Photography: Art Saura (FGFRI, Finland).

ICES Insight

ISSUE NO. 44 / SEPTEMBER 2007

Welcome!

With Issue 44, we change editorial direction of the publication formerly known as the *ICES Newsletter*, and present it under its new name, *ICES Insight*.

You'll recognize the look and layout, but the focus has changed. Instead of material of time-limited interest, we will offer more in-depth articles exploring subjects that feature prominently in ICES work. The material will appeal to an informed general readership as well as to our faithful ICES community. The new slant will make *ICES Insight* a useful tool to reach beyond the community of ICES interests to a wider audience.

ICES Insight will appear annually, a month before the ASC. We would be pleased to hear your suggestions for articles. Share your ideas with Louise Scharff, ICES coordinating secretary, louise@ices.dk. The editorial agenda will be determined by the middle of February, and articles will be due by the end of May.

The recently introduced Bulletin Board on the ICES website, **www.ices.dk/iceswork/bulletin.asp**, will keep you informed of immediate developments in the Secretariat, ideas and advances in ICES working and expert groups and committees, and news from ICES Member States and associated institutions.

We hope this issue of *ICES Insight* will inform and stimulate you. If it does, let us know. If you think you can do better, let us hear what's on your mind.

ICES Insight Editorial Team

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Investigating the mysteries of the eel

Fired by a life-long interest in the eel, Henrik Sparholt joined the Galathea 3 expedition to study the eel on its spawning grounds in the Sargasso Sea.

Despite more than a century of research, much of the life history and spawning biology of European eel (*Anguilla anguilla*) remains a mystery. At the same time, European and American eel (*A. rostrata*) face a catastrophic decline, and our understanding of this decline is hampered by our lack of knowledge of the species' biology.

ICES fishery assessment scientist Henrik Sparholt's interest in the eel began in his childhood when, growing up in Denmark, he caught them in the lakes and estuaries around his home. As a biologist, he continued to be fascinated by the eel's mystery and complexity. When the third round-the-world Galathea expedition was announced, Sparholt was determined that an eel research project in the Sargasso Sea would be part of the programme. Collaborating with a team of international scientists, Sparholt joined the expedition in the Caribbean and conducted studies that have provided enough data to keep scientists busy for years.

According to Sparholt, "We assume that both species spawn in the Sargasso Sea, but the only evidence we have is the newly hatched larvae. Spawning eels have never been caught, and we can only infer indirectly the depth at which they spawn. What's more, our previous assumptions that eel constitute one genetically homogenous population have been challenged by studies that use genetic markers".

The Danish navy vessel "Vædderen" looks right at home in the deep-water port of Frederiksted, St Croix. St Croix was part of the Danish West Indies until the islands were sold to the US in 1917.

All photos courtesy of Henrik Sparholt.

Originally, Sparholt proposed a project to sample newly hatched larvae of European eels and other eel species from the potential spawning locations. The project would estimate the eels' decline by comparing current data on larvae abundance with data from previous cruises. And Sparholt wanted to do what had never been done: catch an adult spawning eel.

The project acquired greater dimension, however, when Sparholt joined forces with Michael Møller Hansen, a Danish geneticist, who proposed an analysis of eel larvae, both European eel and other species, using DNA markers to test if genetically different populations are present, and to identify whether hybridization between American and European eel is restricted to certain areas.

MATURE SILVER EELS BEGINNING THEIR MIGRATION FROM IRELAND WOULD BE IMPLANTED WITH ELECTRONIC TAGS THAT RECORDED DEPTH, TEMPERATURE, AND LOCATION.

Sparholt recalls, "The project gained momentum, and more people joined us. We ended up with a team that could cover the whole ecosystem: from physical and chemical parameters to molecules, particles, virus, bacteria, zooplankton, phytoplankton, fish, and even whales!"

The expanded project aimed to investigate the plankton ecosystem in which the eel larvae are spawned, focusing on the hydrographic influence on productivity and plankton distribution.

Mature silver eels beginning their migration from Ireland would be implanted with electronic tags that recorded depth, temperature, and location. The results would be sent by satellite to the scientists in the middle of the Sargasso Sea, allowing them, it was hoped, to locate spawning eels and catch them using a large, midwater trawl.

"These tags, which were developed by an American company, can be timed to be released at a specified time," says Sparholt. "The idea was to tag them before they migrate in November – they spawn February through June. We would be in the Sargasso in April and could target our fishing, based on data from the satellite-connected tags. We only know the spawning area on a broad scale – within 2000 kilometres east to west and 500 kilometres north to south, so we needed help in limiting our area".

Because eel spawning may be induced by a new moon and the researchers would be in the area on the full moon of 19 March 2007, they hoped that the data supplied by the tags would help them concentrate their efforts. Of the 22 tags implanted, they received data from 15. "We haven't heard from seven of the tags at all, but that is normal with this type of tag," explains Sparholt.

Unfortunately, the tagged eel did not reach the Sargasso Sea. "They only made it about a third of the way", says Sparholt. "So, either they use a year and a half instead of half a year to reach the Sargasso Sea from Europe, or the tags' extra water resistance was too much for the eel and they have been lagging behind the eels with no tags. We don't know – yet".

THERE HAD BEEN TWO 20-TONNE WHALES JUST NEXT TO WHERE WE WERE FISHING. OR MAYBE IT WAS A SUBMARINE...

One day, in the middle of the sea that Sparholt describes as "a biological desert", the chartered commercial trawler lost its trawl. "Everything from the doors on down", is how Sparholt remembers it. "Something must have gotten in it, but we still don't know what. Maybe a whale or a huge school of fish, but it must have been big to take the trawl, which was 120 metres wide horizontally by 20 metres. Our best guess is a humpback whale. There had been two 20-tonne whales just next to where we were fishing. Or maybe it was a submarine", he adds wryly. The net has an alarm that sounds when the catch weighs more than half a tonne. A few seconds after the alarm sounded, the whole vessel shuddered and the gear was lost.

Another interruption occurred when the crew received a Mayday from a small Polish sailboat alone in the middle of the Sargasso Sea with a mast broken during a short but intense storm. The "Vædderen" crew repaired the motor, allowing the sailboat to limp to the nearest port, Bermuda.

The team completed three north–south transects, each separated by 300 kilometres. "We covered the spawning area very well and got enormously good data on eel larvae, an excellent statistical distribution of the data", says Sparholt. The data has been sent to Silkeborg, Charlottenlund, and Canada, where it will be analysed. Approximately 230 eel larvae were caught, and genetic studies will be performed on them. "Also," says Sparholt, "we have samples of zooplankton and phytoplankton, so we have a lot of data to be worked up over the next two years".

The BigMIK plankton net on the surface. The BigMIK is the larger version of the well-known MIK plankton net, which is used on routine IBTS surveys in the North Sea.

A longline is prepared, using squid as bait. To the crew's great disappointment, the line came up empty.

A large tornado touched down about a kilometre from "Vædderen".

The crew in the Sargasso Sea.

Sparholt is also enthusiastic because the eel larvae that were caught might allow stomach analysis for the first time, which is relevant to the future of eel larvae aquaculture.

THE TRAWLER FISHED FOR NINE DAYS, BUT CAUGHT VERY LITTLE; IT REALLY IS A BIOLOGICAL DESERT OUT THERE.

The name Galathea

Galathea, or Galatea in the usual English spelling, was one of the 50 daughters of the Greek sea god Nereus, the so-called Nereids. Galathea means "she who is milk-white", and her beauty so enthralled the Cyclops Polyphemus that he fell in love with her. The most famous of the Nereids was Thetis, which happens to be the name of one of the three sister frigates of "Vædderen", all built in 1992.

Sparholt points out that, over the last two or three decades, the eel stock has decreased to historically low levels. "Seven or eight years ago, ICES recommended a complete stop to eel fishing and urged the development of a recovery plan. It wasn't until June 2007, that the EC and its member countries finally adopted a management plan for eel. In those seven years, the situation has gotten even worse. Eel is down to 1% recruitment, compared with what it should be. The situation is critical".

All in all, Sparholt says, "It was a fantastic and unforgettable experience. The enthusiasm, energy, and inspiration on board were great. We had splendid weather and managed to do more than expected. The crew was outstanding, and we all carry away special memories, for example swimming in the crystal-clear, cobalt blue water of the Sargasso Sea, which", Sparholt reminds us with a laugh, "is six kilometres deep!" He has only one regret. "Unfortunately, we didn't catch an adult eel. The trawler fished for nine days, but caught very little; it really is a biological desert out there. Not much was seen on the echosounder either. So, it is still a mystery where the adult eel are hiding.

"Still, all of the data we collected might tell us why the Sargasso Sea is an ideal environment for the eel larvae and why the adults migrate thousands of kilometres to get there".

The history of the Galathea expeditions

The Galathea 3 expedition is part of a venerable Danish tradition of maritime exploration. The first two Galathea expeditions stand out with particular clarity partly because of their scope and success and partly because they had several destinations in common, enabling scientists to observe developments that stretched over an entire century.

From 1845 to 1847, the first Galathea explored the Nicobar Islands, arranged the transfer of Denmark's Indian colonies to the British East-India Company, and negotiated new trade contracts in China. The corvette's voyage around the world was undertaken at the behest of King Christian VII, who requested the Royal Danish Academy of Sciences and Letters to appoint "persons learned in the study of Nature and aides to assist them". The expedition's success was celebrated 100 years later when its namesake Galathea 2 struck out on a deep-sea oceanographic mission between 1950 and 1952. Galathea 3 was seen as a way of furthering Danish scientific interests as well as sparking interest in science to boost the recruitment of future scientists. The expedition was brought into Danish schools with a direct satellite connection, allowing the Danes, quite literally, to look over the shoulders of the research scientists.

"VÆDDEREN" WAS HOME TO 100 PEOPLE ON THE NINE-MONTH EXPEDITION, INCLUDING SCIENTISTS, MEDIA REPRESENTATIVES, AND THE 50-MAN NAVY CREW.

The expedition included 71 individual sea- and land-based research projects; the main themes covered oceanic processes, climate change, and earthquake research. In addition, marine biological studies of animals from whales to bacteria and plants were carried out, and research projects within the humanities spanned a wide range of subjects. Altogether, 124 project proposals were submitted to independent governmental research councils, and 71 were finally selected by the Danish Expedition Foundation.

The third Galathea expedition sailed on the Danish navy surveillance vessel "Vædderen" (The Ram), measuring 112.5 metres from the prow to the stern, and 14.5 metres from port to starboard. "Vædderen" was home to 100 people on the nine-month expedition, including scientists, media representatives, and the 50-man navy crew. The ship underwent extensive rebuilding and modernization to make it suitable for the research projects.

"Vædderen" set sail from Copenhagen in August 2006 to circumnavigate the globe and returned in April 2007, after 34 000 nautical miles.

The ship sailed the North Atlantic, with stops in the Faroe Islands and Greenland and turned south along the west coast of Africa, continuing across the Indian Ocean to Australia and the Solomon Islands, via New Zealand and the Antarctic. It turned north along the west coast of South America to the Galapagos Islands, through the Panama Canal to the Caribbean, where Sparholt joined the expedition, and concluded its circumnavigation of the globe with a visit to Boston.

Later this year, Issue 7 of the ICES Journal of Marine Science will contain a suite of 15 papers presented during the theme session, "Is There More to Eels than Slime?", at the 2006 ICES Annual Science Conference.

A small, grey-mottled flying fish (Exocoetidae) and, to its right, a sargassum fish (Histrio histrio) among sargassum weed. The sargassum fish spends its entire life associated with floating sea grass beds, mostly sargassum algae. Sargassum fish do not swim much, but rather just follow the sargassum beds. Flying fish, on the other hand, take short gliding flights over the water, to escape predators.

A significantly higher number of northeast Arctic cod recruits is predicted for 2008 and 2009.

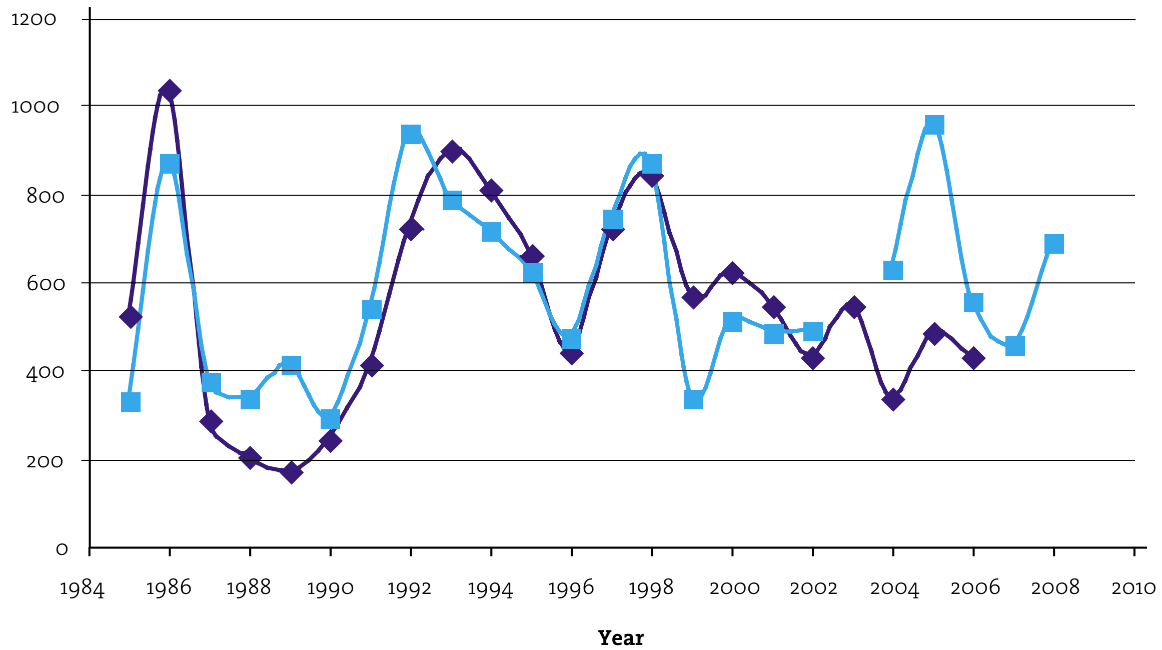
700 million new cod recruits in 2008

Einar Svendsen reports that, in 2008 and 2009, recruitment to the northeast Arctic cod stock in the Barents Sea will be significantly higher than in 2007. Medium-strong year classes are predicted, while the numbers of 3-year-old recruits in 2007 indicates a rather weak year class. This emerged from recent modelling studies at the Institute of Marine Research (IMR) in Norway.

Seventy per cent of recruitment to the cod stock in the Barents Sea seems to be regulated by the climate and its effect on the primary production in the Barents Sea during the cod's first year. This possibly allows a nearly three-year prediction of the annual variability of the number of 3-year-old recruits. Even if the results are promising and robust, however, more work is needed to pinpoint several of the basic processes involved. At present, the methodology is not part of the fisheries advisory system.

IMR runs a large-scale three-dimensional numerical model (ROMS), developed at the Rutgers University, to describe short- and long-term variability in ocean circulation and water properties. In addition, IMR has developed a model (NORWECOM) for simulating primary production of the functional algal groups, diatoms, and flagellates. The NORWECOM system, implemented with ocean physics from ROMS, has been run to simulate conditions over the past 25 years for the North Atlantic and the Arctic oceans. Modelled time-series of volume fluxes, primary production, and drift of cod larvae through their modelled ambient temperature have been analysed in conjunction with estimated time-series based on observations of 3-year-old cod recruits in the Barents Sea, obtained from ICES. Individual time-series account for less than 50% of the recruitment variability; however, a combination of simulated inflow of Atlantic water (during fall) and primary production (in April) accounts for 70% of the variability with a three-year lead. The prediction indicates an increased recruitment for 2007 to 2008 of about 450 to 700 million individuals, with a standard error below 150 million.

Annual recruitment (purple line) of 3-year-old northeast Arctic cod, based on international observations and calculations; and statistical prediction (light blue line) based on dynamically modelled (during the year of spawning) inflow of water to the Barents Sea during the fourth quarter and the primary production for the total Barents Sea in April.



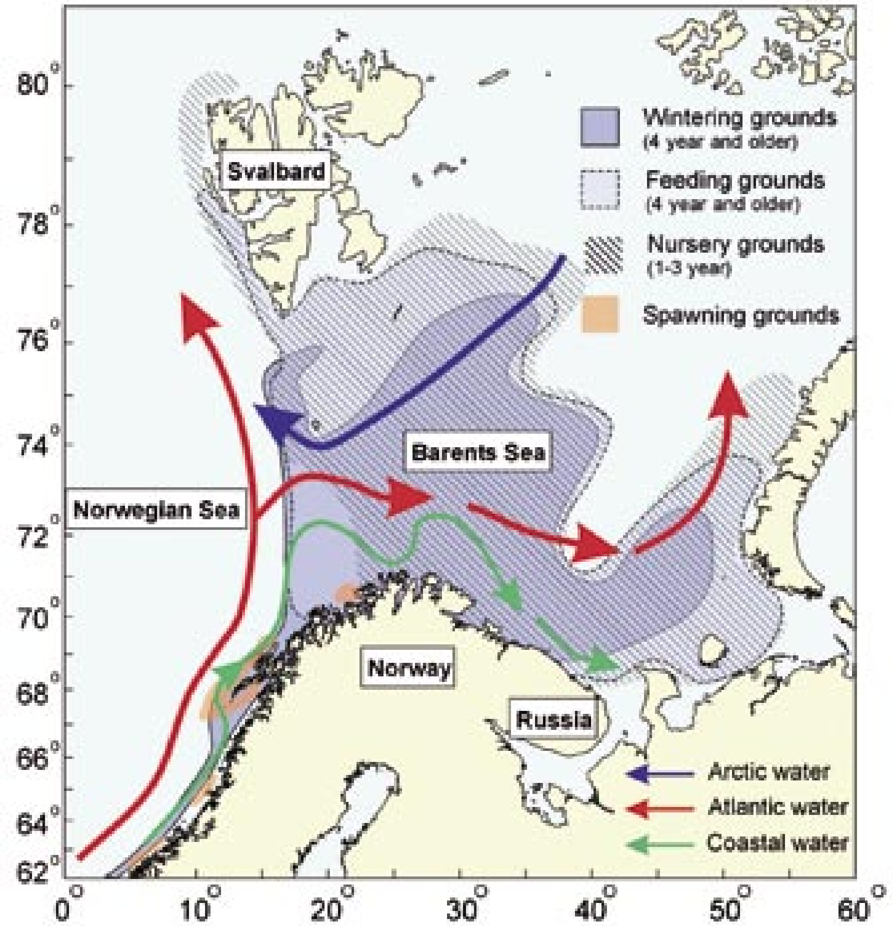
The ability to predict recruitment accurately is probably the most important factor in rapidly improving fishery management advice, particularly the ability to give early warning of potential failure in recruitment. It is important to recognize that this recruitment prediction system has depended on long-term monitoring and assessment of the cod stock. This is done regularly by ICES, based on reported catches of fish and monitoring performed mainly by PINRO in Murmansk, and by IMR. The stock assessment methods have revealed higher uncertainties in recent years, and we believe that recruitment in 2004, and particularly in 2005, was higher than estimated by ICES. An alternative reason is that a high mortality, for which we have no explanation, has occurred over one- or two-year stages. For the past 25 years, the cod spawning stock has generally been significantly higher than 200 000 tonnes. If this drops significantly, we will have to consider the size of the spawning stock.

MORE WORK IS NEEDED TO PINPOINT THE BASIC PROCESSES INVOLVED.

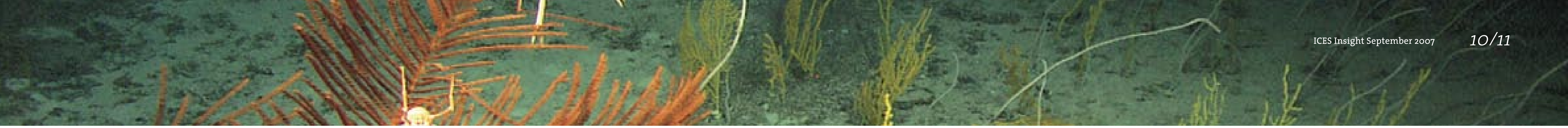
Although it seems logical that primary production is positively linked to recruitment, at present there is no clear explanation for the negative relation to inflow in the fourth quarter. One hypothesis is that juvenile cod are not as stationary as assumed and that, with strong flows, the juveniles drift too far eastwards in the Barents Sea. During winter and spring, the juveniles may then be hit by the formation of extremely cold bottom water caused by surface cooling, hence causing high mortality. The weakest link in this analysis is the lack of zooplankton information, because zooplankton is the critical food source for the growth, and consequently survival of cod larvae and juveniles. Performing the analysis further back in time will also strengthen the work.

Biography

Einar Svendsen has worked for 27 years researching physical oceanography, remote sensing, and marine ecology. He has published more than 50 scientific review articles and taken part in 17 large expeditions (several as chief scientist) in the Arctic and Antarctic and the northern seas. Between 2004 and 2006, he was chair of the ICES Oceanography Committee and a member of the ICES Consultative Committee. Recently, he took up his new position as research director at the Institute of Marine Research, Norway.



An overview of the northeast Arctic cod's distribution area.

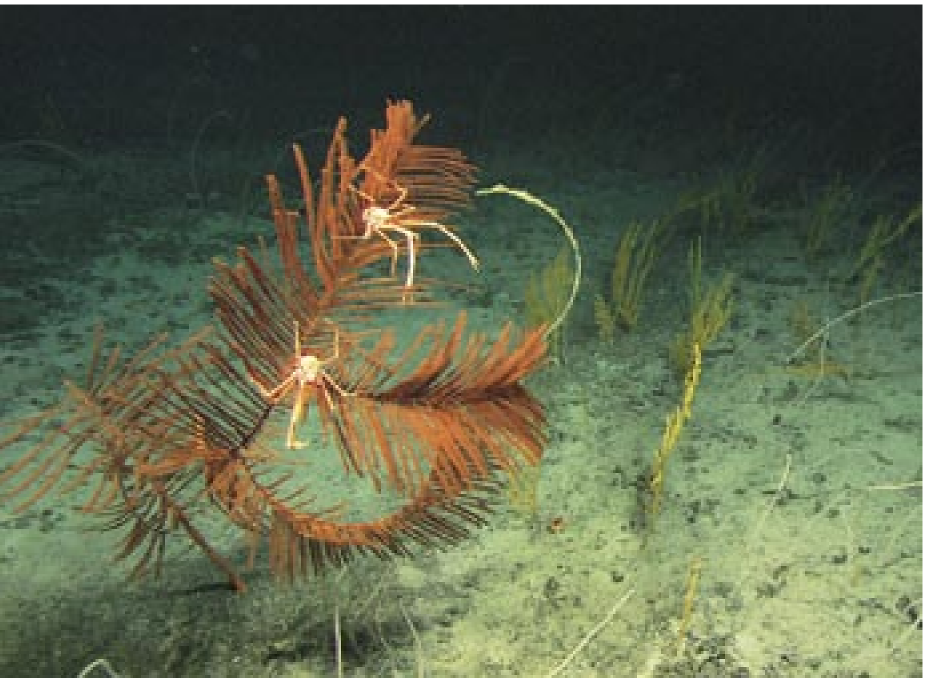


Corner Rise Seamounts: the impact of deep-sea fisheries

When these authors go mountain climbing, they start in the middle and head for the top. The peaks in question are seamounts, which rise from the sea floor, but never quite see the light of day. Les Watling, Rhian Waller, and Peter J. Auster have spent considerable time exploring the Corner Rise Seamounts and their biota. Here they report on what they saw on an expedition in 2005 and the damage done by deep-sea fisheries.

North Atlantic seamounts and ridges have been targeted by fisheries since the 1970s, especially roundnose grenadier (*Coryphaenoides rupestris*), orange roughy (*Haplostethus atlanticus*), and alfonsino (*Beryx splendens*), among others (Magnusson and Magnusson, 1995; Kulka *et al*., 2003; ICES, 2004). Although landings of fish must be reported to one of the regional fishery management organizations, there is no requirement to report amounts or kinds of bycatch. Consequently, it has not been possible to assess the environmental cost of these fisheries.

In 1976, the Soviet Union began a series of fishery investigations on the Corner Rise Seamounts to explore for viable species and catches (Vinnichenko, 1997). In that year, after finding commercially viable numbers of fish (mainly alfonsino), as many as 17 trawlers caught a total of ~10 000 tonnes. The next year, eight vessels fished at Corner Rise, but the results were disappointing: only ~800 tonnes were caught.



Kükenthal Peak, Corner Rise Seamount, 1230 m, 23 August 2005. Sand-covered basalt; large black coral (Pteridopathes sp.) with two uroptychid squat lobsters; golden fans are in genus Paramuricea, and white whips are unknown primnoids.

Photos courtesy of Les Watling for the Deep Atlantic Stepping Stones Expedition team, IFE, URI-IAO, and NOAA.

This fishery mimicked the problems found in other deep-sea fisheries: initially strong catches declined rapidly to a low level. In 1987, as many as four trawlers took only ~2300 tonnes of fish, and catches remained low through 1996, the last year that fishing activities were reported. In 1994, about 400 tonnes of alfonsino were taken, and in the subsequent two years, 3500 and 600 tonnes of fish were caught, respectively.

Alfonsino was the main fish exploited at Corner Rise, but other species of economic importance were also taken, including cardinalfish (*Epigonus telescopus*), black scabbard (*Aphanopus carbo*), wreckfish (*Polyprion americanus*), barrelfish (*Hyperoglyphe perciforma*), and Mediterranean roughy (*Hoplostethus mediterraneus*; Vinnichenko, 1997). Notes on bycatch are not available; neither are specific fishing locations within the Corner Rise complex.

SUBSEQUENT REPEATED PASSAGES OF THE GEAR CONSIDERABLY ERODED THE SUBCRUSTAL MATERIAL.

In 2005, we visited the Corner Rise seamounts with the remotely operated vehicle (ROV) "Hercules" and were able to catch on video evidence of trawl fishery activity that had occurred in the 1970s. The Corner Rise Seamounts comprise a group of ~21 peaks, three of which, it appears, have been heavily fished (Vinnichenko, 2002). Using the multibeam bathymetry system on the NOAA ship "Ronald H. Brown", we mapped in detail 14 seamounts in this group and partially mapped another three along the western edge. Six of the Corner Rise Seamounts have moderately flat tops that are within reach of deep-sea trawlers. ROV dives were conducted on or near the summits of only two of these, but also on slopes and plateaux below the summits of another two. We saw trawling damage on the summit of Kükenthal Peak ("35°31.645N 51°55.467W) and the slope of the northwestern corner of Lyman Peak on Yakutat Seamount (35°16.831N 48°05.557W).

At Kükenthal, the dive began at a depth of about 950 m. The ROV landed at the base of a wall, which arose from a sand-covered plateau. There were few organisms on the wall, but the sand was populated by colonies of the bamboo coral *Acanella eburnea*. At 915 m, there were marks on the rocks that were interpreted as being from fishing gear, but they were faint. At this depth, the substrate was predominantly sand, grading into cemented carbonate.

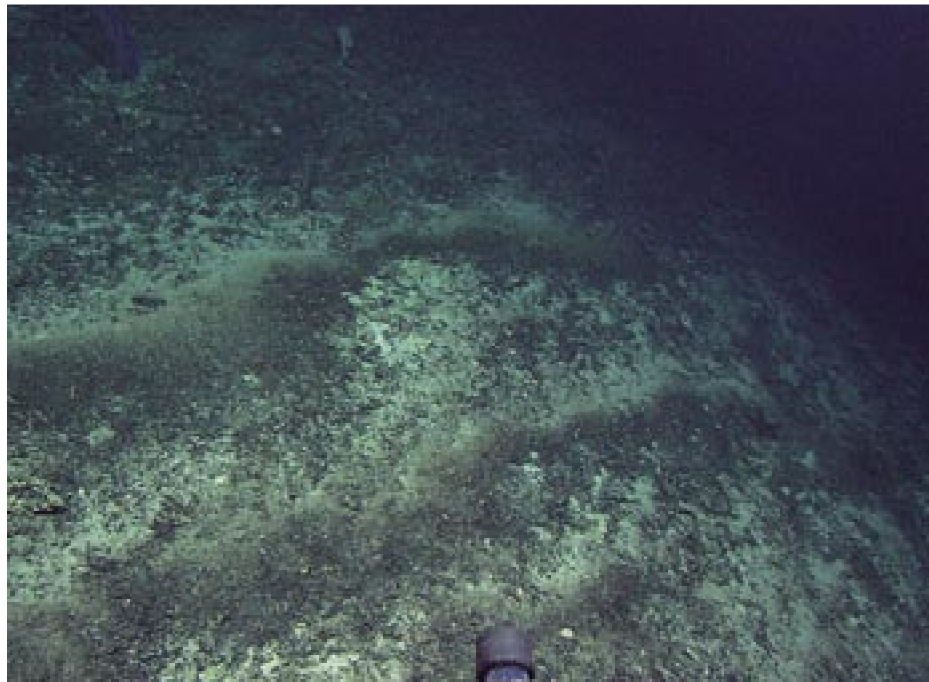
We collected several specimens of *A. eburnea* and the black coral *Parantipathes larix*. We saw the first trawl marks at 895 m depth, beginning with distinct marks on the edge of the large plateau leading to the summit (Waller *et al.*, in press). There were no corals or other large fauna on the summit, but concave sponges were abundant. Several of these were cut by part of the gear dragging along the bottom (possibly net weights). We don't know whether these sponges recolonized the area after cessation of the initial heavy round of trawling, or whether the summits of these seamounts are naturally devoid of large corals and sponges. For example, Dive 4 at Milne Edwards Peak and Dive 5 at Verrill Peak on Calloosahatchee Seamount were also at fishable depths (1280 and 1100 m, respectively), yet showed no signs of having been trawled, at least in the area of the ROV track. However, an almost completely dead piece of the soft coral *Paragorgia*, with sponges and a small colony of *Corallium* attached, was found lying on the seabed. This coral and other organisms clearly had been brought to the surface somewhere and thrown overboard soon enough that part of the colony was still alive. It is possible that this seamount was also fished, but not at a level where just one ROV dive would have encountered marks.

Near the summit of Kükenthal, the calcareous crust that was abundant over the length of the dive track was heavily damaged, with most of the crust removed. We suspect that the doors of the trawl impacted the area near the summit quite heavily, breaking through the crust and exposing the sand below. Subsequent repeated passages of the gear considerably eroded the subcrustal material.

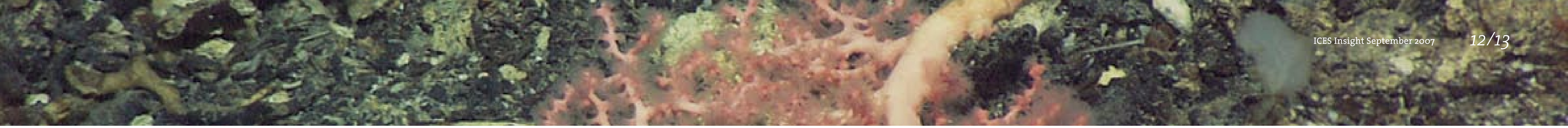
Yakutat Seamount, 1520 m, 15 August 2005. Lophelia rubble on bottom of overturned vase sponge.

Yakutat Seamount, 1435 m, 15 August 2005. Piece of living Paragorgia sp., lying next to broken Lophelia and carbonate crust.

We conducted three ROV dives on Yakutat Seamount. Only the dive on the northwest slope of Lyman Peak revealed extensive reworking of material, caused by trawl gear. This dive began at 1634 m depth. Throughout much of the dive, the bottom consisted of basalt walls or slopes of varying degree, interspersed with sandy areas. In many spots, the sand was only a veneer over the rock, but in others, the sand was deep enough to provide habitat for unknown sand burrowers. Throughout the dive, we noted large deposits of fossil or subfossil scleractinians *Lophelia pertusa* and *Desmophyllum dianthus* intermixed with the "bones" of bamboo corals. All were sufficiently old to have a coating of black manganese dioxide.



Yakutat Seamount, 1425 m, 15 August 2005. View across knoll showing deep gouge marks in the carbonate crust, into which old Lophelia rubble has been moved by local currents.



black corals, and octocorals from the abundant megafauna. At 1536 m, we noted a turned-over or "thrown back" lump of fossil *L. pertusa*, with a large sponge attached. At 1516 m, we encountered a dead *Paragorgia* sp. skeleton, and at 1427 m, we approached the summit of a knoll with a larger amount of dead *L. pertusa* than seen previously.

At regular intervals, the *L. pertusa* was interspersed with broken carbonate crust and old *Paragorgia* sp. colonies. The entire area of this plateau summit was marked with long, almost parallel gouges, suggesting that fishing gear was routinely pulled over the area in the same direction.

Both peaks had abundant fossil and subfossil *Lophelia pertusa* coral debris, as did at least two other seamounts at the same depths. It is possible that for these seamounts, which are just below the depth of the Gulf Stream core, water temperatures in the area could have warmed enough sometime in the past 10 000 years to have caused the death of the *L. pertusa* that were present. However, there are clear trawl gear marks on these seamounts, as well as numerous overturned corals, so it is most likely that this seamount was also fished by Soviet vessels.

Yakutat Seamount, 1427 m, 15 August 2005. View of broken carbonate crust on edge of knoll.

The exact extent of the damage is difficult to assess, however, because it is unknown whether the corals were dead to begin with, or how much biodiversity was associated with the scleractinian debris. A number of studies have found that dead scleractinian structures form habitats for more associated species than live scleractinians, and so it is quite possible that trawling in this area lowered the diversity and biomass. Many encrusting sponges were also seen, and these can be a sign of disturbance to coral communities.

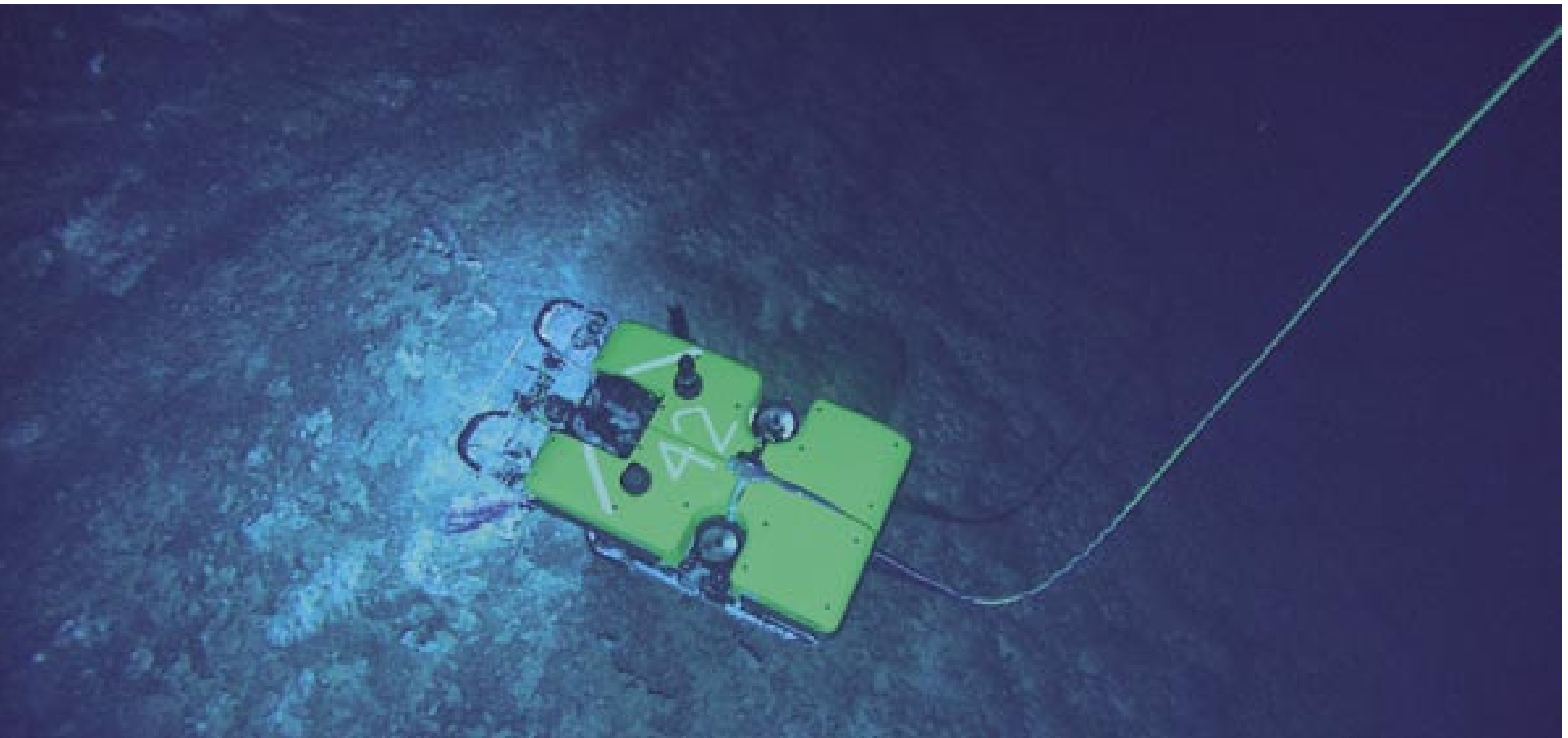
In other areas of the world, such as south of Tasmania (Koslow *et al.*, 2001) and off New Zealand (Clark and O'Driscoll, 2003), images from camera tows have shown that heavily fished seamounts are pretty much devoid of large, sessile animals. Our examination of the peaks of the Corner Rise Seamounts is the first to show a similar lack of organisms in an area of the North Atlantic known to have been fished by deep-sea trawl gear. Unfortunately, because of the lack of precision in the Soviet reports, we are forced to use "ecological forensics" to determine exactly where the trawling occurred and what the impact of this fishing was on the seamount community.

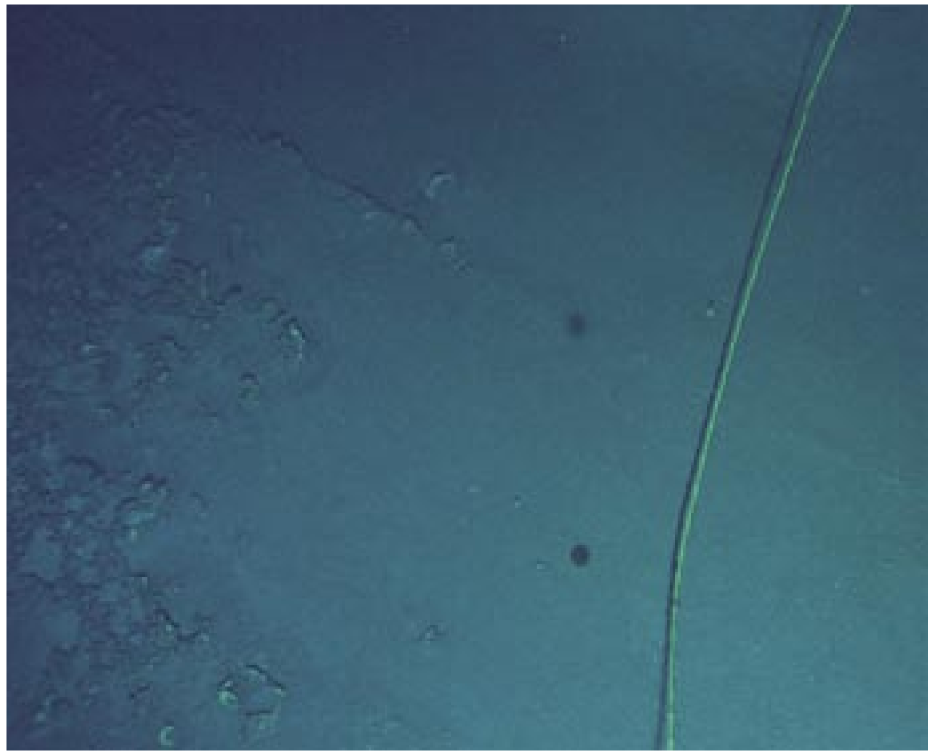
THERE WERE NO CORALS OR OTHER LARGE FAUNA ON THE SUMMIT...

In the future, it would be ideal for ROV studies to be conducted immediately after an area is fished, using location data provided by the fishing industry. NOAA's National Marine Fisheries Service provided this kind of information for their trawling efforts on Bear Seamount, and we were able to target a dive transect, using the deep submersible "Alvin" across a trawl gouge made in the sand on the seamount summit. Only carefully located dives and knowledge of past fishing effort will allow us to assess the degree of impact of fishing gear on seamounts and ridges in the North Atlantic.

This work was supported by the NOAA Office of Ocean Exploration. The images were obtained through the professional work of the pilots and technicians of the ROV "Hercules" (IFE and the University of Rhode Island IAO) and the captain and crew of the NOAA Ship "Ronald H. Brown".

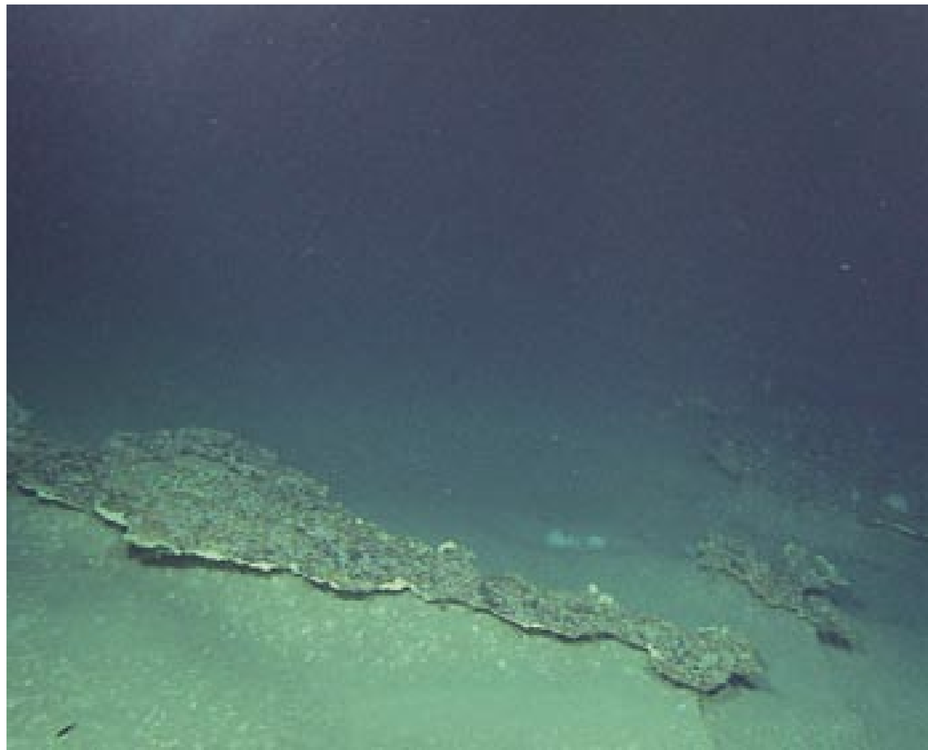
Yakutat Seamount, 1424 m, 15 August 2005. View of the ROV "Hercules" working on the knoll where trawl gouges can be seen in the upper left.





Kükenthal Peak of Corner Seamount, 825 m, 22 August 2005. View from Argus showing the tether leading to ROV "Hercules" stretching across bare sand and the remains of carbonate crust to the left. Trawl marks can be seen in the sand leading to the crumbled crust.

Kükenthal Peak of Corner Rise Seamount, 825 m, 22 August 2005. Close-up of smashed carbonate crust and underlying sand and shell sediment. Note crust removed in linear direction across image.



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Biographies

Les Watling is a benthic ecologist and a professor of oceanography at the University of Maine. Les received his PhD from the University of Delaware. His research interests have primarily spanned two areas: crustacean taxonomy and phylogeny, and benthic oceanography. His benthic interests focus on the impact of humans on benthic environments, with an emphasis on organic enrichment and habitat disruption.

Rhian Waller is a postdoctoral fellow working at the Woods Hole Oceanographic Institution. She is a benthic ecologist, interested in populations of cold-water corals, how they inhabit and reproduce in the deep sea, and how these populations are interconnected through the world's oceans.

Peter Auster is Science Director for the National Undersea Research Center and an Assistant Professor-in-Residence in the Department of Marine Sciences. He uses a range of diving technologies, from snorkel and scuba to deep-sea submersibles to observe how communities of fishes are distributed within underwater landscapes and how the behaviours of individuals vary in order to find prey and avoid predators. His research interests include studies of the effects of fishing on fish habitat and the role of marine protected areas in the conservation and sustainable use of marine biological diversity.

Fishing technology in the 21st century: an ICES symposium

The ICES symposium "Fishing technology in the 21st century: integrating fishing and ecosystem conservation" was held in Boston, Massachusetts, from 30 October to 3 November 2006, at Boston's Seaport Hotel.

It was co-hosted by the Gulf of Maine Research Institute. The conveners were Christopher W. Glass, USA, Stephen J. Walsh, Canada, and Bob van Marlen, the Netherlands. The symposium was organized around four interrelated themes:

- Ecosystem-sensitive approaches to fishing – reconciling fisheries with conservation through improvements in fishing technology;
- Current status of mobile and static sampling gears used in resource surveys;
- Fishers' responses to management measures and their socio-economic effects;
- Fishery forum on integrating fishing and ecosystem conservation: the way forward.

The meeting was truly a global event that attracted 289 attendees representing government and NGO scientists, academics, students, industry representatives, and fishers from more than 30 countries. One hundred and forty-six papers were submitted, of which 63 were selected for verbal presentation and 83 presented as posters. Fifteen symposium manuscripts will be published as Issue 8 of the *ICES Journal of Marine Science* in November 2007.

The symposium was unique in that it crossed several disciplines. The purpose was to address biological and socio-economic issues relating to bycatch and discarding from commercial fishing operations, and the impact of fishing gear on sensitive habitats; a further goal was to address the performance and effectiveness of fishing gears used in fishery-independent resource and ecosystem surveys. These issues have not been addressed collectively in any international symposium. The need to do so was made more urgent by the nature of global fisheries: many stocks have collapsed, and it becomes increasingly clear that there is a pressing need to protect bio-diversity and improve our ability to estimate the resource, while providing fishers access to the resource.

A key area addressed was how to obtain and quantify industry responses to declining stocks and increasing management regulations and integrate them with fishery- and ecosystem-based management advice.

On Day 5, a Fisheries Forum was held, with an invited panel of world experts from industry and science, to discuss how perceptions and decisions of fishers and resource managers affect the success of achieving sustainable use and successful management of fishery resources. It attracted many fishers, industry participants, and academics from the northeast US, eastern Canada, Europe, and Southeast Asia.

In addition to ICES sponsorship, the meeting received generous support from the Northeast Consortium, the Gulf of Maine Research Institute, National Fisherman, MIT Seagrant, NOAA Fisheries, Marine Fisheries Institute, and Manomet Center for Conservation Sciences.

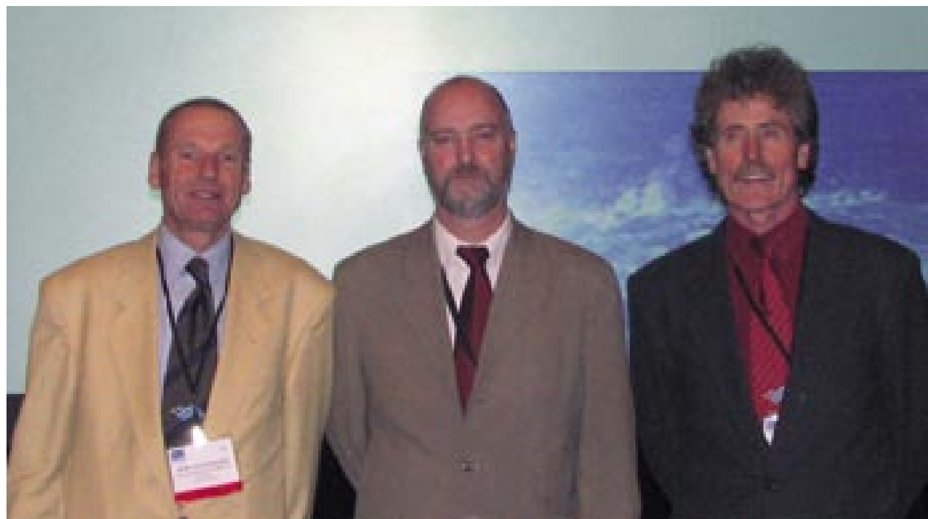
Several awards were given at the end of the symposium.

Best Oral Presentation was awarded to Michael Breen, FRS Marine Laboratory, Aberdeen, UK, and Best Poster presentation was awarded to Bram Couperus, Institute for Marine Resources and Ecosystem Studies, IJmuiden, the Netherlands.

Best Student Oral Presentation was awarded to Ingrid Bouwer Utne, Norwegian University of Science and Technology, Trondheim, Norway, and Best Student Poster was awarded to Ankorn Boutsen, Tokyo University of Marine Science and Technology, Tokyo, Japan.

LOGO

The artwork featured in the ICES 2006 Boston logo, titled "Sacred Cod", was created by Eric Hopkins, a noted aerial landscape painter, student pilot, and gallery owner. He lives in North Haven Island, Maine, and can be contacted at www.erichopkins.com.

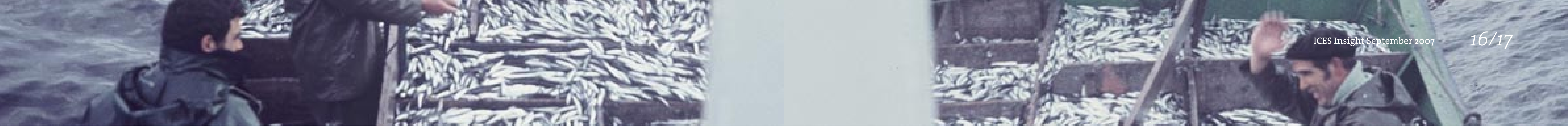


The conveners, left to right:

Bob van Marlen, Institute for Marine Resources and Ecosystem Studies, IJmuiden.

Chris Glass, The Northeast Consortium, University of New Hampshire.

Steve Walsh, DFO Northwest Atlantic Fisheries Centre, St John's.



Bay of Biscay anchovy: a resource in crisis

Begoña Villamor, Pablo Abaunza, Pierre Petitgas, Jacques Massé, and Andrés Uriarte explain how the crisis of the Bay of Biscay anchovy can be avoided in the future.

Anchovy (*Engraulis encrasicholus*) is the short-lived pelagic fish of great importance to fishing in Spain and France. Bay of Biscay anchovy are characterized by their seasonal migrations, the intense growth they undergo throughout their short lives (three or four years at the most), their early sexual maturity (from the first year of life), their formation in shoals (above all, during the spawning season in spring), and the space they occupy, depending on abundance (the greater the abundance, the larger the spawning ground). One of the most important characteristics is the enormous interannual fluctuations in the abundance of its population, with high and variable natural mortality. These fluctuations are caused by the great variations in recruitment, driven mainly by environmental factors.

Evolution of the fishery

Historically, the Bay of Biscay anchovy fishery has generated a large annual production, exceeding 80 000 tonnes in 1965. Figure 1 shows how, from the mid-1970s, catches declined and remained low in the 1980s. The distribution area for anchovy showed a parallel reduction compared with previous years. The 1990s showed a return to levels similar to those of the 1970s, and since 2002, catch levels have been extremely low.

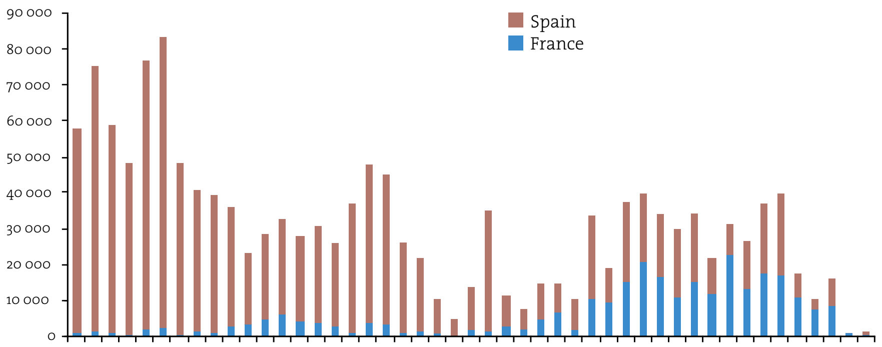


Figure 1. *Historical evolution of the anchovy fishery since 1960.*

It is noteworthy that the development of the French fishery was accompanied by a change in the spatio-temporal distribution of the catches, where in the 1990s, an autumn fishery developed on the northern French Biscay shelf.

The problems behind the crisis

The first thing that must be mentioned is the highly variable nature of the anchovy, as determined by its biological and ecological characteristics. As it is a short-lived species, with two or three ages making up the catchable stock, the strength or weakness of the age classes decisively determines the annual stock biomass in the sea. This does not happen in long-lived species such as cod, hake, or monkfish. In these cases, there are many ages that make up the population, and the good, normal, and weak age classes of different years are intermixed, so leaving the biomass in the sea and catches much more stable, or at least leading to much less pronounced declines.

The problem with the Bay of Biscay stock is that the recruitment detected since 2001 has been extremely weak, and 2005 showed the lowest recruitment of the historical series. As a result, not enough new individuals have been incorporated into the population to let it recover, and so the spawning biomass of the stock has fallen enormously, to estimates for the years 2005 and 2006 of just 14 826 t and 22 300 t, respectively (data from the ICES Working Group on Assessment of Mackerel, Horse Mackerel, Sardine, and Anchovy). There is a minimum limit below which the spawning biomass should not fall (B_{lim} = 21 000 t). As with most commercially exploited species, it has not yet been determined for anchovy whether any stock–recruitment relationship exists that explains the variation in recruitment in terms of changes in the abundance of the adult stock.

In this situation, the precautionary principle should be imposed in order to prevent the stock from collapsing as a result of the strong fishing activity, generating high fishing mortality and aggravating the poor recruitment. In these cases, scientists are aware of other short-lived pelagic species in which a large effort of fishing activity has been added to weak recruitment, leading to the collapse of the stock for many years, as happened to North Sea herring or California sardine.

It is true that these situations are reached as much with the help of oceanographic conditions as with fishing intensity itself. Favourable or unfavourable oceanographic and environmental conditions in space and time, including the presence of predators, are a basic condition for the success or failure of the annual recruitment, which ultimately depends on where and when larvae are affected. The resulting biomass of the stock tends to stabilize or decline. Bay of Biscay anchovy eggs and larvae develop from March/April until August. In August, the first juveniles are seen. The larvae drift from spawning grounds in summer towards the southwest, influenced by northeasterly winds. Bay of Biscay anchovy recruitment has been described as being positively influenced by coastal upwelling in the second and third quarters of the year along the French and Spanish coasts in the southeast of the Bay of Biscay (46°N 4°W) under northeasterly wind conditions, and negatively influenced in the third quarter when the water column stratification is broken under stormy conditions with southwesterly winds. In September, juveniles reach 6–7 cm and are mainly found in the oceanic area. In autumn, the juveniles migrate towards their spawning areas, influenced by northeasterly winds. In autumn/winter, the main juvenile areas are found in French coastal areas.

Changes in the distribution and schooling pattern of Bay of Biscay anchovy

The population has disappeared from the Spanish coast, and spawning grounds have been lost. Based on circulation models, larval drift reveals that the larvae, born in the current French spawning grounds, move towards the Spanish coasts, but fail to recolonize there.

Recent anchovy juvenile research surveys reveal that juveniles are found alone, separated from the adults, in the oceanic area and along the Spanish coasts; however, the juveniles are now found together with the adults along the French coasts.

One of the hypotheses currently being studied is whether the juveniles need to find the adults to colonize particular habitats effectively. This would allow closure of the life cycle and the maintenance of the population in its habitats.

In the 1990s on the French shelf, anchovy was generally aggregated in small schools, 15–30 m above the bottom during the day, and ascended to the surface during the night. The usual behaviour of this species was to stay close to the bottom during the day and to scatter at the surface layer at night. Since the beginning of the 2000s, more and more anchovy have appeared at the surface as very small schools and also desegregated in the surface layer (0–20 m) during night and day. Changes in the schooling pattern may change the catchability of the commercial fishing gears, and these changes are currently being analysed, based on historical research survey echosounder data.

Other current biological facts to be considered

In Bay of Biscay anchovy, there has been a gradual reduction in the spawning ground and population concentration, an unmistakable symptom of stock depletion since the 1970s. Reduction of the spawning ground and the concentration of shoals reduce the range of environmental conditions in the population, making its recovery more difficult. Documented collapses are always accompanied by a reduction in spawning grounds, the grouping of shoals, even longer periods of variability in recruitment than normal, and continued failures of recruitment. After a year or two of the failure of recruitment (regardless of the reason), the spawning stock becomes reduced to levels that produce so few eggs that one or even several years of good larval survival are not enough to rebuild the stock.

In Bay of Biscay anchovy, the viability of the current stock is understood to depend on an essential habitat in front of the Gironde estuary on the French shelf. That area is an important

In the 1970s, catches remained at around 30 000 t without great variations (between minimum and maximum values of 22 000 t and 48 000 t). In the 1980s, the stock experienced serious declines, with landings of less than 5000 t in 1982 and 8000 t in 1986, and of approximately 10 000 t in 1981, 1985, and 1989. The 1990s showed a return to levels similar to those of the 1970s, with catches of between 20 000 t in 1991 and 40 000 in 1993. Since 2002, catch levels have been extremely low, between 10 000 t in 2002 and 1200 t in 2005. In 2005 and 2006, the fishery was closed for part of the year (Figure 1).

autumn/winter nursery area, as well as a major spawning ground for first spawners. In addition to management with TACs to protect spawning biomass, the usefulness of spatial management scenarios for the protection of essential habitats is under investigation.

Resource assessment and management

The current situation of the stock calls for the utmost protection of the juveniles as well as what is left of the spawning population, because the recovery of the anchovy population depends entirely on a good recruitment entering the population this year. That is to say, the preferred aim of managing a resource like anchovy should be to prevent the collapse of the stock–recruit binomial through the maintenance of stable spawning biomass above a certain critical level (B_{pa} = 33 000 t).

For this reason, the scientific reports drawn up within ICES and the STECF recommend that the Bay of Biscay anchovy fishery should remain closed at least until anchovy biomass estimates for 2007 and recruitment for 2006 are available. These new estimates will be based on the results of the research surveys of spring 2007, carried out during the anchovy spawning season.

These acoustic and daily egg production method research surveys reflect fairly accurately the abundance of the stock. As with other stocks of small pelagic species that tend to form in shoals, the catch per unit of effort of the commercial fleets (purse-seiners and pelagic trawlers) is not always a trustworthy index of stock abundance, because catchability may change depending on gear, tactic, and schooling aggregation pattern (Figure 2). So, assessment models must be calibrated using fishery-independent information. For the efficient management of this resource, an indicator of recruitment strength is also needed to be able to apply adaptive management.

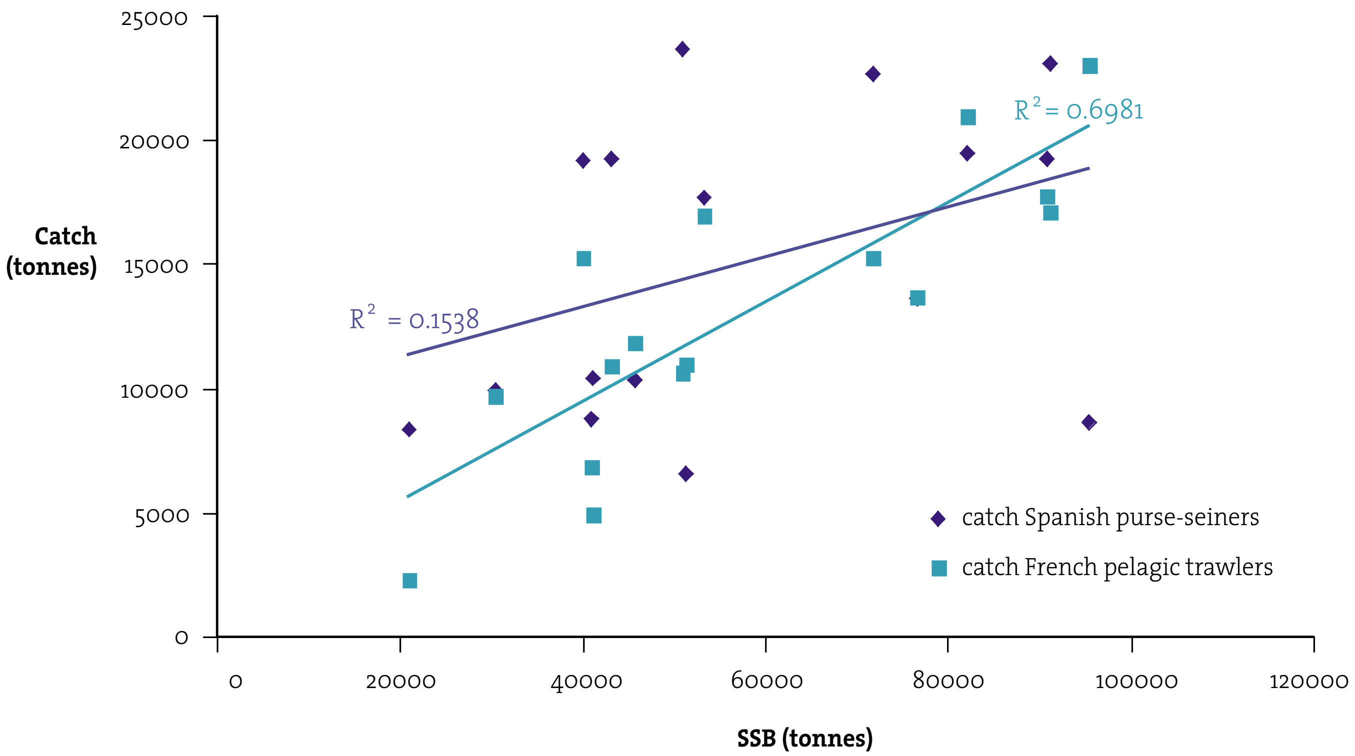


Figure 2. *The relationship between spawning-stock biomass, estimated by the ICES Working Group on Assessment of Mackerel, Horse Mackerel, Sardine, and Anchovy, and commercial catches, as reported to that group.*

Currently, a series of research surveys is being developed along these lines for the period of the juvenile phase of anchovy (autumn) to learn its ecology and estimate the abundance of new recruits. It is anticipated that, once the usefulness of this new historical series has been established together with the spring surveys, the Bay of Biscay anchovy can be managed more efficiently, and these episodes of crisis can be avoided as far as possible.

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The authors have been working in Bay of Biscay anchovy stock assessment and ecology for more than 15 years, attending the relevant ICES working groups. They have been involved in many projects related to the study of pelagic species and research surveys. Begoña Villamor and Pablo Abaunza can be contacted at IEO, Instituto Español de Oceanografía, PO Box 240, 39080 Santander, Spain. Pierre Petitgas and Jacques Massé can be contacted at IFREMER, French Research Institute for Exploitation of the Sea, PO Box 21105, Nantes, France. Andrés Uriarte can be contacted at AZTI, Instituto Tecnológico, Pesquero y Alimentario, 20110 Pasajes, Guipúzcoa, Spain.

Links to these relevant ICES working groups can be found at **http://www.ices.dk/iceswork/workinggroups.asp**

ICES Working Group on Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy.

ICES Study Group on Regional Scale Ecology of Small Pelagics.

ICES Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IV.

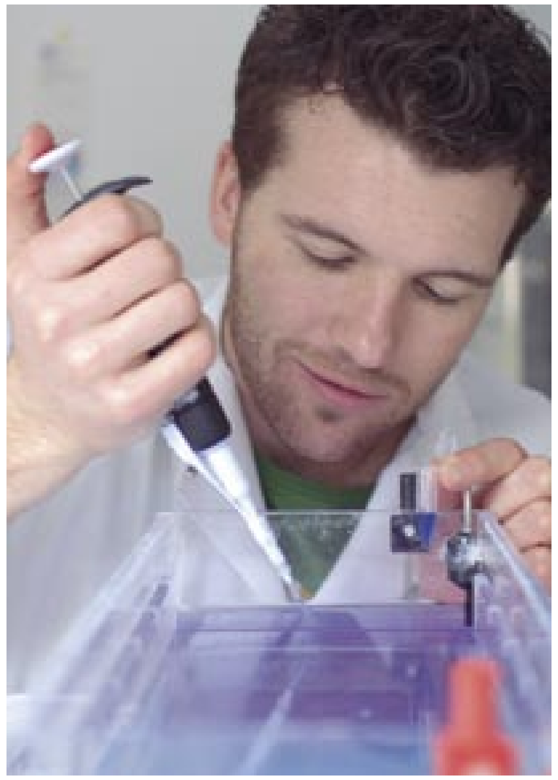
Onboard a Spanish purse-seiner, fishing for anchovy in the Bay of Biscay. Photo by Jóse Luis Cort.

What DNA can do for you: genetic methods in fishery management and biodiversity conservation

Einar Eg Nielsen asks us to look into the future.

The inspectors enter the fish shop. Immediately, they spot a sign on the counter: "Fresh North Sea Cod Filets". They cut out minute samples from the white flesh of four filets and insert them in their "Instant DNA Genotyping®" device. After a couple of minutes, the situation is clear. Two of the filets are cod from the Baltic Sea, where fishing is currently banned.

This scenario may sound futuristic, but it is a realistic option for the not-so-distant future. Currently, molecular genetic tools are undergoing an unprecedented revolution in the wake of the characterization of the human genome. Spin-offs to areas beyond the medical sector are evident, and the field of fishery genetics is no exception. The emerging technologies and broadened insight into the evolutionary processes on the DNA level are already changing our ability to characterize fish populations genetically and providing invaluable advice on their sustainable management in a changing environment.



Morten Limborg, an undergraduate student at the Danish Institute for Fisheries Research, conducting DNA research. He charted the statistics on sprat in Figure 1. Photo by Finn Sivebæk Jensen.

Genetics in fisheries: an historical perspective

The use of genetic methods in fisheries is not new. Pioneering work in the early 1960s by Sick, Frydenberg, and Møller, studying different forms of the oxygen carrying protein haemoglobin in cod, already demonstrated the great potential for identifying isolated populations (stocks), based on genetic differences. In fact, their groundbreaking studies were among the first to investigate genetic variation in the wild for any organism. Since then, a large body of genetic data has been compiled for many of our commercially important fish and shellfish species.

THE PROPERTIES OF DNA MAKE IT POSSIBLE TO STUDY ALL LIFE STAGES OF FISH, FROM EGG TO ADULTS – WITHOUT HAVING TO KILL THEM.

Initially, the choice of genetic markers was on various proteins (enzymes), which could be extracted from different tissues (e.g. flesh, eyes, and brain). However, in the 1980s, DNA-based methods started to emerge and have now almost completely replaced proteins as genetic markers. There are many good reasons for choosing DNA as the focus of genetic studies. DNA is the basic blueprint of all genes. It is found in every cell of an organism. It only requires minute (a single cell) samples of tissue. And it can be extracted reliably from degraded or processed tissue.

These properties make it possible to study all life stages of fish, from egg to adults – without having to kill them. We can also study all stages of the production chain from freshly caught specimens to canned fish. Finally, only a tiny drop of dried blood or slime on a knife will tell us not only which species it was used on, but also in many instances, in which population the fish originated.

Landscape genetics

One of the primary applications for genetic methods in fisheries has been to delineate "stock structure", that is, to identify isolated local populations, with limited or lacking exchange of individuals and genes to other populations. The rationale in a management context is to secure long-term sustainability of fisheries and protect biodiversity by ensuring that specifically vulnerable populations are not overexploited owing to their small size, slow growth, or easy accessibility. Consequently, the basic question asked of fishery geneticists has been, do fish from these two locations come from different stocks? In many species, DNA-based methods have clearly demonstrated marked genetic differences among populations, calling for separate management. However, with recent developments, "landscape genetics" offers a better alternative; this merging of population genetics and landscape ecology allows us to correlate the genetic information with geographical, physical, or biological data (e.g. the catch position of an individual and its salinity and temperature environment). Now, besides determining whether populations are genetically different, we can identify the major genetic breaks across the marine landscape resulting from reduced migration, and determine the most likely external factors causing the isolation.

DNA-BASED STUDIES HAVE PROVIDED RELATIVELY GOOD "GENETIC MAPS", INDICATING THE RELATIONSHIPS BETWEEN POPULATIONS FOR A NUMBER OF OUR COMMERCIALLY IMPORTANT SPECIES…

The emerging pattern is that local populations are often found in relation to local circulatory systems, such as currents and eddies, which allow retention of eggs and larvae, but also in areas where large environmental transitions take place. For example, a recent study of genetic variation among alleged populations of herring in the North Sea/Baltic Sea region (Bekkevold *et al*., 2005), established that salinity at the time and place of spawning – rather than geographical distance or temperature – was highly correlated with the genetic differences observed among populations.

This finding for herring is not unique. Particularly in relation to the Baltic Sea, all marine fish species investigated demonstrate a genetic transition corresponding with the environmental gradients (see Figure 1). DNA-based studies have provided relatively good "genetic maps", indicating the relationships between populations for a number of our commercially important species, and we have identified which marine landscape features to look for to fill in the last black areas on these maps.

The DNA detectives

DNA "bar coding" will tell you, with relative ease, which species is on your plate; however, a genetic map is an essential baseline for any kind of DNA-based fish forensics at the population level. An individual's population of origin can be determined with very high certainty by matching the genetic signature of an individual to populations with different genetic profiles. Then the most likely (or unlikely) population of origin can be assessed statistically. In fishery management, this individual assignment (IA) method has a wide range of applications in relation to illegal, unreported, and unregulated fishing (IUU), which is a major problem in most fisheries and is currently high on the political agenda in most countries and the European Union.

DNA-based IA can be used both for assessing the level of IUU by checking the population of origin throughout the production chain – from boat to plate – and for enforcing regulations by providing hard evidence in court cases. IUU poses a particularly large problem in the case of the Atlantic cod. Many populations are at historical lows, mainly as a result of overfishing, emphasizing the need for protection to rebuild depleted stocks. However, it is estimated that a large part of the fishing remains IUU (e.g. 35–45% for Eastern Baltic cod). From the genetic maps for cod, it is evident that the geographically close Eastern Baltic cod and North Sea cod are very distinct and, consequently, it has been demonstrated that individual cod from these populations can be identified with almost 100%

certainty using DNA (Nielsen *et al.*, 2001). This knowledge was exploited recently in a Danish court case, where a fisher was accused of landing North Sea cod above his quota and reporting them as Baltic cod. Five cod were subjected to DNA analysis and were shown to belong to the North Sea population, not the Baltic population as alleged.

DESPITE THE OBVIOUS POTENTIAL OF DNA-BASED FISH FORENSICS, IT IS SURPRISING HOW LITTLE THESE METHODS ARE BEING USED.

The IA method can also be used in consumer protection and information. For example, fish from some relatively polluted sea areas are not recommended for consumption, for example during pregnancy. Likewise, consumers want to know if their fish originates in a stock that was fished sustainably. So, there seems to be a clear demand for an enforceable traceability system, below the species level.

False labelling of population of origin is not imaginary. A DNA-based investigation of cod, sold as North Sea cod in shops at the Swedish west coast a number of years ago, proved that 17 of 42 individuals were Baltic cod, and another five did not group with known cod populations from Europe or North America.

Despite the obvious potential of DNA-based fish forensics for fishery management and traceability, it is surprising how little these methods are being used. Part of the explanation may be the lack of large, international DNA databases to which the genetic profiles of "unknown" individuals can be matched. Coordination of collection and storage of genetic data by ICES and the EU would provide a giant leap forward in promoting practical implementation.

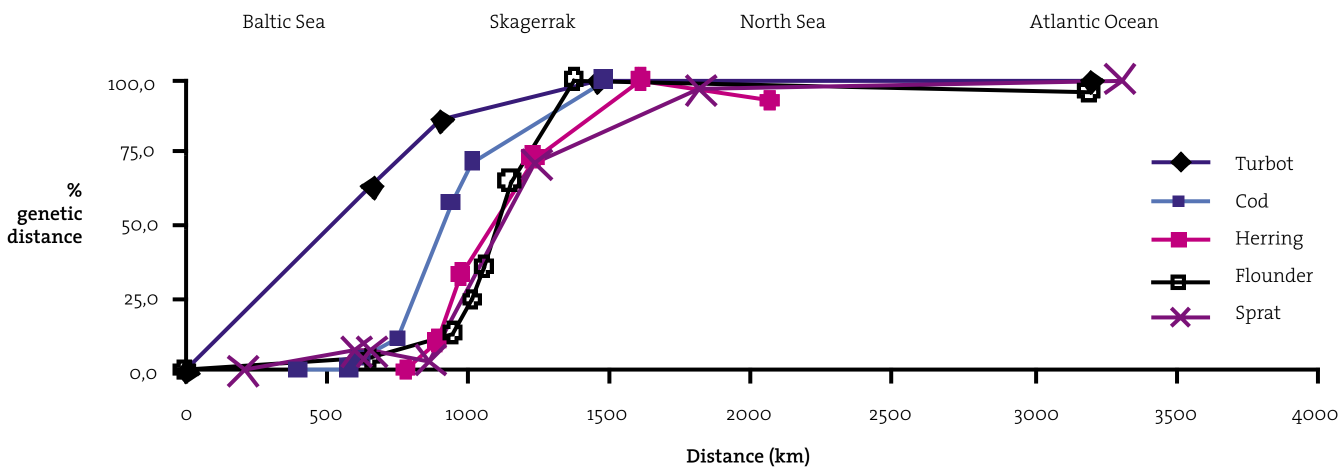


Figure 1. *The relationship between geographic distance and relative genetic distance for five species of marine fish across a transect from the low-saline inner Baltic Sea to oceanic salinities in the Atlantic Ocean. The major shift in genetic composition for most species appears between the Baltic Sea and Skagerrak, coinciding with the most dramatic salinity changes, from below 10 psu to more than 25 psu.*

DNA from the archives

Genetic analyses are not restricted to contemporary tissue samples. Historical collections of scales and otoliths found at many fishery research institutions can be used easily as a source of DNA. The DNA may be in lower quantities and of poorer quality than in fresh tissue and require more stringent laboratory procedures to avoid contamination, but the extra effort is certainly worthwhile, considering the uniqueness of the data that can be acquired. Studying the genetic composition over many decades will enable us to monitor populations genetically.

Temporal genetic changes can be translated into demographic changes. For example, has the population structure as we see it today been stable throughout the period studied? How large have the populations been? Have they lost genetic variation? Have some populations received migrants from, or been replaced by, other populations? These are important questions for fishery management and the conservation of biodiversity within species.

Relatively few studies have been conducted on historical tissue collections so far, but some general trends are emerging already. In general, population structure seems to be relatively stable; however, the genetically effective population sizes, i.e. the number of fish that actually contribute offspring to the next generations, seems to be much smaller than the number of potential parents within populations. This probably reflects the extreme mortality of eggs and larvae of most marine fish, leaving many parents without progeny.

Currently, two of the hottest issues in fisheries are predicting the impact of global change on the distribution and abundance of fish populations, and the role of fisheries in reducing age- and size-at-maturity by removing the largest and fastest growing fish, a practice called fishery-induced evolution.

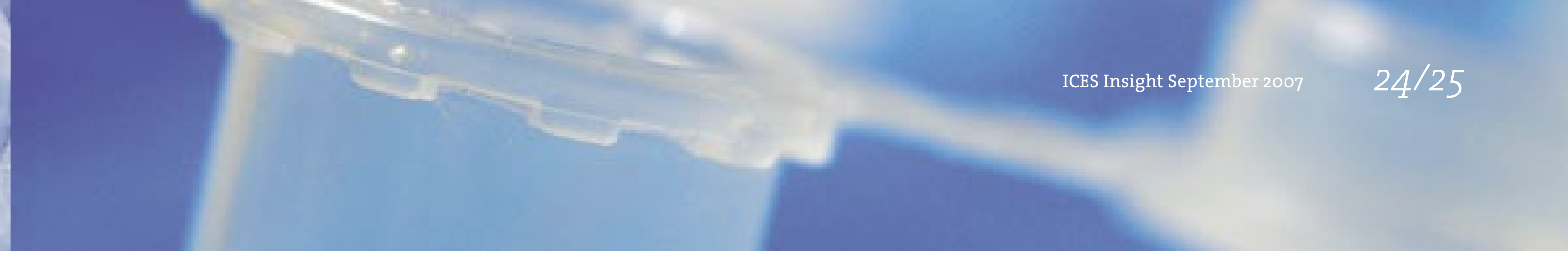
Using DNA from historical collections, we can look into the past to predict the future. In relation to global change, it is possible to correlate historical temperature changes with population responses. That is, have the populations stayed and adapted genetically or have they moved to another suitable area, fitting the physical and biological requirements of each specific population? Similarly, it is possible to correlate historical fishing pressure and observed changes in age-at-maturity with changes on the DNA level in genes playing an important role for growth and maturation. Thereby we can evaluate whether the observed early maturation has a genetic background and how large a role fishing plays in these changes.

...IT HAS BEEN DEMONSTRATED THAT INDIVIDUAL COD FROM THESE POPULATIONS CAN BE IDENTIFIED WITH ALMOST 100% CERTAINTY USING DNA.

However, investigating the genetic background of life-history changes in fish requires a focus on the study of genes that really matter in the life of a fish, the so-called candidate genes.

Genes that matter

Candidate genes are genes with a known function; in fish, they are expected to play an important role in relation to adaptation to the local marine environment inhabited by the population. Candidate genes are often involved in a physiological process (e.g. coding for haemoglobin). Variation at the DNA level among different forms of the gene is expected to be



correlated with the survival and reproduction of the individual carrying different gene variants. Candidate genes are rapidly becoming the focus of a large body of research in fishery and aquaculture genetics, for obvious reasons.

Knowledge of genetic variation, which favours fish in their native environment over fish from other populations (so-called local adaptations), can change the way we perceive life in the oceans. If we find that the majority of local fish populations are also locally adapted, and thus carry unique genetic variation essential to survival under specific local conditions, it demonstrates that identification and sustainable management of many, if not all, population components is essential to maintain sustainable fisheries and for biodiversity conservation.

DESPITE THE OBVIOUS POTENTIAL OF DNA-BASED FISH FORENSICS FOR FISHERY MANAGEMENT AND TRACEABILITY, IT IS SURPRISING HOW LITTLE THESE METHODS ARE BEING USED.

Imagine that a locally adapted population is fished out completely. This population cannot be replaced by other populations within an historical time frame, because the genetic make-up required to sustain life there is not readily shaped from other populations. So, even if the locality is rapidly recolonized, the new local population is expected to suffer from a productivity depression while adapting to the new environment. Very few data on DNA-based local adaptation are currently available; however, new research on a candidate gene for stress tolerance in European flounder (Hemmer-Hansen *et al.*, in press) has demonstrated large differences between individuals from the North Sea and the Baltic Sea, signalling local adaptations to the high level of environmental stress (e.g. temperature and salinity) in the Baltic Sea. Clearly, knowledge of such adaptive genetic variation is very valuable in aquaculture breeding programmes, where specific gene variants that improve the traits of interest, such as growth, disease resistance, and late maturation, can be targeted for an accelerated productivity improvement.

The way forward

From this discussion, one could get the impression that DNA-based methods can solve most of the problems in fishery science. This is far from the truth. In fact, making good use of genetics in fisheries requires close cooperation between classical fishery scientists and population geneticists. Population genetics is a highly specialized, technical discipline – which can be difficult for scientists in other fields to follow, resulting in many misunderstandings about what DNA can or can't do. This has led to frustrations not only for fishery managers but also for the population geneticists. However, there is a very good general trend of integrating population genetics and fishery science in common research projects, which we strongly support.

An obvious field for common projects is combining information from DNA with the rapidly evolving field of data storage tags (DSTs). By correlating information on the position of the fish in relation to external cues, such as light, temperature, and oxygen content, with genetic information on population of origin and candidate gene variation, we could significantly improve our ability to understand not only how a fish behaves, but also discover new aspects of why fish swim in the sea!

Epilogue

In 1975, King and Wilson stated that, "all the biochemical methods agree that the genetic distance between humans and the chimpanzees is probably too small to account for their substantial organismal differences", and instead "evolutionary changes in anatomy and way of life are more often based on changes in the mechanisms controlling the expression of genes than on the sequence changes in proteins". Such gene expression analysis does not target DNA but messenger-RNA, which is the link between DNA and the protein. So maybe in a few years, the sequel to this article will be titled "What RNA can do for you".

POPULATION GENETICS IS A HIGHLY SPECIALIZED, TECHNICAL DISCIPLINE – WHICH CAN BE DIFFICULT FOR SCIENTISTS IN OTHER FIELDS TO FOLLOW...

Literature

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Biography

Einar Eg Nielsen is a senior research scientist at the Danish Institute for Fisheries Research and the Technical University of Denmark, and Chair of ICES WGAGFM (Working Group on Application of Genetics in Fisheries and Mariculture). His work focuses on population genetics of anadromous and marine fishes, and he has published more than 20 papers since 1996. He was among the first to exploit the genomic revolution to study genetic variation among fish populations in the wild and in aquaculture.

Morten Limborg working in the lab at the Danish Institute for Fisheries Research.

Change and opportunity in the ICES data community

Top photo:
WGDIM members from left to right:

Helge Sagen (NOR, co-Chair), Marcin Wichorowski (POL), Peter Wiebe (USA, co-Chair), Jan Szaron (SWE), Friedrich Nast (GER), Adi Kellermann (ICES), Gaynor Evans (UK), Hjalte Parner (DEN), Ebba Mortensen (FAR), Michèle Fichaut (FRA), Serge Scory (BEL), Riita Olsonen (FIN), Karin Larsen (FAR), Christopher Zimmermann (GER, co-chair), Lesley Rickards (UK), Richard Ayers (UK), Robert Gelfeld (USA, front), Pekka Alenius (FIN, back), Georgiy Moiseenko (RUS), Sara Almeida (POR), Andy South (UK), Ole Folmer (DEN), Taco de Bruin (NED), Josefine Egekvist (DEN)

The Chairs of the newly formed Working Group on Data and Information Management, Helge Sagen, Peter H. Wiebe, and Christopher Zimmermann look to the challenges ahead and invite data users to become members.

These are interesting times to be active in the ICES data community, be it as data user, data provider, or data manager.

The Working Group on Data and Information Management (WGDIM) was recently established, a new manager of the Data Centre has taken over, a new ICES data policy implemented, and much more.

ICES formed the WGDIM to replace the Working Group on Marine Data Management (WGMDM) and the Study Group on Management of Integrated Data (SGMID). The group is a mix of data-using scientists and data-providing managers.

WGDIM has a challenging mission:
- To provide ICES with solicited and unsolicited advice on all aspects of data management, including technical issues, data policy and strategy, and user-oriented guidance;
- To represent ICES in setting standards for global databases;
- To provide an important interface for the whole range of data management in ICES and to promote good data management practice;
- To support and guide ICES efforts to integrate its data and develop products to serve the community's needs, and to assist ICES to remain a significant node for marine data access and storage in the North Atlantic.

WGDIM is the first group to report directly to the Consultative Committee, reflecting its importance to the advisory and the science committees.

During its first meeting in Copenhagen, 12–14 June 2007, the group recognized the need for additional members drawn from the ranks of data users. Therefore, it encourages wider participation, specifically of users and suppliers of marine data, to broaden its advice. Contact the co-Chairs for more information!

The first meeting came after a year of change and rapid development within the ICES data community. Julie Gillin, former head of the ICES data centre, left ICES in February. Her successor, Neil Holdsworth, started in July.

The ICES trawl survey database DATRAS was expanded to host a number of additional surveys, and the user interface was improved. Also, the system's functionality has been increased.

The team working on developing the first integrated ecosystem ICES database, renamed from DOME to EcoSystemData, has been expanded, and a facility to browse the data on the web will be available for testing from early November 2007.

InterCatch is ICES new fish stock assessment input database, and was used this year by the first assessment working groups. InterCatch will be updated to improve its user friendliness and is expected to be fully implemented by 2008.

A review of the status of hydrographic data inventories at ICES was conducted by an independent expert. The reviewer recommended that, while continuing the collation of hydrographic data, focus should be increased on strengthening the links between hydrographic, environmental, and fisheries data, and should aim at building the basis of an integrated advice.

WGDIM discussion included the implementation of the new ICES data policy and the development of data collection guidelines. The data policy, adopted in October 2005, emphasizes both open access and the proper acknowledgement of data sources. It is now fully implemented for all data held at ICES or collected under ICES auspices, both recent and historical. So, almost all ICES data are now considered to be in the public domain, with the exception of certain sensitive fishery data.

The working group has made a good start and looks forward to working with the ICES community and the ICES data centre, to foster good data management and access to ICES data.

The co-chairs can be contacted as follows:

Helge Sagen
helge.sagen@imr.no

Peter H. Wiebe
pwiebe@whoi.edu

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Christopher.
zimmermann@ior.bfa-fisch.de

Our far-flung young scientists at the 4th International Zooplankton Production Symposium 2007 in Hiroshima, Japan

With the help of an ICES travel award, Carmen Garcia-Comas, Daniel Mayor, and Lidia Yebra attended the 4th International Zooplankton Production Symposium 2007 in Hiroshima, Japan. Here is their report.

Talking about zooplankton is difficult. Outside the world of zooplankton, no one has the faintest idea of what you are talking about. At an international zooplankton symposium, it's difficult because you are required to stand before the world's most respected and knowledgeable zooplanktologists and convey the quality and relevance of your science. A stressful date in any young researcher's diary!

WE EXPRESS OUR GRATITUDE TO ICES FOR PROVIDING THE OPPORTUNITY TO ATTEND THE SYMPOSIUM.

Nonetheless, such a meeting only occurs every four years and is an ideal opportunity for junior scientists, like ourselves, to introduce and promote our research to an international audience. In fact, it is encouraging to see that, thanks to funding provided by symposium-related organizations, many young people have the opportunity to rub elbows with an international audience of such high standing.

The symposium was indeed an international event, with 334 participants representing 46 countries. It was the largest meeting of zooplanktonologists in the world, exceeding the last zooplankton symposium held in Gijón by one participant!

The ICES travel awards not only enabled us to present our research to the wider community of zooplankton scientists, but also to listen and learn from the research of others. Furthermore, it allowed us to meet and discuss our ideas with the many researchers that otherwise we know only as names in journals.

The breadth of science presented at the week-long meeting reflected the scale of the event, with studies ranging from DNA bar coding to multidecadal time-series analysis and futuristic imaging systems, such as holograms. Many studies documented how zooplankton communities are responding to global climate change, which has strengthened the resolve of zooplankton scientists to continue and expand their studies.

The three of us had the great opportunity of presenting our work as oral presentations. And although standing in front of more than 100 people is stressful, it was very rewarding to receive feedback from the experienced researchers in our fields and to exchange ideas with young scientists like ourselves.

It was Carmen García-Comas' first international meeting in her field, and she found it "slightly overwhelming". Session 1 was dedicated to time-series analyses, during which she presented her work comparing the copepod communities of two Mediterranean time-series using the Zooscan system. Using the Shannon index to describe size diversity in one of the time-series, she revealed interesting patterns that relate copepod community changes to local and regional environmental changes.

Carmen Garcia-Comas, Daniel Mayor, and Lidia Yebra at the 4th International Zooplankton Production Symposium 2007 in Hiroshima, Japan.

Despite the preliminary nature of these results, the use of size distribution to describe a zooplankton community seems very promising. During the session, we noticed synchronicities among series located in different oceans and systems, such as the changes recorded until the end of the 1980s. These synchronicities led us to continue the search for indices representing global environmental forcing. It was also remarkable to attend the talk given by Evelyn C. Pielou, Session 1's invited speaker, because after a life dedicated to this field, her enthusiasm and energy are undiminished.

Daniel Mayor presented his paper "Sublethal effects of elevated CO_2 on *Calanus finmarchicus*" at Session 3, a session that examined how climate variability and human perturbations are influencing zooplankton foodwebs. It documented the apparent reproductive failure of a keystone copepod in a world in which the seas are acidified by 8000 ppm CO_2 – the concentration expected to occur in areas of the deep ocean as a result of CO_2 disposal strategies. Another paper examining the effects of increased CO_2 concentrations on invertebrate growth by Kurihara and co-workers also documented significant, negative effects. Together, these papers confirmed the conclusions of Victoria Fabry, whose plenary lecture on the effects of CO_2-induced ocean acidification described a range of negative effects. The level of interest in the emerging field of ocean acidification research suggests that a dedicated session on this topic may well be part of the next symposium.

...STANDING BEFORE THE WORLD'S MOST RESPECTED AND KNOWLEDGEABLE ZOOPLANKTOLOGISTS... A STRESSFUL DATE IN ANY YOUNG RESEARCHER'S DIARY!

Session 8, "Zooplankton biochemistry and physiology: practical and potential biotechnology application", was an exciting opportunity for Lidia Yebra to discuss her recent work on *Calanus finmarchicus* growth and dormancy with a wide range of zooplankton researchers. New methods were presented with promising results, opening a wide range of possible applications to facilitate the study of zooplankton physiology, behaviour, taxonomy, and so on. She found it very encouraging to meet other scientists, who are either developing new techniques or are interested in new applications of biochemical methods, such as the one she presented.

MANY STUDIES DOCUMENTED HOW ZOOPLANKTON COMMUNITIES ARE RESPONDING TO GLOBAL CLIMATE CHANGE

Like all researchers, we are aware that "all work and no play makes Jack a dull boy". The sun shone in Hiroshima all week, revealing the city's residents to be extremely friendly and welcoming, and always eager to help us find our way in the city. They overcame difficulties in communication simply by accompanying us to our destinations!

It seemed that an unscheduled symposium session took place each evening. Participants from different countries and research domains exchanged opinions on a wide range of themes, well beyond the limits of science, over a glass of sake or a meal. The food deserves a special mention. Participants tasted an enormous variety of dishes, often of unknown origin, a point that was determinedly ignored. A great experience for our palates!

Finally, as a special cultural outing organized through the symposium, we visited the temples of Miyajima, literally "Shrine Island", which is famous for Itsukushima shrine. Its large, orange torii (gate) stands in the ocean during high tide and was featured on the symposium's poster. Nature served as a perfect backdrop for the many shrines spread all over the island.

Summing up, this week was full of positive experiences for all three of us. We express our gratitude to ICES for providing the opportunity to attend the symposium, which has widened both our scientific and cultural horizons.

Niels Daan: former retiree

Jake Rice pauses to reflect on Niels Daan's past and future careers.

Quite a crowd from the ICES community gathered in IJmuiden, the Netherlands, on 19 April 2007, and with good reason: our former editor, our creative and practical source of ideas, our firm but constructive critic, and above all, our friend, Niels Daan, was retiring. In honour of his long and exceptional career in fishery and marine science, Wageningen Institute for Marine Resources and Ecosystem Studies (IMARES) organized an outstanding scientific symposium and a delightful reception. Niels and Chantal, his life partner, threw quite a party afterwards.

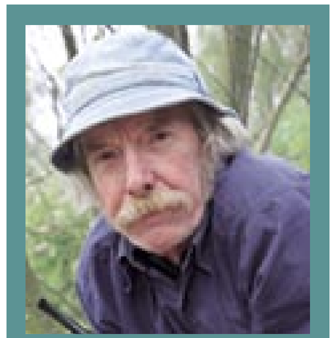
It was inspiring to spend a day listening to Niels' former colleagues give presentations that, more than reviewing recent research, challenged the audience to really think about how the ocean works. In those challenges, Niels' real influence on fishery and marine science was obvious. During the social events that followed, it was exhausting trying to keep up with several academic generations of scientists attempting to enjoy themselves as much as Niels always manages to do. In a way, doing so was a means of showing the respect and love that we all feel for this exceptional man.

Unfortunately, all the effort was wasted. The events were meant to celebrate Niels' retirement, but Niels' retreat from the working world hasn't happened. He's still working. This isn't an accident or a case of Niels being too slow to understand that his time has passed. Niels has been carefully orchestrating the deception of his phoney retirement for years.

I first met Niels at the Working Group on Multispecies Assessment (WGMA) in 1982. For most of that decade, I had the privilege of working with Niels and a group of other outstanding scientists, in what we "greybeards" refer to as the "real ICES".

Bringing predator–prey dynamics into the fishery-assessment and advisory process was recognized as an important scientific (and management) problem. And a hard one: it would take years, significant resources, and a mixture of experts to solve, and no one could promise success – or describe in incremental performance indicators what the path to success would look like.

In the ICES process of the day, the scientific community was able to sell the Delegates on the idea of allowing us to at least try; we convinced them that the potential benefits were worth the risk. The Delegates, working with their States and the European governance system, found the resources necessary to allow a couple dozen scientists the freedom to have a go at building – and testing – a system for multispecies assessments. It took several years, but WGMA achieved one of "Pope's miracles" (referring to another false retirement): the estimation of the thousand parameters. (Editor's note: John Pope was a core member of the PWG. After "retirement" from CEFAS, he continued to work on or think about marine ecosystems and fish populations, and found himself busier than ever.)



In April 2007, Wageningen IMARES organized a symposium (Food for Thought) titled "Dynamics of fish and fishers". It was planned as a tribute to Niels Daan, who officially retired from Wageningen IMARES, and recognized his contribution to fishery science. The one-day symposium featured contributions from international fishery scientists, as well as colleagues from national universities and applied research institutes. A wide variety of research topics was covered, both topical and related to work in which Niels Daan has been active, including fisheries, ecosystems, and sustainable management of marine living resources. A selection of the presentations will be published in a special volume of the *Journal of Sea Research* in early 2008. Presentations can be viewed at the IMARES website, www.wageningenimares.wur.nl/UK/symposium.

A decade later, a few members of that group were reminiscing over a whiskey at an ICES ASC about how everything has changed. The things we did in WGMA in the 1980s could never happen under present circumstances. Bottom–up planning of new science, funding projects without dozens of annual incremental progress benchmarks, a working group whose terms of reference were the equivalent of "solve a problem" rather than "produce these products" – that was all gone by the late 1990s.

What we lamented was only in small part the imposition of more bureaucracy on our professional lives. We can survive paperwork – no one better than Niels, who proved to be a brilliant editor-in-chief of the *ICES Journal*. What we really felt was the loss of the intellectual stimulation that comes from a really hard problem, some good colleagues, and the time to solve it. You just don't get that from a working group meeting where everyone is beavering away to produce everything on a long list of narrowly defined, product-oriented Terms of Reference (or from a working group meeting that resembles a mini-symposium, where everyone presents papers on what they have been doing and tells each other how much progress they are making on "increasing knowledge" – but that's a different essay).

Characteristically, Niels was vocal in his criticism of what had been lost, and characteristically, Niels had some specific, practical proposals. By the end of the evening, the Private Working Group had been born, and the idea was sold the next day to the ICES Secretariat and General Secretary. The PWG was not to be just an excuse to get together with friends; we would have Terms of Reference for our annual meeting, and under Niels' leadership, we would produce a working group report after each one. But we would choose the problem on which we would work ourselves, a problem hard enough to be a real challenge and important enough to be worth the effort. We would fund the travel and time ourselves, so we would only be accountable to ourselves for our progress.

Creating the PWG was a subversive move by Niels and his co-conspirators. Undoubtedly, he was pre-planning his retirement as an excuse for a good party and a great symposium, but otherwise retirement was the professional equivalent of a stage setting. It may look like a retirement, but behind the scenes, things are very different. During the first seven, week-long meetings of the PWG, we did work hard on hard problems, hard enough to finish the sixth paper documenting our efforts. In each one, Niels applied his comprehensive knowledge of fish biology, fish ecology, and the North Sea to keep our products and progress tied to real ecosystems, not just elegant equations. His editing made my texts in native-speaker English significantly shorter and clearer. In short, he was everything a working scientist is supposed to be (or *was* supposed to be, before a working scientist's priorities changed to bringing in funding and filling out time accounting sheets).

The 2007 meeting is just over. Retired scientist Niels Daan attended as usual. But like Professor Pope, the PWG member who preceded Niels in the retirement deception, he didn't act retired. He remained engaged in every discussion; he analysed data, testing for the presence of patterns emerging from models; he edited text to be shorter and clearer; and he prowled the woods and streams of the neighbourhood, finding and identifying a staggering array of plants and animals (terrestrial and freshwater), making sure he knew the Ontario ecosystem well, before he left it.

The many tributes paid at Niels' retirement party reviewed his contribution to fishery and marine science and reflected the esteem we all have for him. Niels' central role in creating the PWG and keeping it both intellectually daring and productive is an ominous hint, though, that all those tributes may have been premature. Niels is far from done: far from done as a productive scientist, as an inspiration and source of ideas, and as a friend. The best may be yet to come.

Belying his influence, Niels Daan's curriculum vitae is quite simple. Here is the short version.

Personal data

Name: Niels Daan
Date of birth: 21 April 1942

Research interests

Population dynamics, fish ecology, multispecies models, ecosystem effects of fishing, community metrics

Education

1953–1960
Alexander Hegius Gymnasium, Deventer (Beta sciences)
1960–1967
University of Amsterdam. Leaving certificate Biology (Cum Laude)
Subjects: Physiology, Fisheries Biology, Taxonomy
28 May 1975
University of Amsterdam. PhD Mathematics and Natural Sciences (Cum Laude)
Thesis: Ecological Consequences of the Fisheries on North Sea Cod.

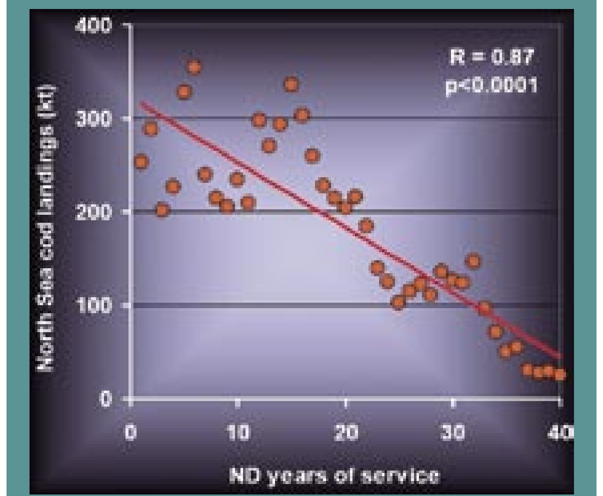
Professional experience

1967–2007
Netherlands Institute for Fisheries Research (RIVO), currently Wageningen Institute for Marine Resources and Ecosystem Studies (IMARES)
- 1967–1988
  Member of the scientific staff of the Marine Department
- 1988–1993
  Head of Demersal Fisheries Department
- 1994–1997
  Head of Biological Research Department

1982–1994
Part-time Extraneous Professor in Applied Aquatic Ecology, University of Amsterdam
1997–2002
Editor-in-Chief, *ICES Journal of Marine Science*
Other
Visiting expert at the Fish Stock Evaluation Branch, FAO, Rome, Italy, 1973
Short mission as fisheries research expert to Palembang, Sumatra, Indonesia, 1974
Visiting associate professor, Dalhousie University, Halifax, Canada, 1976–1977
Workshop on Ecosystem Models in Seattle, WA, 1980

Memberships

ICES 1969–present
Too numerous to mention, but including memberships as chairperson of several groups and committees and as co-convenor of ICES symposia
Other
Also too numerous to mention, but including committees and commissions throughout Europe and abroad



In his farewell presentation "Imagine you were a fish: what would (or could) you do?" at the IMARES symposium, Niels Daan posed the question, "So, why did the North Sea cod decline?". In his latest hypothesis, he traces the correlation between the decline in North Sea cod landings and the period of his years of service. Just a coincidence? We'll let future generations decide.