



International Council for  
the Exploration of the Sea  
Conseil International pour  
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# ICESCIEM

## **ICES Annual Science Conference**

**22-25 September 2004 in Vigo, Spain**

### **Conference papers**

The following pages contain summaries of papers or posters that will be presented at the 2004 ICES Annual Science Conference, which may be of interest to the media<sup>1</sup>. A short summary is provided and the full abstract and contact details of the author are at the end of the document.

### **Free entry for journalists**

Representatives of the media are very welcome to attend the conference and will be exempt from all registration fees. For further information about the conference please see: <http://www.ices.dk/iceswork/asc/2004/index.asp>

### **Telephone interviews**

Alternatively you can contact Neil Fletcher, ICES Communication Officer who will be at the conference to arrange telephone interviews. Before 15 September contact Neil on 0045 33386713. After 15 September call Mobile 0045 40847938 or E-mail: [neilf@ices.dk](mailto:neilf@ices.dk)

### **What happened to North Sea fish?**

FF:40

Scientists developed a mathematical model of the North Sea food chain. Using the model they estimated that the total amount of fish in the North Sea has decreased from around 26 million tons at the end of the 19<sup>th</sup> Century, to around 10 million tons in 1991.

### **Blue shark “bachelor clubs” on seamounts**

K11

Sharks are 20 times more abundant over seamounts than in surrounding waters. Of the sharks that are attracted to seamounts, blue sharks are the most common, and in this paper the author discusses the possible reasons for huge gatherings of male blue sharks over seamounts in the Pacific and Atlantic Oceans.

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<sup>1</sup> Please note that the papers have been chosen as an information service and do not in any way reflect the views of ICES. Also scientific papers presented at the ICES Annual Science Conference are to be regarded as work in progress. Any conclusions drawn in any of the papers are subject to change, in the light of peer review carried out at the conference and/or subsequently.

## **Giant squid hit by airguns in the Bay of Biscay?**

CC:29

Dead giant squid normally wash up on Spanish shores at the rate of about one a year. But in autumn 2001, scientists were surprised to find 5 huge animals stranded in a single week on beaches in the Bay of Biscay. Two years later it happened again, when another 4 animals stranded on the Biscay coast in September 2003.

What was particularly strange was that the scientists could find no obvious external cause of death in these apparently healthy giant squid, which ranged in weight from 60-200kg and length of 7-12 metres. But internal examinations shed some light with the discovery that two animals in particular had suffered extensive damage to internal muscle fibres and their stomachs and digestive tracts. They had also suffered severe damage to their ears that would have effectively disorientated them.

The coincidence was that at the time of both mass strandings, geologists had been running a seismic airgun survey in the vicinity with a line of 10 towed airguns—each capable of firing out 200 decibel sound pulses down to the seabed. The authors discuss the possible impact of seismic airguns on the giant squid and whether further controls may be needed on seismic surveys to protect marine animals.

## **Closed area provides food and shelter for juvenile cod**

Y:10

Since 1994, large areas of the Georges Bank (East coast of USA) have been closed to trawlers, and the authors describe the recovery of seabed habitats. They observed a number of changes which include more and bigger scallops, sea urchins, sea stars and whelks and greater sponge coverage. Many of the species that grew more abundant in the closed area are food for juvenile cod and other bottom-living fish or are thought to give juvenile cod hiding places from predators.

## **Plaice “Big Brother” in the North Sea**

K:05

Scientists are now putting the lives of plaice in the North Sea under the spotlight. Using high-tech electronic tags that record the depth and environmental conditions the fish experience, they have been able to map the movements of 165 plaice in the North Sea.

While the tags are state-of-the-art, it seems that fish are already recording similar information in their own independent system in their otoliths—tiny bones in fish ears that grow as the fish grow. As well as being used to age fish, recent studies have shown that the chemical composition of these bones may reflect the environmental history of the fish.

Scientists now hope that by combining the data from electronic tags with the fishes' own historical record in the otoliths they will be able to learn more about plaice migration and behaviour and may even be able to reconstruct a fish's movements during its lifetime.

## **Give Celtic Sea whiting a chance to spawn**

Y:13

This paper makes the case that whiting stocks in the Celtic Sea could increase if their spawning area was closed to fishing either throughout the year or at least during the spawning season. Other restrictions on fishing would also be necessary or the whiting would just be overfished as soon as they left the closed area.

### **Common dolphins' last supper**

Q:09

Between 1991 and 2003, 322 common dolphins washed up dead on the Galician coast of Northern Spain. Because most of the dolphins had met a premature end in fishing nets they still had their last dinners in their stomachs, so scientists were able to discover that they had been eating small blue whiting, sardine and scad.

### **Grey seal teeth monitor climate change**

K:27

A seal's age can be estimated by looking at the yearly growth layers in its teeth. Because the growth layer is thicker when the seal is well-fed and thinner during leaner times, a seal tooth is also a bit like a "black box" that records the good and bad periods in its life. In this paper the author looks at the potential for grey seal teeth to help monitor climate change - in this case through links between the thickness of the growth layer, cold water temperatures and availability of fish prey.

### **Tagging deep-water fish - without getting wet?**

K:80

Scientists put tags on fish to monitor their movements. The problem for the fish is that being hauled out of the sea and tagged can be quite a stressful experience, particularly for deep-water fish which are less likely to recover from being brought up from the ocean depths. But recently, Icelandic scientists have been testing a new 'remote' way of tagging where the fish, in this case deep-sea redfish, don't even have to leave the seabed.

How it works is that a special net is towed along the seabed to catch the fish. Once inside the net, the fish pass into the tagging area which is monitored by four cameras. A researcher on the surface vessel uses these cameras as his "eyes" to sneak up on the fish and tag them using a remotely operated tagging gun. The fish are then released and when they are caught in the future they will give scientists valuable information on their movements.

### **Protect cold-water corals before it is too late**

AA:07

Scientists warn that measures to protect cold-water corals off the west coast of Ireland are not moving quickly enough. Recent video surveys of cold-water coral areas in the region of the Porcupine Bank, in summer 2003, revealed heavy trawl scars, barren sediment and flattened coral rubble. The survey also captured evidence that trawling is still damaging cold-water coral reefs when a discarded trawl net was filmed on the seabed full of smashed coral—some of which was still alive. Because cold-water coral reefs take hundreds of years to develop, the authors are warning that something needs to be done now to protect them from trawling, before it is too late.

### **Pacific oysters suck up Dutch baby mussels**

K:10

Pacific oysters (*Crassostrea gigas*) were first introduced to Dutch waters in 1964 and have spread so rapidly that there are concerns over their effects on the Dutch marine ecosystem. A particular worry is that the oysters may be eating the larvae of native shellfish - such as mussels - when they filter their food from the surrounding water.

To find out if there is any truth in this the authors first calculated the sucking power of the oysters and found that they are strong enough to suck in and eat other shellfish larvae. Then the authors went out on to the Oosterschelde Estuary to compare the amount of shellfish larvae in the water above oyster beds with those in oyster free

areas. As they suspected, they found that shellfish larvae were much scarcer in the water above an oyster bed than on a nearby 'oyster free' area, indicating that oysters may be eating the next generation of native shellfish.

### **The impact of trawling on New Zealand seamounts**

AA:09

New Zealand scientists looked at the impact of trawling on the presence of cold-water coral on seamounts. On lightly fished seamounts (less than 10 trawls per year) coral habitat was seen on 30% of seabed images with an average coverage of 52%. Meanwhile on the heavily trawled areas (between 40-1500 trawls per year) coral was only seen on 2% of seabed images and covered on average only 2% of the area.

### **Trout farm kills off Atlantic salmon in Brittany**

S:03

This paper describes research on the impact of a trout farm on wild salmon stocks in the River Scorff in Brittany. The author compared the survival of salmon in the zone of pollution from the trout farm with those further downstream, out of its influence. The conclusion was that pollution from trout farm effluents caused a significant increase in salmon deaths before they spawned.

### **Spanish salmon hit by global warming?**

S:06

In the last 50 years salmon stocks have declined in rivers in the Asturias region of Northern Spain. The authors discuss the possible reasons for the decline including the impact of global warming.

### **Have hake been fooling scientists?**

K:66

The first mass tagging of European hake (member of the cod family) took place in 2002 when 1307 hake were tagged and then released. Since then 37 fish have been recovered and scientists have been surprised to discover that the fish they are measuring are twice as big as they expected them to be in the time scale. Although the results are only from a small sample of fish they indicate that hake may grow much faster than was previously thought. The author highlights the need for more extensive tagging work.

### **Marine protected areas - how to get the most out of them**

Y:15

Protected areas have been common practice on land since the beginning of the 20<sup>th</sup> Century but it is only recently that reserves are being set up in marine ecosystems. The author discusses the best size and spacing of networks of marine reserves for maximum fisheries yield.

## Full abstracts

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### FF:40 - Trophic modeling of the North Sea

By G. M. Daskalov and S. Mackinson

A detailed mass-balance trophic model of the North Sea was built applying the Ecopath with Ecosim methodology. The model structure was set to 71 functional groups. The different species either constitute single groups or are aggregated clusters of species based on information on abundance, diet, and commercial or functional importance. The commercially important target fish species are divided into juvenile and adult groups (e.g., cod, whiting, herring). Several non-target fish species, which are also commercially and/or functionally important are represented as single species or family groups (e.g., hake, dab, Triglidae). Other species are included in aggregated groups based on similar taxonomic or functional characteristics. The model was supplied with new estimates of biomass, production and consumption rates of fish and invertebrates. Biomasses of ~80 non-target fish species monitored by the International bottom-trawl survey, which are not subject to regular stock assessment, were estimated and compared with previous studies. Detritus (POM and DOM) and fishery discards constitute separate groups. The diet matrix was compiled using 1991 year of stomach data and literature sources. Data on the landing and discards of 39 different fishing fleets was compiled from the 1991 Scientific Technical Committee for Fisheries data in combination with UK Fishing activity database and Trio Discards database (CEFAS). Biomass estimates were compared to historical data. Total fish biomass in the North Sea decreased from ~26 million tons by the end of the 19<sup>th</sup> century to ~10 million tons in 1991. The biggest change was in exploited target species e.g. gadoids (cod, haddock, saithe), mackerel, herring and flatfish. Gadoids and mackerel/horse mackerel also decreased between 1980s and 1991, but herring and some prey-fish (e.g. dab, flounder) increased in 1991 compared with 1980s. There was also an important decrease in cetaceans, seabirds and elasmobranchs and an increase in seals in 1991 compared to the 1880s. Development of the North Sea ecosystem model is steered by a strategic work plan for the development, scientific reviewing of parameters, sensitivity testing and application of the model. Future work will include temporal and spatial simulation of alternative fishing and environmental change scenarios.

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### K:11 - The dense male aggregation over seamounts as an integral part of species range in the Blue shark *Prionace glauca*

By Feodor Litvinov

In addition to permanent species populations of seamounts, there are dense aggregations of oceanic and semioceanic sharks over some of them: *Prionace glauca*, *Isurus oxyrinchus*, *Alopias superciliosus*, *Sphyrna zygaena*. Sharks are up to 20 times more abundant there than in oceanic waters. Such aggregations exist in East Atlantic, over Meteor, Yer, Erving and Atlantis in Northern Hemisphere, and over Whale Ridge to the South. In Eastern Pacific such aggregations were observed over Nazka Ridge, and westward and eastward of Galapagos Islands, not related to any pronounced mounts. Blue shark *Prionace glauca* absolutely dominates these aggregations. Calculations carried out on the base of fossilized shark teeth on seamounts and teeth replacement rate suggest that Blue shark forced out *Isurus spp.* from dominant position just some thousands (m.b. even hundreds) of years ago. Aggregations mainly consist of Blue shark adult males of 170-280 cm; in East Atlantic these are associated with young sharks of 50-140 cm in Moroccan and Namibian neritic waters. So, one may see the pairs (adult male aggregations)-("kindergartens") corresponded to northern and southern groups of populations. Most probable such "male clubs" are intended for first copulation with young females, leaving neritic "kindergartens" for oceanic waters. Similar picture may be seen in East Pacific: there are Blue shark "kindergartens" in Santa Barbara and Ensenada waters; such places may be supposed in South America neritic waters. It is still unknown, such aggregations are all-the-year-round or seasonal, but it is clear that aggregations of top predators significantly influence oceanic ecosystems, including seamounts.

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### **CC:29 - A review of records of giant squid in the north-eastern Atlantic and severe injuries in *Architeuthis dux* stranded after acoustic exploration**

By A. Guerra, A. F. González, and F. Rocha

A review of the verified reports to date of *Architeuthis dux* showed that 43 % (146 specimens) of worldwide reports were derived from the north-eastern Atlantic. Biological data are presented on fifteen females and two males from Asturian waters (Northern Spain). Both males represent the two first records captured off the Iberian Peninsula. Immature and maturing females ranged from 60 to 140 kg total weight, whilst mature males weights were 42 and 66 kg. The peculiar observation of spermatophores embedded in the skin of one of the males near the proximal part of the ventral, ventro-lateral and dorso-lateral arms is discussed. A comparison was undertaken of several morphometric measurements between both sexes and between these two males and five other north-eastern Atlantic males from which data were available. Two incidents of multiple strandings affecting nine specimens in 2001 and 2003 appear to be linked spatially and temporally to geophysical prospecting using air-gun arrays in the Bay of Biscay. Here we present evidence of acute tissue damage in the stranded and surface-floating giant squids. The incidence of such cases during two research cruises contemporary with integrated geological and geophysical studies of the continental margin of the Cantabric Sea indicate that acoustic factors could have caused or contributed to the organ and tissue lesions that probably caused the deaths of these animals. Thus, further environmental regulation of such activity may be warranted to protect animals of the continental slope.

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### **Y:10 - Biomass in the bank: effects of fishing reserves on the benthic fauna inside a closed area (Poster)**

By Jeremy S. Collie, Rebecca G. Asch, and Page C. Valentine

We monitored the recovery of benthic fauna in one of the large areas on Georges Bank closed to bottom fishing since December 1994. Site-specific sampling was conducted on two occasions before closure and roughly once a year after closure, resulting in a 10-year timeseries. We compare the benthic fauna at sites inside and outside the closed area, which are otherwise similar in depth and sediment composition. An assortment of trawls, dredges, seabed photography, and recolonization trays was used to sample the megafauna, defined here as small fish and invertebrates larger than 5 mm. The biomass, number of individuals, and number of species increased significantly with time inside the closed area. Community composition shifted as several species of crabs, mollusks, and echinoderms increased in abundance. The abundance-biomass curves shifted over time toward individuals with larger mass, such as scallops, sea urchins, sea stars, and whelks. Percent seabed cover increased for some taxa, especially sponges. The study site is a Habitat Area of Particular Concern for juvenile cod. Many of the taxa that grew more abundant inside the closed area are prey species for cod and other demersal fish species. The colonial epifauna, which also increased, are thought to provide the juvenile cod protection from predators.

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### **K:05 - Determination of plaice lifetime movements in the North Sea by linking natural and electronic data records**

By Ewan Hunter and Audrey Darnaude

The aim of this study is to describe the lifetime movements of plaice, *Pleuronectes platessa* L., in the North Sea, by linking the geographical movements recorded by fish tagged with electronic data storage tags (DSTs) to chemical signals simultaneously laid down in the ear-stones (otoliths) of the same fish. By linking these state-of-the-art techniques, we aim to provide information on the population dynamics of North Sea plaice, which would be otherwise unattainable using conventional methods.

DSTs allow continuous records to be made of ambient conditions experienced by free-swimming fish in their natural environment. To date, we have used tidal (depth) data to reconstruct the geographical movements of 165 free-swimming plaice from returned DSTs, for periods of up to two repeat migration seasons. Plaice independently record ambient conditions throughout their lifetime by the accretion of calcium carbonate on the otoliths. Recent studies have demonstrated how the chemical composition of the otoliths may reflect the environmental history of individual fish. Matching the DST data with age markings on the otoliths may allow the retrospective positioning of fish in space and time throughout their lifetimes.

We aim to compare the reconstructed movements of around 80 DST-tagged plaice with the chemical signatures laid down simultaneously in the otoliths, in order to characterise annual migration routes. Although in its early stages, this work may for the first time allow interpretation of the migration history of plaice prior to tagging, and determination of the time and source of recruitment, thereby linking studies of pre- and post recruitment fish behaviour. In terms of exploitation, the results from this study have the potential to improve the parameterisation of assessment methods currently applied in fisheries management, and will therefore feed directly into management advice designed to promote sustainability.

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### **Y:13 -- Modelling spatial and seasonal dynamic of the whiting population in the Celtic Sea**

By Marion Verdoit-Jarraya, J.-L. Gouzé, and D. Pelletier

Most demersal and benthic fish populations exhibit spatial and seasonal patterns in relation to their annual life cycle, particularly through migrations between spawning areas and feeding areas. In spite of this, most models used for stock assessment, are not spatially and seasonally structured.

However, such models are necessary to assess the impact of spatio-seasonal management measures (such as closures of areas and/or seasons), which are more and more advocated as an additional management tool to reduce over exploitation.

We constructed a model which describes the dynamics of the Celtic Sea whiting, a species that migrates seasonally in relation to reproduction.

The model is linear, with both discrete space and time (two patches and two seasons), structured by demographic stages. This mathematical model is first used to estimate some parameters such as the fecundity coefficient or transfer rates between stages. Then, we explore the impact of different fishing effort allocation schemes in time and space, on the dynamics of the population. The sensitivity of the results to parameters is studied.

Results show that higher abundances could be reached by closing the reproduction area either throughout the year, or only during spawning season. However, additional management measures would be necessary, because the population would still be overexploited if reallocation of fishing effort were the only way of regulating exploitation.

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## **Q:09 - Variability in the diet of common dolphins (*Delphinus delphis*) in Galician waters 1991–2003 and relationship with prey abundance**

By M. B. Santos, G. J. Pierce, A. López, J. A. Martínez, M. T. Fernández, E. Ieno, C. Porteiro, P. Carrera, and M. Meixide

Analyses of marine mammal diets in Galician waters have been carried out over the last 13 years as part of four consecutive European funded projects. The species that is best represented in samples from stranded animals is the common dolphin *Delphinus delphis*, for which 322 non-empty stomachs were analysed during 1991–2003. We quantified interannual and seasonal variation in the diet, as well as differences between the diets of male/female and juvenile/adult dolphins. Although sampling is based on stranded dolphins, the majority showed evidence of having died as a consequence of interactions with fisheries (by-catch). The influence of the cause of death on stomach contents was examined. The most important prey species were (small) blue whiting (*Micromesistius poutassou*), sardine (*Sardina pilchardus*) and scad (*Trachurus* sp.), all of high commercial importance in Galician waters, and (in the first quarter of the year), sand smelt *Atherina* sp. Interannual trends in the importance of sardine and blue whiting in the diet of common dolphins appear to track trends in spawning stock biomass and recruitment strength respectively. Preliminary estimates are also made for the amount of fish removed by the common dolphin population in Galician waters.

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## **K:27 - Grey seal teeth as indicators of climate variability**

By M. O. Hammill

The effects of environmental changes on marine mammal life history parameters are poorly understood. Annual growth layers in the teeth of marine mammals have long been used for age determination. In some species, changes in tooth structure also provide a record of life-history changes such as age at sexual maturity, or records of major climatic events, e.g. El Niño. Here, we examined growth layer development in longitudinal sections (N=392) of Northwest Atlantic grey seal (*Halichoerus grypus*) canine teeth. Age, sex, and a large scale environmental variable, Minimum Cold Intermediate Layer Temperature (MCILT) all had a significant effect ( $p < 0.05$ ) on the thickness of the first Growth Layer Group (GLG1), while only sex had a significant effect on the thickness of GLG2. GLG1 of males was thicker than that of females. In both sexes, GLG1 thickness declined with age. GLG1 thickness was standardized to remove the effects of age and sex and the resulting deviations were compared to changes in MCILT. During the time series (1965-1998), standardized GLG1 thickness was positively correlated with changes in MCILT ( $p < 0.05$ ). Correlations were also observed between fish stock biomass and MCILT. Grey seal pups begin entering the water during February-March at which time they must also learn to feed. Changes in GLG1 thickness likely reflects the foraging success of pups during their first year of nutritional independence. Although MCILT is only one measure of environmental conditions, changes in this factor have important ecosystem effects that can also be detected at higher trophic levels.

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## **K:80 - Underwater tagging of deep sea redfish. New technique for tagging fish at great depths (poster).**

By Þorsteinn Sigurðsson and Vilhjálmur Þorsteinsson.

With an Underwater Tagging Equipment (UTE), developed in collaboration between the Marine Research Institute in Reykjavík and STAR-ODDI, fish has been tagged in its natural environment. This is done by replacing the tagging equipment with the codend of the trawl, tagging the fish when it passes through the equipment. The tagging equipment is controlled from the vessel through the cable wire where the researcher can view the fish from four cameras, move the tagging gun into place and tag the fish. The tags usable in the UTE are both dummy tags and active electronic tags that can give temperature and depth profiles of the fish. The UTE has been used to tag redfish of size between 32-52

cm, but other species have entered the equipment such as saithe and have been tagged with success. The tagging equipment can also be used for tagging medium size round fish such as tusk, cod and haddock. The paper describes briefly the UTE device and it's including results of the first recaptured fish from tagging in October 2003.

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## **AA:07 - Evidence of major fisheries impact on cold-water corals in the deep waters off the Porcupine Bank, west coast of Ireland: are interim management measures required?**

By Anthony Grehan, V. Unnithan, A. Wheeler, X. Monteys, T. Beck, M. Wilson, J. Guinan, J.H. Spencer, A. Foubert, M. Klages, and J. Thiede.

Measures to conserve representative examples of cold-water coral reefs in Ireland through the designation of sites as Special Areas of Conservation (SACs) under the EC Habitats Directive are underway. However, evidence of damage to corals by fishing obtained during the RV Polarstern expedition ARK XIX Leg 3A to the Porcupine Sea Bight and Bank during summer 2003 suggest 2003 suggest that more immediate management measures are required. A total of 9 dives were carried out with the IFREMER deep-sea 'VICTOR 6000' Remotely Operated Vehicle (ROV) on carbonate mound and deep-water coral locations in the study area. High resolution video and close-up digital stills were used to document the impact of fishing activity and the presence of lost gears. A series of mounds and scarps investigated along the western edge of the Porcupine Bank, in water depths of 600-1000m, were most severely impacted. One double mound system, named the Twin Mounds, appeared to be heavily trawled, as evidenced by the presence of trawl scars, barren sediment and flattened coral rubble. On the nearby Giant Mound, images of lost trawl gear filled with coral (some of it still living), provided clear evidence that reefs are being destroyed by present fishing activities. The results presented provide irrefutable proof of a serious threat from current fishing practices to the physical integrity of the pristine and physically complex deep-water coral ecosystem. The need for interim measures to protect deep-water corals in the period before SAC designation becomes effective is discussed.

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## **K:10 - Are introduced oysters (*Crassostrea gigas*) hampering the recruitment of indigenous bivalve filter feeders?**

By Karin Troost, Pauline Kamermans, Eize J. Stamhuis, and Wim J. Wolff

Since their first introduction in 1964, Japanese oysters (*Crassostrea gigas*) are spreading rapidly throughout Dutch estuaries. They are expected to affect Dutch ecosystems profoundly. One way in which they might affect indigenous filter-feeding bivalves is by filtering their pelagic larvae, thereby hampering their recruitment. We studied the ability of adult oysters to filter bivalve veliger larvae of different species. Inhalant feeding current velocities of Japanese oysters and blue mussels (*Mytilus edulis*) were assessed using Digital Particle Image Velocimetry. These velocities were compared with average swimming speeds of bivalve veligers from literature. Inhalant feeding current velocities of both oysters and mussels were higher than swimming speeds of bivalve veligers, indicating that both species might be able to filter large amounts of veliger larvae. However, shear rate profiles revealed inhalant oyster feeding currents to be more diffuse than inhalant mussel feeding currents. This may

cause veligers to be less able to detect feeding currents of oysters in time, increasing the chances of being filtered. Additionally, in the Oosterschelde estuary larval numbers in the water column above an oyster bed were compared with larval numbers above a reference site. Significantly less mussel larvae were found above the oyster bed than on the reference site. This supports the theory that adult oysters filter veliger larvae. Larval numbers of oysters however showed completely the opposite. More oyster larvae were present above the oyster bed than above the reference site.

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### **AA:09 - The influence of deepwater coral habitat and fishing on benthic faunal assemblages of seamounts on the Chatham Rise, New Zealand**

By A. A. Rowden, M. R. Clark, and S. O'Shea

Seamounts are prominent and widely distributed features of the New Zealand marine environment, and also the focus of important commercial fisheries and some exploratory mineral mining. Scientists in New Zealand are involved in a number of integrated programmes to study the physical and biological processes of seamounts. In 2001 a study was undertaken of eight of the 'Graveyard' seamounts (depth at peak 748–1004 m) on the Chatham Rise, an area that has been heavily trawled for orange roughy since the early 1990s. Half of the study seamounts were considered 'unfished' (total of <10 trawls per seamount) and the other 'fished' (total of 40–1500 trawls per seamount). Benthic macroinvertebrate assemblages of each seamount were sampled using epibenthic sleds, whilst the presence of habitat-forming fauna (e.g. live corals), substrate type and indications of trawling (e.g. trawl door marks) were determined using a towed underwater camera that took images 2–5m above the seabed. Analyses of resulting data revealed that the assemblage composition of 'fished' and 'unfished' seamounts was significantly different, and that 'unfished' seamounts possessed a relatively large amount of coral habitat (30% of seabed images, 52% mean cover) comprising live *Solenosmilia variabilis* and *Madrepora oculata* (predominantly on the seamount peaks) whilst 'fished' seamounts possessed relatively little coral habitat (2% of seabed images, 2% mean cover). Substrate was heterogenous on all seamounts, although seabed images indicated that 'fished' seamounts had a greater proportion of the substrate type "coral rubble" than 'unfished' seamounts (77% versus 65% of images, 41% versus 33% mean cover). Indications of trawling were observed over seven times more frequently on seabed images from 'fished' as opposed to 'unfished' seamounts. Multivariate analyses revealed that the variability observed in macroinvertebrate assemblage composition between the study seamounts can in part be explained by the relative occurrence of live coral and coral rubble (both structural habitats). The results of the study are discussed with respect to New Zealand's national seamount management strategy, the subsequent protection from fishing of three of the study seamounts (1 'fished' and 2 'unfished'), and the need for ongoing monitoring and research to derive conservation practices that allow for sustainable seamount fisheries.

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### **S:03 - Pollution from fish farm effluents increase in-river mortality of adult Atlantic salmon prior to spawning**

By Etienne Prévost

Fish farm effluents are point sources of pollution known to have an impact on the production of Atlantic salmon (*Salmo salar*) juveniles. They potentially have effect on adult Atlantic salmon before spawning as well. I tested this hypothesis on the Scorff R. (Brittany, France), a small coastal stream in which a major trout farm is located. A prior study on the salmon juveniles allowed to identify the zone impacted by the fish farm pollution. Using radio-tracking data, I compared the (non-fishing) mortality of salmon adult which passed through this zone, with that of fish who stayed further downstream where

the influence of the source of pollution is considered to be negligible. A Bayesian testing approach was used and revealed that pollution from fish farm effluents caused a significant increase in the mortality of salmon adult before the spawning time.

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### **S:06 - Effects of global warming on Atlantic salmon sea-run timing at the southern edge of the European distribution**

By America G. Valiente, F. Juanes, E. Garcia-Vazquez, and F. Juanes

Atlantic salmon *Salmo salar* populations at the edge of the species distribution are the most vulnerable to environmental changes. Those inhabiting southern European rivers are expected to be particularly affected by global warming. However, they are exploited as a very valuable resource for the region, attracting tourism and generating high incomes. In the central part of northern Spain (Asturias) there is a long tradition of sport fisheries (angling). The first salmon caught in a river each year is called “campanu” and is highly prized in a public auction. Analysis of a 50-year time-series demonstrates that the main Asturian populations of Atlantic salmon have declined significantly. Their run timing has changed over the last 20 years as inferred from significant delays in the date of capture of the campanu. This change is statistically associated with an increase in temperature indices and is independent of the annual start date of the fishery. Such a disturbance in the life history timing of a species due to global change can be considered a warning signal of future asynchrony in the freshwater ecosystems where this anadromous species is present.

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### **K:66 - Do we need to revise growth estimation of European hake (*Merluccius merluccius*)?**

By H. de Pontual, A. L. Groison, and C. Piñeiro

Discrepancies between published descriptions on hake growth are well known. To determine whether there are real, depending on the area of capture or artefacts depending on uncertainties in age estimation, we carried out a pilot experiment on hake tagging in 2002. A codend was specially designed to catch fish in good condition. In all, 1307 fish were tagged with anchor T-bar tags, injected with oxytetracycline and released. This experiment represented the first recorded mass tagging of European hake. To date we have had 35 fish and 5 tags returned to the laboratory (a 3.1% return rate). For combined sexes, the somatic growth rate was estimated at  $0.038 \pm 0.020$  cm day<sup>-1</sup>. Males and females did not differ significantly in somatic growth rate for the observed size range. Annual growth rate was estimated at  $21.10 \pm 0.91$  cm year<sup>-1</sup> from 5 fish which had more than 200 days at liberty. Otolith growth was compared to a growth model established from previous data. Marked otoliths were also read (blind reading) by 2 experts and estimated ages were compared to otolith growth after the OTC mark. The results indicate that recaptured fish grew faster than expected by a factor ca. 2. Criteria used for routine ageing produced overestimated ages and may need to be revised. Although based on scarce data, this study highlights the need to carry out a large-scale tagging experiment of the European stocks in order to improve biological knowledge, assessment and subsequent management decisions.

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### **Y:15 - Spacing and configuration of marine reserve networks**

By David M. Kaplan

While protected areas have been common practice in terrestrial systems since the beginning of the 20th century, it is only recently that reserves are being implemented in marine systems. Results indicate that reserves could provide an efficient and effective way to manage marine resources for conservation and fisheries management. There is a growing body of modeling and theoretical literature that addresses the unique challenges present in the design of optimal systems of marine reserves. Here we develop a general size and age structured model for evaluating the effectiveness of a system of marine reserves along a linear coastline for sustainability and maximizing fisheries yields. We review results from the model for systems of uniformly spaced marine reserves along an infinite coastline. Then we proceed to examine the consequences of variability in marine reserve spacing. Results show that variable spacing can in some cases significantly improve both catch and recruitment for fish species that were harvested to near-collapse before the implementation of marine reserves. This occurs when reserves in certain areas are closer together, creating regions of local sustainability. In this case, local sustainability is at the expense of complete collapse in areas with few reserves and catch is highly spatially uneven. We then proceed to add larval advection to the model. Variable reserve spacing can increase the probability of success of a system of marine reserves in the face of unknown or variable advection rates. Finally, we examine the consequences of edge effects and adult movement for the stability and population dynamics of a system of marine reserves.

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