.

Contact author: Ralf van Hal, Wageningen IMARES (Institute for Marine Resources and Ecosystem Studies), PO Box 68, 1970 AB IJmuiden, The Netherlands [e-mail: Ralf.vanhal@wur.nl].

---

**ICES CM 2009/F:03**

---

**The interaction of fisheries and climate change: socio-economic and management perspectives**

Anthony Charles

Climate change, operating through related physical changes (e.g. sea level, ocean temperature) has biological implications (e.g. changes in primary productivity) which in turn produce direct impacts on human uses of the ocean (e.g. fishing, tourism, ports) and broader induced impacts on human society (e.g. social, economic, community). In fisheries, the effects of climate change are bound to interact with the effects of fishing, in their cumulative impacts on fish stocks, and on human aspects of the fishery system. It is important to recognize that the overall approach to, and the specific components of, fishery management will have major effects on this interaction. Accordingly, this paper explores two main considerations. First, socio-economic and behavioural aspects of fisheries need to be monitored in the face of climate change, as these will likely have strong management and assessment implications. Second, the need to address the combination of climate change and fishing as forcing factors in fisheries reinforces the necessity for adopting a broad-based precautionary approach to management decision-making, and for re-designing management systems so that their structure and methods are more robust and adaptive.

Keywords: fishery systems, robust fishery management, ecosystem approach to fisheries, climate change impacts, climate change adaptation.

Contact author: Anthony Charles, Saint Mary's University, Halifax, Nova Scotia, Canada B3H3C3 [tel: +1 902 420 5732, e-mail: tony.charles@smu.ca].

---

**ICES CM 2009/F:04**

---

**A shift in a hake (*Merluccius merluccius*) population in the northwest Mediterranean induced by a combined effect of climate and fishery harvesting**

M. Hidalgo, T. Rouyer, E. Massutí, J. Moranta, B. Guijarro, and N. C. Stenseth

The drastic change in the climatic conditions in the North Atlantic in the early 1980s triggered changes in local weather and hydrographical conditions in the Mediterranean Sea. Meanwhile, long-term fishery harvesting on the European hake (*Merluccius merluccius*) off the Balearic Islands (northwest Mediterranean) underwent changes in the population properties and structure in the early 1980s, which could trigger a change in the ecological response to the climatic variability. We hypothesize that these two processes were linked and, in turn, a combined effect of fishery harvesting and environmental changes in the North Atlantic produced an ecological shift in hake population off the Balearic Islands. Before 1980, the North Atlantic climate influenced the population dynamics of hake, which had a healthy size structure with moderate fishery exploitation. Seven-year cycles in the North Atlantic climate provided favourable conditions to build up consistent cycles in the hake population of the Balearic Islands. After 1980, fishery exploitation had eroded the size structure of the population, eliminating larger individuals, which made the population strongly dependent on younger age classes (juvnescent population). At the same time, the North Atlantic climate shift reduced the window of favourable conditions to about five-year cycles, and also changed the Mediterranean hydrographical conditions that affected hake dynamics. Consequently, the population has not had enough time to build up an equivalent population to the period previous to 1980 under favourable environmental conditions. In conclusion, after 1980 the hake population stayed more dependent on interannual variations in recruitment, which are closely related to the interannual variability of local weather conditions.

Keywords: European hake, juvenescent population, North Atlantic climate, northwest Mediterranean.

Contact author: Manuel Hidalgo: Centre for Ecological and Evolutionary Synthesis (CEES), Department of Biology, University of Oslo, PO Box 1066, Blindern, 0316 Oslo, Norway [tel: +47 22 85 50 65, fax: +47 22 85 40 01, e-mail: manuel.hidalgo@bio.uio.no].

---

**ICES CM 2009/F:05**

---

**Changes in the Barents Sea fish community induced by environmental change and fishery**

M. Aschan, M. Fosshem, and R. Primicerio

A spatiotemporal analysis of Barents Sea survey data from the deeper parts of the Barents Sea demonstrates a sudden change in fish community structure and abundance taking place in the 1990s. The rapid ecological change includes reduced abundance, biomass, and mean weight of individuals, increased pelagic–demersal ratio, and modified fish community structure. The change in fish community structure is concomitant with climatic change and increasing fishing effort. Fishery may amplify the effects of climate forcing, and oppose recovery from the impact of climatic events. To characterize the effects of climate and fishery, survey trawl data, temperature data, and logbook data from the shrimp fishery and the groundfish fishery were analysed. Twenty species were identified throughout the study period ranging from 1982 to 2007. A northern and a southern species component were identified. Their composition is stable over time, but their range of distribution changes depend on sea currents and temperatures. High caution is needed in the management of all human activities in the Barents Sea as a result of its low species diversity and resilience.

Keywords: Barents Sea, climate change, fish community, fisheries.

Contact author: *Michaela Maria Aschan, Norwegian College of Fishery Science, University of Tromsø, 9037 Tromsø, Norway [tel: +47 776 46953, cell phone: +47 99261458, fax: + 47 776 46020, e-mail: michaela.aschan@nfh.uit.no].*

---

**ICES CM 2009/F:06**

---

**Temperature-modified stock–recruitment relationships for Northwest Atlantic fish stocks: a meta population approach**

Janet A. Nye and Jason S. Link

In a previous study we documented poleward shifts in the distribution of many fish stocks that were correlated with large-scale oceanographic indices rather than changes in population abundance. However, shifts in spatial distribution were exacerbated in heavily fish stocks and varied spatially among stocks within a species. Stocks at the southern extent of their range experienced more dramatic movements than stocks at the northern extent of their range. In this work, we hypothesize that low recruitment in southern stocks relative to the northern stocks can explain the differences in spatial shifts observed within species. First, we conducted a meta-analysis of stock–recruitment relationships among stocks within species that frequently occur in the US northeast continental shelf ecosystem. Then we developed and evaluated stock–recruitment relationships modified by environmental variables that can be used to improve stock assessment models. Including an environmental parameter improved the fit of these recruitment models, despite the penalty of an additional term and possible additional source of variability. Incorporating an environmental variable into stock–recruitment relationships may be a promising method to consider the effects of fishing and the environment simultaneously.

Keywords: Atlantic multidecadal oscillation, AMO stock–recruitment, climate change.

Contact author: *Janet A. Nye, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole Laboratory, 166 Water St., Woods Hole, MA 02543, USA [tel: +1 508 495 2325, e-mail: janet.nye@noaa.gov].*

---

**ICES CM 2009/F:07**

---

**Considering the both fishing and climate in a model of the Celtic Sea and the Bay of Biscay: what do we learn?**

Sylvie Guénette, Didier Gascuel, and Stéphanie Mahévas

The Celtic Sea and the Bay of Biscay have been fished intensively for at least a century. Already sizeable between the two World Wars, the fisheries resumed after 1945 with the support of governmental subventions to modernize the fleets, thus causing an unprecedented increase in

fishing capacity in the region. This project examines the impact of fishing on this ecosystem using an Ecosim model. Of the numerous species that are exploited in the ecosystem, only a dozen were the subject of stock assessment because of their importance for the industrial fleets. Thus, most coastal species were never assessed. The model is articulated around the industrial species (cod, hake, megrim, anchovy, mackerel, horse mackerel, whiting, haddock, plaice, sole, herring, monkfish, and Norway lobster), their prey and predators, for a total of 40 groups. Cod, hake, and Norway lobster were separated in juvenile and adult stanzas to account for species size-structured interactions among themselves and the fisheries. The model, driven by fishing mortality, was fitted to catches and biomass using indices of productivity of the North Atlantic. The model is able to predict biomass and catches of most exploited species, from 1975 to 2006. The effects of various indices of ocean productivity are compared, and the respective effect of fishing and climate are examined. We demonstrate that major changes occurred during the period. The increasing fishing pressure led to decreasing biomasses of targeted groups and to a significant change in the trophic functioning of the ecosystem. The EcoTroph plug-in is used to build synthetic graphical representations of Ecopath outputs and it highlights that fishing impact modifies both the biomass and the production trophic spectra. Finally, we simulated various fishing scenarios, using either Ecosim or EcoTroph. We demonstrate that both approaches lead to consistent results, which confirm that the highest trophic levels, mainly composed of gadoids, are significantly overfished in the Celtic Sea and Bay of Biscay. Reaching maximum sustainable yield, now officially defined as the management objective by European Fishery Policy, would imply strongly decreasing the real fishing pressure.

Keywords: none

Contact author: Sylvie Guénette, 1 Université Européenne de Bretagne, Pole halieutique AGROCAMPUS OUEST, France [e-mail: sylvie.guenette@agrocampus-ouest.fr].

---

## ICES CM 2009/F:08

---

### **EcoSystemData—Delivering data and tools that facilitate the study of climate and fishery exploitation interactions**

Carlos Pinto, Hans Mose Jensen, and Neil Holdsworth

This paper describes the EcoSystemData integrated repository of data. This system was developed to improve integrated data requests covering, for example, the study of climate change in relation to large ecosystem dynamics. A major advantage offered by EcoSystemData is that it joins physical, chemical, and biological measurements into one system. The data can be queried and analysed in ways that would otherwise have been far more difficult for scientists looking across fisheries and sea climate disciplines. The main goal of ICES EcoSystemData is to function as an aggregation and data delivery service in which different types of data can coexist and interact for multiple purposes, such as large ecosystem management decision support tools, fishery management, conducting studies of ecosystem dynamics, and climate change studies. EcoSystemData stores datasets such as biological community data, contaminants, biological effects, and oceanographic data. Part of the action plan is to incorporate fish trawl survey data and fish predation data in summer 2009. In EcoSystemData the user defines layers and each of these layers can contain data from one or more datasets across data disciplines. It also allows the user to overlay several layers and download all the data in the same format. EcoSystemData was also developed to give the user a rich web experience, allowing the user to interact with visual tools such as maps, charts, and tables. The data can be previewed and analysed prior to extraction. In summary, the user has a tool to work with data integration in which data can be searched, previewed, and extracted, and is able to take advantage of the integrated data structure when using the system.

Keywords: integrated management, ecosystem data, geographical information system, map spatial planning, fisheries, environment, oceanography, stomach data, rich web experience, mapping data.

Contact author: Carlos Pinto, ICES, H.C. Andersens Blv. 44-46, DK-1553 Copenhagen V, Denmark [tel: +45 33386713, e-mail: carlos@ices.dk].

---

**ICES CM 2009/F:09**

---

**A fishery-induced cause of regime shifts that does not require a change in environmental conditions**

The Private Working Group (Daan, Gislason, Pope, Rice)

As the concept of “regimes” gains acceptance, there is increasing discussion of changing productivity regimes for populations, as well as of regime changes in whole communities. This use of regime is being applied to stocks that have productivity indicators such as recruitment or growth rates that alter abruptly and remain in a different (often less productive state) for some time thereafter. The modelling work of the Private Working Group (PWG) has found that fishing pressure that is around the maximum sustainable, combined with production of an exceptionally strong year class (whatever the cause), may result in exactly that pattern occurring for somatic growth rate of a population, and to the extent that size-at-age affects reproductive value, recruitment rate as well. The effect only requires that mean somatic growth rate for the exceptionally strong cohort be lower than the mean somatic growth rate of more “typical” cohorts—a relationship that is commonly observed and may have several causes. The paper describes the mechanisms producing the effect and presents modelling results that demonstrate both its likely magnitude and persistence once it occurs. It also presents another possible way that fisheries can interact with environmental conditions that may produce regime-like changes in population dynamics, even if the environment is not altered in a regime-like manner.

**Keywords:** regime, growth rate, overfishing, productivity, strong year classes.

*Contact author: Jake Rice, Fisheries and Oceans Canada, 200 Kent Street, Ottawa, Ontario, Canada K1A 0E6 [e-mail: [jake.rice@dfo-mpo.gc.ca](mailto:jake.rice@dfo-mpo.gc.ca)].*