

Theme Session D

Census of Marine Life: Community and species biodiversity in marine benthic habitats from the coastal zone to the deep sea

ICES CM 2006/D:01

Using bottom type and water depth information to predict bycatch species in a sea scallop (*Placopecten magellanicus*) fishery

S. J. Smith, V. E. Kostylev, B. J. Todd, and C. Frail

The sea scallop (*Placopecten magellanicus*) fishery in Southwest Nova Scotia in scallop fishing area 29 is unique in a number of ways. This new fishery has had full monitoring in terms of annual surveys, observer coverage, catch sampling and satellite monitoring systems since it began in 2001. In 2002, a three-year joint project agreement was signed with the fishing fleets, Natural Resources Canada, and Department of Fisheries and Oceans, with all parties providing funds to conduct multibeam sonar acoustic mapping of the sea floor and associated scientific work. Maps of high-resolution bathymetry, acoustic backscatter strength and surficial geology have been produced from this project. In addition, benthic data were collected using photographic and video equipment for the analysis of the distribution of benthic assemblages in relation to bottom type. Scallop fishing area 29 and the adjacent German Bank area are located off the southern end of Nova Scotia in the eastern Gulf of Maine; both areas are the offshore continuation of the prominent Maritime penneplain on the adjacent land. The rugged geomorphology of this area is dominated by outcropping bedrock composed of metasedimentary rocks intruded by granitoid plutons. Water depths range from 30 m to 250 m.

The sea scallop fishery occurs in the richest lobster (*Homarus americanus*) grounds in Canada (Lobster Fishing Area 34) and the fishery observer coverage was implemented to monitor the degree to which lobster occurred in the bycatch. Other fish and invertebrate species are also recorded by the observers. We fit a multinomial generalized linear model to these observer data which allows us to predict the probability of a particular species or groups of species occurring as bycatch in the scallop fishery as a function of bottom type, fishing area, and water depth. These predictions are compared with the distribution of species assemblages identified by photo and video records. This model shows promise for evaluating the impact of the scallop fishery on the species biodiversity in an area. It is expected that the adjustments to the scallop fishery resulting from this study will improve scallop catches, minimize gear losses, and greatly reduce bycatch and damage to epibenthic communities.

Keywords: Stock assessment, community biodiversity.

Contact author – Stephen J. Smith: Population Ecology Division, Department of Fisheries and Oceans, Bedford Institute of Oceanography, 1 Challenger Drive, Dartmouth, Nova Scotia, B2Y 4A2, Canada [tel: +1 902 426 3317, fax: +1 902 426 1862, e-mail: smithsj@mar.dfo-mpo.gc.ca].

ICES CM 2006/D:02

Spatial and temporal trends in species richness of the total North Sea fish community and its southerly and northerly components separately, based on the IBTS, 1977–2005

Niels Daan

A method is provided to correct spatial and temporal information on the number of species recorded in the International Bottom Trawl Survey for geographic and annual differences in survey effort. The application indicates systematic regional differences: species richness is lowest in the central North Sea and highest in Scottish waters, in the Kattegat, and in the Channel area. These differences appear to be related to the intrusion of species that typically inhabit surrounding areas. When the community is split into northerly and southerly species, the former reach the highest diversity in waters typically deeper than 100 m and the latter in water depths less than 50 m. Although richness of northerly species is less in the southern North Sea, richness of southerly species is not only high in the southern North Sea but also along the Scottish coast and in the Kattegat. Temporal trends show a gradually increasing richness over the past 30 years of both components (and thus also of the total fish community), the rate of which did not differ significantly. These trends are discussed in relation to other changes in the fish community and possible causes.

Keywords: Fish community, North Sea, northerly species, southerly species, species richness, trends.

Contact author – Niels Daan: IMARES, P.O. Box 68, 1970 AB IJmuiden, The Netherlands [tel: +31 255 564 646, fax: +31 255 564 644, e-mail: niels.daan@wur.nl].

ICES CM 2006/D:03

The distribution and relative abundance of elasmobranch species along North-Western African shelf and slope (from Gibraltar to 16°N) as compared to retrospective data (70s–80s) and environment

S. Yu. Guliugyn, F. F. Litvinov, and A. M. Sirota

The present paper describes the elasmobranch species communities of the Central East Atlantic lower shelf and upper slope zone. The data was collected in a bottom trawl survey in 2005 May–June between 16°05' N and 30°30' N. The trawl hauls were carried out at the depths of 200–449, 450–699, and 700–1000 meters. 21 species of sharks and skates were investigated, 647 specimens in total. The relative abundance, occurrence, relative density, and distribution pattern were determined for each species. The analysis of the vertical distribution of species revealed two bathymetric groups, at 200–300 meters (sublittoral group) and at 400–900 meters (superbathyal group). Histograms of the relative abundance of species and figures of the vertical structure of community and distribution patterns are presented, as well as the results of a comparative analysis of the present data with data from similar investigations in adjacent waters in 1972–1983.

Keywords: elasmobranch community, species abundance, vertical distribution, sublittoral group, superbathyal group.

Contact author – Feodor Litvinov: Atlantic Scientific Research Institute of Marine Fisheries and Oceanography (AtlantNIRO), Dmitry Donskoy st., 236000, Kaliningrad, Russia [tel: +7 4012 225 887, e-mail: flit@atlant.baltnet.ru].

ICES CM 2006/D:04

Benthic habitat mapping in offshore USA sea scallop (*Placopecten magellanicus*) beds based on underwater video surveys

Bradley P. Harris, Kevin D. E. Stokesbury, Jacob I. Nogueira, and Michael C. Marino II

Comprehensive assessments of marine ecosystems incorporating abiotic and biotic components, natural and anthropogenic disturbances, and fishery harvests are being pursued with increasing frequency. Mapping benthic habitats, on appropriate spatial scales, is an essential first step, providing a backdrop for assessing fisheries, as well as the impacts of environmental change, and disturbances on the benthos. Presently, the habitats of the Northeastern USA continental shelf are poorly understood.

Substrate distributions rely heavily on geological sampling (e.g. grabs and cores), while megabenthos information is typically derived from bycatch in fisheries surveys. These historical datasets are spatially and temporally inconsistent. Sidescan, and more recently, multi-beam sonar methods provide improved sediment and sea

floor morphology information, but presently little of the continental shelf has been mapped. Furthermore, these methods do not directly sample megabenthos. Beginning in 1999, we conducted a visual census of surficial substrates and megabenthos in offshore sea scallop (*Placopecten magellanicus*) beds using underwater video in a centric, systematic, quadrat survey design. Presently, we have examined 123,192 quadrates, viewing 184,642 m² of sea floor along 60,000 km² of continental shelf. These data were used to map surficial substrates and megabenthos, assess the impacts of a short-term sea scallop fishery, produce an identification key for megabenthos and substrates, and provide fishery managers spatially explicit sea scallop density and size distribution information.

Keywords: Habitat mapping, sea scallop, substrate, megabenthos.

Contact author – Bradley P. Harris: The University of Massachusetts – Dartmouth, Department of Fisheries Oceanography, 706 South Rodney French Blvd., New Bedford, MA 02744, USA [tel: +1 508-910-6359, fax: +1 508-910-6396, e-mail: bharris@umassd.edu].

ICES CM 2006/D:05

Structure and function in deep, northern Gulf of Mexico food webs

Gilbert T. Rowe

The community structure and function of the living components of the benthic boundary layer in the northern Gulf of Mexico have been assessed in recent cooperative investigations. Estimates of standing stocks of bacteria, Foraminifera, metazoan meiofauna, macrofauna, invertebrate megafauna, and demersal fishes across a 3-km depth gradient are compared to measurements of Sediment Community Oxygen Consumption (SCOC) measured with incubation chambers on a remote benthic lander or submersible-deployed chambers. The rates and stocks have been incorporated into food web models that represent carbon flow into and out of the benthic boundary layer system. Zonation of groups of species appears to correlate with total community carbon demand. A comparison of the upper continental slope (450- to 1000-m depth) with the Sigsbee Abyssal Plain (3.4- to 3.7-km depth) illustrates that the decline in all groups with depth is steeper in the larger forms (fishes and megafauna), resulting in a relative increase in the importance of smaller sizes (bacteria and meiofauna) in carbon stocks and cycling. The species lists generated have been deposited in OBIS as a contribution from the COMARGE initiative in the CoML.

Contact author – Gilbert T. Rowe: Texas A&M University Galveston, PO Box 1675, Galveston, Texas 77553-1675, USA [e-mail: roweg@tamug.edu].

ICES CM 2006/D:06 – Withdrawn

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ICES CM 2006/D:08

Seamounts: ecology, fisheries and conservation: a new contribution from CenSeam

T. J. Pitcher, P. J. B. Hart, T. Morato, M. Clark, and R. S. Santos

This new contribution co-produced by CenSeam addresses relevant issues on seamount ecosystems and their fisheries. It creates a fresh synthesis, which leads the way to an improved insight into seamount ecology and identifies measures necessary to conserve seamount biodiversity and integrity. Themes running throughout the book go from locating the world's seamounts to reviews of biodiversity, analyses of fisheries and the basis for sustainability seamount fisheries, amongst many other topics. The fauna associated with seamounts can broadly be divided into those that live all the time on or around the structure and those that visit for a specific purpose such as feeding or to reproduce. Seamounts are important stopping points for a range of large oceanic animals including whales, turtles, seabirds, and of course fish. Many seamounts have large cold-water coral assemblages, which form a densely structured sub-habitat on the peaks and around the edges of the mounts. These are very vulnerable to trawling where the heavy gear smashes the coral and destroys the communities dependent on it. There is an urgent need to understand better the damage caused and to devise management measures to conserve these important habitats. The most evident result that emerged from the book was that the ecology of seamounts is unique and poorly known. We estimate that there could be up to 100,000 seamounts scattered through the world's oceans. Only a handful of these have been sampled effectively such as the Cobb Seamount off the west coast of North America and the Great Meteor Seamount in the eastern north Atlantic.

Keywords: seamounts, biodiversity, fisheries, conservation.

Contact author – Paul J. B. Hart: Department of Biology, University of Leicester, Leicester LE1 7RH, UK [tel: +44 116 252 3348, fax: +44 116 252 3330, e-mail: pbh@le.ac.uk].

ICES CM 2006/D:09

Zoogeography of decapod crustaceans in the Euro-Asiatic Seas of Arctic region

Vasily Sokolov

This study examines all Russian collections of Arctic *Decapoda* in the Zoological Institute of Russian Academy of Sciences, S.-Petersburg, in the Zoological Museum of Moscow State University, and in the Institute of Oceanology, Moscow, which were obtained during various expeditions in Norwegian, Greenland, and north Russian Seas from 1880 to 1996. In addition materials collected in coastal waters of the Barents and White Seas

during the various investigations by the Russian Federal Research Institute of Fisheries and Oceanography were analyzed. Approximately 100 species and subspecies of *Decapoda* occurred in the area investigated.

The fauna of *Decapoda* of Eurasian Arctic Seas includes subtropical, boreal, arctic-boreal, and arctic species. The percent of the Arctic species in decapod fauna increases from the Norwegian Sea to the East-Siberian Sea from 9.7% up to 68.8% and then sharply decreases to 12.1% in the southern part of the Chukchi Sea. All the Arctic species belong to the group *Caridea*. A few species of *Anomura* and *Brachyura* were observed in the Barents and the White Seas, and also in the Chukchi Sea and in the eastern Laptev Sea. The endemics of the Arctic regions comprise approximately 3% in all species. Two species, *caridean* genera *Bythocaris* and *Bythocarides* represent the deep-water fauna in the Arctic Basin. On the basis of the results of the analysis of T-S pairs six ecological groups were identified as decapod species from the Euro-Asiatic Seas basins.

Keywords: *Decapoda*, biodiversity, coastal zone, endemic, Arctic seas, species.

Contact author – Vasily Sokolov: Russian Federal Research Institute Fisheries and Oceanography, V. Krasnol'skaja 17, Moscow 107140, Russia [tel. +7 425 264 8374, e-mail: vsokolov@vniro.ru].

ICES CM 2006/D:10

Community and species biodiversity in benthic fauna of the Barents Sea

Michaela Aschan and H. Trannum

The community structure of the Barents Sea benthos is studied and species assemblages for the northern, eastern, and southern Barents Sea are identified. The biogeography and the diversity of the benthos in the Barents Sea are described in relation to environmental variables. A novel method has been developed to effectively sample a large number of epifauna samples. A juvenile bag was attached to a Campelen survey trawl at 125 stations in the Barents Sea. The stations covered the central part of the sea, with a depth range from 164 to 484 m. At 12 selected stations also infaunal samples were collected with the van Veen grab, to investigate the similarity between these sampling modes. In the epibenthic samples 197 taxa were recorded, where most were crustaceans (107 taxa). A Canonical correspondence analysis (CCA) revealed depth and temperature, which are correlated with longitude and latitude, as significant environmental variables ($P=0.002$) influencing the faunal distribution. 17 of the taxa were found to adequately represent the variation of the sampled communities, and are suggested as indicator species that can be used in monitoring effects of climate change.

Keywords: Epibenthos, biodiversity, monitoring, ecology quality measures, indicator species, Barents Sea, climate change.

Contact author – Michaela Aschan: Institute of Marine Research, P.O. Box 6404, NO-9294 Tromsø, Norway [tel: + 47 9926 1458, e-mail: michaela.aschan@imr.no].

ICES CM 2006/D:11

Seabed Biodiversity of the Continental Shelf of the Great Barrier Reef Region

Roland Pitcher, Peter Doherty, John Hooper, Peter Arnold, and Neil Gribble

Until recently, little was known about the distribution, abundance and diversity of habitats and biota of the deeper seabed between the coral reefs of the Great Barrier Reef (GBR) Marine Park. From 2003 to 2006, the GBR Seabed Biodiversity Project has been mapping these habitats and their biodiversity along the length and breadth of the region.

The Project is now producing comprehensive biodiversity inventories & maps, developing risk indicators with respect to fisheries sustainability, and assessing the status of biological assemblages. This information will help managers to conserve important habitats and rare biodiversity, and to ensure that fisheries within the Park are ecologically sustainable.

The scale of the project is large (>200,000 km²) and can be achieved only by applying multi-disciplinary skills of multiple investigators from the collaborating agencies, with funding support from CRC Reef, FRDC, and the National Oceans Office.

Methods include analyses of bio-physical relationships between species diversity and the physical environment (e.g. large-scale datasets such as satellite remote sensing, oceanographic model output, sediments and bathymetry), as well as human disturbance, as a basis for biodiversity prediction and mapping.

Progress and results from fieldwork, biological identifications and analyses will be presented.

Contact author – Roland Pitcher: CSIRO Marine & Atmospheric Research, 233 Middle Street (PO Box 120), Cleveland, Qld. 4163 Australia [tel: +61(7)3826 7250, fax: +61(7)3826 7222, e-mail: roland.pitcher@csiro.au].

ICES CM 2006/D:12

Population genetics and dispersal: can one be used to predict the other?

Sebastian P. Holmes and Jaap van der Meer

Because of the intrinsic difficulties in tracking small organisms, the ability of a species to disperse has often been inferred from its population genetics. However, for many studies there are inconsistencies between the results obtained, for the dispersal capacity of a species,

from population genetic studies and that which would be inferred from their mode of reproduction. Such inconsistencies begets the question, are population genetics a reliable measure of the dispersal capacity of a species? To date, there are no reported studies that have attempted to resolve this issue.

In this study, a novel approach was used to answer this question. Egg masses containing developing embryos of *Abra tenuis*, a high intertidal aplanic benthic bivalve mollusc, were collected in the field, marked with an invisible fluorescent stain (Calcein) and placed back onto the mud flat. Concurrently, the population genetic structure of both the experimental and neighbouring populations of *A. tenuis* was examined using a RAPD PCR methodology. Analysis of the genetic data obtained indicated, in contrary to what would be expected from its mode of reproduction, that hatched *A. tenuis* juveniles appeared to disperse and that dispersal between neighbouring populations was highly directional and population specific. Tracking of the marked (stained) individuals determined, as for the population genetic data, that dispersal occurs in *A. tenuis*, over distances > 2 km between physically separated populations. In addition, the dispersal patterns observed for the marked animals aped the same dispersal patterns observed in the population genetic data. Hence it is concluded that population genetic studies, at a sufficient level of resolution, can be accurately used to predict the dispersal potential of a species. The mode of reproduction adopted by a species, however, cannot.

Contact author – Sebastian Holmes: Port Erin Marine Laboratory, Port Erin, Isle of Man, IM9 6JA, UK [tel: +44 1624 831 016, fax: +44 1624 831 001, e-mail: s.p.holmes@liverpool.ac.uk].

ICES CM 2006/D:13

A small hotspot of benthic biodiversity on the north-west Atlantic continental shelf

Jeremy Collie, Page Valentine, John Anderson, and Donald Gordon

The northern edge of Georges Bank supports a highly productive and diverse benthic community. Our study area is the gravel pavement on the Canadian side of Georges Bank in water depths of 70–85 m. This area has been surveyed periodically by Canadian and U.S. researchers because of its importance as fish and scallop habitat. On joint cruises from 1994 to 2005, the substrate has been characterized with side-scan and single-beam sonar. Site-specific sampling has been conducted with photo/video transects, and benthic samplers. Much of the gravel habitat over thousands of square kilometres is disturbed by bottom fishing gear and exhibits relatively low biodiversity. However, in some small areas the gravel has a biogenic covering of colonial epifauna and exhibits high benthic diversity. One area, dubbed the “mussel bed” is 14 km² in size and is almost completely covered with hydroid colonies. This epifaunal habitat contains the highest numerical abundance, biomass, and

species richness of benthic megafauna that we have observed on Georges Bank. High benthic productivity in this area is fuelled by upwelled waters from the Gulf of Maine. The shelf-edge front moves over the northern edge of the bank such that the water column is well mixed in winter and stratified in summer. The gravel substrate is undisturbed by winter storms, thus providing a stable substrate for mussel and epifaunal growth. This benthic community is vulnerable to potential oil and gas development, bottom-fishing disturbance, and to colonization by invasive species.

Keywords: benthic biodiversity, colonial epifauna, Georges Bank, outer continental shelf.

Contact author – Jeremy Collie: University of Rhode Island, Graduate School of Oceanography, Narragansett, Rhode Island 02882, USA [tel: +1 401 874 6859, fax +1 401 874 6240, e-mail: jcollie@gso.uri.edu].

ICES CM 2006/D:14

A Global Modelling Method for predicting benthos diversity and abundance: Using RandomForest to link public available historic survey data with environmental data for the Bering Sea region and beyond

Falk Huettmann *et al.*

Benthos provides a foundation for much of the ocean life and diversity. As done with many other marine components, opportunistic but concentrated small-scale effort has been directed at inventorizing and sampling benthos. However, much of the arctic benthos data is still not truly digital available to the public; nor are many of the datasets truly compatible. Here, for the first time, I present well proven methodologies used in global biodiversity modeling for predicting benthos diversity and abundance world-wide. These spatial models use currently the best compiled benthos database for the Alaskan region from various sources such as provided benthos data, but as well literature references that were digitized. A 'presence only' decision-tree modeling approach (RandomForest from Salford Systems Ltd; boosting/bagging) was used by linking benthos data to monthly mean chlorophyll a concentrations, sea surface temperature and other environmental predictors including bathymetry within ArcGIS. Powerful benthos distribution maps were developed, and the relative importance of individual environmental predictors was assessed for the model. Confirmatory overlays with marine wildlife are discussed. The value of metadata, alternative assessment data, continued data collection and further improvements of model predictions and inferences are highlighted. The modelling technique presented here is based on automated software methods, soon to be freely available online data and the latest modelling statistics such as boosting and bagging; it can be used as a convenient and powerful GIS modelling template to be applied globally for online data such as ArcOD, and others available via OBIS and GBIF.

Keywords: Pelagic ocean diversity, OBIS, ArcOD, benthos, predictive modelling, boosting and bagging.

Contact author – Falk Huettmann: EWHALE lab – Biology and Wildlife Dept., Institute of Arctic Biology 419 IRVING I, University of Alaska, Fairbanks, AK 99775-7000, USA [tel: +1 907 474 7882, fax: +1 907 474 6716, e-mail: fffh@uaf.edu].

ICES CM 2006/D:15 – Poster

Mapping benthic invertebrate assemblages from bottom trawl hauls observations

S. Vaz, J. Martin, Y. Verin, and D. Le Roy

Benthic invertebrates caught by bottom trawl hauls during the French IBTS in February 2006 were opportunistically identified and their presence or dominance was recorded in the southern North Sea. The data was explored using statistical methods adapted to community analyses showing both the structure of the assemblage with its principal indicator species (TWINSPAN, Principal Component Analyses). Correlations to environmental parameters such as depth, seabed stress, temperature, salinity, and chlorophyll *a* concentration were investigated (Redundancy Analyses). Diversity indices were then used to further explore the differences between each of the previously defined sub-communities. Finally, the distribution of each type of assemblage was mapped as well as their diversity levels using geostatistics and GIS, resulting in a seabed habitat map for the southern North Sea. Such study may be renewed in the future to obtain more detailed information on benthic invertebrate distribution and assemblages and will prove very useful for the conservation and protection of natural marine habitats.

Keywords: North Sea, benthic invertebrates, seabed habitats, GIS.

Contact author – S. Vaz: Ifremer, Laboratoire Ressources Halieutiques, 150 quai Gambetta, BP699, 62321, Boulogne/mer, France [tel: +33 321 99 56 00, fax: +33 321 99 56 01, e-mail: svaz@ifremer.fr].

ICES CM 2006/D:16 – Poster

Community and species diversity of deepwater cephalopods along the northern mid-Atlantic Ridge

Uwe Piatkowski, Michael Vecchione, and Richard E. Young

In summer 2004 the Norwegian RV "G.O. Sars" provided the platform for an international expedition to the northern mid-Atlantic Ridge. This expedition was the major field study initiative of the MAR-ECO project (Patterns and processes of the ecosystems of the northern mid-Atlantic; www.mar-eco.no), a pilot project within the Census of Marine Life programme. A major focus of the expedition was to sample pelagic and demersal nekton and to map its distribution pattern. Sampling covered discrete horizontal layers of the water column, partly down close to the seafloor, using a variety of large-sized pelagic trawls ranging from 1 to 10,000 m² net opening.

The net sampling was complemented by ROV observations to a depth of 2,500 m. A total of 1,261 cephalopods were sampled, belonging to 29 families, and at least two new species. Here we report the first results on cephalopod species composition, diversity, and geographical distribution patterns. Cephalopod diversity increased significantly from north to south. The squid genera *Gonatus* and *Mastigoteuthis* were the most abundant cephalopods in terms of numbers. The data represents one of the largest cephalopod collections ever made along the mid-Atlantic Ridge and provides new insights into the cephalopod deep-sea fauna of the Atlantic Ocean.

Keywords: Cephalopods, diversity, community structure, mid-Atlantic Ridge.

Contact author – Uwe Piatkowski: *Leibniz-Institut für Meereswissenschaften (IFM-GEOMAR), Düsternbrooker Weg 20, 24105 Kiel, Germany [tel: +49 431 600 4571, fax: +49 431 600 1515, e-mail: upiatkowski@ifm-geomar.de].*

ICES CM 2006/D:17 – Poster

The Census of Marine Life in Europe

Bhavani E. Narayanaswamy and Graham B. Shimmield

The European Project Office for the Census of Marine Life (EuroCoML) has been operational for a year. EuroCoML has several aims including expanding partnerships/coordination with relevant European programmes/general growth of CoML; increase participation of European scientists in CoML projects; to improve taxonomy and species data throughout Europe as well as to improve biodiversity and ecosystem information. During the year that the project office has been running, strong links have been forged with several of the European led CoML projects as well as funding workshops for new initiatives. These workshops include developing novel programmes such as looking at invasive species within European waters as well as expanding on and augmenting some of the CoML projects that are underway. An example of this is a workshop aimed at looking at the drivers of change in coastal biodiversity and moving from descriptive analyses of patterns of diversity to a process-oriented approach aimed at understanding the causes of change. One of the proposed outcomes of this workshop is to increase the capacity of European Natural Geography in Shore Areas (EuroNaGISA) and as a result contribute to the main NaGISA programme.

EuroCoML also aims to have a strong education and outreach programme in place with an aim to increase awareness of the general public to the diversity of the marine environment. This has already started with a deep-sea workshop with plans to develop a travelling exhibition.

Keywords: EuroCoML, biodiversity, workshops, invasive species.

Contact author – Bhavani E. Narayanaswamy: *European Census of Marine Life Project Office, Dunstaffnage Marine Laboratory, Oban, Argyll, PA37 1QA, Scotland, UK [tel: +44 1631 559 305, e-mail: Bhavani.Narayanaswamy@sams.ac.uk].*

ICES CM 2006/D:18 – Poster

A Global Template for predicting pelagic species diversity and abundance: Using TreeNet to link public available historic seabird data with remotely sensed environmental data for the Gulf of Maine

Falk Huettmann and Simon Pittman

Over the past 50 years considerable effort has been directed at surveying pelagic seabirds. Yet, many of the historical datasets still offer large potential in terms of ecological analyses. Here, for the first time we develop predictive spatial models of species diversity using the Manomet Database (housed in the PIROP database freely available at OBIS-SEAMAP) of seabird data collected in the Gulf of Maine from the 1960s to the 1980s. We corrected for survey effort and used a 'presence only' decision-tree modelling approach (TreeNet from Salford Systems Ltd) by linking bird data to monthly mean chlorophyll *a* concentrations, sea surface temperature, turbidity and other environmental predictors including bathymetry within ArcGIS. Distribution maps were developed for Razorbills, Auks, Shearwaters, Storm-petrels and overall seabird species richness for the Gulf of Maine, and the relative importance of individual environmental predictors was assessed for each model. We emphasize the value of Metadata, alternative assessment data, continued data collection and further improvements of model predictions and inferences. Our models allow us to evaluate the importance to seabirds of regions both within the Gulf of Maine (e.g. Stellwagen Bank, Bay of Fundy, shelf regions) and more broadly to examine the Gulf of Maine in the context of the North Atlantic region. The modelling technique used here is based on automated software methods, freely available online data and the latest modelling statistics; it offers itself as a convenient GIS modelling template to be applied globally for online data such as ArcOD, and others available via OBIS and GBIF.

Keywords: Pelagic ocean diversity, OBIS, ArcOD, seabirds, predictive modelling.

Contact author – Falk Huettmann: *EWHALE lab – Biology and Wildlife Dept., Institute of Arctic Biology 419 IRVING I, University of Alaska, Fairbanks, AK 99775-7000, USA [tel: +1 907 474 7882, fax: +1 907 474 6716, e-mail: fffh@uaf.edu].*

ICES CM 2006/D:19

Origins of the North East and North West Atlantic marine biota

Mark J. Costello, Edward Vanden Berghe, Cliff Cunningham, and Serge Rotenberg

The North Atlantic marine fauna and flora is believed to have evolved from trans-Arctic dispersal of Pacific species, *in situ* speciation, and perhaps northward dispersal of southern Atlantic species. Subsequent influences include trans-Atlantic dispersal, human introductions from other oceans, and natural events such as glaciations that may have created dispersal barriers and/or caused regional extinctions. Recent online species information systems, including the European Register of Marine Species and North West Atlantic Register of Marine Species, facilitate comparison of species composition and richness across the North Atlantic. We used this data to test the

hypotheses that (1) most trans-Atlantic species are pelagic or planktonic for all or significant periods of their lives, and (2) the benthic NW Atlantic fauna and flora is a random subset of that of the NE Atlantic. If the above are true, we would also expect patterns to hold at both species and higher taxonomic levels, i.e. similar proportions of species per genus, and genera per family in the NW and NE Atlantic. Exceptions to these patterns are discussed, including the locations of introduced species. The implications of these hypotheses are that dispersal, not local habitat conditions, are the most important factor in the origins of the North Atlantic biota, such that human introductions may radically alter species composition and ecosystem structure.

Contact author – Mark J. Costello: Leigh Marine Laboratory, University of Auckland, PO Box 349, Warkworth 0941, New Zealand. [e-mail: m.costello@auckland.ac.nz].