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Changes and their consequences

The dust has only started to settle after the many changes that resulted in an overhaul of the ICES structure. Celine Byrne considers the origins of these changes in her article "Adopt + Adapt = Adept", after which this issue of *ICES Insight* examines the results of the work done by three groups created by those changes.

In his article "What Lies Beneath?", Erik Olsen explains the difficulties faced by practitioners of marine spatial planning (MSP). ICES answered the challenge in 2010 by launching a strategic initiative on MSP: the Joint ACOM/SCICOM Strategic Initiative on Area-based Science and Management. Olsen argues that ICES products must be made readily available.

Taking their cue from the lyrics of Bob Dylan, Martin Lindegren, Christian Möllmann, Anna Gårdmark, and Thorsten Blenckner write about the Working Group on Integrated Assessments of the Baltic Sea in their article "The Times They Are a-Changing". They describe the ICES/HELCOM working group as a multinational, multidisciplinary group of scientists, who, as the lyrics say,"gather round people"in a regime-shift quest.

Instead of retaining a single, regionally oriented group in the restructuring, the framers of the ICES Science structure created a steering group dedicated to gathering together groups that focus on a regional approach. In "SSGRSP – the square peg in a round-peg society", Yvonne Walther explains how this group – the Science Steering Group on Regional Sea Programmes – has managed to establish itself and add member groups to its burgeoning structure.

The last Annual Science Conference in Poland was held in Warsaw 32 years ago. That this year's meeting should take place in Gdańsk is particularly fitting because Poland took up the Presidency of the EU Council on 1 July 2011. With Poland in the spotlight, Zbigniew (Steve) Karnicki, Tomasz Linkowski, and Piotr Margonski review the ninety-year history of Poland's National Marine Fisheries Research Institute.

In 2006, reforms to the ICES structure and changes in policy granted stakeholders observer status during the advisory process. In light of this, Ellen Johannesen's "Opening the Box: the Dawn of Transparency" describes a ground-breaking course offered by ICES Training Programme that "blows the lid off the black box" which used to stand as a metaphor for the drafting of *ICES Advice*.

Canada's coastline is 243 791 kilometres long (16.2 per cent of the world's coastline) and spans three oceans (Atlantic, Pacific, and Arctic). The huge challenge of managing the oceans sustainably is the subject of Paul Snelgrove and Uschi Koebberling's article "CHONe: Census and Consensus in Canada".

A relatively long chapter in the history of the *ICES Journal of Marine Science* comes to a close as Andrew I. L. Payne passes the torch to a new editor-in-chief. In his reminiscences "Confessions of a Word-a-holic", Andy looks back on the good times and the not-so-good.

Sarah B. M. Kraak believes that it is possible to use the "public goods game" to find incentives to preserve the commons, as she explains in her contribution, "Overcoming the 'Tragedy of the Commons' in Fishery Management".

Finally, in our cover story, Emory D. Anderson marks the fifty-fifth anniversary of the publication of that landmark in quantitative fishery science known popularly as simply "Beverton and Holt". Anderson, who was ICES General Secretary from 1989 through 1993, writes from the privileged position of having known the authors.

As always, we thrive on your comments and would be happy to consider your ideas for future articles. Send both to info@ices.dk.

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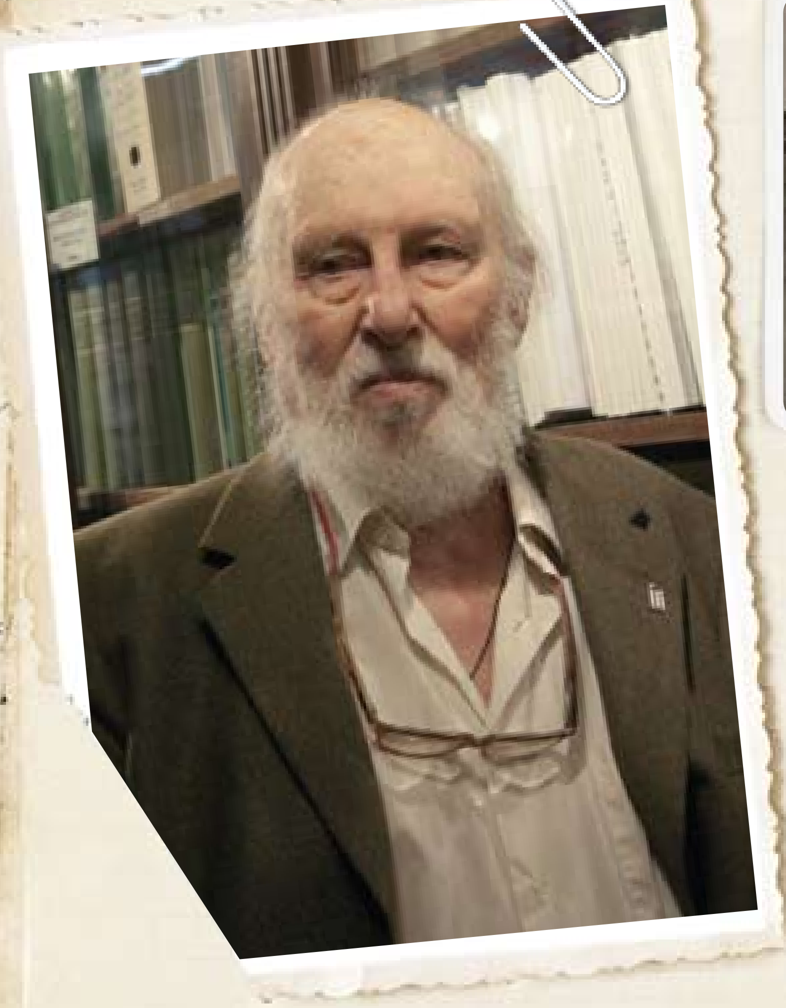
▲ *Sidney Holt (left) and Ray Beverton together for the last time at the 1 – 6 April 1984 Dahlem Workshop in Berlin on Exploitation of Marine Communities. Photo courtesy of Sidney Holt.*

Contents



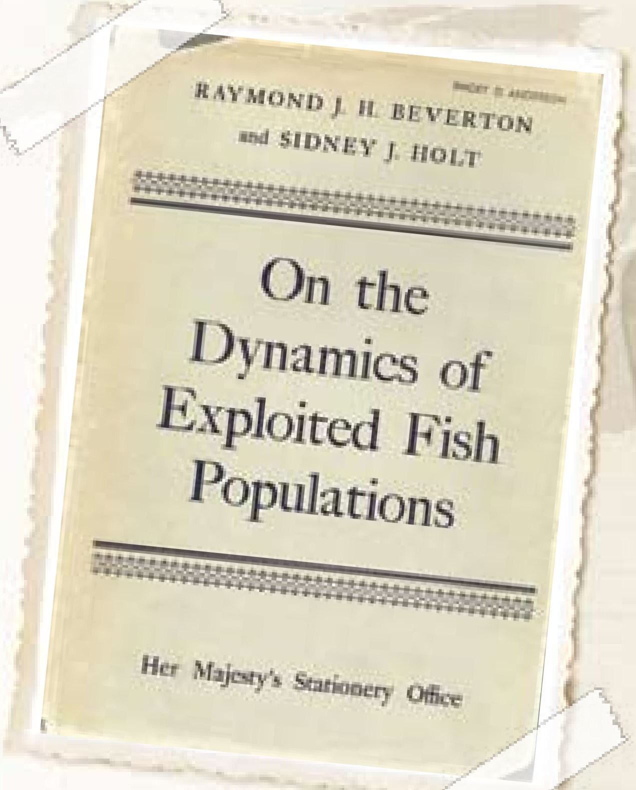
▲ Ray lecturing on fish population dynamics in Ireland in the 1950s. Photo courtesy of Kathy Beverton.

◀ Sidney in the library of the Institut Océanographique de Paris in 2011. Photo courtesy of Tim Holt.

▶ The cover of this author's well-worn, dog-eared copy of "the bible", purchased in 1965.

Standing on the shoulders of giants

***Emory Anderson** looks back over the lives of Ray Beverton and Sidney Holt, who set the standard for quantitative fishery science.*



Seeing that little bit further – a testament to creativity

Although the phrase "standing on the shoulders of giants" has often been ascribed to Isaac Newton, who famously wrote the words to his rival Robert Hooke in 1676, its origins lie a little further back in history. The first written record comes from 1159, when John of Salisbury, an English theologian and author, recounted the teachings of Bernard of Chartres, a twelfth-century French Neo-Platonist philosopher, scholar, and administrator.

Bertrand of Chartres said that we are like dwarfs on the shoulders of giants. We can see more and look further than they can, not by any virtue of our own sharpness of sight, but because we are raised up and carried high by their giant size.

The phrase became quite common in Newton's time and can also be found in the writing of Didacus Stella, Robert Burton, George Herbert, and Samuel Coleridge Taylor. Bernard, Newton *et al*. were expressing modesty in their own work and paying homage to the research and thinking of those great minds that had gone before them.

Today, the phrase can be found in dedications to past masters throughout the fields of science, technology, the arts, and popular culture – as we modern-day dwarfs continue to look that little bit further.

Next year, 2012, marks the 55th anniversary of the 1957 publication of the premiere book on quantitative fishery science: *On the Dynamics of Exploited Fish Populations*, by Raymond J. H. Beverton and Sidney J. Holt. Although earlier anniversaries of this classic monograph have been commemorated in both a book (Payne *et al*., 2008) and a special journal issue (Pitcher and Pauly, 1998), it is appropriate that ICES should pay tribute to "the bible of fisheries science" (Le Cren, 1958; Cushing, 1995) and to the two brilliant young scientists who wrote it, because of the enormous influence of "the bible" on the subsequent work of ICES fish stock assessment working groups over the past half century.

Why is this treatise so important and so special? Based on earlier work by Baranov (1918), Russell (1931), and Graham (1935), it amalgamated for the first time existing theory and mathematical models into a single, age-based yield equation as a function of recruitment, growth, natural mortality, and fishing mortality, commonly referred to as the "yield-per-recruit equation". It also introduced many other concepts, such as the catch equation, density-dependent growth and mortality on yield, length-based assessment, trawl mesh selectivity, multispecies modelling, and marine reserves. The work led to the development of virtual population analysis (VPA; Gulland, 1965), which became the standard tool of ICES fish stock assessment working groups in the late 1960s and early 1970s. VPA is still in use today, albeit in conjunction with many additional sophisticated statistical/mathematical refinements of the basic Beverton and Holt model (Ulltang, 1996), and later led to multispecies VPA (Sparre, 1991).

Without a doubt, the original work by Beverton and Holt (1957), in conjunction with related papers by one or both of them (e.g. Hulme *et al*., 1947; Beverton, 1949, 1953, 1954; Holt, 1949; Beverton and Holt, 1956), launched a sea change in the way fishery resources were assessed by ICES and its Member Country scientists, as well as by fishery scientists worldwide.

Equally remarkable is that both Beverton and Holt were relatively young when they produced their *magnum opus*. Ray was only 24 and Sidney 21 when they began their collaborative effort in 1947. Major accomplishments such as theirs are generally made in mid-career, not as a first effort!

Ray Beverton first arrived at the Lowestoft Fisheries Laboratory in autumn 1945, following his third year at the University of Cambridge. Sidney Holt arrived in spring 1946, after graduating from the University of Reading. The two were together for a few weeks before Ray returned to Cambridge for his final year. Michael Graham[1] said to them:

> I want the two of you to really see if you can't put the whole of this fish population stuff on a more substantial basis. We've had a go at it – the sigmoid curve stuff, Thompson is doing arithmetic over in Seattle, and it really needs a more systematic approach (Beverton and Anderson, 2002).

[1] *Director of the Lowestoft Fisheries Laboratory, 1945–1958.*

▲ *Ray Beverton (left) and Sidney Holt (right) working on their* magnum opus *in 1949 in the Fisheries Laboratory, Lowestoft. Ray is writing next to a three-dimensional cardboard model of a yield isopleth diagram, while Sidney is operating a hand-Brunsviga calculating machine. Ray later had the honour of demonstrating this model to the Duke of Edinburgh during his visit to Lowestoft. Photo courtesy of the Centre for Environment, Fisheries, and Aquaculture Science (Cefas), Lowestoft.*

▲ *Ray at the Lowestoft Fisheries Laboratory in 1953. Photo courtesy of Kathy Beverton.*

▲ *Sidney Holt in 1960 while working for the FAO Fisheries Division in Rome. Photo courtesy of Sidney Holt.*

When Ray returned to Lowestoft in summer 1947, after receiving his MA with first-class honours in zoology, Graham told them:

> Well, I'll give you four years. We'll leave you alone for four years to your own devices. I can't tell you how to do it. I'm satisfied you know more than I can tell you about it. It's up to you. If you don't succeed at the end of four years, I can't protect you any longer. You'll have to take a chance after that, but for those four years, I will. (Beverton and Anderson, 2002)

▲ *Lowestoft Fisheries Laboratory cricket team at an afternoon game at Downing College, Cambridge University, probably in 1954 or 1955. Back row (left–right): David Jenkins (scorer), Ernie Warford, Des Perryman, Phil Kett, Fred Revill, Dick Margetts, and John Gulland. Front row (left–right): Terry Williams, Bernard Bedford, Ray Beverton (captain and alumnus of Downing College), Doug Jeffries, and Aubrey "Nick" Nichels. Photo courtesy of Kathy Beverton.*

Ray met Kathy, his wife-to-be, in 1943/1944, and they were married in 1947, shortly before moving to Lowestoft. For recreation, Ray loved music (he played the flute and piano), woodwork, gardening, fishing, golf, and cricket. Sidney, who also married in 1947, enjoyed sailing (sailing kayak), rugby, mountain walking, reading, and music (listening to jazz and playing the cornet).

Ray and Sidney worked together for four years (1947–1951) in a room in a house adjacent to the Laboratory, so as to be isolated from the rest of the staff. They never argued and had a unique partnership. Their styles differed considerably: Ray was well organized, did most of the writing, worked late at home most nights, and contributed most to the later parts of the book; Sidney did the majority of the mathematics and calculating, and contributed most to the first parts of the book. Alarmingly, their collaboration once nearly ended. Ray and Sidney had gone to London to visit their parents and were returning to Lowestoft on Ray's motorbike when they went under a truck that suddenly pulled out into the road. Ray suffered concussion and spent some time in hospital; Sidney had a few minor cuts and bruises.

The technical work on the book was mostly completed by about 1950, and Sidney left to take a job with the Nature Conservancy in Scotland and, later, in 1953, went to work for the Fisheries Division of the Food and Agriculture Organization (FAO) of the United Nations (UN) in Rome. Until 1954, when the manuscript was finally finished, they corresponded by letter and worked on new ideas and revisions to the text during all-night sessions whenever Sidney returned to Lowestoft. Some may wonder why the authorship of the book was "Beverton and Holt" instead of "Holt and Beverton". According to Sidney, "it was purely alphabetical".

The book was published by Her Majesty's Stationery Office (HMSO), which initially refused it because of its size (533 pages), the extensive and complicated equations and graphics that required detailed typesetting, and a feeling that the book would not sell. Only after Michael Graham threatened to resign as Director of the Lowestoft Laboratory did HMSO agree, and also agreed to print 1500 copies (instead of the usual 100–200). The book obviously became very popular: a second printing was made in 1965 by HMSO, a third facsimile printing (with three pages of errata from the second printing) in 1993 by Chapman & Hall, and a fourth printing in 2004 by Blackburn Press. It is without doubt the most cited reference in fishery science.

It is without doubt the most cited reference in fishery science.

After its publication, it began to be used as a textbook in university courses on quantitative biology, especially in the United States, a use for which it was probably never intended. I purchased my copy of the book in 1965/1966 for a course in advanced fishery biology while pursuing a PhD at the University of Minnesota. I first met Sidney that same year; he was one of the "visiting firemen" brought in from around the world by my major professor to present seminars to the fishery graduate students. Coming from FAO in Rome, and with his hair combed forwards along the sides of his head, he looked to me like Julius Caesar!

Even before the book was published in 1957, Ray and Sidney devoted considerable time and effort lecturing and presenting their findings to various fora, such as ICES and the International Commission for the Northwest Atlantic Fisheries (ICNAF). They taught two fish population dynamics courses at Lowestoft in the late 1950s, which had been recommended by ICES. Many of the participants pictured below subsequently became well known and held important positions in fisheries; three (Gotthilf Hempel, Basil Parrish, and Ole Johann Østvedt) later became Presidents of ICES.

In summer 1957, Ray went to East Africa to study the Lake Victoria fisheries. David Garrod[2] recalls the following story:

> One incident with Ray has always stuck in my mind. It was in 1957 on the veranda of the Royal Norfolk Hotel in Nairobi – the big game safari starting point

Participants (left–right) at the "Fish Population" course given at Lowestoft 20 February–7 March 1957: George Bolster, Robert Clarke, Ole Johann Østvedt, Alec Gibson, Luit Boerema, Aage Jonsgård, Torolf Lindström, Albert Percier, Don Hancock, Rodney Jones, Richard Vibert, Rui Monteiro, Dick Laws, Sidney Holt, Dietrich Sahrhage, Manuel Larrañeta, Jón Jónsson, Arvid Hylen, Erling Bratberg, Vincent Hodder, Alav Aasen, John Gulland, Olav Dragesund, Ronald Keir, Knud Peter Andersen, Gotthilf Hempel, Basil Parrish, Ray Beverton, and Dick Baird. Photo courtesy of the Centre for Environment, Fisheries, and Aquaculture Science (Cefas), Lowestoft.

[2] *Director of the Lowestoft Fisheries Laboratory, 1989–1994.*

◀ *Ray Beverton (standing right) working with fishers on Lake Victoria in East Africa in 1957. Photo courtesy of Kathy Beverton.*

▼ *Ray at an ICES Statutory Meeting in the early 1990s. Photo courtesy of Kathy Beverton.*

– and I was quaffing a mid-day beer with Ray and others. Ray was dressed as the quintessential casual Englishman abroad in non-fitting long trousers cut off at the knees, drainpipe style, and in a smart shade of orange masquerading as khaki and standing out in any local crowd. Then an American in full bush kit came over to Ray because he really looked the part and said, 'Say, are you guys white hunters?' as he laid down his rifle. Ray visibly welled with pride at having been recognized as a part of that hallowed fraternity. It really made his day to feel he had blended as a natural part of the big game scene! Ray spent a couple of months with us on Lake Victoria. He showed me what fisheries science was all about and set me on the path that led to Lowestoft.

Beverton served as Deputy Director of the Lowestoft Laboratory from 1958 to 1965, during which time he served on a number of ICES committees, chairing the Comparative Fishing Committee during 1959–1962. In 1965, he became Secretary of the newly established Natural Environment Research Council (NERC) in the UK, a position he held until 1980. Following short stints as lecturer in several universities, he became professor of fishery science at the University of Wales, Cardiff, retiring in 1990. Of relevance to ICES, Ray was appointed Editor of the *Journal du Conseil* (now the *ICES Journal of Marine Science*) in 1983, remaining in that post until 1991, and regularly attended ICES Statutory Meetings (now the Annual Science Conference). I recall first meeting Ray at the 1987 Statutory Meeting in Santander, Spain, when I was ICES Statistician. In his capacity as Editor, he endeared himself to many young authors, for whom he would "bend over backwards" to help improve their manuscripts. Ray was extremely personable and unpretentious, with the result that almost everyone who met him claimed him as their friend.

Ray's last Statutory Meeting was in 1993 in Dublin. I will never forget the end of the Closing Session when President David Griffith expressed special thanks to me as outgoing General Secretary, to Fred Serchuk as outgoing chair of the Advisory Committee for Fisheries Management (ACFM), and to Chris Hopkins as outgoing chair of the Consultative Committee. There was initially polite applause from the audience, but then, at the back of the room, Ray got to his feet, applauding a little harder, and he was followed by former President Jakob Jakobsson, sitting nearby. Soon, the entire audience was on its feet applauding loudly. That was a moment I'll always remember.

The last time I was with Ray was in May 1994 when he came to Woods Hole to begin a lecture tour of selected National Marine Fisheries Services (NMFS) laboratories. The video-taping of his three lectures provided the basis for their later publication (Anderson, 2002a). The following year, Ray passed away on 23 July at the age of 72. His widow, Kathy, still lives in Wales.

▶ *Guests at a party on 2 May 1994 at the time of Ray Beverton's lecture at the NMFS Northeast Fisheries Science Center in Woods Hole, Massachusetts, USA. Kneeling (left–right): Marvin Grosslein, Stephen Clark, Steven Murawski, and Andrew Rosenberg. Standing (left–right): Herbert Graham, Jack Pearce, Frank Almeida, William Overholtz, Wendy Gabriel, Kevin Friedland, Vaughn Anthony, Ray Beverton, Ray Conser, Emory Anderson, and Paul Rago (and daughter Grace). Photo courtesy of Steven Murawski.*

As mentioned before, Sidney went to work with the FAO in 1953 and served there and in other UN agencies for the next 25 years. Even before retiring from the UN in 1979, he was very involved in the conservation of the great whales through the International Whaling Commission (IWC). According to Ray, "Sidney had achieved a wonderful result. He had saved the great whales in the early 1970s" (Anderson, 2002a). Subsequent to his retirement, he has continued his efforts to curtail commercial harvesting of whales as adviser to various IWC member country delegations and non-governmental organizations (NGOs).

After 1957, Ray and Sidney only occasionally interacted in fishery work, such as in ICNAF. The last time they were together was in 1984, although they spoke on the phone after Ray suffered his first stroke in 1995. Both received numerous honours and awards for their scientific achievements from various governments, agencies, and organizations. For further details on their lives and achievements, including humorous stories that could not be given here because of lack of space, readers are referred to Shelton and Hawkins (1995), Cushing and Edwards (1996), Ramster (1996), Anderson (2002a, 2002b), Beverton and Anderson (2002), and Holt (2004, 2008a, 2008b).

In contrast to Ray, Sidney had little involvement with ICES. His last participation was in the ICES Symposium on "100 Years of Science under ICES", held in August 2000 in Helsinki (Anderson, 2002b), where he presented a paper (Holt, 2002). True to form throughout the four-day symposium, Sidney sat attentively in the front row and asked questions of nearly every presenter. One humorous incident involving Sidney and Katherine (Kathy) Richardson[3] is worth quoting. Kathy presented an invited keynote paper (Richardson, 2002), but as her paper was not scheduled until the second day, she arrived late and checked into her hotel shortly before a reception the first evening. Kathy relates the following story:

> I can clearly recall an "eye-catching" man in the same elevator at the hotel on the way down to the lobby to walk over to the reception. We were alone

[3] Former biologist at the Danish Institute for Fisheries and Marine Research, active participant in the work of ICES in the 1980s and 1990s, chair of the ICES Advisory Committee on the Marine Environment (ACME; 1992–1996), Professor of Biological Oceanography at Aarhus University at the time of the symposium, and currently Vice Dean, Faculty of Science, University of Copenhagen.

▲ A meeting of the Advisory Committee of Experts on Marine Resources Research (ACMRR) in the mid-late 1960s in Rome. Seated around the table (left–right): Basil Parrish (Chair of the ICES Consultative Committee), Sidney Holt (Director of FAO's Fisheries Resources and Operations Division), Mario Ruivo (member of the Fisheries Resources and Operations Division and Secretary of ACMRR), Alfred Needler (ACMRR Chair from Canada), and Roy Jackson (FAO Assistant Director-General for Fisheries), with Fred Popper (Deputy Assistant Director-General for Fisheries) behind Jackson. Photo courtesy of Tim Holt.

▲ *In this photo taken by Mike Sissenwine, Ray is shown at the wheel of the "Interlude" (Mike's sailboat), entering the Patuxent River from Chesapeake Bay. The photo was taken in May 1994, during Ray's lecture tour of selected National Marine Fisheries Services laboratories.*

◄ *Sidney wearing his "Holt Faction" cap, a label given him and three others by the Japanese delegation to the International Whaling Commission. Photo courtesy of Sidney Holt.*

in the elevator, and he was eye-catching for a couple of reasons – I towered over him (tall women notice and are conscious of the relative proportions between people). He was dressed for ICES (i.e. conservatively), but hadn't changed his hairstyle since Woodstock. He also had eyes that lit up and bounced around like bubbles on his face. Given the visual impression I had just formed of the man, I convinced myself he was an NGO person of some sort.

His friendly conversation (and bubbly eyes) made it clear that he had nothing against being seen conversing with a younger (although at that point by no means young!) woman. He told me about his concern for whales in the Antarctic. This whale interest supported my classification of him as an NGO man, and I wondered vaguely what on earth he was doing at an ICES meeting, but, on the other hand, it was a history symposium, and my experience of historians (my sister is one) is that they can have the strangest interests.

As we wandered along, I (in very "popular" and pedagogical language) tried to explain to him "my" science and what I was doing at a history symposium. The paper I was giving the next day actually focused on what Beverton and Holt had, in my eyes, meant for scientific development in ICES. In the early days of ICES, fisheries and plankton people worked together to understand the abundance of fish in the ocean, but what was missing in order to quantify the link was a method to measure primary production. Just as that method became available (Steemann Nielsen, 1952), Beverton and Holt (1957) appeared on the scene and "proved" that it wasn't necessary to worry about that plankton stuff anyway. It was ironic that Sidney Holt, on that day in Helsinki, should run into the one person in ICES who wishes their paper had never been published!

▲ *Sidney, in his home in Umbria, Italy, operating the Brunsviga purchased for him by his sons. Photo by Tim Holt.*

All the while I regaled him with this story, he never let on who he was (and to his credit, he didn't "hold it against me" – we remained friends or at least friendly communicators both at the symposium and for some time afterwards). I knew Ray, and it just never occurred to me that this well-matured hippie/NGO man could possibly have been his colleague. Who it was who told me at the reception that I had walked in with Sidney Holt, I cannot remember, but at that point, I was so embarrassed that I think I probably crawled into my own shell to lick my wounds.

Having celebrated his 85th birthday on 28 February 2011, Sidney is still going strong. He lives on a small farm in Umbria, Italy, returned with his two sons to Lowestoft in April 2008 to attend the launch of the series of essays commemorating 50 years of the 1957 treatise (Payne *et al.*, 2008), still writes papers, is an advocate for the great whales, and has also recently become re-engaged in marine fishery management.

Emory Anderson was ICES Statistician during 1985 – 1989 and General Secretary from 1989 through 1993. In 2008, he became an editor of ICES Journal of Marine Science *as well as editor of* ICES Cooperative Research Report *series and consulting editor of* ICES Insight *magazine.*

Acknowledgements

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Literature cited

Anderson, E. D. (Ed). 2002a. The Raymond J. H. Beverton Lectures at Woods Hole, Massachusetts. Three Lectures on Fisheries Science given May 2–3, 1994. US Department of Commerce, NOAA Technical Memorandum NMFS-F/SPO-54. 161 pp.

Anderson, E. D. (Ed). 2002b. 100 Years of Science under ICES: Papers from a Symposium held in Helsinki, 1–4 August 2000. ICES Marine Science Symposia, 215. 610 pp.

Baranov, T. I. 1918. On the question of the biological basis of fisheries. Nauchnyi Issledovatelskii Ikhtiologischeskii Institut Isvestia, 1: 81–128.

Beverton, R. J. H. 1949. Assessments of yield in the plaice population of the southern North Sea. Challenger Society, 3: 10–11.

Beverton, R. J. H. 1953. Some observations on the principles of fishery regulation. Journal du Conseil Permanent International pour l'Exploration de la Mer, 19: 56–68.

Beverton, R. J. H. 1954. Notes on the Use of Theoretical Models in the Study of the Dynamics of Exploited Fish Populations. US Fishery Laboratory, Beaufort, N. Carolina, Miscellaneous Contributions, 2. 154 pp.

▲ *Sidney (right) chatting with (left–right) David Garrod, Joe Horwood, and John Pope at the Cefas Laboratory at Lowestoft in April 2008. During this visit to Lowestoft, Sidney gave a talk entitled "Three lumps of coal: doing fisheries research in Lowestoft in the 1940s". "Three lumps of coal" referred to the amount of fuel brought daily to Ray and Sidney's little office in the annex to the main Laboratory building to keep them warm each day. Photo courtesy of Tim Holt.*

Beverton, R. J. H., and Anderson, E. D. 2002. Reflections on 100 years of fisheries research. ICES Marine Science Symposia, 215: 453–463.

Beverton, R. J. H., and Holt, S. J. 1956. A review of methods for estimating mortality rates in exploited fish populations, with special reference to sources of bias in catch sampling. Rapports et Procès-Verbaux des Réunions du Conseil Permanent International pour l'Exploration de la Mer, 140 (Part I): 67–83.

Beverton, R. J. H., and Holt, S. J. 1957. On the Dynamics of Exploited Fish Populations. Ministry of Agriculture, Fisheries and Food. Fishery Investigations, London, Series II, XIX. 533 pp.

Cushing, D. 1995. Ray Beverton, 1922–1995: a personal tribute. Journal of Fish Biology, 47: 929–930.

Cushing, D. H., and Edwards, R. W. 1996. Raymond John Heaphy Beverton, C.B.E. Biographical Memoirs of Fellows of the Royal Society, 42: 25–38.

Graham, M. 1935. Modern theory of exploiting a fishery, and application to North Sea trawling. Journal du Conseil Permanent International pour l'Exploration de la Mer, 6: 25–35.

Gulland, J. A. 1965. Estimation of mortality rates. Annex to Arctic Fisheries Working Group. Report of meeting in Hamburg, 18–23 Jan. 1965. ICES Document CM 1965/Gadoid Fish Committee: 3. 9 pp.

Holt, S. J. 1949. Biodynamic assessments of fish populations. Challenger Society, 3: 10.

Holt, S. J. 2002. ICES involvement in whaling and whale conservation, and implications of IWC actions. ICES Marine Science Symposia, 215: 464–473.

Holt, S. J. 2004. Foreword to the 2004 printing. In Beverton, R. J. H., and Holt, S. J. 1957. On the dynamics of exploited fish populations, pp. i–xxiii. Blackburn Press, New Jersey, USA. 533 pp. + 3 pp. of errata.

Holt, S. J. 2008a. Three lumps of coal: doing fisheries research in Lowestoft in the 1940s. A talk by Sidney Holt to a Cefas seminar in Lowestoft, Suffolk, UK, 25 April 2008. Unpublished. 20 pp.

Holt, S. J. 2008b. Foreword. In Advances in Fisheries Science. 50 Years on from Beverton and Holt, pp. ix–xxi. Ed. by A. Payne, J. Cotter, and T. Potter. Blackwell Publishing, Oxford. 568 pp.

Hulme, H. R., Beverton, R. J. H., and Holt, S. J. 1947. Population studies in fisheries biology. Nature, 159: 714–715.

Le Cren, D. 1958. Review of Beverton & Holt 1957. Journal of Animal Ecology, 28: 150–151.

Payne, A., Cotter, J., and Potter, T. (Eds). 2008. Advances in Fisheries Science. 50 Years on from Beverton and Holt. Blackwell Publishing, Oxford. 568 pp.

Pitcher, T. J., and Pauly, D. (Eds).1998. Special Issue Beverton and Holt Jubilee. Reviews in Fish Biology and Fisheries, 8: 225–370.

Ramster, J. 1996. Professor Ray Beverton 29 August 1922–23 July 1995. ICES Journal of Marine Science, 53: 1–9.

Richardson, K. 2002. Linking plankton and fish production throughout the history of ICES. ICES Marine Science Symposia, 215: 156–163.

Russell, E. S. 1931. Some theoretical considerations on the "overfishing" problem. Journal du Conseil Permanent International pour l'Exploration de la Mer, 6: 3–20.

Shelton, R. G. J., and Hawkins, A. D. 1995. Obituary. Professor Raymond (John Heaphy) Beverton, CBE, FRS, FIBiol. Reviews in Fish Biology and Fisheries, 5: 393–397.

Sparre, P. 1991. Introduction to multispecies virtual population analysis. ICES Marine Science Symposia, 193: 12–21.

Steemann Nielsen, E. 1952. The use of radio-active carbon (C14) for measuring organic production in the sea. Journal du Conseil Permanent International pour l'Exploration de la Mer, 18: 117–140.

Ulltang, Ø. 1996. Stock assessment and biological knowledge: can prediction uncertainty be reduced? ICES Journal of Marine Science, 53: 659–675.

Emory Anderson has contributed supplementary information to this article, which can be found in ICES Inside Out *2011 Issue No. 4. You can find it online here: http://www.ices.dk/InSideOut/No4%202011/Insideout2011-No.4.3.pdf.*

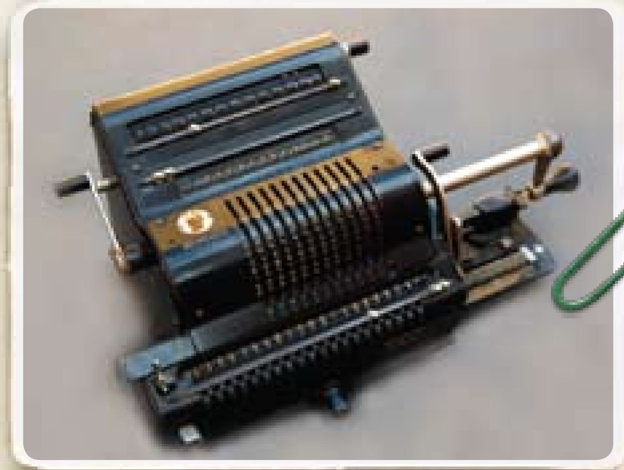
The Brunsviga calculator

– Emory Anderson

The technical work of Beverton and Holt (1957) required a considerable number of calculations. As this was the pre-computer era, the authors initially employed Ray's helical slide rule, but a year or so into the project, they acquired a German-made Brunsviga manual rotary calculator, which Sidney generally operated, courtesy of war reparations. Sidney recalls that the machine worked beautifully and that he developed very strong wrists. Towards the end of the project and after Sidney had left Lowestoft, the Brunsviga broke down and Ray was forced to revert to his slide rule for the final calculations. According to Sidney, a remarkable, tiny Curta rotary calculator (nicknamed the "math grenade"), made in Liechtenstein, finally arrived to provide temporary relief, especially as a "laptop" for use in checking figures during tedious train journeys.

▲ *The Curta mechanical rotary calculator was developed by Curt Herzstark while a prisoner in the Buchenwald concentration camp during World War II. It was first marketed in 1948 and was considered the best portable calculator available until rendered obsolete with the introduction of electronic hand calculators in the early 1970s.*

Sidney's sons recently purchased for him the identical model on eBay. It works well, sits on the window sill of his home in Umbria, Italy, and reminds him daily of life in the post-war years back in Lowestoft.



▲ *This is an identical version of the model of the Brunsviga rotary calculator that was used by Sidney in the 1940s at the Lowestoft Laboratory. This version was purchased recently for Sidney by his sons. Photo courtesy of Tim Holt.*

The Brunsviga rotary calculator has an interesting history. Its unique machinery involved a pin wheel and cam disks. First invented in 1878 by W. T. Odhner, a Swedish engineer working in Russia, the patent was acquired in 1892 by the German company Brunsviga-Maschinenwerke Grimme, Natalis & Co., which improved, manufactured, and marketed the machine under the name "Brunsviga". Many models were developed and marketed over the years, at least into the 1950s, and were considered reliable, accurate, and affordable. The pinwheel calculator became the standard type of calculator until electronic pocket calculators came into use in the early 1970s.

POLE STAR: the National Marine Fisheries Research Institute

Charting the course for Polish fishery research since 1921

The recent promotion of Poland's leading marine fishery institute to the position of national institute confirms the high quality of the work that it carries out. Here, ***Zbigniew (Steve) Karnicki****,* ***Tomasz Linkowski****, and* ***Piotr Margonski*** *review the events that have taken place during the National Marine Fisheries Research Institute's ninety-year history.*

◄ *RV "Baltica" of the NMFRI in Gdynia and Institute of Meteorology and Water Management. Photo B. Szpiganowicz.*

June 2011 marked the ninetieth anniversary of Polish sea fishery research, a momentous anniversary, which few scientific institutions with a similar profile can match. The present-day National Marine Fisheries Research Institute (NMFRI) was founded in Hel, a small town on the Hel peninsula, in 1921 as the Sea Fisheries Laboratory (SFL), and despite several changes in name and organizational structure, it has maintained the continuity of its scientific staff and its focus ever since.

Its activities and scientific research are inextricably linked to Polish fisheries and their development. Initially, research focused on Polish coastal waters, but as the fisheries expanded so too did the research, to include Baltic offshore waters, the North Sea, and increasingly wider regions of the world's seas and oceans. Expanding alongside the Polish fisheries, the SFL, by now the Marine Station, moved in 1938 to new headquarters in Gdynia, which is currently the home of the Gdynia Aquarium, part of NMFRI.

NMFRI activities and scientific research are inextricably linked to Polish fisheries and their development.

By the late 1970s and with a new name, the Sea Fisheries Institute had a staff of more than a thousand employees and operated four research vessels, including two oceanic stern trawlers. However, since the introduction of exclusive economic zones (EEZs) and catch restrictions to counteract the effects of overfishing in many high-seas fishing grounds, the geographic range of research conducted at NMFRI has been somewhat curtailed. Once again, research focuses principally on the Baltic Sea, and the Institute now employs 213 people, of whom thirty-three are scientific staff.

Beginnings

Poland regained its sovereignty and access to the Baltic Sea in 1918. By the following year, steps were already being taken to create an institution that would focus on studying the sea and its resources. Formally a "laboratory for biological and technical research within the area of sea fisheries", the Sea Fisheries Laboratory (SFL) was founded in 1921. Organizational matters took some time to finalize, and Kazimierz Demel, the Laboratory's first scientific staff member, was hired in December 1922. Five months later, in May 1923, he sailed on his first research cruise to collect material relating to juvenile flatfish. Initially, the SFL had few employees, but the public took great interest in the Laboratory because little was known about the Baltic and its resources. Demel's first publication appeared in 1924 and focused on fishing methods and the gear used by fishers, as well as on the ichthyofauna of the southern Baltic Sea. This was also the year in which Poland and the International Council for the Exploration of the Sea (ICES) first came into contact, when Michał Siedlecki participated in the annual ICES Statutory Meeting in Copenhagen.

▼ *The first research cutter used by the Marine Station and owned by the Sea Fisheries Institute, the small cutter "Ewa", ca. 1935. Photo courtesy of the NMFRI archive.*

The period leading up to World War II was quite stormy for the SFL. The Laboratory continued to develop and broaden its range of activities, while at the same time intensifying cooperation with ICES. In the eight years of its research activity, the Laboratory had already published forty-four articles on sea fishery and marine biology. Topics included the composition of marine ichthyofauna in areas exploited by Polish fisheries, zoogeographic and biological analysis of the ichthyofauna, applied fishing methods, descriptions of fishing grounds, and the composition and quantitative occurrence of benthic assemblages. The articles, especially those on benthic assemblages, were innovative and broadly applicable, not just to the Polish portion of the Baltic Sea; however, their publication in Polish unfortunately limited their accessibility.

The SFL experienced organizational changes in its first decade, and even closed down in 1931. However, by 1932, the SFL had been re-established as the Marine Station, with a new organizational arrangement.

During the mid-1930s, the Marine Station collected research material using the small cutter "Ewa", as well as other vessels belonging to the fishery administration or local fishers. It began publishing the results of its research and organizing summer courses in marine biology for Polish university students. This became a tradition that was maintained well into the 1980s.

In late 1938 and early 1939, the Marine Station moved from Hel to its new headquarters in Gdynia, thus providing excellent working conditions for the staff, who then comprised nine scientists, six research vessel crew members, and several technicians. However, the outbreak of World War II interrupted the operations of the Marine Station.

After World War II

During the war, there was significant destruction to the headquarters of the Marine Station. In May 1945, the then Minister of Industry decided to reopen the station, but under its previous name, the Sea Fisheries Laboratory, and appointed Mieczysław Bogucki as director and Kazimierz Demel as vice-director. The most urgent task for the new leadership of the SFL was to reconstruct the damaged building and resume regular research. Sampling of biological materials was recommenced in April 1946 from a fishing cutter.

Unique technologies were developed for peeling krill, producing blocks of frozen krill meat, and making krill meal.

The Laboratory began to develop dynamically. In addition to the existing departments of biology and ichthyology, a technology department was established that focused on fish processing, especially salting herring, which at that time was the basic technique used for preserving herring and which allowed for country-wide distribution.

In August 1946, Mieczysław Bogucki and Walerian Cięglewicz (who became ICES President in 1969) participated in the annual ICES Statutory Meeting in Stockholm as the first post-war representatives from Poland. Later, however, political expediencies were to disrupt contact with ICES, this time for seven years. The courses in marine biology, which had been interrupted by the war, were re-established and, by the end of 1946, the Laboratory was able to recover its library collections, which had been requisitioned during the war, from the German authorities.

The organization acquired the cutter RV "Michał Siedlecki" in 1948, which was used to investigate the fishing grounds of the Baltic, as well as to experiment with fishing gear and fish processing. The results of these investigations were implemented in the fishery industry, specifically in the introduction of pelagic pair trawls and the exploitation of new fishing grounds for Polish fisheries, such as those in the Bornholm Basin.

▼ *New premises of the Marine Station in Gdynia (1939). Photo courtesy of the NMFRI archive.*

In 1971, the SFI took possession of the most modern oceanic research vessel of the time, the RV "Profesor Siedlecki", which had been constructed in the Polish shipyards in cooperation with, and co-funded by, the FAO.

In 1947, the SFL was incorporated into the Sea Fisheries Institute (SFI), an association which had been established in 1928 to support the development of Polish marine fisheries. The two institutions were merged in an effort to direct the Laboratory's research towards practical aims and to support the fishery industry. Gradually, administration of the fisheries and direct support for the industry were assigned to other institutions, and the SFI moved exclusively into research and development, although its research interests remained relevant to the fishing industry.

By the early 1950s, the SFI had expanded to include five departments: Oceanography, Ichthyology, Fishing Techniques, Fish Processing Technology, and Fishery Economics.

After a seven-year absence, SFI delegates began again to participate in ICES meetings. The SFI began to publish the *Bulletin of the Sea Fisheries Institute, Gdynia* on a regular basis, and the Institute's building was remodelled to accommodate a marine aquarium. Plans for the aquarium had been drawn up before the war, and it eventually opened in 1971. As the Institute grew, it obtained another research vessel: a small motorized trawler, the RV "Birkut". The SFI research vessels sought out new fishing grounds for Polish fishers in the Skagerrak and the North Sea.

Polish offshore fisheries began to expand energetically at the end of the 1950s. The SFI staff assisted in the design and construction of new fishing vessels and participated in pioneering cruises to the Barents Sea and the waters off Greenland, and in the historic cruise of the first factory trawler to the Northwest Atlantic. The SFI's RV "Birkut" set sail on a cruise to explore the fishing grounds off the west coast of Africa.

Expansion of Polish fisheries

The period from 1960 to 1980 was one of continued vibrancy and expansion for Polish long-distance fisheries and, simultaneously, for the SFI, which provided scientific support to the entire fishery industry, encompassing everything from catching to processing. More than a thousand staff members were employed by the Institute at this time. The vast majority of work undertaken at SFI during this period served the fishing industry. A special scouting fishing section was created, responsible for collecting information on potential fishing grounds that had not yet been explored by the Polish high-seas fleet. SFI staff members sailed the Seven Seas as they participated in scouting cruises to collect data about the size and suitability of stocks and, simultaneously, to develop new fishing gear and methods for handling and preserving raw materials, along with new fish-processing technologies and quality standards. It was a time when absolute faith still existed in the unlimited resources of the seas and their exploitation by modern fish-processing vessels.

▼ *The flagship of the SFI research vessel fleet RV "Profesor Siedlecki" in Admiralty Bay, King George Island, Antarctic (1977). Photo courtesy of the NMFRI archive.*

▲*The core of the scientific staff of the Marine Station in 1937. Standing from left to right: Walerian Cieglewicz (President of ICES in 1969–1972), Adam Bursa, Władysław Mańkowski, Stanisław Kijowski, Zygmunt Mulicki. Sitting: Borys Dixon, Mieczysław Bogucki, Professor Michał Siedlecki (first Polish Delegate to ICES), Kazimierz Demel (first scientific employee of the Sea Fisheries Laboratory in Hel). Most of these scientists achieved professor titles at a later stage of their careers, i.e. Walerian Cięglewicz, Władysław Mańkowski, Zygmunt Mulicki, Mieczysław Bogucki, and Kazimierz Demel, and took positions as directors (Mieczysław Bogucki) or science directors of the Marine Station and/or the Sea Fisheries Institute in Gdynia (Kazimierz Demel, Walerian Cięglewicz, and Władysław Mańkowski). Photo courtesy of the NMFRI archive.*

International cooperation continued to strengthen, and many SFI staff members became United Nations Food and Agriculture Organization (FAO) experts, working both at the organization's headquarters in Rome and on projects in the field. Staff also participated in many regional fishery organizations.

In the early 1970s, the SFI began cooperating with the US National Marine Fisheries Service, an organization within the National Oceanic and Atmospheric Administration (NOAA), on a project that continues to the present day. Initially, the two institutions conducted joint research from aboard the SFI's RV "Wieczno" in regions of the Northwest Atlantic. The greatest achievement of this project was the creation, in 1974, of the SFI's Plankton Sorting and Identification Center at Szczecin. For more than thirty-five years, this department has steadily established a unique position in this field in terms of the scope of its activities and the qualifications of its personnel.

As both Polish high-seas fisheries and the SFI were so intrinsically linked, they reached the peak of their expansion and development together in the early 1970s. In 1971, the SFI took possession of the most modern oceanic research vessel of the time, the RV "Profesor Siedlecki", which had been constructed in the Polish shipyards in cooperation with, and co-funded by, the FAO. With this vessel, the SFI began investigating the fishing resources available in the Southwest Atlantic near the Falkland Islands.

In 1971, to mark the fiftieth anniversary of the SFI, the Gdynia Aquarium was officially opened, displaying specimens that had been collected by staff of the Institute since 1921 and donated by captains, Polish merchant-navy sailors, and fishers.

In 1975, investigations into fish resources and other marine organisms in the Antarctic region of the Atlantic were initiated. Expeditions were organized by the SFI and the Polish Academy of Sciences aboard the RV "Profesor Siedlecki", as well as aboard commercial fishing vessels. The voyages resulted in the discovery of new fishing grounds, the development of new fishing gear, and the expansion of preservation methods. Specifically, this applied to the exploitation of Atlantic krill (*Euphausia superba* Dana, 1850).

It was a period of pioneering studies on a global level. Unique technologies were developed for peeling krill, producing blocks of frozen krill meat, and making krill meal. Studies focused on how to obtain high-quality oil from krill, and the SFI staff also investigated the chitin and chitosan derived from krill, concentrating on describing and understanding the properties of these substances in order to permit greater control during processing and modification and thus obtain an end-product with the desired properties. The results of these studies were an indisputable success on a global scale.

The presentation of these results in the international arena played an important part in the SFI being awarded the honour of organizing the Sixth International Conference on Chitin and Chitosan, which was held in Gdynia in 1994. The SFI staff aboard the RV "Profesor Siedlecki" also took part in several cruises organized by the Polish Academy of Sciences within the BIOMASS/ FIBEX and SIBEX programmes/experiments (the First and Second International Biological Investigations on Marine Antarctic Systems and Stocks) in the late 1970s and early 1980s. The fruits of these cruises were numerous publications and the continued expansion of the Institute's scientific staff.

Initially, the SFL had few employees, but the public took great interest in the Laboratory because little was known about the Baltic and its resources.

A return to roots

The implementation of EEZs combined with the depletion of fish stocks in most high-seas fishing grounds led to the gradual extinction of Polish long-distance fisheries. This had a significant impact on the SFI because the demand for research began to decline rapidly. The political and economic transformations of the late 1980s drastically altered the conditions for financing scientific research. Research priorities also shifted. Fisheries and research in the Baltic, which the SFI had never discontinued, once again became a priority.

The oceanic research vessels were either sold or scrapped, to be replaced in 1993 by the RV "Baltica", which conducts environmental and fishery-resource research in the Baltic Sea. Construction of the vessel was supported financially by the State Committee for Scientific Research. It is co-owned by the SFI and the Institute for Meteorology and Water Management. As the geographic range and scientific scope of the SFI research decreased, so did the number of staff, which currently stands at 213 employees. This includes the staffs of the Gdynia Aquarium, the Plankton Sorting and Identification Center in Szczecin, the Research Station in Świnoujście, and the crew of the research vessel. The five scientific departments of the SFI are currently staffed by eighty-eight employees, of whom thirty-three are scientists.

The fundamental pursuits of the SFI currently include international cooperation led by ICES, participation in European Union Framework Programmes, and the conduct of research essential to national implementation of the European Union Common Fisheries Policy. This last task is supported by the National Programme for the Collection and Management of Fisheries Data. The SFI has a long history of participation in international projects funded in part by the EU, but it also supports its own scientific work with funds allocated by the Polish Ministry of Science and Higher Education for statutory activities. The SFI has also been successful in obtaining funding from competitions for research sponsored by government and regional administrations, through consulting for business, both at home in Poland and abroad, and by writing expert opinions contracted by state administrations.

Currently, the SFI comprises five scientific departments: Fishery Resources, Fisheries Oceanography and Marine Ecology, Processing Technology and Mechanization, Fishery Economics, and Food and Environmental Chemistry. Recently, fundamental investigations of the Baltic environment have increased measurably with better availability of resources.

Without these studies, it would not be possible to implement the recommended ecosystem-based approach to managing fishery resources. However, it was the results of research conducted for application and implementation in the fisheries and foodstuffs industries that earned it high scores in the two previous audits conducted by the Polish Ministry of Science. The Plankton Sorting and Identification Centre continues to cooperate with the US National Marine Fisheries Service, while simultaneously analysing more and more samples for European institutions. The Gdynia Aquarium, which is a department of the SFI, plays a key role in broadening the public's knowledge of the seas. In recent years, more than 40 000 children from primary and secondary schools have attended educational programmes at the Aquarium, a number unprecedented not only in Poland, but throughout Europe. The Gdynia Aquarium receives around 400 000 visitors annually.

The Gdynia Aquarium, which is a department of the SFI, plays a key role in broadening the public's knowledge of the seas.

The director of the SFI is a member of the European Fisheries and Aquaculture Research Organization (EFARO), and in May 2011, the SFI hosted the EFARO General Assembly in the city of Sopot, adjacent to Gdynia on the Baltic coast. The Institute also cooperates and conducts dialogues with fishery organizations in Poland and abroad within the framework of the Baltic Sea Regional Advisory Council.

In celebration of ninety years of high-quality research, the SFI obtained the status of national institute in June 2011 and has since changed its name to the National Marine Fisheries Research Institute (NMFRI).

In September 2011, thirty-two years after the historic ICES Statutory Meeting held in Warsaw in 1979, the Ministry of Agriculture and Rural Development is pleased to host ICES Annual Science Conference 2011 in Gdańsk. The NMFRI is a co-organizer of this event.

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Tomasz Linkowski is the NMFRI Director, Polish Delegate to ICES (1993–present), and was an ICES Vice-President (1999–2001).

Piotr Margonski is Head of Department of Fisheries Oceanography and Marine Ecology at NMFRI and Polish Delegate to ICES (2008–present).

The Professor Kazimierz Demel Medal

The Professor Kazimierz Demel Medal is awarded for outstanding scientific and organizational research achievements, as well as for popularizing knowledge of the sea in the fields of biology, ecology, and fisheries. The Medal is awarded to Polish or foreign individuals, institutions, or associations, based on nominations submitted to the Professor Kazimierz Demel Medal Committee. The silver-plated bronze Medal was designed by the artist Józef Jezierski and was minted at the National Mint in Warsaw in 1991. The first recipient was ICES in 1991.

What lies beneath?

Successful marine spatial planning requires the connectedness that exists within the marine environment to flow through our work. ***Erik Olsen*** *considers how current efforts can be enhanced.*

◀ *The act of encapsulating an undersea environment is closer to rendering the unfolding of a dance.*

Our world is three-dimensional, but we conceptualize, manage, and utilize our environment in two-dimensions. We live in houses that are described by floor plans and located in countries that are represented by two-dimensional maps. We write in two dimensions, our computer screens present information in two dimensions, and we store our visual memories in two-dimensional photographs. Cognitively, we favour two-dimensional processes.

The world beneath the waves is also three-dimensional, but it requires an unequivocally three-dimensional representation. Significant processes, components, and geographical features exist simultaneously, one above the other, in a way that completely confounds any attempt to depict it two-dimensionally.

The act of encapsulating an undersea environment is closer to rendering the unfolding of a dance.

Adding the fourth dimension of time complicates the picture further. The processes have duration, the components are often moving, with varying dynamics, and the endless cycle of the seasons imposes constant change. Seen in these terms, the act of encapsulating an undersea environment is closer to rendering the unfolding of a dance.

Merely depicting its subject is the first challenge faced by marine spatial planning (MSP), but its goal – the creation of a management plan that integrates the myriad elements of the different forms of human use, conflicting goals and interests, scientific knowledge, stakeholder involvement, and governance – seems unreachable. And all of this in an environment that is "invisible" to us because it is hidden beneath the waves.

The appeal of MSP is its promise to translate the ecosystem approach into practical management action and to find ways of accommodating the competing demands of human uses in a marine space.

It offers a way of managing marine space while remembering ecological, social, and economic objectives, and a solution to the problem of transforming many, although not all, of the concepts of the ecosystem approach into practical action. Using marine space as an arena, it is possible to test different management approaches and their effects on both the entire ecosystem and human activities, not just on a single ecosystem component or activity.

Unfortunately, few examples of the ecosystem approach (or ecosystem-based management) are practically implemented in management and advice. Moreover, in order to manage ecosystems successfully, it is particularly important to consider the spatial dimension of management. Also, until now, all existing examples of MSP plans take a two-dimensional approach to the final mapping and zoning.

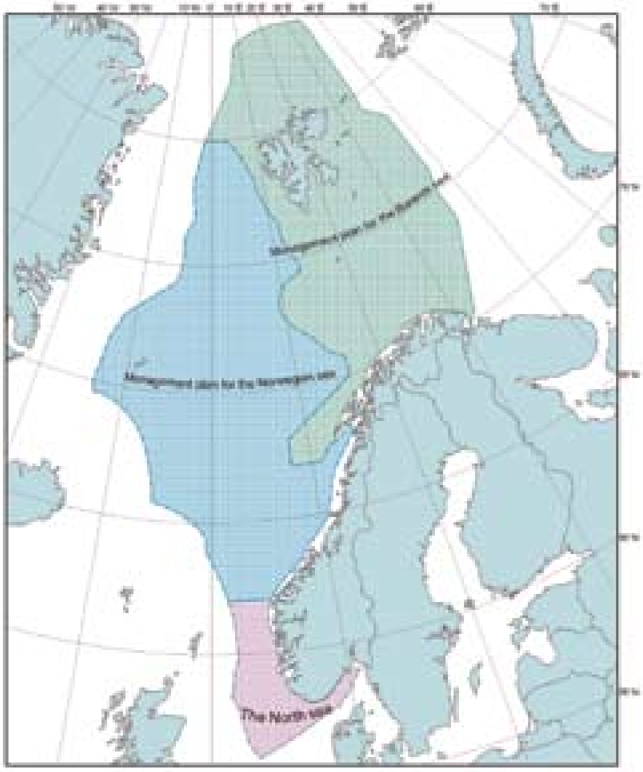
Why all the fuss?

Traditional management of human marine activities has been on a sector-by-sector basis. Spatial considerations have informed sectoral management, but these regulations have not been recognized in a wide cross-sectoral or ecological context, and this is the key point in MSP.

Such planning is accomplished by using marine space as an arena for overlaying, contrasting, and comparing sectoral management with overarching management aims, and, in some cases, identifying sectors where sectoral policies are poorly developed in a spatial context.

We are attempting to manage the human use (or non-use, i.e. conservation) of the marine environment. How we go about this differs from sector to sector. The differences arise from a combination of culture, scientific background, governance, and politics. The successful integration of these often contradictory sectors requires that we find a common ground, and marine space is the most obvious starting point, because all human activities use marine space.

MSP thus offers benefits to all parties involved in managing the marine environment. First and foremost, it offers an overarching system for governance that gives certainties to all parties involved. For managers, it is a practical procedure that leads to compromise management solutions to conflicting interests and aims. For fisher and industry groups, it ensures that their interest



▲ *The areas planned for Norway's three integrated management plans (spatial plans), where the whole ecosystem and all human activities are seen in conjunction.*

in securing rights and access to areas is treated clearly and fairly in the management process. For environmental groups (and other NGOs), it ensures that sectoral management is put in a wider, ecosystem-based context, where aims for good status of the environment are given due considerations. Lastly, for the decision-makers (politicians), it reduces the conflict level and offers a choice of management options that allows those in power to put their political goals into action.

MSP builds on existing sectoral management and policies, and aims to combine these in a spatial context, but it should not be seen as a replacement for existing sector-based management. MSP is a complement to these, a way of encouraging cooperation for the greater good.

Traditional management of human marine activities has been on a sector-by-sector basis, mostly aimed at technical regulations or regulation of intensity.

Spatial complications of species distributions

Marine ecosystems are complex, not only because of the third dimension and inaccessibility, but also because the connectedness of the marine system is much stronger than systems on land. On land, physical features, such as mountains, rivers, lakes, and deserts, form impassable barriers to plants and animals, and function as natural boundaries to their distribution.

In the marine environment, most organisms have planktonic eggs or larvae that can easily bypass areas of unsuitable bottom habitat, such as trenches and mountain ranges. However, the same water masses that facilitate distribution may act as effective barriers to distribution, preventing the spread of eggs and larvae. The boundaries formed by these water masses are driven by the Earth's climate system and are not static but vary in space and time.

Defining features such as currents, frontal systems, and ice edges in a map suitable for management is difficult at best. In a planning context, this stochasticity is harrowing because it makes it very difficult to create a plan that captures the distribution of ecosystem components in a biologically sensible manner while not oversimplifying.

A map showing the distribution of ice-associated seals in an Arctic ocean can be used as an example. Seal distribution varies with the ice edge, which varies seasonally and interannually, depending on shifting climate conditions. Mapping their distribution area would encompass all areas where they are observed, although at any given time, the seals only use a very small portion of the total potential habitat. A way of circumventing this problem has been to define key areas for ecosystem components, i.e. those areas of greatest importance for the continued survival and productivity of the component.

What has been achieved

Current MSP development has focused on the interaction between human activities and the environment. The socio-economic dimension has largely been overlooked and is the greatest shortcoming of most existing plans. This may be because many MSP plans have been developed by managers with the support of natural scientists and engineers, while social scientists and economists have, at best, played a peripheral role. Including them as equal members in the development of MSP is necessary to give socio-economic considerations their proper place in MSP. Without it, the plans will be

▲ *The zoning plan for the petroleum industry in the Barents Sea integrated management plan (from Olsen* et al.*, 2007).*

unable to predict the effect on a community's jobs, taxes, infrastructure development, etc. – all essential knowledge for the decision-makers when making final decisions on contentious issues, or balancing socio-economic returns against conservation. Current MSP plans have mostly been driven by the needs of managers and decision-makers, often under tight time restrictions. Therefore, most processes have been largely expert-based and many have not been given a thorough review owing to time constraints. Our experience from fishery management demonstrates the value of thorough scientific reviews of our management plans and advice. This facilitates the acceptance of the plans and advice among all parties because quality is controlled. Most current MSP plans lack this review, and invite criticism that calls into question the validity of the plan itself.

The role of science in MSP

Scientific knowledge and analysis play a crucial role in successful MSP, and are relevant and useful at all stages. Scientific advisors typically follow the processes from start to finish. Some stages of the MSP process depend more than others on scientific input, including: (i) setting goals and objectives, (ii) establishing a baseline, and (iii) looking into the future. All of these stages depend on a thorough scientific understanding of the ecosystem and its human uses. MSP requires not only traditional species-specific advice on population levels, distribution, and life history, but also demands knowledge based on ecological science of trophic interactions, ecosystem goods and services, and vulnerability to human activities. All of this knowledge should also, to a large extent, be made available for mapping so that integrated maps and analyses of ecosystem components, vulnerability, and human use can be developed.

Currently, this is the major challenge of scientific advice to MSP processes. MSP requires integrated scientific advice, but science is typically specialized and distributed so that each scientific community controls its own dataset. Sharing data through international web services is essential to supporting MSP, and there are currently several regional and international projects and processes in place that support this. This provides the necessary infrastructure for sharing data and knowledge, but at this early stage, most of the data resides in closed databases at institutions.

For ICES to succeed as the foremost advisor on marine science in our area, also in relation to MSP, requires us to put this extra effort into our analyses and reporting.

How ICES contributes

ICES is aware of the push for the development of MSP plans both internationally and within the ICES area. Europe is in the forefront of the development of MSP, in terms of both practical management plans and developing its theoretical foundations. Therefore, in 2010, ICES launched a strategic initiative on MSP: the Joint ACOM/SCICOM Strategic Initiative on Area-based Science and Management (SIASM). The aim of this initiative is to develop the scientific foundations for MSP.

The first step in this process has been to ask what is the role of science in MSP and how can ICES aid the development of this role? This was the key issue for debate at a workshop in Lisbon in November 2010 (Workshop on the Science for Area-based Management: Coastal and Marine Spatial Planning in Practice). It is clear that the scientists who act as advisors in an MSP process must often act as both managers and scientists. Having dual roles is difficult, and they should be very clear on what role is appropriate at any stage in an MSP process.

The role of ICES Science is to provide knowledge, a role that ICES has played for more than 100 years in numerous management processes. It is clear that ICES can and should play an important role in MSP development in the ICES area. However, ICES work has traditionally concentrated on ecosystem components and on sectors rather than on ecosystems. Most of ICES output has been in the form of text and tables; distribution of the maps that are produced is usually limited to expert group reports. In order to be useful to MSP, our ICES products must be made available for spatial presentation and analyses. We must make the spatial data behind our maps and reports readily available for future use. In most cases, this is easy, but it requires a little extra effort on the part of the scientists in the expert groups, as well as ICES data managers. However, for ICES to succeed as the foremost advisor on marine science in our area, and in relation to MSP, requires us to put this extra effort into our analyses and reporting. With the development of the EU's Marine Strategy Framework Directive, and a probable increase in wind-energy projects as well as numerous regional initiatives, it is certain that our usual clients will require ICES to be capable of giving advice in a more spatial context relevant to MSP. ICES is in a unique position to provide the scientific knowledge necessary to support managers to establish MSP plans with a vision. Let us use our opportunity to contribute constructively to changing the world!

Literature cited

Douvere, F., and Ehler, C. 2009. New perspectives on sea use management: initial findings from European experience with marine spatial planning. Journal of Environmental Management, 90: 77–88.

Olsen et al. *2007. The Norwegian ecosystem-based management plan for the Barents Sea: a case study. ICES Journal of Marine Science, 64: 599–602.*

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Most organisms have planktonic eggs or larvae that can easily bypass areas of unsuitable bottom habitat, thereby bypassing trenches, mountain ranges, etc. However, the same water masses that simplify distribution may act as more effective barriers to distribution, preventing the spread of eggs and larvae.

DO IT YOURSELF

Marine spatial planning (MSP) concentrates on the uses of marine space in order to integrate the management of all human uses in an ecosystem-based context. A broad and commonly cited definition of MSP is:

> Analysing and allocating parts of three-dimensional marine spaces to specific uses and non-use, to achieve ecological, economic, and social objectives that are usually specified through a political process. (Douvere and Eheler, 2007.)

Development of practical approaches to MSP started after the Johannesburg Declaration in 2002, but after 2006, the field exploded, and an Internet search for "marine spatial planning" now returns hundreds of thousands of articles or reports on the issue. Many of these are either practical guides to implementing MSP or reports on how MSP has been implemented in different sea areas. The drive to implement MSP is so strong that it is being put in place before it has been fully developed scientifically and institutionally.

In this respect, managers and decision-makers are spearheading the process while scientists are evaluating the pros and cons of these early plans in order to develop codes of good practice, while developing the theoretical framework from the bottom. A challenge at this stage, therefore, is to combine the theoretical approaches with the best practices developed from real-world MSP plans.

Several nations that have developed, or are developing, MSP plans have carried out such a review in order to combine best practices and a theoretical framework, but the most comprehensive reviews have been made by intergovernmental institutions, such as UNESCO, EU, and HELCOM. Several practical guides to developing MSP have appeared, with many commonalities.

- MSP is a dynamic, regular management process, not a static plan that is made once and set in stone. It is similar to other management cycles that are used in the sectoral management of fisheries, petroleum, and other human sectors.

- Involvement of stakeholders at all stages of the process is essential to the establishment of an acceptance for the MSP plan.

- Setting common goals and establishing a governance structure are important steps prior to evaluating concrete management options.

- Establishing a baseline for human activities and the state of the ecosystem (and to map this) is essential to pinpointing both key issues at stake: main pressures and gaps in current knowledge.

- Look into the future. An MSP plan should analyse or define future conditions in terms of both human development and ecosystem state (e.g. taking into account changes in the Earth's climate).

- Mapping and analysing conflicts of interests is an essential step towards achieving the integration of sectors and interests.

- A map showing different uses and non-uses (e.g. marine protected areas) allocated to the area is an essential output of an MSP plan.

Implement, monitor, and revise the plan

Making a zoning plan is just one step in an MSP process, the success of which depends on completing the other steps. All managers and decision-makers who want to develop an MSP plan in order to have a zoning plan that solves all conflicts should bear this in mind, and they should show restraint and allow adequate time to conduct a comprehensive MSP process, as advised by all existing guides for best practice.

SSGRSP – the square peg in a round-peg society

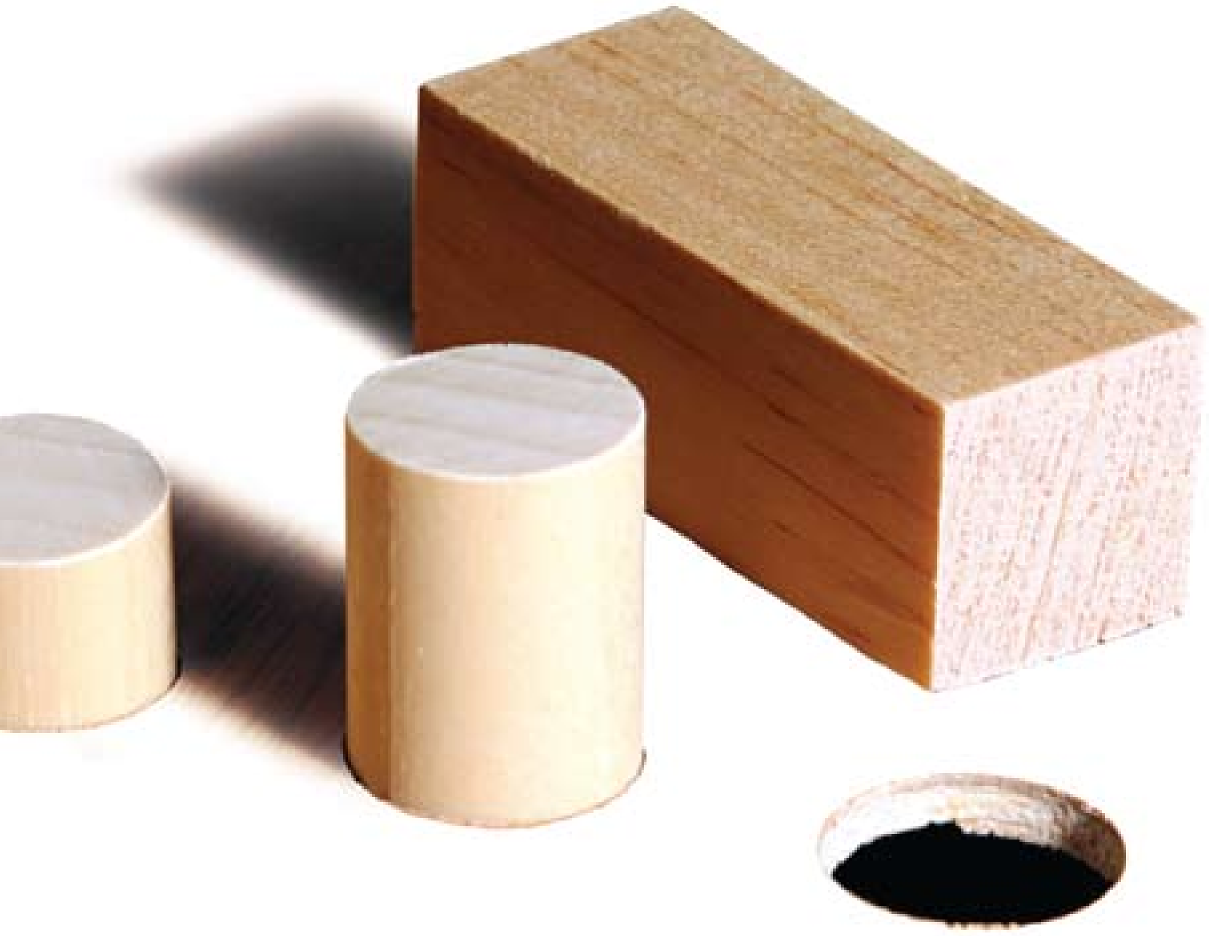
When round pegs are the new model and you define yourself as a square peg, what to do? ***Yvonne Walther*** *wonders how to introduce change while keeping functional parts of the old regime.*

The creation of the Science Committee (SCICOM) opened many doors to the future of ICES science, effectively changing the components of the system from square pegs to round ones. However, one square peg remained: the Baltic Committee (BCC). This was the last of the regional scientific committees, which were to be replaced by Science Steering Groups, each devoted to a different scientific discipline, reflecting the needs of *ICES Science Plan*.

As it would have been unfair to retain a single group dealing with regional science, a new idea formed, with input from expert group chairs in the soon-to-fade-away BCC and friends in the similarly fated Consultative Committee. The result was the Science Steering Group on Regional Sea Programmes (SSGRSP).

The vision was to pick up the science based on a regional approach and feed it into the advice, emphasizing its regional character. The core activity was, and still is, "integrated ecosystem assessments". The goal was to build upon the achievements of Baltic expert groups, which had reached an advanced stage of development as a result of their coordination with HELCOM, their cooperation with the Baltic Sea Large Marine Ecosystem (LME) project, and regional funding from projects such as BONUS (the Joint Baltic Sea Research and Development Programme).

The expert groups included: (i) the Working Group on Integrated Assessments in the Baltic (WGIAB); (ii) the Study Group for the Development of Integrated Monitoring and Assessment of Ecosystem Health in the Baltic Sea (SGEH), underpinned by the BEAST project (Biological Effects of Anthropogenic Chemical Stress: Tools for the Assessment of Ecosystem Health), funded by BONUS, which seeks to develop integrated measures of chemical pollution and the tools needed to detect and understand human-induced pressure on the Baltic Sea ecosystem; and last, but not least, (iii) the Study Group on Baltic Sea Productivity Issues in support of the BSRP (SGPROD). Added to the portfolio was the Working Group on Holistic Assessments of Regional Marine Ecosystems (WGHAME).

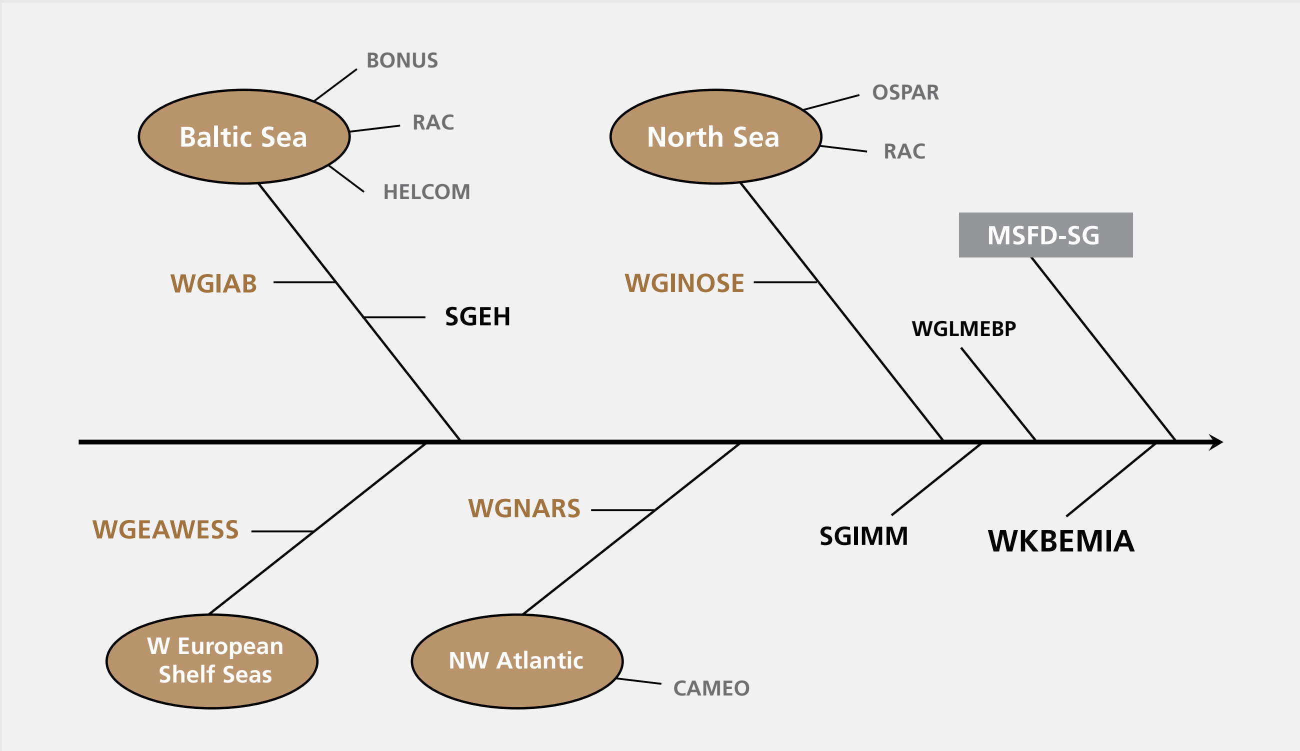


This was the starting point but development continues. The current groups with their acronyms are shown in the schematic structure (see overleaf), which we affectionately named the "Fishbone" of the SSGRSP.

At the Annual Science Conference (ASC) 2009 Berlin, we were challenged by Advisory Committee (ACOM) Vice-Chair Carl O'Brien with the words "If you really want to do something useful, why not benchmark the Integrated Ecosystem Assessments within ICES?" The core team took the bait, and we are still chewing on it. The Workshop on Benchmarking Integrated Ecosystem Assessments (WKBEMIA) will come to life in November 2011.

The new workshop will mark the start of what is planned to be an iterative process. The first step is to suggest guidelines for integrated assessments in ICES. It is hoped that views from stakeholders will be included in the course of action. Furthermore, the recently appointed ACOM chair Jean-Jacques Maguire is enthusiastically urging us to really create advice that is truly integrated and make good use of the results from ICES expert groups. At the SSGRSP meeting at this year's ASC in Gdańsk, there will be a roadmapping discussion to develop cooperation between WGBAS and WGIAB to create integrated advice, using the Baltic as the first case study.

From lessons learned in the Baltic, we have already started to reach out to other regional seas. Almost immediately, the Northwest Atlantic came on board, forming their own joint programme and starting the exploration of integrated assessments in the Working Group on the Northwest Atlantic Regional Sea (WGNARS). They were followed closely by the Working Group on Ecosystem Assessment of Western European Shelf Seas (WGEAWESS). The WGHAME re-formed as the Working Group on Integrated Assessments of the North Sea (WGINOSE).



▲ *Each oval represents a regional programme and its attached expert group. The blue acronyms attached to the Regional Programme are affiliated organizations or structures. A few EGs are outisde the regions because their function is more overarching.*

Another benefit of regional science programmes is the role played by the SSGRSP in summarizing for the ICES community the knowledge available that will be incorporated in the implementation of the Marine Strategy Framework Directive.

The scientific scope of SSGRSP also expanded, with a workshop on coupled ecological–economic modelling (Workshop on Introducing Coupled Ecological–Economic Modelling and Risk Assessment into Management Tools, or WKIMM), which was re-established in 2011 as the Study Group on Integration of Economics, Stock Assessment, and Fishery Management (SGIMM). The group will focus on case studies on ecological–economic modelling as a tool for advice. The work of SGIMM has made it possible to present a special ICES theme session at the World Fisheries Congress in Edinburgh in 2012, "Ecological–Economic Modelling Tools for Integrated Fish Stock and Fishery Management".

The team of expert group chairs finds the exchange of expertise between groups very rewarding, and the newly integrated groups have been given a head start by the viable input from the established groups. The SSGRSP is proving to be a creative environment for new ideas on regional science. A very important part of the work is to create opportunities for the expert groups, their chairs, and members. Regular WebEx meetings are held to share experiences, and the groups meet annually at the ASC. These meetings, to be held this year on 19 and 21 September, are open to all registered conference participants who would like to explore and become part of our work.

From lessons learned in the Baltic, we have already started to reach out to other regional seas.

We welcome new additions to the SSGRSP portfolio and invite the participation of members who are willing to try the integrated assessment concept in their own region. The pot is really cooking, and I think the result will be quite tasty.

Yvonne Walther has worked for the Swedish Board of Fisheries since 1991, and in 2011, moved to the Swedish University of Agricultural Sciences, as a result of organizational changes. She deals primarily with monitoring and stock assessment of cod in the Baltic, and has a special interest in otolith science and using cod otoliths as a tool to track migration and environmental history.

***Martin Lindegren**, **Christian Möllmann**, **Anna Gårdmark**, and **Thorsten Blenckner** share views and visions from the Working Group on Integrated Assessments of the Baltic Sea.*

Dylan probably didn't mean to be a-singin' about marine science, but his lyrics are more elegant than the scientist's "ecological regime shifts, they are a-happenin'".

Times are indeed a-changing and, over the course of recent decades, an increasing number of alarming reports concerning collapsing fish stocks, toxic algae blooms, hazardous jellyfish invasions, and vanishing coral reefs have become everyday news, not to mention the overarching threat of global warming.

As regime shifts may, or may not, be entirely reversible, management strategies that maximize ecosystem resilience are vital.

The awareness that these occurrences may not be isolated but highly interlinked has been growing within the scientific community at large, eventually leading to the formulation and adoption of the theory of alternative states, framing the very concept of so-called "ecological regime shifts".

As the term implies, ecological regime shifts are abrupt, large-scale changes in the basic structure and function of ecosystems; in the case of marine ecosystems, these changes affect many of the components of marine foodwebs, ranging from phytoplankton to fish and marine mammals. These regime shifts are often caused by multiple forces, including both natural and human-induced factors, such as changes in climate, overfishing, and eutrophication.

As most marine systems are affected by all of these factors, it is often difficult to disentangle the ifs and hows of their effects on ecosystem regime shifts. However, it is of vital importance to be able to separate these effects in order to develop management strategies that may achieve a sustainable use of our marine resources, both now and for generations to come. As regime shifts may, or may not, be entirely reversible, management strategies that maximize ecosystem resilience – the ability to withstand and buffer against change – are vital.

Despite the often striking consequences of marine regime shifts, the detection, understanding, and prediction of these events is far from straightforward. In fact, it takes a considerable amount of scientific effort as well as integration of knowledge, experience, data, and most importantly, people.

The following discussion highlights the joint work and major findings of one of the working groups dedicated to large-scale ecosystem assessments: the ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (WGIAB). The WGIAB is a multinational, multidisciplinary group of scientists, who, as the lyrics say, "gather round people wherever you roam" in a regime-shift quest aimed at (i) assessing the state and dynamics of the Baltic Sea ecosystems, (ii) considering the use of ecosystem modelling in these assessments, and (iii) developing adaptive ecosystem-based management strategies for the different Baltic Sea ecosystems.

The Baltic Sea, in its present state, is a young (ca. 4000 years), brackish-water ecosystem consisting of a number of sub-basins, here defined as the Sound (the western Baltic transition zone to the North Sea), the central Baltic Sea, the shallower gulfs of Riga and Finland, and the northernmost Bothnian Sea and Bothnian Bay (Figure 1). Despite their regional characteristics in terms of species composition, patterns, and dynamics, all of the basins demonstrate common responses to some, mainly climate-related, external driver. In addition, the Baltic Sea is heavily influenced by human impact from the approximately 85 million people inhabiting the drainage area, causing widespread problems with eutrophication, toxic substances, and overfishing.

Despite their own regional characteristics, all basins share common responses to some, mainly climate-related, external driver.

In the late 1980s, the Baltic Sea ecosystems underwent large-scale changes in both the open sea and coastal areas (Figure 1). For example, in the central Baltic Sea, the cod stock collapsed, only to be replaced by sprat, the main zooplanktivorous fish species in the area; released from

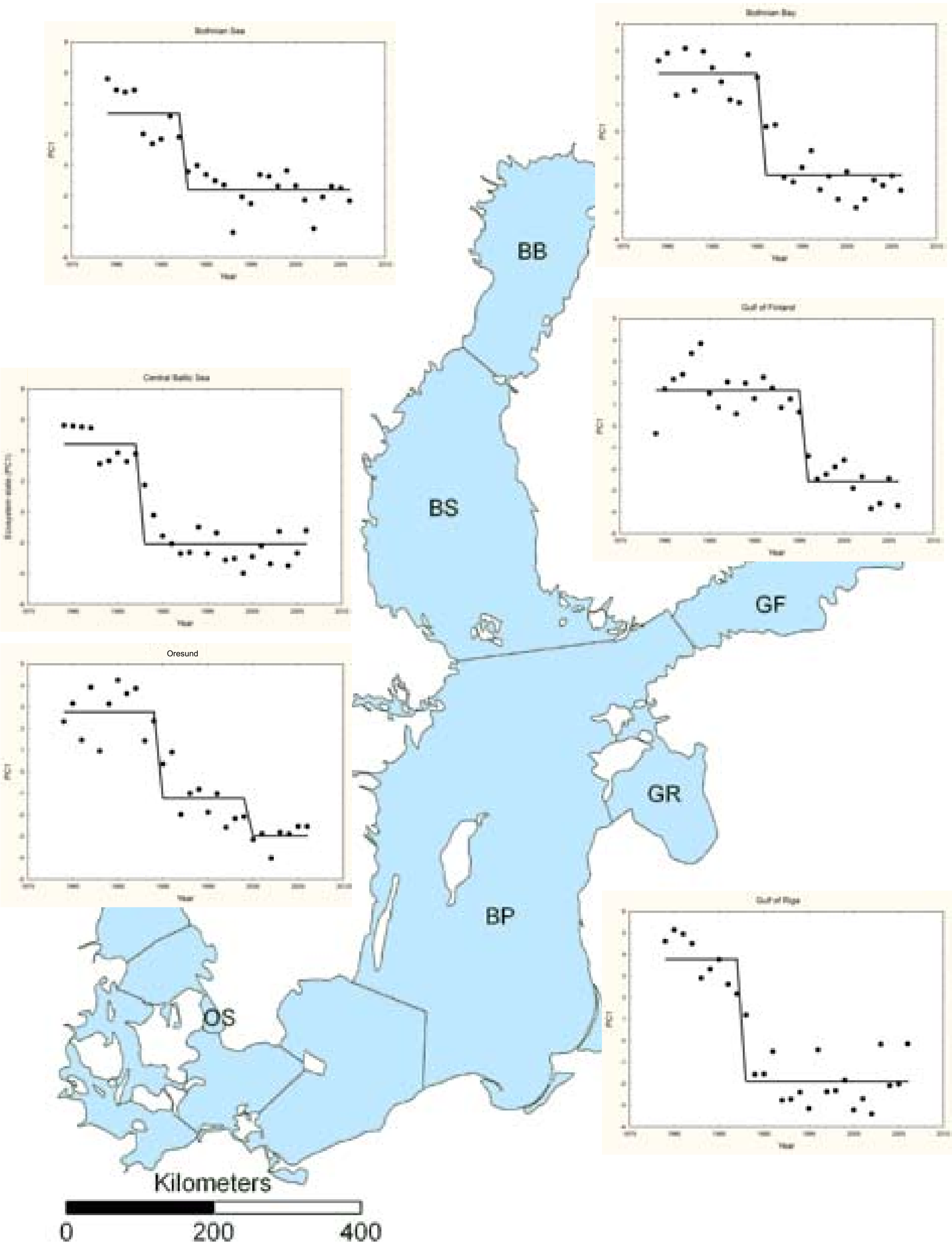
▲ *WGIAB members during the 2011 meeting hosted by the Mediterranean Institute for Advanced Studies (IMEDEA) in Esporles, Spain.*

predation, the sprat stock then rose to unprecedented levels. In turn, these changes appear to have reduced the biomass of zooplankton in the foodweb, which may then have affected the phytoplankton biomass (Figure 2). These chains of events, as the ecosystem changed from bottom–up to top–down control, is clear evidence of a so-called "trophic cascade", which is the response of an ecosystem as it shifts into an alternative state, i.e. a regime shift. The consequences of these changes are dire. So what causes these regime shifts, which are observed and identified throughout the entire Baltic Sea?

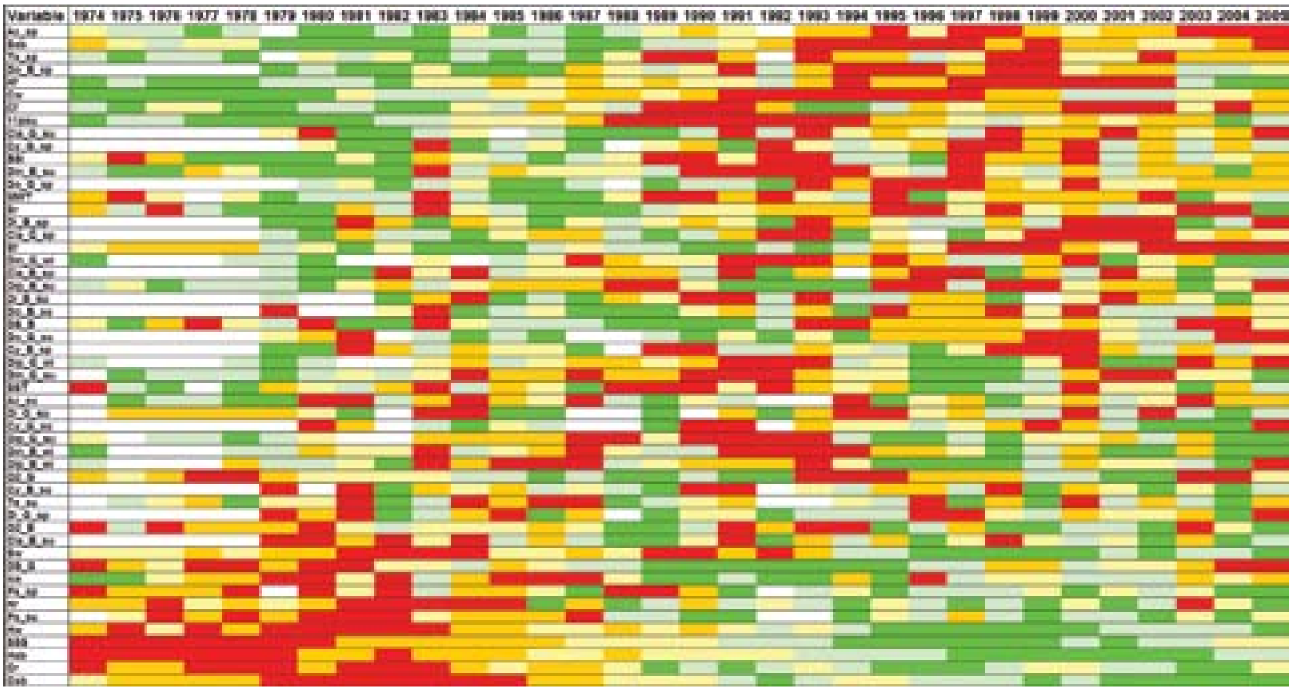
A crucial management question is not whether ecosystems are changing but if they can change back, or more importantly, be prevented from changing fundamentally in the first place.

Based on a comparative analysis across all sub-basins of the Baltic, hydrographic changes have been identified as the main, but not the only, cause of the ecosystem regime shifts. Given the synchronous timing, magnitude, and geographical extent of these regime shifts, which extend throughout the entire North Atlantic, atmospheric–oceanographic changes are the most likely drivers. In the Baltic, hydrographic conditions are mainly influenced by large-scale circulation patterns causing periodic inflows of high salinity and oxygen-rich water from the North Sea. In the mid-1980s, the atmospheric pressure in the North Atlantic region changed, as indicated by a sharp shift in the North Atlantic Oscillation (NAO) index from a negative to a positive phase, which gave rise to considerable changes in temperature, salinity, and oxygen conditions throughout a major part of the Baltic. These climate anomalies, by means of direct and indirect biological feedbacks, most probably triggered the simultaneous regime shift observed in the Baltic Sea and beyond.

At the same time, both overfishing and eutrophication have been identified as additional drivers of regime shifts in the Baltic, alongside the predominant effect of altered climate forcing. In the central Baltic, a combination of overfishing, eutrophication, and lack of inflows of saline water from the North Sea resulted in oxygen deficiency in deep water. This led to increased cod egg mortality, which may partly explain the recruitment failure and subsequent collapse of the cod stock. On the other hand, rising temperatures and the bottom–up-driven availability of zooplankton species, favoured by warmer and less saline conditions, seem to have favoured the increased recruitment and biomass of sprat, as well as increasing



▲ ***Figure 1.*** *Time-series from 1979–2006 of the ecosystem state (i.e. first principal component (PC1) derived from a principle component analysis) for the different basins; BB = Bothnian Bay; BS = Bothnian Sea; GF = Gulf of Finland; GR = Gulf of Riga; BP = Baltic Proper; OS = Oresund. (Source: Blenckner* et al.*, in press.)*



▲ ***Figure 2.*** *Traffic-light plot of the development of the central Baltic Sea ecosystem. Abiotic and biotic time-series are transformed to quintiles, colour coded (green = low values; red = high values) and sorted according to their loading on the first principal component. (For more information, see working group reports; source: Möllmann* et al.*, 2009.)*

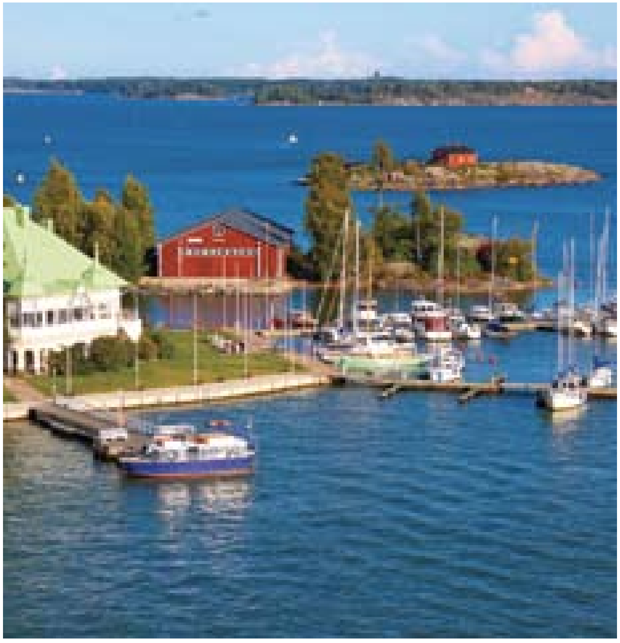
herring populations in the gulfs of Riga and Bothnia. In summary, the Baltic Sea regime shifts have been triggered by multiple external drivers, some of which are the direct result of human actions. Although ecosystems can withstand single pressures, multiple human-induced stressors acting jointly fundamentally affect ecosystem structure and function. Therefore, a crucial management question is not whether or not ecosystems are changing but whether they can change back or, more importantly, can be prevented from changing fundamentally in the first place.

The lessons learned from the Baltic Sea suggests that local, mainly human-induced pressures may erode ecosystem resilience, thereby making it more vulnerable to large-scale changes in the physical environment.

The capacity of an ecosystem to persist in the face of change depends on its resilience. Resilient ecosystems are able to absorb external pressure without changing their essential structure and function; however, if the resilience is weakened, even a relatively small change in external drivers can trigger a regime shift. As a worst-case scenario, ecosystems may even be prevented from switching to a more favourable state because of internal feedbacks maintaining the ecosystem in its unfavourable state – a phenomenon called *hysteresis*.

The lessons learned from the Baltic Sea suggest that local, mainly human-induced pressures, such as overfishing and eutrophication, may erode the resilience of the ecosystem, thereby making it more vulnerable to large-scale changes in the physical environment. Indeed, the shifts observed in ecosystems across the Baltic (Figure 1), which affect entire foodwebs, occurred in response to changes in temperature and salinity after being weakened for decades by overfishing and eutrophication.

As large-scale climate conditions can only partly be influenced, coordinated and cross-disciplinary management efforts targeting more readily manageable local factors (e.g. limiting the exploitation of top predators and reducing nutrient loads) seem to be the preferred ecosystem-based management actions. This is in order to maintain, restore, and maximize ecosystem resilience and prevent further potentially irreversible changes to marine ecosystems. The massive decrease in fishing effort in recent years, combined with the improving hydrographic conditions, and the subsequent increase in the eastern Baltic cod stock suggest that "times are indeed a-changing" once again.



▲ *Some harbours of the Baltic. Clockwise: Stockholm Harbour, Sweden; Gdańsk Harbour, Poland; Nyhavn, Copenhagen, Denmark; Helsinki Harbour, Finland.*

Biographies

Martin Lindegren is newly elected co-chair of WGIAB, a post-doc at DTU-Aqua, with main interests in foodweb dynamics and ecosystem modelling.

Christian Möllmann is professor in Marine Ecology at the University of Hamburg, previous chair of the WGIAB, and current initiator of the newly formed group for the North Sea (WGINOSE).

Anna Gårdmark is a senior scientist at SLU-Aqua, Swedish University of Agricultural Sciences, focusing on species interactions and food-web modeling in exploited ecosystems.

Thorsten Blenckner is a senior aquatic ecologist at the Baltic Nest Institute, Stockholm Resilience Centre, with an interest in ecosystem dynamics and the response to multiple drivers.

Further reading

Working group reports are available online at http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=199

Lindegren, M., Diekmann, R., and Möllmann, C. 2010. Regime shifts, resilience and recovery of a cod stock. Marine Ecology Progress Series, 402: 239–253.

Möllmann, C., Diekmann, R., Müller-Karulis, B., Kornilovs, G., Plikshs, M., and Axe, P. 2009. Reorganization of a large marine ecosystem due to atmospheric and anthropogenic pressure: a discontinuous regime shift in the Central Baltic Sea. Global Change Biology, 15: 1377–1393.

Möllmann, C., Blenckner, T., Casini, M., Gårdmark, A., and Lindegren, M. 2011. Beauty is in the eye of the beholder: management of Baltic cod stock requires an ecosystem approach. Marine Ecology Progress Series, 431: 293–297.

OPENING THE BOX:

THE DAWN OF TRANSPARENCY

Ellen Johannesen *joins a group of knowledge-seekers on a course presented by the ICES Training Programme.*

"The mind of a scientist can seem unfathomable to some people – as if scientists were aliens with arcane, inaccessible thought processes."

– Barbara Ettinger

Invited to "open the box" by the ICES Training Programme, participants in the course entitled "Opening the Box: Stock Assessment and Fisheries Advice for Stakeholders, NGOs, and Policy-makers" hoped that they would soon be initiated into the mysteries shrouding the stock assessments and fishery advice issued annually by ICES. To those untrained in the art of compiling graphs and tables, *ICES Advice* has sometimes given the impression of being indecipherable. In the light of a new dawn of transparency, ICES offered this opportunity to look into the box that has seemed closed to so many outsiders.

The reforms to ICES structure and changes in policy carried out in 2006 granted observer status to stakeholders during the advisory process. Consensus-building and participatory approaches are now the order of the day for environmental management and decision-making. Bringing more transparency to the advisory process by opening it to observers builds confidence in the process's rigorous scientific method and confirms that the advice is not merely the product of whim or magic.

Although opening the box allows outsiders to peer in, communicating the language of science to non-scientists remains a challenge. This challenge is described by Doug Wilson in his book *The Paradoxes of Transparency*. The paradox lies in the observation that, although the process of producing fishery advice has now been revealed, a certain level of mathematical skill is still required in order to understand the assessments and advice.

ICES Advice is a massive report that, in the past, has relied heavily on tables and graphs, with a formally worded text. It is clearly meant for users who are trained in the mathematics and discipline of fishery science, and who require or request specific information. It is therefore difficult for the non-expert to extract the essence of the often complex information, which can lead to overgeneralization and loss of subtle distinctions. Nonetheless, in response to new demands from clients and stakeholders, it is now necessary to distil the advice into clear and simple messages.

To those untrained in the art of compiling graphs and tables, *ICES Advice* has sometimes given the impression of being indecipherable.

How can we balance these two conflicting approaches to *ICES Advice*? One way, producing advice that non-experts can understand, is an important part of transparency and democratic management of natural resources. Training stakeholders and observers how to understand the calculations that make the stock assessment models work is another way, and ICES is currently pursuing both of these strategies.

▲ *Participants on the ICES Training Course "Opening the Box: Stock Assessment and Fisheries Advice for Stakeholders, NGOs, and Policy-makers" outside ICES Secretariat, Copenhagen in October 2010.*

ICES Training Programme is a new and developing part of ICES capacity that was launched in 2009. As an international intergovernmental organization, ICES is ideally placed to command a large audience for training. The ICES Training Committee is comprised of high-profile scientists from institutes of ICES Member Countries, who can assess the training needs of the ICES Community. When the training courses began, courses on stock assessment were offered at both an introductory and an advanced level. During one of the introductory courses, it was suggested that another course be added – one that focused less on how to calculate assessment models and more on understanding how they work. It became clear that the demand among stakeholders was to understand the assessment process but not necessarily to calculate the assessments themselves.

Therefore, the Training Committee took the next logical step and launched the course "Opening the Box". The name refers to the historical black-box approach that was the norm in the ICES fishery advice process until the 1990s, when working-group scientists involved in producing the advice were not allowed to communicate with anyone (even their institutions) before it was completed. This policy was driven by the fear that messages would be misinterpreted before agreement had been finalized. This approach enabled fishery science to speak with one voice, but it did not help outsiders to understand the process. These days, the box is opening, but even with an open box, the complexity of the assessment process makes it difficult for the average stakeholder to understand.

This may explain why thirty-six students were at the ready when this course opened in October 2010. Countries from Northern Europe were well represented, and participants from outside the ICES Area included one each from Italy, Greece, and Hong Kong. It is notable that when participants were asked to organize themselves into four categories – fisheries, policy, research, and NGOs – the four groups were roughly even. This happy and totally random distribution was a feature that many participants, as well as the instructors, described as a strength of the course.

With the arrival of the era of transparency all this is set to change, and ICES has decided to light the way for the uninitiated.

Defined by the focus of their work, participants from each category cited understanding the advice as their main reason for attending the course. One participant, Björn Stockhausen from the Institute for the Protection and Security of the Citizen (IPSC), part of the European Commission's Joint Research Centre, also noted the importance of stakeholders understanding the process from the outset: "Stakeholders should be involved from the beginning any time policy is being developed and decision-makers are making decisions that will affect them, not just in fisheries".

The three instructors, Martin Pastoors (Centre for Marine Policy, the Netherlands), Christopher Zimmermann (von Thunen Institute/Institute for Baltic Sea Fisheries, Germany), and Ciaran Kelly (Marine Institute, Ireland) are all seasoned fishery scientists with many years of involvement in the ICES advisory process. Martin Pastoors previously chaired the Advisory Committee on Fishery Management, and Chris Zimmermann is a current member of the Advisory Committee.

The three-day course, which covered a vast amount of information, was dynamic, with instructors responding to questions by tailoring presentations to the needs of the participants.

Instructor Ciaran Kelly explained that the aim behind "opening the box" was not only to enable people to understand complex assessments but also to welcome stakeholders to the Secretariat. According to Kelly, "We wanted to open the box by creating an opportunity for people to look in, and get them in the building and meet the staff. Many ICES clients are remote, and this exercise helped the users of the *ICES Advice* understand the organization. Being welcomed into the office of the General Secretary and being allowed to ask questions outside the scope of the course helped them to understand the organization. So, in this respect we achieved the goal of letting people look into ICES and the advice".

Participant Sally Clink, Executive Secretary of the Baltic Sea Regional Advisory Council, considered this aspect of the course a highlight, because she has often viewed ICES as a closed organization. "Sometimes, it seems as if the blinds are drawn down, the buttons get pushed, and then the answer is spat out".

Although the instructors did an excellent job of "demystifying" the advice process, the opportunity to work alongside fellow stakeholders reminded her of "the socio-economic realities…. Fishers depend on this advice, and we need to be confident that the decisions being taken are the right ones".

On the other hand, David Anderson, Chief Executive Officer of the Aberdeen Fish Producers Organisation, someone who is well acquainted with the tension between all of the parties involved – scientists, politicians, and industry – developed a greater awareness of the tasks that the scientists faced.

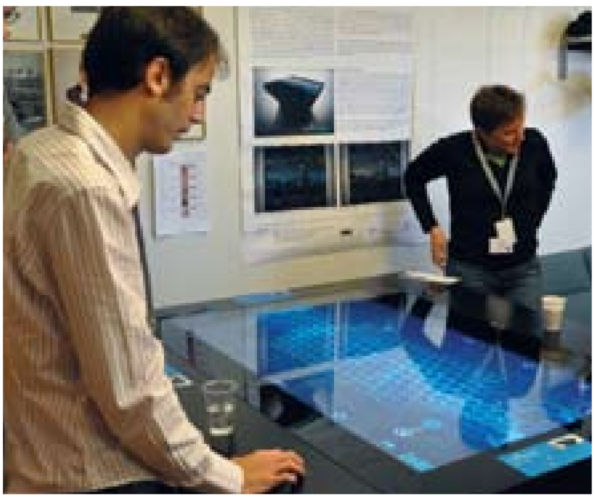
ICES role as an international inter-governmental organization leaves it poised to command a large audience for training.

Overall, the course was well received and its success was further underlined by the unanimous feeling that it should be continued and possibly offered as a three-tiered programme: introductory, intermediate, and advanced.

Literature cited

ICES. 2010. Report of the Training Course: Opening the box: Stock assessment and fisheries advice for stakeholders, NGOs and policy-makers (TCSAFAS), 5–7 October 2010, ICES Headquarters, Copenhagen. 14 pp.

Wilson, D. C. 2009. The Paradoxes of Transparency – Science and the Ecosystem Approach to Fisheries Management in Europe. MARE Publication Series No. 5, Amsterdam University Press, Amsterdam. 197 pp.



▲ *Taking a break from the course: participants Alexandre Rodriguez from NWWRAC and Louize Hill from WWF try out the ecoOcean game.*

CHONe: Census and

Paul Snelgrove and Uschi Koebberling explain how an ongoing programme is guiding research into sustainable oceans in a challenging environment.

When your jurisdiction includes 16.2 per cent (243 791 km) of the world's coastline and spans three oceans (Atlantic, Pacific, and Arctic), sustainable ocean management is a huge challenge. Such is the case for the 34 million people of Canada, whose numbers pale compared with the more than 500 million in the 27 countries along the European Union's coastline, which spans 143 261 km.

The scientific landscape is changing

An integrated ecosystem-based management approach, called for in Canada's 1997 Oceans Act, has replaced the single population-based approach that dominated ocean management for many decades. It requires a shift not only in how Canada's oceans are managed but also in the required scientific information. International agreements add to the problem's complexity, including commitments to the Law of the Sea, and to the Convention on Biological Diversity, under which Canada agreed to increase its marine protected areas from the current 1 per cent to 10 per cent, and to respond to urgent needs on climate change in the Arctic Ocean, where sea ice has been melting at an alarming rate. Although the mandate for ocean management in Canada has expanded, the funding to support the required ecosystem-based science has not.

> Canada agreed to increase its marine protected areas from the current 1 per cent to 10 per cent.

Over the past decade, the Census of Marine Life project simultaneously created the foundation for global marine biodiversity research, built a model of large-scale scientific collaboration, and contributed to a technological revolution that is reshaping ocean sciences. It brought new tools and technologies for sampling, observing habitats and animal migrations, modelling ecosystems, and identifying new species and knowledge gaps. Canadian scientists, who held many leadership positions in the ten-year project, built on this experience to create the Canadian Healthy Oceans Network (CHONe), a collaborative, multidisciplinary research network involving university and government scientists from coast to coast. Now in its fourth year, with funding from the Natural Sciences and Engineering Research Council of Canada (NSERC), provincial and university financial support, and ship time from Fisheries and Oceans Canada, CHONe has expanded its network of collaborations and formed strategic partnerships with national and international marine science organizations, including ICES, to create and integrate new marine conservation tools and knowledge.

Through these collaborations, CHONe is bringing cutting-edge tools and technology to its network. For example, the underwater laboratories of the NEPTUNE and VENUS observatories use fibre-optic cables to provide continuous data on dynamic ocean ecosystems; a state-of-the-art underwater vehicle (ROPOS) collects precision samples from remote habitats; novel microparticle trackers provide new understanding of larval dispersal and population connectivity; advanced GIS applications enhance habitat mapping and prediction for better spatial management; image recognition tools facilitate organism identification and habitat mapping; and with new genetics and taxonomy tools, CHONe is helping to build a barcode library and taxonomic inventory for Canada's marine species.

To provide policy-relevant information on biodiversity and ocean health, CHONe's research programme is organized into the three themes of biodiversity in time and space, ecosystem function, and population

consensus in Canada

connectivity. Each is led by theme leaders from academia and government to ensure that projects are relevant to policy applications, and results will be presented in a framework that helps the management community understand the ramifications of actions in a complex marine system and to address key national marine conservation priorities.

As Canada accelerates its pace to create networks of marine protected areas to meet international obligations, it needs relevant ecosystem indicators, risk-based frameworks, knowledge of habitats of special importance, and understanding of the pathways of change and their drivers. Cabled observatories and remotely operated vehicles, for example, provide CHONe researchers with unprecedented opportunities for real-time study of the dynamics of benthic communities in relation to natural habitat variability and allow CHONe scientists to develop models of ecosystem dynamics and services.

To help Canada address climate-change impacts in the Arctic Ocean, scientists faced a very large study area with never-before sampled ecoregions. Working collaboratively with ArcticNet, a major Centre of Excellence research programme on the interaction of ecosystems and human health, researchers used novel tools to collect samples and explore habitats of the Arctic Corridor. They discovered an Arctic more diverse than expected but with severely endangered marine mammals. This work will continue in partnership with ArcticNet and the Canadian Aquatic Invasive Species Network to assess and predict impacts and help develop mitigation strategies as the Arctic continues to warm.

Cabled observatories and remotely operated vehicles provide CHONe researchers with unprecedented opportunities.

▲ *Canada's three oceans: the Pacific, the Arctic, and the Atlantic, showing Discovery Corridors in yellow. These locations are focal areas for biodiversity research.*

	Arctic	Eastern	Western
Phytoplankton	1002	626	482
Infauna	1033 (53 m^2)	1145 (178 m^2)	814 (20 m^2)
Malacostraca	385	323	242
Zooplankton	372	381	481
Macroalgae	210	350	650
Total (not including microbes)	**2830**	**3072**	**2838**

Known species from each of Canada's oceans, showing a more diverse Arctic than expected (numbers in parentheses show total area sampled).*

**Source: Archambault, P., Snelgrove, P. V. R., Fisher, J. A. D., Gagnon, J-M., Garbary, D. J., Harvey, M., Kenchington, E.,* et al. *2010. From sea to sea: Canada's three oceans of biodiversity. PLoS One (2010), doi 10.1371/journal.pone.0012182.*

Securing ocean health: applying marine biodiversity science

The challenge now is to create effective conduits to communicate findings, moving from surveys to predictions of biodiversity patterns and driving factors, to provide accessible datasets, to develop ecosystem-based management tools, and to establish metrics for outcomes of marine protected areas.

- Biodiversity research provides taxonomic baseline data, informs on the biology of critical species, and defines critical habitat.
- Ecosystem health research contributes new assessment methodologies and disturbance models.
- Sources and sinks research offers metapopulation input to management strategies and assesses impacts of oceanographic events on recruitment.

Like the European science community, CHONe must establish new forms of research governance and foster dialogue between the marine scientific community and the policy and industry sectors by developing mechanisms for a concerted dialogue and a science–policy partnership that is sustainable in the long term. The biodiversity research community and Canadian government agencies are developing a dialogue that must be sustained over the long term, beyond the five-year horizon of research networks, if we are to make headway on a complex problem in a world with strained research budgets and increasing resource needs. The next step is to link with researchers and apply this knowledge by taking advantage of key ICES working groups, including ICES new marine biodiversity initiative, which CHONe helped to shape. Parallel efforts are already underway to engage scientists from around the world in the development of an international research programme to follow on from the Census of Marine Life, and to utilize existing collaborations and shared methodologies in order to continue building a new understanding of marine biodiversity that ICES and other groups can help translate into policy application.

▲ *Sea ice level in January 2011. Pink line indicates the January 1979 to 2000 average extent.*

Paul Snelgrove is a professor in the Ocean Sciences Centre and Biology Department of Memorial University and Director of the NSERC Canadian Healthy Oceans Network.

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Confessions of a word-a-holic

As he prepares to pass the torch to a new editor-in-chief of the ICES Journal of Marine Science, ***Andy Payne*** *looks back on more than twelve years editing the* **Journal**, *eight of which was as E-i-C.*

Many years ago (almost 40 in fact), I realized that I actually enjoyed the tasks of scientific editing and improving the written use of the English language, and I sought ways to incorporate both of these tasks into what was then the long working career ahead of me. Fortunately, some of my colleagues and acquaintances, both then and over the years, saw some value in me developing my editorial skills, and allowed me to take on a succession of editorial duties and tasks for several scientific journals. My mentor then was an Afrikaans academic with a brilliant command of the English language. I owe a huge amount to Hajo (Boontjies = Beans in English) Boonstra for setting me on the right road to competent editing. Fast forward to today, and I look back on these experiences with great pleasure as I prepare to stand down after some eight years of stewardship, i.e. serving as Editor-in-Chief of the *ICES Journal of Marine Science*.

There have been frustrations along the way, of course, and there are a few authors and reviewers whose names I have listed in my private "black book", so it is not surprising that many editors will tell you that editing can sometimes be a thankless task. However, in my opinion, the pros have far outweighed the cons. It is always exciting to see a new issue appear in print, and also gratifying to have helped and supported authors in the presentation of their scientific ideas and results to the public in a professional manner, whether or not they specifically acknowledge your efforts.

Purely from the perspective of the *ICES Journal*, my first exposure was in 1998, as guest editor for an ICES symposium held in Cape Town, South Africa, where I was then based. Given this experience, perhaps I should not have been surprised when, within a month of taking up a new research post in the UK, the then Editor-in-Chief, Niels Daan, wrote to me out of the blue, asking whether I would consider joining his team as an editor. Accepting his invitation with alacrity, I little knew that I would very soon be applying for his position as E-i-C of the *Journal*, when he took well-earned retirement.

The past eight years have been a huge learning curve for me, extending well beyond the spectrum of editing *per se*. However, through working with several highly competent people at ICES, some of them still there, being involved in the change of publisher, entering the era of electronic submission and publication, and making masses of very good friends along the way, I can only describe my experience with the *Journal* over the past decade or so as a privileged one.

I will mention no names (other than that of Niels, for whose editing abilities and leadership I will always have the deepest respect, and who gave me the confidence to take on this task in the early 2000s) for fear of omitting someone. Instead, I will reminisce about a few of the issues that will probably remain in my memory long after handing on the reins to my hugely experienced successor at the end of December 2011. However, it would be remiss of me not to thank sincerely my colleague *Journal* editors and ICES support staff over the years (their names appear in the inside front cover of the *Journal*) for their support, understanding, enthusiasm, and above all warm friendship.

I will never forget the many evening and weekend hours that I have devoted to keeping the *Journal* where I believe it deserves to be: in the top echelon of marine scientific publications worldwide.

As an example of things that remain memorable, I will never forget the many evening and weekend hours that I have devoted to keeping the *Journal* where I believe it deserves to be: in the top echelon of marine scientific publications worldwide. Currently, we receive about one standard issue manuscript every day and, although many fall by the wayside and don't command a great deal of my time, I am always at least aware of their content and potential scientific value. My family will probably be surprised to see me so often outside my study in future, but I hope to find some less self-absorbing pastimes to keep my mind active and me out of their hair.

Another issue I will never forget is that the business of publishing is highly competitive, and the several months, off and on, that I spent evaluating six highly professional publishing houses for what they could offer ICES and its *Journal*, were they to be employed to publish it, was a great eye-opener. Each of them offered us a great package, but I remain convinced that the one offered by Oxford University Press (OUP) was, and still is, the best suited to ICES current needs. Of course, I may be

Andy collecting information for his PhD during the late 1970s. The species is South African Kingklip, *Genypterus capensis*, in this case caught by trawl.

Late 1970s, Andy (third from left, doing the lifting) playing social rugby for the then Cape Town Sea Fisheries Research Institute team against the SABC (South African Broadcasting Corporation) team in Cape Town.

Mid-1980s measuring a small snoek (*Thyrsites atun*) on a groundfish research cruise off South Africa on FRS "Africana", in the halcyon days when he was still allowed to go to sea.

somewhat biased after working with such enthusiastic and professional people at OUP, who have become more friends than business partners over the years, but that is what publishing is all about: building mutually beneficial relationships. It was OUP who strongly recommended that appointments to the editorial team be made in a formal, contractual way, rather than by the old-style "gentlemen's agreement" that we had adopted – and they were most certainly right. Also, the older one gets, the more difficult it can be to embrace new technology, so taking on ScholarOne as our electronic publishing tool proved both challenging and, thanks largely again to the technical support proffered by OUP staff, ultimately rewarding.

I remember thinking about what I wanted to achieve for the *Journal* when I took over the reins in 2003 and, looking back, I wonder how successful I have been. Given my lifelong interest in the English language, one of my aims was always to ensure the quality of the written and illustrative material in the final publication, which, of course, had to be scientifically sound and largely innovative. I believe that I have achieved that target and, hopefully, have provided a base on which my successor can build his future vision for the *Journal*, perhaps in other directions.

I also wanted to broaden the disciplinary base covered by the *Journal* in terms of subject material and, where possible, to provide more publishing opportunities for scientists from ICES Member Countries and from other countries, whose work could perhaps have been published elsewhere than the *Journal*. Perhaps I have been less successful in achieving these two aims, and for these reasons: (i) the increased competition for space resulting from the increasing number of submissions, and (ii) the need to maintain a high impact factor, which, whether we like it or not, is the basis on which many customers evaluate our performance and make decisions on subscribing to and offering their work up for publication in journals. I suspect, therefore, that my hopes were too optimistic for current publishing reality, but progress has still most certainly been made. The *ICES Journal* is now, in my opinion, exactly where it should be: publishing innovative, cutting-edge material relevant not only to ICES Member Countries, but also to the rest of the world.

The *ICES Journal* is now, in my opinion, exactly where it should be: publishing innovative, cutting-edge material.

I would like to recount here, though, perhaps the only time in my handling of the *Journal* when I was completely "gob-smacked" by a comment, made in public, about *Journal* machinations. The then Chair of the Publications Committee, in seeking a candidate successor, was seemingly perturbed when I nominated one of the other editors of the Journal for the position, and asked how there could be any "discipline" in future if two editors held such responsible ICES positions alongside each other. As it happened, he needn't have worried, because his replacement Chair and I worked very well together,


Also on FRS "Africana" in the mid-1980s, using trawl-on-bottom time to catch up on ageing Cape hake (Merluccius capensis) otoliths.


He rarely plays (and never sings) these days, but Beatriz still does like to sing! The Payne/Roel singers doing a gig at an office social in the early 1990s in Cape Town.

both in our two completely separate roles, and supported each other when the need arose; indeed, the originator of the comment himself applied to become a *Journal* editor some years later, and the editorial team remains a focused, disciplined, and happy one with him on board.

At this point, I shall bring these brief reminiscences to a close and simply thank one and all for allowing me to occupy this privileged position within ICES for so many years. Maybe I will have more time to myself in future, and maybe I will take on a few other editorial challenges, but never anything at the highly pressured level that I have recently experienced, and never in competition with ICES and its *Journal*. I still enjoy the English language immensely, so all I ask for is the understanding of those who have "crossed swords" with me over the years on the style and content of their own work. I have never held grudges, and have always treated everyone similarly, young and old, inexperienced and vastly experienced, so my sometimes forthright comments and decisions should be viewed in that light, simply as an attempt to help everyone better themselves in terms of the written and published word. Again, thank you.

I wish Howard every success in taking the *Journal* to even greater levels of excellence in the years to come.

Andrew (Andy) I. L. Payne was born in Cardiff, Wales, and worked in southern Africa, mainly South Africa, for 30 years (leaving as the Director of the (former) Sea Fisheries Research Institute) before returning to the UK. Currently, he is an International Fisheries Consultant at Cefas Lowestoft, and lives in England (mainly) and Spain. He personally wrote/edited the coffee table book Oceans of Life off Southern Africa *and lead-edited two volumes for Cefas (*Management of Shared Fish Stocks *and* Advances in Fisheries Science: 50 years on from Beverton and Holt*). He is married to Beatriz Roel, former Chair of several ICES working groups, most recently WGWIDE (Widely Distributed Stocks), and has four children. In his nearly 40 years as an editor, he has served a variety of journals and has worked for the* ICES Journal of Marine Science *since 2000, but has been a loyal member of the ICES family since the early 1990s.*

Howard Browman will assume his duties as Editor-in-Chief at the beginning of 2012.

▶ *A meeting of the editors of the* ICES Journal of Marine Science *held at ICES ASC 2009 in Berlin. Standing from left: Rochelle Seitz, John Ramster, Pierre Pepin, Bill Turrell, Emory Anderson, Verena Trenkel, Andy Payne, and Panayiota Apostolaki. Sitting: Sarah B. M. Kraak, Audrey Geffen.*

Overcoming the “tragedy of the commons” in fishery management

__Sarah B. M. Kraak__ considers how to use the “public goods game” to find incentives to preserve the commons.

In situations of declining or depleted fish stocks, fishers seem to have fallen prey to the "tragedy of the commons". This occurs because fishers face the dilemma that, although they understand that limiting their catches would pay off in the form of sustainable future catches, they can never be sure that the catch which they have just sacrificed will not be immediately snapped up by competing fishers. Standard economic theory predicts that, in such dilemmas, individuals are not willing to cooperate and sacrifice catches in the short term, and that, consequently, the resource is overharvested. However, over past decades, a multitude of research endeavours have shown that humans often achieve outcomes that are "better than rational" by building conditions where reciprocity, reputation, and trust help to overcome the temptations of short-term self-interest (Kraak, 2011).

The biological roots of this cooperative behaviour are gradually being understood (Sigmund, 2010). Studies have provided insight into why and how a natural human tendency to cooperate under certain conditions could have evolved and become hard-wired; the evolutionary roots of human altruism are evident from the fact that chimpanzees display similar behaviour. The hard-wiring itself, namely the physiological basis of trust and cooperation, is being unravelled, giving birth to the discipline of neuroeconomics (Zak, 2008); the hormone oxytocin appears to play a role, and neural correlates in the brain have been uncovered. Moreover, a genetic polymorphism has been found to correlate with individual variation in levels of trust, cooperation, and generosity. Human nature turns out to be self-interested and altruistic! Fishery management could utilize this potential for spontaneous responsible fisher behaviour by setting conditions that enhance natural cooperative tendencies.

Elinor Ostrom, 2009 winner of the Nobel Prize in Economic Sciences, has replaced the grim and gloomy predictions of humans being stuck within the tragedy of the commons with a more optimistic picture. Decades of field research have shown that individuals systematically engage in collective action, for example, to increase the likelihood of sustaining natural resources, without an external authority to offer inducements or impose sanctions. Ostrom (2009) provides an analysis of factors conducive to collective action in real-world examples.

▲ *Nobel Prize laureate Elinor Ostrom has lamented "Many policies based on the assumption that externally imposed sanctions are necessary have exacerbated the very problems they were intended to ameliorate".*

On the negative side, the large resource size of high-sea fisheries, the large uncertainty in knowledge of the state of the resource, and the mobility of fish are all non-conducive to pro-social collective action; unfortunately, these variables are not under our control. On the positive side, when users share a common knowledge of the system and of how their actions affect each other, have full autonomy at the collective-choice level in order to devise and enforce some of their own rules, and depend on the resource for a substantial portion of their livelihoods, pro-social collective action is more likely.

Recently, it has become apparent that central intervention from authorities often directly undermines existing willingness to cooperate and obey the rules, and diminishes any stewardship motives (Bowles, 2008; Richter and van Soest, 2011). Policies based on the assumption that humans can only be lifted out of the economic trap through externally imposed sanctions have been subject to major failure and have exacerbated the very problems they were intended to ameliorate. They remove the possibility of people signalling their good behaviour to their social peers. Economic sanctions may also make people feel that they can "buy the right" to be non-cooperative by paying a fine or fee; in this way, they buy the right to overexploit the common resource. Similarly, the market for carbon-emission permits might be perceived as trading the rights to pollute the world. Also, too much monitoring may produce the counter-intuitive result that individuals feel they are not trusted and thus become less trustworthy. They may assume that formal organizations are charged with the responsibility of taking care of their joint needs and that cooperation is no longer needed. Importantly, whereas economic incentives, such as fines, tend to diminish any existing social capital when they are imposed externally, the opposite seems to be the case when they are imposed from within, by peers. Translated into the fishery-management context, this would imply that, even if managers believe it is desirable to keep institutional sanctioning, it may be important to involve the stakeholders in decision-making, for example, on the level of sanctioning. Alternatively, the stakeholders themselves could institutionalize financial sanctions from within through their producer organizations.

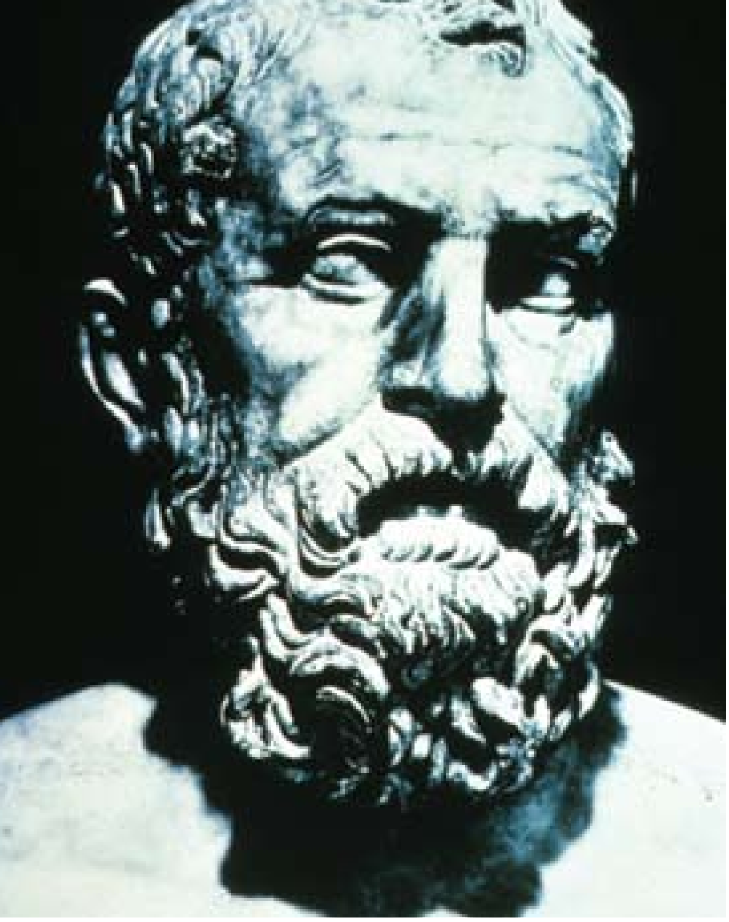
These ideas resonate well with the intentions of the European Union as reflected in the Green Paper on Reform of the Common Fisheries Policy (Commission of the European Communities, 2009). According to this Green Paper, the general framework for fishery policy would be set on the basis of a Commission proposal, but detailed implementation decisions could be taken at a regional level through a process of stakeholder interaction.

This reflects the recognition that a fishing industry cannot be managed effectively without the cooperation and participation of fishers in the formulation of policy and in the implementation and enforcement of laws and regulations.

One dogma that may have to be abolished is that fisheries data at the individual vessel level are often strictly confidential.

The conclusion from Kraak (2011) and Bowles (2008) is that small differences in institutional design may lead to very different outcomes in terms of cooperative fisher behaviour to overcome the tragedy of the commons. Human nature displays both self-interest and altruism, depending on external conditions, which can be manipulated. Thus, self-interested cynical people may become responsible moral agents under the right conditions. Settings that enhance these desirable outcomes include (i) non-anonymity – fishers' individual choices should be publicly known among them and/or within their wider social community; (ii) provision of knowledge to fishers on the state of the resource and on the urgency and impact of their responsible behaviour; (iii) fishers' self-decision on rules and (levels of) economic sanctions; and (iv) face-to-face communication among fishers and between fishers, managers, and other stakeholders.

One dogma that may have to be abolished is that fisheries data at the individual vessel level are often strictly confidential. This suggestion follows from the findings that, in order to maintain high levels of cooperation, it appears to be important to use the opportunity to acquire information on each other's contributions, because this is required for reputation-building and for the (social) rewarding or punishing of each other's behaviour. In the current situation, where individual vessel-based fisheries data are confidential, one such opportunity for monitoring each other's level of pro-social behaviour is absent.



▲ *Athenian statesman and lawmaker Solon (ca. 638–558 BC). In drawing up his laws, Solon was ridiculed for supposing that his countrymen's greed could be kept within bounds by means of laws. He replied that he was framing his laws in such a way as to make it clear that it would be to everybody's advantage to keep the laws rather than to break them.*

Let the games begin!

The public goods game is an experimental model commonly used to study social dilemmas. For example, €5 is given to each of four people, who are given the option of investing some or all of their endowment in a group project by contributing, without discussion, any amount between €0 and €5 into the public pool. The contributions are collected, and the total amount is then doubled and divided equally among the players, irrespective of their contribution. If each of the four players contributed €1, each of them would receive €2 (i.e. a net gain of €1). If only three of the four players contributed €1, each of the three contributors would have a net gain of €0.50, but the defector would have a net gain of €1.50.

The prediction from standard rational economic theory is that no one will ever contribute anything because each €1 contributed yields a return of only €0.50 to its contributor (corresponding to a relative loss of €0.50), no matter what the others do. This is a public goods problem because the group would be best off (i.e. taking home €10 each) if each member contributed €5. However, individual short-term self-interest is at odds with long-term interest. In these experimental settings, people usually cooperate more than is predicted by standard economic theory; nevertheless, observed cooperation is heterogeneous, declines quickly over time, and is often suboptimal.

Translating the public goods game into a fishery-management setting

In a previous article (Kraak, 2011), I used thought experiments to consider how this model could be translated into a fishery-management context. Imagine that four fishers each have a catch quota of five fish. They are told (analogous with the above) that each of them can invest in the rebuilding of the fish stock by refraining from catching between 0 and 5 fish. The total number of spared fish will be doubled and then divided among the group.

In a fishery-management context, it may be more realistic to consider units other than individual fish, such as tonnes of fish, proportion of individual quota share, or allocated effort. In the experimental setting, the experimenter has an apparently unlimited amount of money available with which to artificially double the amount contributed to the common pool. In reality, it would be impossible to double the amount of fish in the common pool. Fortunately, however, fish multiply naturally!

Fish that are left in the pool for any length of time will increase in biomass by the amount of growth minus the natural mortality over that period. Indeed, the dilemma of reducing fishing intensity to the level of maximum sustainable yield demands that fishers forego some yield in the short term while gaining yield in the long term.

For example, the weight of a typical catch of cod from the Irish Sea will increase by a factor of 1.4 if the stock is left alone for one year. Furthermore, because large fish command a better price than small fish, the cod will also have increased in value by a factor of 1.6. Let us call this factor W (for "wait") and assign it a value of 1.5.

According to the rules of the game, each of the four fishers makes an individual decision to postpone using a portion of his quota entitlement until, for example, the next year. The next year, the total amount of catch sacrificed by all of the fishers, multiplied by W, and divided by the number of fishers in the group will be added to each fisher's basic quota entitlement for that year. Assuming that W is 1.5, if each of the four fishers sacrifices catch this year valued at €1000, they would each be allowed to add catch valued at €1500 to their quotas (i.e. a net gain of €500 each) next year. If only one fisher sacrifices this year's catch (value of €1000), each of the four fishers would be allowed to add catch valued at €375 to his/her quota next year; the cooperative fisher would, therefore, suffer a net loss of €625, whereas the defectors would each enjoy a net gain of €375. Note that when the TAC and the quota for the next year are being calculated through standard stock-assessment procedures, an assumption is being made about the current year's total catch; our calculations above are valid providing that any catch sacrificed is not added ("returned") to the modelled stock size.

The calculations above ignore the economic phenomenon of *discounting*, which arises from the rational preference to receive benefits today rather than postponing them until tomorrow: €100 today has a greater value than €100 next year, which is why borrowed money has to be paid back with interest. Great uncertainty about the future results in a high discount rate, and this constitutes one of the fundamental problems in resource management. In our calculations, we could reduce the gain with a factor representing the discount rate – as long as its inverse is (much) smaller than *W*. With a discounting factor of 0.9 $year^{-1}$ and *W* equalling 1.5, the perceived gain that drives the cooperation would be +0.35. Another aspect fundamental to making the fishing game more realistic is group size. The experimental setting of four people in a group is very artificial. National quotas are usually distributed to several hundred fishers. Whereas in the example with four players, a player who contributes €1 would lose only €0.50 if the three other players defect; he/she would lose €0.99 (almost all of the €1 contribution) if all of the others in a group of 200 players defected. The gains if all players cooperate do not depend on group size; they are always double the total starting amount. Thus, the rationality of cooperation decreases with group size.

In any case, in the restrictive settings of the model described by the basic public goods game, not a great deal of cooperative behaviour can be expected because the fishers are caught in the tragedy of the commons. Thankfully, humans do not always make decisions based on what is economically rational.

Experimental studies have confirmed that human subjects preferentially help others who have a positive image score.

Exploring the game when reputation matters

Theorists have demonstrated that cooperation can evolve through *indirect reciprocity*. This refers to the phenomenon that individuals who help others are given support, and that supporters as well as helpers accrue a positive reputation or image score. Experimental studies have confirmed that human subjects preferentially help others who have a positive image score.

Milinski *et al.* (2002a) measured the increase in cooperation under indirect reciprocity. In their experiment, participants played a version of the public goods game with an added dimension that they called the "indirect reciprocity game". This game assigns some participants to the role of donor and others to the role of recipient in a public situation where no direct reciprocity is possible. Donors have the option of donating a sum to an assigned recipient who will never be able to reciprocate this gesture. The sum received will be greater than the sum donated by an arbitrary factor; in this experiment, the donors "paid" 2.5 and the recipients "received" 4.

Rounds of both games were played alternately, decisions were made confidentially, and after each round, the outcomes were displayed publicly.

Milinski and his colleagues found that cooperation (and consequently average individual pay-off) in the public goods games increased significantly when they were alternated with the indirect reciprocity games. Over eight rounds, the probability of cooperation in purely public goods games fell from 84 to 45 per cent, but it remained around or above 84 per cent when these games were alternated with indirect reciprocity games, in which case the average individual pay-off was 1.45-fold higher.

Translation of the game when reputation matters into fishery-management settings

The outcome of the above experiment indicates that (i) people are more inclined to contribute to the common pool if their reputation is at stake, and (ii) people reward each other for generosity. If we imagine this game being used as a management tool in a hypothetical fishing community where players are not anonymous, it is expected that generous contributors will receive benefits in their local communities throughout the year, while defectors may become social outcasts. It is precisely this expectation, of receiving favours vs. becoming a social outcast (whether partly or wholly unconscious), that operates as an incentive to contribute more generously. However, if only one round of the public goods game is played per year in this hypothetical fishing community (naturally interspersed by the rest of the year, during which indirect reciprocity takes place), an individual will not be allowed quick adjustment of the level of cooperation in response to feedback about their reputation and generosity. Perhaps multiple rounds per year would have to be played.

Moreover, in a real-world situation, this may only work if a fishery is harvested by fishers in a relatively small local community, where all fishers know each other personally and interact extensively year-round, i.e. where reputation is important. An important prerequisite if this system is to work may be the publication of the outcomes of the public goods game, with participants' full names, for example, in the local newspaper.

In a similar experiment that tested the effect of reputation and indirect reciprocity (Milinski *et al*., 2002b), it was found that, when people donated publicly to a well-known charity, they themselves received increased donations from members of their peer group. Thus, people are rewarded for generosity not only towards fellow players, or towards a common pool of direct interest to the players, but also towards a charity from which only third parties benefit. This has important implications, as explained in the following experiment.

One could envisage establishing a mixture of rewarding fishers with some extra quota for next year combined with the more abstract reward of stock growth.

When the public good game really is for the public good

In another experiment, Milinski *et al*. (2006) demonstrated that if, in contrast to the standard protocol (where the common pool is divided among the participants), it is promised that the pool will be invested to encourage people in the society at large to reduce their fossil fuel use (through an advertisement in a national newspaper), players can behave altruistically. The experimenters found that the basic level of unselfish behaviour was enhanced if the players were provided with expert information describing the state of knowledge in climate research. Analogous to the previous experiment, personal investments in climate-change prevention increased substantially if social reputation was at stake.

Translation of the public good game into fishery-management settings when it really is for the public good

The discovery that individuals are willing to invest in a public good that conveys an uncertain benefit, which is diluted among the whole of society, is an important one for our case. It implies that fishers may be cooperative not only if their sacrificed quota is given back to them multiplied by W at a later stage, but also if the only gain to the individual fisher is the possibility of a rebuilt or increased stock. This is important, because, if this were not the case, the stock would not necessarily benefit from such cooperation; after all, fish that were not taken out today would be taken out tomorrow (or rather next year). However, if fishers, under the right conditions, can experience an incentive to invest in the rebuilding of the stock itself – a public good that is shared by all people, not just by their group of players – this can be used in fishery management. In this scenario, fishers would be willing to sacrifice catches for the sake of stock increase, from which they themselves and everybody else may benefit in an undetermined future and by an undetermined and uncertain amount.

As an illustration, the recommended TAC for the Celtic Sea cod stock (ICES Divisions VIIe–k) in 2009 was 2600 tonnes, which was predicted to bring the spawning-stock biomass in 2010 to 8800 tonnes (ICES, 2008). If 10 per cent of that TAC (i.e. 260 tonnes) had been sacrificed, those fish, allowing for growth and natural mortality, would have increased in biomass by a factor $W = 1.4$ to 364 tonnes, resulting in an increase in predicted stock biomass of 4 per cent. Alternatively, if the 10 per cent had not been sacrificed but only postponed for one year, then the 260 tonnes would have been added to the TAC for the next year, and a net gain of only 104 tonnes would have been added to the stock biomass. This would mean that there had only been a 1 per cent increase in the predicted stock biomass.

One could envisage establishing a mixture of rewarding fishers with some extra quota for next year combined with the more abstract reward of stock growth. The fishers' incentive to postpone some of this year's catch would then be partly a "direct" gain (a known increase in quota, albeit postponed to next year) and partly an "indirect" gain through stock growth. The net gain of 104 tonnes could, for example, be split between extra quota and stock growth at a ratio of 1 to 9; in this case, fishers would experience a quota increase of 4 per cent and the predicted stock biomass would still benefit from a 1 per cent increase. Note that even a 1 per cent benefit is probably more than the reduction in society's fossil fuel use that could be expected to result from a newspaper advertisement, as in the experiment by Milinski *et al.* (2006).

Nevertheless, the future states of both fish stocks and catches are notoriously difficult to predict, and such uncertainty results in a high perceived discount rate. One of the (many) reasons fishers do not favour conservation plans, despite their apparent long-term benefits, is that stock–catch predictions are often wrong. Consequently, even if it is predicted that, by taking less today, all fishers will benefit tomorrow, fishers know this will not necessarily happen.

Another interesting result of the experiment by Milinski *et al.* (2006) is that altruistic behaviour was enhanced if the players were provided with expert information describing the state of knowledge in climate research. For our purpose, this suggests that it may be important to inform fishers of their expected gains from projected stock growth.

Literature cited

Bowles, S. 2008. Policies designed for self-interested citizens may undermine "the moral sentiments": evidence from economic experiments. Science, 320: 1605–1609.

Commission of the European Communities. 2009. Green Paper: Reform of the Common Fisheries Policy. COM(2009), Brussels. 163 pp.

ICES. 2008. Report of the Working Group on the Assessment of Southern Shelf Dermersal Stocks (WGSSDS), April 30–May 6, 2008, Copenhagen, Denmark. ICES Document CM 2008/ACOM: 12. 548 pp.

Kraak, S. B. M. 2011. Exploring the "public goods game" model to overcome the tragedy of the commons in fisheries management. Fish and Fisheries, 12: 18–33.

Milinski, M., Semmann, D., and Krambeck, H. J. 2002a. Reputation helps solve the "tragedy of the commons". Nature, 415: 424–426.

Milinski, M., Semmann, D., and Krambeck, H. J. 2002b. Donors to charity gain in both indirect reciprocity and political reputation. Proceedings of the Royal Society B, 269: 881–883.

Milinski, M., Semmann, D., Krambeck, H. J., and Marotzke, J. 2006. Stabilizing the Earth's climate is not a losing game: supporting evidence from public goods experiments. Proceedings of the National Academy of Sciences of the United States of America, 103: 3994–3998.

Ostrom, E. 2009. A general framework for analyzing sustainability of social–ecological systems. Science, 325: 419–422.

Richter, A. P., and van Soest, D. P. 2012. Global environmental problems, voluntary action and government intervention. In Governing Global Environmental Commons: Institutions, Markets, Social Preferences and Political Games. Ed. by E. Brousseau, T. Dedeurwaerdere, P-A. Jouvet, and M. Willinger. Oxford University Press, Oxford, UK.

Sigmund, K. 2010. The Calculus of Selfishness. Princeton University Press, Princeton, NJ. 173 pp.

Zak, P. J. 2008. The neurobiology of trust. Scientific American, 298: 88–95.

Since 2008, Sarah Kraak has been a senior postdoctoral fishery researcher at University College Cork, based at the Marine Institute, Ireland. She is a member of the Scientific, Technical, and Economic Committee for Fisheries, which advises the EC. Having been involved in stock assessment and management-strategy evaluation related to mixed demersal fisheries, she is now mainly interested in developing innovative strategies for fishery management, especially considering the human factor.

ELLEN JOHANNESEN SAYS, "FOOLING AROUND IS SERIOUS BUSINESS"

People engage in game-playing for amusement, but games are also a tool for learning. Technology makes it possible to use games and simulations in powerful ways. Computer games can help players imagine what it would be like to interact in simulations of any real-world situation, for example, as a racing-car driver or a football player in the World Cup.

In the game ecoOcean, players interact with an overfishing simulation. The game is an attempt to demonstrate to the public the common-pool problem: players try to achieve as many points as possible by catching fish, relying on the same fish stock and, therefore, competing for the resource. If all players catch as many fish as they can, the fish stock will soon be depleted. It is only by communicating and sticking to common rules that a sustainable, higher overall catch can be reached. The game can be played by up to four players, who view the ocean on a common screen, and it takes between two and five minutes to complete.

Development of the ecoOcean game began in 2007, when a joint research team of economists and biologists at the University of Kiel had the idea of conducting economic experiments in which students and fishers play a game assigning marine protected areas and then investigate the rationale behind the players' decisions. Funding for the game's development was part of an initiative by the German Science Foundation (DFG) to support research on specific topics in universities and institutions. In Kiel, the Cluster of Excellence "Future Ocean" sponsored the cooperative endeavour between the departments of Economics and Fishery Biology.

Presented with the opportunity to be part of an exhibition at the Deutsches Museum in Munich, the developers were determined to create a game that could engage the public in an appealing and graphic way, with sustainable fishing issues driving the development of the game to its current form. The game won the "Out of the Box" award for the most original contribution to the ICES Annual Science Conference 2010 in Nantes. It was then taken to the ICES Secretariat for the training course "Opening the Box: Stock Assessment and Fisheries Advice for Stakeholders, NGOs, and Policy-makers" in order to serve as a talking point for course participants and Secretariat staff.

The game is not limited to its current form. The developers wanted to ensure that the software and associated model used in the game could be modified in order to investigate further the original ideas in relation to economic experiments. In the words of Jörn Schmidt, the fish biologist involved in developing the game:

> We had the model programmed to be very flexible so that any complexity can be included to add realism with respect to the fish stocks. In the future, we really want to use the same piece of software, not necessarily the table, but the same software to conduct economic experiments. The specific direction depends a bit on the specific research question.

Jörn Schmidt, Dennis Nissen, and Daniela Menge are part of the team who developed ecoOcean. They are seen here (above left) at play in Nantes, France, at ICES Annual Science Conference 2010.

Further sources

Software development: Dennis Nissen; e-mail: post@dennisnissen.de

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Exhibition concept and coordination: Daniela Menge; e-mail: info@danielamenge.de

Scientific concept and project development: Martin Quaas, Till Requate, Rudi Voss, and Jörn Schmidt; e-mail: jschmidt@economics.uni-kiel.de

Funding organization: Cluster of Excellence "The Future Ocean". Available online at: www.future-ocean.de; www.presse@ozean-der-zukunft.de

Adopt + Ad

Celine Byrne traces the history of the recent changes in ICES structure.

ICES General Secretary Gerd Hubold opened the January 2009 issue of *ICES Inside Out* with a welcome to "a new era of advice-oriented science and science-based advice". In that welcome, two of the pillars that constitute ICES structure – science and advice – had become seamlessly entwined.

The changes that have taken place within ICES to facilitate this embrace may not have happened as easily as the General Secretary's words imply. For an organization with a history as long as ICES (now 109 years), change was never going to take place without a little resistance and a lot of discussion.

Nonetheless, the final years of the last decade saw the creation of the Advisory Committee (ACOM) and the Science Committee (SCICOM), the new leadership that would direct ICES ever forward into the constantly changing seascape of marine science. Both committees were established as equal partners and empowered by ICES Council to speak and act on behalf of the organization – ACOM on status and management issues concerning the marine ecosystem, and SCICOM on the direction of the Science Programme. The very adoption of these new names gave the outsider, as well as members of the ICES community, a sense of the balance implied by the General Secretary's words.

When Poul Degnbol joined the ICES Secretariat as Head of Advice in 2010, he spoke of the importance of the interconnectedness of Science and Advice. "I think it very important that… we keep the link between Science and Advice. Advice has to be based on the best available science, and we have to be proactive in our Science Programme so that we build the basis for future challenges in Advice".

In the words of the ICES publication *A Vision Worth Sharing*, ICES vision "clearly embraces the need for advice as the ultimate driving force behind ICES, while at the same time recognizing that advancing scientific capability is the key to fulfilling this need. Sound and credible advice depends on scientific information. Scientific information without a vehicle for translating it into advice will lose the focus it needs to be relevant and responsive".

In this spirit, it is fitting that it was Advisory Services which took the first steps in the process that would change the working structure of ICES.

Speaking with one voice

Previous to the creation of ACOM, Advice had operated under three committees, the Advisory Committee on Fishery Management (ACFM), the Advisory Committee on Ecosystems (ACE), and the Advisory Committee on the Marine Environment (ACME). Their strategic direction was overseen by the Management Committee on the Advisory Process (MCAP).

ACE, which was introduced in 2001, was expected to address advice on ecosystem management. Instead, MCAP realized that it was a sign that further change was needed. If ICES was to embrace an ecosystem-based approach, the existence of these three committees was in fact acting as a barrier, because the advice on fish stocks, ecosystems, and environment were all being dealt with in separate channels. ICES Advice needed to speak with a single voice.

Hans Lassen, the previous Head of Advice, pointed out the danger of continuing without a unified advisory service. "You can close an area to fisheries for instance on a management issue, but you can also close the same area because there are cold-water corals, and obviously ICES must have a common approach to such issues. We can't have, to give an extreme example, the fishery committee saying that you certainly can fish here, while the ecosystem group says, no, you certainly cannot fish there. ICES must make up its mind; it is confusing to the outside world to have three different groups speaking".

Although the need for greater integration of a holistic ecosystem-based approach was established, there were many more drivers for change. Flexibility and a more intensive management of the system were needed.

apt = Adept

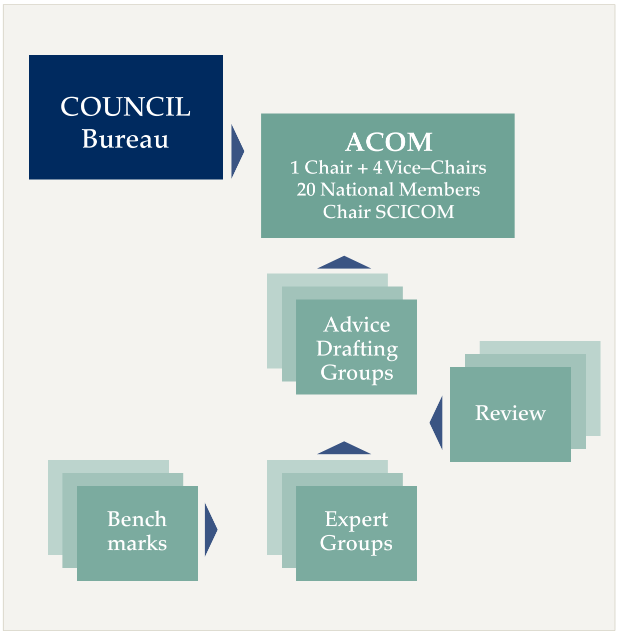
Major elements that pushed the idea forwards included a change in timing of the delivery of the fishery advice, calls for transparency, a stronger link to the Science Programme, heavy workloads, quality assurance, and the need for a single ICES voice.

Discussions took place between the ICES scientific community and members of the different Advisory committees, seeking more efficiency, while considering the reflections of MCAP.

A new framework was presented to Council and was approved in October 2007. This led to the establishment of the Council Working Group on Advice, which filled in the details. In February 2008, Council adopted a comprehensive resolution establishing ICES Advisory Services, and ACOM held their first meeting that same month. The key elements of the reform were the replacement of the three advisory committees with a single Advisory Committee (ACOM), the formalization of many procedures already in place, and the increased openness of the advisory process to stakeholder observers. National representation was maintained to ensure efficient delegated authority and that the advice remained well balanced.

ACOM membership is made up of one delegate from each of the twenty ICES Member Countries, plus the Chair and four Vice-Chairs. The Chair of SCICOM is a member *ex officio*, thus providing a link between Advice and Science.

ACOM was delegated to speak on behalf of Council on status and management issues concerning the marine ecosystem, and all responsibility for Advice was passed to this new committee. The transfer of responsibility to ACOM, and its empowerment, was a major step in the process. ACOM works under the instruction of the Council, based on multiyear approval of the Science and Advisory programmes. In addition, ACOM's role is to promote ICES as a source of strategic advice for marine policy development and marine scientific research, strategically planning current and future advice needs, to a far greater extent than MCAP had been able to do.



The current advisory system includes expert analysis, review of expert findings, advice drafting, adoption of the advice, and input from all ICES Member Countries. The formalization of the review process was part of a general overhaul to ensure the quality of the scientific basis of the Advice. Advice drafting groups were formalized, and non-ACOM members were permitted to be part of the advice drafting, e.g. chairs of expert and review groups as well as interested parties from industry or NGOs.

Through the active management of the process, new ways of responding to users were created. According to Michael Sissenwine, former ICES President and ACOM Chair, "Without this flexible portfolio, ICES could not have engaged with the European Commission to develop technical assistance for the Marine Strategy Framework Directive". ACOM is ultimately responsible for the content and presentation of advice and is the single voice of ICES regarding advice.

Familiar names for new challenges

In order to facilitate a smooth transition, the former Chairs of ACE (Mark Tasker), ACFM (Martin Pastoors), and ACME (Paul Keizer) were elected as Vice-Chairs of the newly created ACOM. Michael Sissenwine was appointed Chair of ACOM.

Despite the difficulties of the transition year (2008), ACOM successfully fulfilled all commitments and demonstrated a responsiveness and flexibility that would not have been possible prior to the reforms. One of the lessons learned is that ACOM must set limits on its responsiveness and flexibility if it is to maintain quality and harmonize advice needs with ICES internal human and fiscal resources.

Modern communications technology has been essential to reducing workloads and adding flexibility. Live web conferencing facilities (WebEx) now allow reviews to be conducted online, thus freeing up some of the time and costs previously spent on travel.

The change in timing of the fishery advice for the EU is a decision that has increased the workload for many working in Advisory Services, making the first half of the year extremely work-heavy. Introduced in the same period as the structural reform, it posed an additional challenge for those who were already working under pressure to produce high-quality analyses, and it provoked a lot of discussion and resistance when first announced by the European Commission, a major ICES client. Indeed, many wonder whether it was the change in timing of the advice or the structural changes that caused the biggest impact.

Another challenge faced by Advisory Services is the provision of integrated advice that includes oceanographic factors and ecosystem processes. Perhaps because of the heavy workload, and because producing integrated advice is difficult, progress has been slow despite the fact that integrated advice is a key objective of the reform of Advisory Services.

According to Sissenwine, "There is also a disconnect between the oceanographers and ecosystem scientists, who think their research should be reflected in advice, and the scientists framing the advice.

"Everyone agrees that ocean conditions and ecosystem processes influence fishery resources, but operationalizing the use of broad knowledge of relationships and processes to produce stock-specific, annual catch advice is as important a step as conducting the research that created the knowledge.

"A further challenge is that management institutions may not be ready to actually use the integrated advice that they have requested. This shouldn't come as a surprise because managers have asked for integrated advice largely because scientists have told them they needed it, but again, only in vague terms. However, there is some research that is ripe for use in advice and application to management. It’s time for SCICOM, ACOM, and managers to pick some of the ‘low-hanging fruit’ to demonstrate the transition of research to operations and applications".

A new direction for the Science Programme

As the ground was shifting beneath the Advisory Programme, fundamental changes were being planned in the Science Programme. It was recognized that adjustments were necessary to achieve two goals: (i) facilitate the exchange of interdisciplinary ideas and to empower the Science Programme by creating the same independence enjoyed by Advisory Services, and (ii) concurrently strengthen the link between Science and Advice. The result was that the Consultative Committee (ConC), which had led ICES science up to that point, and its subject/area committees (as many as 12 in the 1980s and early 1990s, but reduced to only eight before the recent reorganization), that had focused on individual disciplines were disbanded and replaced by the Science Committee (SCICOM). Membership shifted from the ConC model of election by peers to SCICOM’s approach of national nominations.

Harald Loeng, then Chair of ConC, recognized that it was time for change. "It doesn't help to restructure one part of ICES if the other part doesn’t follow. Personally, I wanted this to go hand-in-hand instead of looking at it as two parallel processes".

ConC had discussed structural changes as early as 2004. As current SCICOM Chair Manuel Barange explains, "It was recognized that ICES needed to beef up its science, to consider the changing landscape, both of the diversity of science organizations and the interdisciplinary needs, to address the multiplicity of impacts on the marine environment". There was the further challenge of involving more participants from the world of academia and bringing more scientists into the ICES community.

The expert groups of the science committees that made up ConC were populated primarily by staff from national institutes, with relatively few participants from non-fishery ministries and universities. Steps towards broadening the participation in the organization had already been put in place in 2000, by encouraging a wider range of disciplines to be attracted to ICES Annual Science Conferences.

As plans were revealed, however, there was major concern among the members of different committees as to whether or not their discipline would exist under the new structure. Added to this was the further concern that many would lose their link to ICES.

National representation

ConC observed the Advisory reform process (particularly the empowerment resulting from national representation) and drew lessons from it. Shifting to a system of national representation was indeed a concern. ICES President Michael Sinclair, who at the time was Chair of the two sequential Council working groups that addressed the Science Strategic Plan and ICES Science structure, notes that "the feeling was that by going to national representation we were going to lose the quality of the expertise in this leadership, and I don't think that happened".

Indeed, Sissenwine felt that national representation was the only way forward for the new science committee. "I recall warning the former Consultative Committee that they would become a poor stepchild to ACOM if the science side of ICES was not empowered like ACOM".

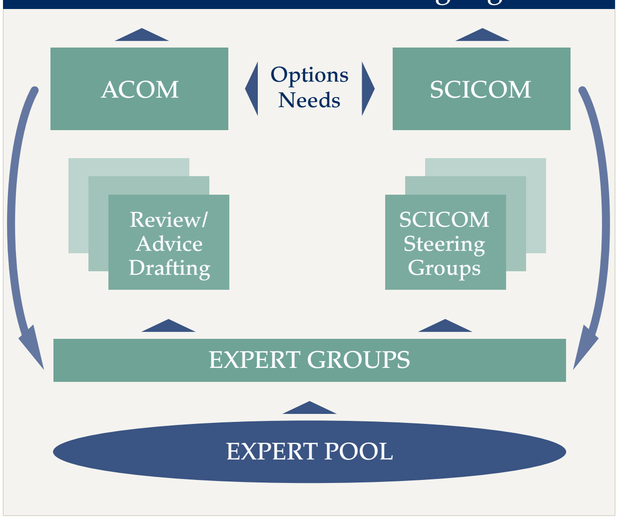
The new structure saw the replacement of ConC with SCICOM, where membership, in contrast to its predecessor, consists of national representation, supported by one alternate member per Member Country. In order to provide additional scientific expertise, the SCICOM Chair is empowered to appoint up to five additional members. It was expected that the five members would be chosen to enhance disciplinary balance. The Chair of ACOM, the General Secretary, and the Head of Science are also members *ex officio* of SCICOM.

Thinking ahead

In May 2009, SCICOM agreed to a structure that established five SCICOM Steering Groups (SSGs) to which the expert groups (EGs) in the Science Programme were allocated:

- Steering Group on Ecosystem Functions (SSGEF),
- Steering Group on Human Interactions on Ecosystems (SSGHIE),
- Steering Group on Sustainable Use of Ecosystems (SSGSUE),
- Steering Group on Regional Sea Programmes (SSGRSP),
- Steering Group on Ecosystem Surveys Science and Technology (SSGESST).

ACOM and SCICOM Working Together



The structure allows EGs to report to more than one parent Steering Group, as well as to ACOM. As Manuel Barange describes, "The Steering Groups ensure that the 80-plus ICES Science expert groups deliver the ICES Science Plan". The SSGs are the direct link between ICES Science leadership and the scientific development being carried out by the EGs.

In addition to the SSGs, SCICOM launched a process to identify Strategic Initiatives (SIs). SIs will strengthen the implementation of the Science Plan. Flexible and time-limited, they will focus on areas that may have been given insufficient attention. Aimed at injecting innovation and dynamism into the organization, SIs help ICES raise its profile among science, management, and policy communities relevant to ICES.

By 2010, three strategic initiatives had been developed into joint ventures with ACOM, helping ICES contribute more effectively to the Science and Advisory needs in specific areas:

- Strategic Initiative on Area-based Science and Management (SIASM),
- Strategic Initiative on Biodiversity Advice and Science (SIBAS),
- Strategic Initiative on Stock Assessment Methods (SISAM).

SCICOM has also developed a partnership with the North Pacific Marine Science Organization (PICES), which includes a Strategic Initiative on Climate Change and Marine Ecosystems (SICCME). This new initiative aims at providing a single voice on science issues related to climate change for the marine science communities of the northern hemisphere, building on the complementary strengths of both organizations.

The development of coordinated SCICOM–ACOM initiatives includes a new steering group on the Marine Strategy Framework Directive, which is working on the development of a coordinated and proactive response from ICES to assist Member Countries and regional organizations in the implementation of the directive.

The Science reform has been a success, but it has also been a substantial challenge in terms of steering, coordination, and integration. During 2010, no less than 1065 scientists attended SCICOM EG meetings (a total of 1362 visits, counting scientists attending more than one meeting), demonstrating the measure of commitment of ICES Member Countries and their research communities. However, according to Barange, "science reform is not the ultimate objective but an opportunity to innovate, evolve, and become more effective at what we do. Our collective challenge is to turn this wonderful participation into outputs and actions that reinforce ICES position as the primary source of knowledge and advice on the marine environment, its ecosystems, and its resources. SCICOM is committed to ensuring that present success translates into an even more successful future, and we will continue to work with the community to this end".

The restructuring of ICES Science and Advice is a step in this direction.

GREATER OPENNESS

The changing political landscape has brought about the need for greater openness and transparency within organizations. ICES is ensuring openness and inclusion of input from a wider range of stakeholders, for example, through its linkages with industry representatives, including substantially increased interaction with regional advisory councils, its active involvement in MARCOM+ (Integrated Marine and Maritime Science Community), and many other such initiatives.

The restructuring of ICES has meant that ICES Council has adopted a policy of greater transparency in order to meet its clients' wishes. Now, all advisory group meetings, with the exception of EGs, are open to stakeholders, who are explicitly invited to the Data Collection and Benchmark Workshops. A benefit of this process, according to ICES General Secretary Gerd Hubold, has been a reduction in criticism. Observers can now see for themselves that the advice originates from the best science. For the advice to be respected, the scientists preparing it should have "no vested interests" and no agenda other than to deliver the best available science "independent of political influence". The maintenance of this scientific integrity, to which ICES owes its distinguished position in the marine science world, is of major concern to Council. ICES must work hard to filter out elements that will produce anything other than the best unbiased advice. Hubold finds that the answer to this is more openness and greater transparency.

ICES CIEM
International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea

International Council for the Exploration of the Sea (ICES) coordinates and promotes marine research on oceanography, the marine environment, the marine ecosystem, and on living marine resources in the North Atlantic. Members of the ICES community include all 20 coastal states bordering the North Atlantic and the Baltic Sea.

ICES is a network of more than 1600 scientists from over 200 institutes. Scientists working through ICES gather information about the marine ecosystem. Besides filling gaps in existing knowledge, this information is developed into unbiased, non-political advice.

ICES mission is to advance the scientific capacity to give advice on human activities affecting, and affected by, marine ecosystems.

What does ICES do?

Science
ICES plans and coordinates marine research through its national delegates and through a large numbers of expert groups, symposia, and an Annual Science Conference.

Advice
ICES is the prime source of scientific advice on the marine ecosystem to governments and international regulatory bodies that manage the North Atlantic Ocean and adjacent seas.

Data
ICES maintains some of the world's largest databases on marine fisheries, oceanography, and the marine environment, and its Data Centre is part of a global network of distributed data centres.

Publication
ICES publishes its scientific information and advice in reports, publications (including *ICES Journal of Marine Science*), electronic media, and on the ICES website. *ICES Journal of Marine Science* is available through subscription. All other ICES publications can be downloaded gratis from the ICES website.

For more information about ICES and its activities visit ICES website, **www.ices.dk.**

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The eye of a sleeping corkwing wrasse (*Symphodus melops*).

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Practitioners faster than scientists – marine nature conservation
by Professor Jan Marcin Węsławski,
Institute of Oceanology PA,
Sopot, Poland

Invited Plenary Lectures

Phytoplankton as indicators of ecosystem response to global change at the land–sea interface
by Dr James E. Cloern,
US Geological Survey, California, USA

Ecosystem-based management for the Baltic Sea – historical development and future challenges
by Professor Ragnar Elmgren,
Stockholm University, Sweden

Theme Sessions

The theme session titles are available on the conference website **www.ices.dk/asc2011/** as well as information about abstract submission, registration, and conference fees. The deadline for submission of abstracts is Friday 15 April 2011. The deadline for early registration is Monday 1 August 2011.

Further information

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Photo: Piotr Margoński, MIR, Poland