

## Theme Session K

### Habitat science to support stock assessment

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#### ICES CM 2009/K:01

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##### **Satellite monitoring of SST for forecasting of northeast Arctic cod year-class strength**

V. M. Borisov, G. P. Vanyushin, B. N. Kotenev, M. Yu. Kruzhalov, A. A. Troshkov, and T. V. Bulatova

A continuous long-term database of sea surface temperature (SST) comprising the results of regional differentiated satellite monitoring has been used to resolve several applied problems. The authors analysed the indirect influence of SST (NOAA satellite data) on the strength of the northeast Arctic cod year-class strength (abundance at age 3+). Four areas in the cod distribution area were selected for the analysis of SST in particular months: spawning grounds off the Lofoten islands (March–April) and three zones of larval drift and pelagic young fish distribution: the West Spitsbergen waters and the Bear Spitsbergen (Nordcap) area (May–October), and Murmansk–Novaya Zemlya area (June–October). Mean monthly SST and anomalous values are computed for the selected areas on the basis of the weekly SST maps for the period 1998–2008. These maps were plotted with satellite SST data, as well as information on vessels, buoys, and coastal stations. All data on each area were classified by season and year. The results indicate that poor generations of cod (2001, 2006, 2007) occurred in years with negative or extremely high positive anomalies of SST in the spawning grounds in March–April. The SST anomalies which were close to normal provide conditions for the appearance of generations with average abundance (1999, 2003, 2004, 2005) or even high abundance (1998, 2000, 2002). A similar influence of SST on the cod year class strength is seen in areas in which pelagic young fish feed before they migrate to the bottom layer (November–December). Examination of the SST influence on cod year class strength during early life (March–October; i.e. spawning till migration to the bottom layer) allows us to identify a relatively narrow range of SST anomalies that are optimal for the appearance of strong generations of cod (+0.1 to +0.7°C) and a broader range of SST anomalies (–0.1 to +1.4°C) that are favourable for the appearance of generations with average abundance. Poor generations are very likely to occur outside these ranges (i.e. when the SST anomalies exceed +1.4°C or are below –0.1°C). A similar pattern was found in computations based on data for two successive years (the year of spawning and the following year, when hydrological conditions indirectly influence the quality of the spawning stock and, consequently, the success of the coming spawning. Results of the analysis of the SST data for the first year of the cod life history allow us to assess the recruitment abundance (i.e. these data could be used to forecast recruitment two years in advance).

Keywords: satellite monitoring of SST, northeast Arctic cod, spawning grounds, areas of early life history, forecast of cod year-class strength at age 3+.

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#### ICES CM 2009/K:02

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##### **Incorporating foodweb and habitat interactions in a forage fish stock assessment**

Howard Townsend

Some researchers have suggested that because of the multiple sources of mortality that forage fish face, fishery managers could use other biological reference points (e.g. total mortality ( $Z$ )) as a benchmark for making management decisions. Doing so would require accounting for other sources of natural mortality. In this paper, we outline the potential for using ecosystem and habitat models to estimate natural mortality for forage fish stocks. We use the Chesapeake Bay Fisheries Ecosystem Model (CBFEM) to generate various sets of a time-series for predation mortality on Atlantic menhaden. In alternative runs of the CBFEM, we use forcing and mediation functions to influence physical factor–species interactions and generate additional time-series of natural mortality. Then, using a simple stock assessment model and the time-series generated with the

CBFEM, we compare the fit of the various formulations (i.e. constant natural mortality, variable natural mortality based on trophic effects alone, and variable mortality-based physical factors and trophic interactions) to determine the utility of incorporating physical and trophic interactions into stock assessment models. These model scenarios and stock assessment approaches are presented to gain insight into the possible responses of menhaden to the fishery management and water quality management actions.

Keywords: forage fish, habitat, ecosystem model, stock assessment.

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### ICES CM 2009/K:03

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#### **Growth and habitat requirements of juvenile flatfish at nursery grounds in Galway Bay, Ireland**

F. De Raedemaeker, D. Brophy, I. O'Connor, and D. Mc Grath

Coastal zones are essential nursery habitats for most juvenile flatfish species. Fish stocks are highly dependent on suitable coastal habitat features for obtaining food, shelter, and rapid growth during the vulnerable juvenile life stage. Understanding the ecological habitat requirements for juvenile flatfish is important in determining their abundance and to reliably predict potential impacts of changing coastal ecosystems on fish stocks. The present study assesses the influence of habitat characteristics on the growth and abundance of juvenile dab and plaice in four nursery areas within Galway Bay, Ireland. Field sampling was carried out in summer 2008 using a beam trawl for the collection of flatfish and a van Veen grab for the collection of sediment. The distribution and abundance of the juvenile flatfish was assessed in relation to biotic (predator-prey abundance) and abiotic (sediment size, organic content, depth, temperature, and salinity) habitat features. The condition and growth of flatfish were compared in different nursery areas and a model of habitat requirements for juvenile plaice and dab was developed. Significant variability of the measured characteristics was observed between nursery areas and high-quality nursery areas for dab and plaice were identified. These results will act as the basis for mapping of essential flatfish habitats in Galway Bay.

Keywords: juvenile flatfish, habitat characteristics, growth and condition, modelling, western Ireland.

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### ICES CM 2009/K:04

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#### **Including the incidental effects of scallop dredging greatly affects fishery models and management advice**

M. Cryer, M. A. Morrison, N. M. Davies, and R. B. Ford

Trawling and dredging often significantly affect both the target species and its supporting benthic habitats, but this knowledge is not frequently conveyed to fishery managers in a form that they find easy to digest. This makes it difficult for managers to balance seemingly ethereal environmental "costs" against the benefits of a fishery. We incorporate field-based estimates of the incidental effects of scallop dredging on scallops and on habitat into a familiar (though individual-based) yield-per-recruit (YPR) framework. In the absence of incidental effects, YPR curves are asymptotic, effectively endorsing heavy fishing. If incidental effects on adults (especially mortality) are included, YPR curves become domed, with roughly 50% loss of yield at high fishing effort. If a relationship between habitat modification and juvenile mortality is included, the descending limbs of YPR curves become steeper, reference rates of fishing mortality decline, and the loss of yield at high fishing effort increases. We advocate this as a tractable stepping stone, using existing information and models, towards more holistic stock assessments. It allows scientists to incorporate ecological observations into their models, and permits managers to consider more

explicitly how harvesting affects the supporting ecosystem, and to evaluate this relative to more palpable and immediate economic benefits.

Keywords: incidental effects, incidental mortality, individual-based-model, per-recruit model, management advice.

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## ICES CM 2009/K:05

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### Habitat science to support stock assessment

Lohandjole Regan

The current concept of stock does not sufficiently accommodate the effects of migration behaviour on population dynamics. New insight on the prevalence and ecological significance of divergent migrations within stocks has arisen through advancing technologies in tracking fish. In particular, otolith elemental analysis may provide a unique perspective on divergent migrations within stocks. This leads to a contingent hypothesis of intrapopulation migratory groups. Having looked at the results of Clark's earlier tagging study, I observed three spatially discrete cohorts of Hudson River striped bass to establish whether such contingents exist, and if so, then how they are regulated. Using frameworks for understanding smoltification in salmonids and ontogenetic niche shifts, I hypothesized that early life decisions regarding energy allocation lead to later divergence in habitat shifts (migration). This mechanism results in the maintenance of retentive and exploratory behaviours and contributes to features of population regulation including persistence, range contraction and expansion, and colonization. Support for the contingent hypothesis (i.e. divergent migration tactics) exists for a diverse array of fish taxa. Assignment of contingents should allow improved specification of factors that affect a population's accessibility to human impacts. Consideration of stock structure should incorporate a hierarchy of biological levels which evaluate both lineage (subpopulation–population–metapopulation–subspecies–species) and accessibility (individual–brood–school/shoal–year class–contingent).

Keywords: stock, life cycle, migration, otolith, habitat, interspecific comparison, marine environment, environmental factor, vertebrate.

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## ICES CM 2009/K:06

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### The Barents Sea ecosystem survey: feeding in a heterogeneous environment

Edda Johannesen, Mette Mauritzen, Ulf Lindstrøm, and Per Fauchald

Habitat selection by predators is largely driven by prey availability. However, the habitat suitability for fish is also determined by physiological constraints induced by, for example, temperature. The Barents Sea ecosystem survey obtains data on oceanographic features, plankton, pelagic fish, and top predators synoptically during the most intense feeding period (August–September). This allowed the study of the selection of feeding habitat for key prey and predator species in the Barents Sea ecosystem. The study period (2003–2008) was characterized by low to increasing biomass of capelin, the main pelagic fish in the Barents Sea, and high temperatures. The high temperatures allowed both cod and capelin to use a wide area for feeding. Cod used a wide variety of prey and habitats and preyed both in the benthic and pelagic domain. Large cod and baleen whales distributed north of the main capelin distribution, possibly to avoid food competition from capelin while feeding on large zooplankton.

Keywords: ecosystem survey, habitat selection, trophic interactions, predator–prey overlap.

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**ICES CM 2009/K:07**

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**Estuarine–coastal connectivity of red drum populations in the Gulf of Mexico**

Gregory W. Stunz and Jay R. Rooker

Stable isotopes ( $\delta^{13}\text{C}$  and oxygen  $\delta^{18}\text{O}$ ) in otoliths were used to assess the degree of connectivity between early life (estuarine) and adult (coastal) habitats of red drum (*Sciaenops ocellatus*). Young red drum were sampled over a three-year period from all major estuaries in the northwestern Gulf of Mexico. North–south gradients were pronounced, with both isotopes becoming more depleted with increased latitude. In four regional nursery zones, a jack-knifed classification success to nurseries was high for all three years: 2001 (92%), 2002 (82%), 2003 (90%). Interannual variability was present, precluding fine-scale (bay) assessments of natal origin; however, the resolving power of pooled year classes grouped into the four regions was still relatively high (77%) and therefore used as a baseline to predict the origin of adult red drum collected in coastal waters during fall spawning runs. Mixed-stock analysis indicated that most of adult red drum sampled in the northern and southern areas was produced from the same nursery. Exchange was markedly high between two zones in the central region; however, the majority of spawning adults matched the nursery signatures of one of the two central zones, with little mixing from nurseries in the north or south. Results from this study clearly indicate that some level of mixings occurs along the coast of Texas for red drum but the majority of adults in spawning aggregations are produced from nurseries in the same region or very close to the region, suggestive of natal homing to specific estuarine corridors.

Keywords: red drum, otolith chemistry, natal origin, habitat connectivity.

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**ICES CM 2009/K:09**

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**Estimating habitat volume based on physical and biogeochemical models**

Katharine A. Smith, Elizabeth W. North, and David H. Secor

We develop an approach that integrates habitat information and numerical models into indices that can inform fishery stock assessments. Coupled three-dimensional circulation and biogeochemical models predict changes in water properties that define fish habitat, including parameters such as temperature, salinity, and dissolved oxygen. When coupled with known physiological tolerances and habitat requirements of a species, model output can be used to estimate the volume of suitable habitat for the species over time. We are developing an open-source numerical model that calculates habitat volume from the predictions of the Regional Ocean Modeling System (ROMS) coupled to the RCA water quality model. We will describe multiple approaches for calculating habitat volume as well as model sensitivity analyses and preliminary results for species that inhabit Chesapeake Bay. We present a precautionary framework by which habitat volume metrics can be incorporated into fishery stock assessment models.

Keywords: none.

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**ICES CM 2009/K:10**

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**Habitat and stock assessment: what is being assessed?**

Jake Rice

Stock assessments have estimated the size of a population unit and its trend over time, generally to inform harvest management decisions. Habitat is inherently a description of features in space. Spatial biomass estimates have had a role in stock assessment (estimates from survey-based extrapolations, geostatistics, etc.). However, merging “habitat” with stock assessment is trying to go further, and explain (causally) some of the variance in abundance with variation in habitat features. Conceptually, there are strong precedents for this; terrestrial ecologists have been explaining patterns of variation in abundance of species with patterns of variation in habitat features for decades. However, there are some new challenges when this is done in the context of stock assessment. One is that spatial management tools do not work in the same way as harvest management tools. Consequently the merger of habitat and stock assessment may require users of stock assessment to redefine their approaches to their tasks as well and they may not be eager to do this without some clear benefits. Another challenge is that although the concept of “habitat” may translate well from terrestrial ecosystems to the seabed and benthos, there are some important differences in the water column. These affect how the spatial tools work, and what can be expected in an assessment using them. The paper will elaborate on these issues, implications, and what can be done about them.

Keywords: habitat, stock assessment, spatial management, population management.

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**Fish and physics: using ocean observing systems to measure effects of seascape dynamics of fishery recruitment**

John Manderson, Josh Kohut, and Beth Phelan

Marine organisms have evolved in a viscous environment with a high heat capacity and solute concentrations similar to intracellular milieus in which drag rather than gravity is the dominant force controlling movements. Physiology, dispersal, and fitness of marine organisms are therefore tightly coupled to multiple scales of benthic habitat heterogeneity as the animals make dramatic ontogenetic habitat transitions required to complete their life cycles. Although most marine habitat studies focus on bottom characteristics that are relatively stable over space and time, pelagic characteristics, often forced by the atmosphere and dynamic in space and time, are frequently the most important factors directly or indirectly regulating vital rates. Dynamic pelagic features and processes are particularly important in determining the timing of formation, durations, locations, and volumes of critical habitats ultimately controlling the recruitment of many marine species. Integrated ocean observing systems (IOOS) now sample oceanographic processes and structures at the broad spatial and fine temporal scales required to describe dynamic pelagic habitat effects on life history processes controlling recruitment. In this paper we discuss fishery applications of IOOS products in terms of: (i) retrospective analysis of stock assessment surveys, (ii) the design of adaptive experiments and surveys measuring the effects of dynamic ocean processes on critical rates affecting fish recruitment, and (iii) technological advances that extend IOOS technology for fishery applications that describe regional patterns of habitat use and spatial population structure which are required for spatial fishery management.

Keywords: none.

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**ICES CM 2009/K:12      Poster**

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**Study of some biological characteristics and population parameters of crucian carp (*Carassius auratus*) in the Gorganrood estuary**

Tahere Bagheri and Aliakbar Hedayati

Because biological characteristics and population parameters are influenced by the specific environmental conditions present in the estuary of the Gorganrood River, we examined the biological characteristics of crucian carp in the Gorganrood estuary and compared them with those from other environments. Sampling was done in autumn and a total of 49 samples were studied belonged to three age groups: 1+, 2+, 3+. Average total length in each group was 75.48, 122.81 and 151 mm and average weight was 8.48, 29.61, 62.2 g, respectively. In whole specimens only females were detected, which probably relates to the parthenogenesis of the species. The Fulton Factor equalled 3.18, indicating positive allometric growth. The moment growth coefficients between age group 1+ and 2+ and between age group 2+ and 3+ were 0.57 and 0.32, respectively. This could be a result of increased gonadic growth and reduced somatic growth in higher age groups. Relative intestine length was approximately 2.57, reflecting the feeding strategy of crucian carp, which is a herbivore. A coefficient factor was calculated to express nutritional status and it equalled 1.06, which is a result of the time of sampling (autumn) and unfavourable environmental conditions. The regression coefficient of length and weight was 0.99, indicating a strong relation between length and weight in this species.

Keywords: growth, age, crucian carp, Gorganrood.

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