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Journal of Northwest Atlantic Fishery Science



Volume 31

Symposium on Deep-Sea Fisheries

Co-editors: J. A. Moore and J. D. M. Gordon

NAFO/ICES/CSIRO Symposium
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Foreword

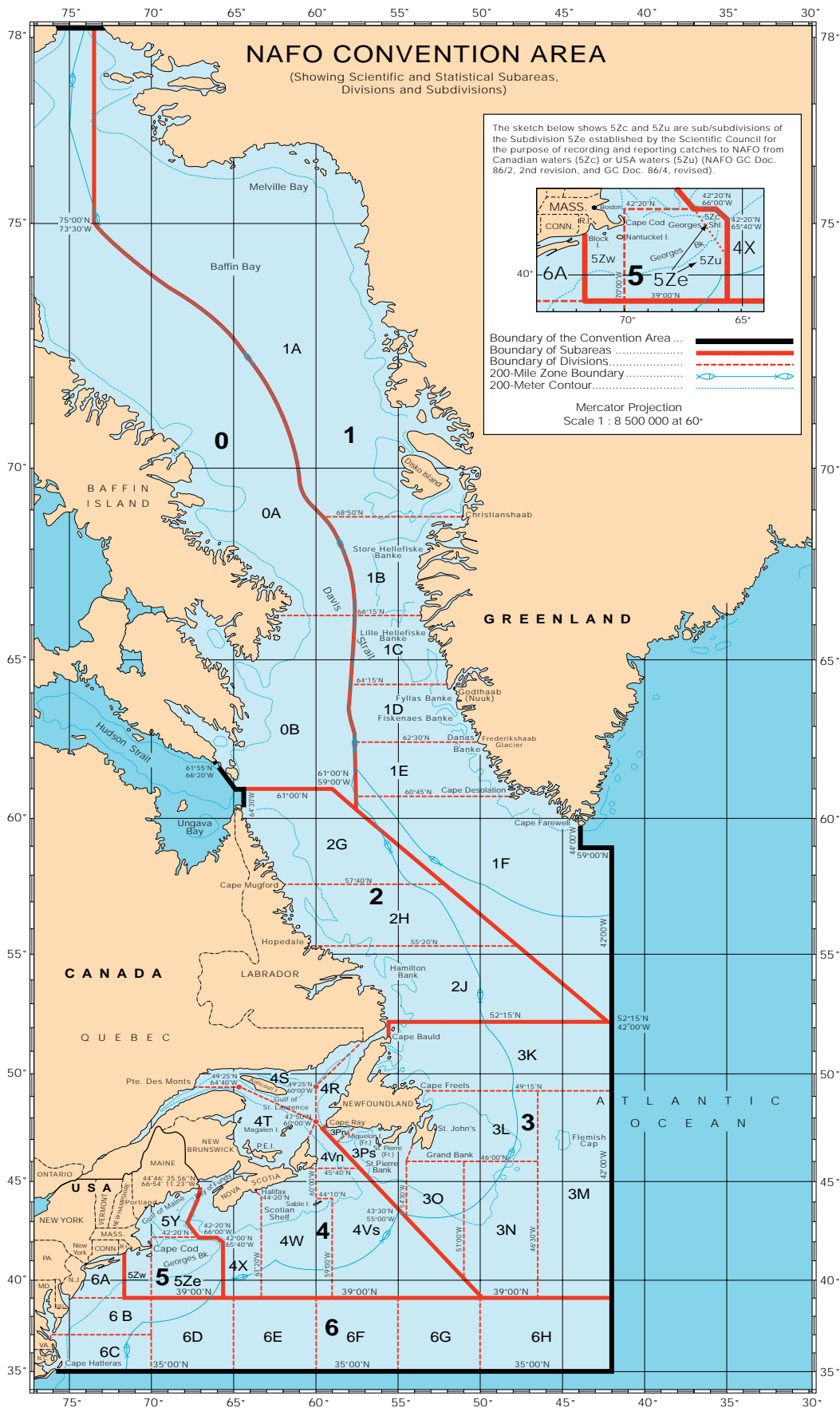
In accordance with its mandate to disseminate information on fisheries research to the scientific community, the Scientific Council of NAFO publishes the *Journal of Northwest Atlantic Fishery Science*, which contains peer-reviewed primary papers and notes on original research, and *NAFO Scientific Council Studies*, which contains review papers of topical interest and importance. Each year since 1981, the Scientific Council has held at least one Special Session on a topic of particular interest, and many of the contributions to those sessions have been published in either of these Publications. For 2001, the Scientific Council initiated this Special Session titled "Deep Sea Fisheries", as a Symposium of topical interest to NAFO. To bring a global perspective, the NAFO Scientific Council invited the International Council for the Exploration of the Sea (ICES) and the Commonwealth Scientific and Industrial Research Organization (CSIRO) to co-sponsor the Symposium (*NAFO Sci. Coun. Rep.*, 2000, p.44). The Joint NAFO/ICES/CSIRO Symposium held during 12–14 September 2001 was hosted by the NAFO Scientific Council, in conjunction with the NAFO 23rd Annual Meeting at the Centro de Convenciones, Plaza de America, Varadero, Cuba. In accordance with the decision of the Scientific Council of September 2001 to publish this issue (*NAFO Sci. Coun. Rep.*, 2001, p.221), this volume of the *Journal of Northwest Atlantic Fishery Science* contains many of the papers presented at the Symposium.

The Symposium was jointly convened by Jon Moore (USA/NAFO) from the Florida Atlantic University, John D. M. Gordon (UK/ICES) from the Scottish Association for Marine Science, and Tony Koslow (Australia) from the CSIRO Marine Research. Due to the unfortunate events of 11 September 2001 in USA, Jon Moore and some authors were unable to attend. A total of 39 oral and 67 poster presentations were made at the Symposium, of which 38 papers were accepted for publication in this issue.

In accordance with the decision of the Scientific Council, Jon Moore, John Gordon and Tony Koslow were invited to undertake the normal Journal editorial work on the submitted papers. Due to unforeseen circumstances Tony Koslow was unable to, and NAFO Scientific Council extended its appreciation to Jon Moore and John Gordon for undertaking these tasks. At the NAFO Secretariat final editorial work was also done as needed to bring this volume to print. While unusual circumstances delayed the publication beyond the Scientific Council's prescribed one year time-frame, this issue captures quality information of current global interest, the stimulating considerations discussed at the Symposium, and the comprehensive coverage achieved at the Symposium.

October 2003

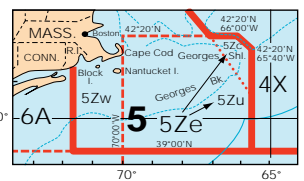
Tissa Amaratunga, NAFO, Deputy Executive Secretary
Technical Editor
Journal of Northwest Atlantic Fishery Science



NAFO CONVENTION AREA

(Showing Scientific and Statistical Subareas, Divisions and Subdivisions)

The sketch below shows 5Zc and 5Zu are sub/subdivisions of the Subdivision 5Ze established by the Scientific Council for the purpose of recording and reporting catches to NAFO from Canadian waters (5Zc) or USA waters (5Zu) (NAFO GC Doc. 86/2, 2nd revision, and GC Doc. 86/4, revised).



Boundary of the Convention Area ... **—**
 Boundary of Subareas ... **—**
 Boundary of Divisions ... **---**
 200-Mile Zone Boundary ... **---**
 200-Meter Contour ... **---**

Mercator Projection
 Scale 1 : 8 500 000 at 60°

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Introduction

The papers in this special volume are a result of the international Symposium titled “Deep-Sea Fisheries” jointly sponsored by the Northwest Atlantic Fisheries Organization (NAFO), the International Council for the Exploration of the Sea (ICES), and the Commonwealth Scientific and Industrial Research Organization (CSIRO). The Symposium was hosted by the NAFO Scientific Council and convened by Jon A. Moore (NAFO), John D. M. Gordon (ICES) and Anthony Koslow (CSIRO) at the Centro de Convenciones de Plaza de Americas, Varadero, Cuba from 12 to 14 September 2001. We are pleased with the success of the Symposium in spite of the unfortunate events of 11 September 2001.

In total, 39 oral presentations were delivered in six sessions, and 67 posters were displayed. The conveners invited both oral and poster presenters to submit papers for publication in this volume. Following the usual peer review and editing procedures of the *Journal of Northwest Atlantic Fisheries Science*, papers the accepted appear in this volume, and most were substantially revised from the original presented at the Symposium. A summary report of the Symposium follows with details on the sessions and contributions. Most of the contributions presented at the Symposium are available as NAFO Scientific Council Research Documents (indicated as *NAFO SCR Doc.*), and are posted on the NAFO website (www.nafo.int).

This Symposium and volume could not have been possible without the cooperation, dedication and hard work of many people, particularly the participants and presenters themselves, listed at the end of the summary report. Special thanks to the NAFO Secretariat staff for handling the logistics and accommodations of the meeting. The editorial process included reviews by T. Amaratunga, J. Moore and J. Gordon as a secondary step. We thank Tissa Amaratunga for his efforts as technical editor and beyond in support of the final publication of this volume. We also thank D. Auby and F. Perry at the Secretariat for their dedicated efforts and help with the manuscripts. Finally, we thank the reviewers of the papers in this volume, several who put forth great effort to review multiple manuscripts. They include: O. T. Albert, A. Andrews, J. Boreman, S. Branstetter, J. Bratney, W. B. Brodie, J. Burnett, S. Cadrin, A. Carbonell, M. Castro, C. Chapman, M. Clark, M. Clarke, M. Collins, G. D'Onghia, R. Ferro, D. Fischer, J. Gage, K. Gilkinson, N. R. Hariede, K. Hartel, L. C. Hastie, J. Link, N. R. Merrett, D. Methven, B. Michaels, J. Musick, J. M. Nance, A. Newton, D. Power, H. J. Rätz, L. Relini, A. Santos, F. Serchuk, C. Silva, C. Smith, J. C. Sorbe, C. Stransky, T. Sutton, M. Treble, P. Tyler, P. Vas, A. Vazquez, J. Weinberg, and J. Witzig, P. J. Wright.

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Report of the Symposium

Hosted by the Scientific Council of the Northwest Atlantic Fisheries Organization (NAFO) 12–14 September 2001

The following text was prepared by J. D. M. Gordon in consultation with the co-conveners and session chairs, and presented to the NAFO Scientific Council during its meeting of 17–21 September 2001.

The Symposium, *Deep-Sea Fisheries*, was held at the Centro de Convenciones de Plaza de América, Varadero, Matanzas, Cuba, with co-conveners J. A. Moore (NAFO), J. D. M. Gordon (ICES), and A. Koslow (CSIRO) during 12–14 September 2001. There were 104 participants from Australia, Austria, Brazil, Canada, Cuba, Denmark, Estonia, Faroe Islands, France, Greece, Iceland, Ireland, Italy, Mexico, New Zealand, Norway, Poland, Portugal, Russia, Spain, United Kingdom, and United States of America.

W. B. Brodie, Chairman of Scientific Council, opened the symposium by welcoming the participants and presenting a brief overview of NAFO and its activities. The participants were welcomed by Mr. E. Oltuski, Ministerio de la Industria Pesquera, Cuba, as the Cuban host, and the President of NAFO and Chairman of General Council.

J. D. M. Gordon welcomed the participants on behalf of the co-conveners. He noted that a theme session on deep-water fish and fisheries at the 1998 ICES Annual Science Conference had resulted in a record number of oral presentations and posters. This meeting had exceeded that number indicating both the rapid development of deep-water fisheries and concerns about their sustainability. He explained that there would be changes to the schedule resulting from the cancellation and/or late arrival of speakers due to the closure of all airports in the USA following the events of 11 September. Regrettably the NAFO co-convener, J. A. Moore, was unable to attend the symposium.

The co-conveners invited D. Power and W. R. Bowering to Chair the sessions on "Redfish" and "Greenland halibut", respectively. M. Clark was invited to Chair the opening session on "*Deepwater Fisheries*".

The Symposium considered current research, advances and impacts of deep-water fisheries in many different locations around the world. In addition, two sessions were devoted to important deep-water fisheries (Greenland halibut and redfish) of the North Atlantic area.

Three invited speakers addressed specific issues within the six sessions. Thirty-five other oral presentations were delivered and 62 posters were displayed. Posters were highlighted in the Greenland halibut session during which five poster authors presented 5-minute summaries of their work.

Session 1: Deepwater Fisheries (Part 1)

The first part of this session, chaired by J. A. Koslow, mostly consisted of descriptions of developing deep-water fisheries. The leadoff invited paper by Koslow and co-authors reviewed recent evidence for high diversity and endemism and highly localized distributions of seamount benthic communities, based on data from the Southwest Pacific. Trawl fishing was shown to be capable of severely impacting these communities, leading to the need to conserve this fauna based on localized networks of representative protected areas.

One paper covered preliminary faunal information from exploratory work at Bear Seamount, just off Georges Bank that had revealed a rich fauna, including 115 species of fish. Another paper described recent trends in the deep-water fishery off southern Brazil and emphasized the need for orderly development of that region's deepwater fishery, based on initial explorations now being carried out with chartered foreign fishing vessels. Their systematic exploration, based on use of a range of gears over that country's deepwater zone, provided a valuable model for deepwater fishery development. In contrast, a paper on the Spanish multi-species deep-sea fishery in the international waters of the Hatton Bank (ICES Sub-area XII) described the rapid development of the Spanish trawl fishery for *Alepocephalus bairdii* (Baird's smoothhead) and *Coryphaenoides rupestris* (roundnose grenadier). Only five years old, the fishery is already Spain's largest deepwater trawl fishery. Data on both the Spanish and

Brazilian fisheries is obtained by observers working from commercial vessels. The Spanish fishery already shows signs of declining catch and catch per unit of effort, indicating that a cautious approach to future management of the fishery is warranted. A space in the program was filled by an unscheduled paper by Hareide, Langedal, Garner and Dyb entitled "Hatton Bank resources and catch results – results from Norwegian exploratory fisheries" that presented interesting results from Hatton Bank, showing a clear relationship between the fish assemblages and water mass characteristics. The fish fauna within the arctic-influenced water to the west of the bank had more coldwater affinities, while the fauna to the east had more typically Atlantic affinities. The authors pointed out that the present division of the region into several ICES sub-areas was probably no longer appropriate scientifically for management of the region.

Another paper on the distribution and density of carnivorous fish species around Lanzarote and Fuerteventura, Canary Islands, used multivariate statistics to extract information from commercial long-line data on community structure in relation to depth and potentially hydrological factors. Their approach illustrated the potential to obtain important ecological information from available commercial catch data. This first session ended with a review of recent catch records, which extend the range for *Hoplostethus atlanticus* (orange roughy) into Canadian waters. The catches were generally quite low, on the order of one individual per set, so the fishery potential appears negligible at present.

J. D. M. Gordon chaired the second part of this much depleted session and presented his invited paper, which aimed to provide an overview of the Rockall Trough (northeast Atlantic) and its deep-water fisheries. Deep-water fishes were first dredged from the area in 1868 and since the 1970s there have been many surveys. The deep-water fishery that began in the 1980s has been well documented and can provide insights into the fishery effects on the ecosystem. The other presentation in this session described a comparison of a long-line and a gill net fishery for *Merluccius merluccius* (hake) in deep-water off southern Portugal.

Session 2: Greenland halibut

This session, which was chaired by W. R. Bowering, comprised 10 presentations grouped into three themes. Two papers were concerned with the effects of fishing on growth and fishing patterns. Two papers considered stock structure issues and six papers described studies on maturation (e.g. length- and age-at-maturity, ovarian maturation and fecundity). The concluding discussion focused almost entirely on the maturation issues. The key results were 1) that length and age at maturity indicated high interannual variation among stocks throughout the North Atlantic; 2) the interpretation of the maturity cycle can be difficult since it has been shown that the fish may not spawn annually and 3) the length and age at maturity was rather similar throughout the North Atlantic except for NAFO Div. 2J+3K where fish matured at a larger size and age. It was also noted that some imprecision in the length- and age-at-maturity can be caused by errors in the visual interpretation of the immature and resting stages and it was suggested that precision could be improved by using histological techniques for interpreting maturity stages. It was also suggested that some of the annual variation observed in length- and age-at-first-maturity might be removed if sampling could be spread throughout the year. For practical purposes averaging maturity rates over some years may be useful for approximating SSB trends.

At the conclusion of the session it was suggested that it might be useful to consider whether the experience of managing long established Greenland halibut fisheries might have something to offer to the management of some of the new deep-water fisheries. It was noted that all Greenland halibut stocks declined rapidly when F increased even at relatively low average values. SSB remains at low levels in most stocks in the North Atlantic but when F is reduced the population can rebuild fairly rapidly as demonstrated by the NAFO Subarea 2 and Div. 3KLMNO stock. However, it remains to be seen whether the SSB will improve to former levels for this stock. From the experience of Greenland halibut it was clear that other species that live much longer, grow slower and have a lower reproductive potential will be much more sensitive to F , even at much lower values. Any stock rebuilding will take much longer, if it occurs at all.

Session 3: Deepwater Fisheries (Part 2): Impacts Assessment and Management

The session, chaired by M. Clark opened with his invited paper describing the deepwater trawl fishery for orange roughy on seamounts off New Zealand. It was shown that seamount habitat could be severely affected by bottom trawling, with extensive removal of coral cover. Another paper showed that the large reefs of *Lophelia* off

the Norwegian coast are also vulnerable to bottom trawling. Management action has been taken to close 19 seamounts around New Zealand, and to prohibit trawling in several areas of reef habitat off the Norwegian coast.

A paper described the distribution of deepwater fish and fisheries throughout the ICES area, which was then followed by a paper presenting and discussing options for their assessment and management. This included data requirements, possible stock assessment models and approaches, and management measures. Strong decreases in catch levels and CPUE in several fisheries highlight the need for immediate management action to limit catches. ICES area boundaries also need to be revised for deep-water species, as they are not consistent with bathymetry or water masses in some areas. Several are also very large, which does not recognize the small spatial scales often necessary to monitor some of these deepwater fisheries to prevent serial depletion of populations/stocks.

Biological data were presented for several deepwater species off Ireland that further advocated a cautious approach to fishery development. Estimates of population replacement rates for deepwater species were much lower than for some shelf species.

In a paper reviewing the track record of stock assessment and fishery performance of several deepwater species, the possibility of episodic recruitment in fish like orange roughy was raised. Long periods of low recruitment between strong pulses adds a challenge to develop appropriate population models, and increases the complexity of estimating sustainable annual yields.

An account was presented of the biology and fishery for the deepwater prawn *Aristeus antennatus* in the western Mediterranean Sea. Established fishing grounds could be extended into deeper waters, but care is required to establish migration and life-history links between the areas.

Session 4: Biology and Life History

The first paper in this session, chaired by J. D. M. Gordon, presented the results of a study of the predator prey relationships of a small, isolated deep-water fish assemblage in the Skagerrak. The food web showed quite clearly the links between the demersal fish and their pelagic prey that appears to be a common feature of the exploited deep-water fishes. A paper on the trophic ecology of the blue whiting in the northeastern Atlantic described the diet and the degree of overlap both within different length classes of the species and also between other pelagics. The role of this species in providing a food source for deep-sea fishes and in transporting the products of the rich plankton blooms of Nordic Seas to the northeastern Atlantic was indicated. How the products of surface production might reach the deeper waters was one of the aspects discussed in a paper on the deep-scattering layers of the Baja California, Mexico.

A study of the behaviour of deep-water fishes in nine habitats observed in the Bay of Biscay using a manned submersible showed that some species were more flexible than others in their choice of habitat. A multivariate analysis of the numerous observed parameters grouped the species in to a number of assemblages associated with one or more habitat types.

Four papers dealt with aspects of the biology of the deep-water witch flounder (*Glyptocephalus cynoglossus*), the deep-water sharks, the blue hake (*Antimora rostrata*) and the roughhead grenadier (*Macrourus berglax*). These four papers, covering a wide range of taxa exemplified some of the many of the characteristics of deep-water species such as slow growth, high age at first maturity, non-seasonal reproduction and missing stages in the life cycle.

Session 5: Redfish

This session was chaired by D. Power and comprised three oral presentations and three posters dealing with various aspects of the biology, ecology and population structure of various species of redfish from the North Atlantic based on both commercial fisheries and fishery-independent surveys.

The three oral presentations covered a variety of topics. The first was a paper on the stock structure and ecology of *S. mentella* and suggested that only a single stock exists in the Irminger Sea. The second paper presented an age validation for *S. mentella* in NAFO Div. 3M and suggested density-dependent growth may be occurring for the 1990 year-class. The final paper provided Norwegian information from a long-line and gillnet fishery for the

'giant' *S. marinus* conducted along the Reykjanes Ridge. The data suggested CPUE declined by 27–85% between 1996 and 1997 before the fishery ceased due to a decline in its economic viability.

The session discussion focused on the population structure and migrations of *S. mentella* in the Irminger Sea. There was no general consensus amongst the participants on whether there were one stock or three.

Session 6: Fisheries Ecology

This session, chaired by J.D.M. Gordon opened with a paper on uncertainties in the age estimation of *Coryphaenoides rupestris* (roundnose grenadier) caused by the removal of the accumulated biomass of older fish at the start of the fishery. Another paper, also utilizing otoliths, described a preliminary attempt to use otolith microchemistry to test the hypothesis that there is only one stock of *Aphanopus carbo* (black scabbardfish) in the North East Atlantic.

A paper describing studies on the distribution growth and exploitation of *Argentina silus* (greater silver smelt) in Norwegian Sea during the early 1980s was followed by a presentation on some of the results of acoustic surveys in the early 1990s. At the start of the fishery this species was managed by TAC but this has now changed to a control of effort by licensing. A paper on the size structure and production of ten demersal species off the Canadian shelf demonstrated the importance of predation as a link between the species in the community and the importance of life history parameters in determining dominance. The deep-bathyal, oligotrophic ecosystem of the western Mediterranean is co-dominated by fish and decapod crustacea. A paper described an analysis of the intensity of faunal change in relation to size and depth using material from two surveys to the southwest of the Balearic Islands.

In the summing up it was noted that otolith collections could be an important record of past history both for age composition and stock identification and should be archived. The Mediterranean, although sharing many of the same deep-water fish species of the Atlantic, is a very different ecosystem (e.g. high temperature, oligotrophic) and the maximum size of many species tends to be smaller. Comparative studies between the Mediterranean and the Atlantic could yield useful insights into processes in the deep-sea.

Poster session

A total of 64 posters, including the five that were associated with short presentations, were on display throughout the symposium and there was a lunchtime viewing session where the authors were present to answer questions.

Summary of Discussions

W. B. Brodie invited each of the chairs of the six sessions to present an overview of their session and to highlight what they considered to be the key results and concerns. The session specific outputs from these summaries have been incorporated in the report of each session described above.

In the general discussion it was considered that the emerging deep-water fisheries could learn from the experience in managing some of the longer established fisheries such as Greenland halibut and redfish. The 2001 report of the ICES Working Group on the Biology and Assessment of Deep-sea Fishery Resources had, at the request of NEAFC, made a first attempt at ranking life history characteristics of deep-water fish in relation to these two species. A recurring theme in many papers had been the fact that the current ICES Sub-areas and Divisions are, in many instances, unsuitable in terms of bathymetry and water masses for reporting information on deep-water species. Given the high discard rates and likely high mortality of escapees in trawl fisheries it was considered to be important to report catch and not simply landings. There is increasing public awareness about the impact of fishing activities on the deep-water ecosystem and the conservation of deep-water coral reefs and seamounts were good examples of how there should be wider involvement in the decision making process. The importance of the use of non-invasive technology for studies in the deep-sea, such as the plans for further exploration of the Bear Seamount, is an area that should be given greater priority.

Conclusion

The Chairman of the NAFO Scientific Council thanked the host country and ICES and CSIRO, for their support in making the Symposium possible. He also thanked the co-conveners for organizing such an interesting and varied collection of papers and posters and the session chairs for helping the meeting to run smoothly. The day-to-day organization had been difficult because some speakers, including one of the co-conveners, had been unable to attend the meeting. The efforts of the Secretariat in coping with these changes were gratefully acknowledged. It is intended to publish a selection of the papers in the *Journal of Northwest Atlantic Fishery Science* within a target time frame of one year.

Symposium Schedule*

Oral Presentations

Session 1: Deepwater Fisheries (Part 1)

(Chair: J. A. Koslow)

Paper No.	Author(s) and Title
1.1	Invited paper: KOSLOW, J. A., B. RICHER DE FORGES, and K. GOWLETT-HOLMES. Biodiversity and conservation in the deep sea: the impact of deepwater fisheries.
1.2	MOORE, J. A., M. VECCHIONE, K. E. HATEL, B. B. COLLETTE, J. K. GABRAITH, R. GIBBONS, M. TURNIPSEED, M. SOUTHWORTH, and E. WATKINS. Biodiversity of Bear seamount, New England seamount chain: results of exploratory trawling. (<i>NAFO SCR Doc.</i> , No. 155, Serial No. N4549, 8 p.).
1.3	PEREZ, J. A. A., R. WAHRLICH, P. R. PEZZUTO, P. R. SCHWINGEL, F. R. A. LOPES, and M. RODRIGUES-RIBEIRO. Deep-sea fishery off southern Brazil: recent trends of the Brazilian fishing industry (<i>NAFO SCR Doc.</i> , No. 117, Serial No. N4505, 21 p.).
1.4	POWELL, S. M., R. L. HAEDRICH, and J. D. MCEACHRAN. The deep-sea fish fauna of the northern Gulf of Mexico. (read by title) (<i>NAFO SCR Doc.</i> , No. 143, Serial No. N4537, 14 p.).
1.5	LORANCE, P., F. UIBLEIN, and R. C. EGUIA. Distribution and density of carnivorous fish species around Lanzarote and Fuerteventura, Canary Islands.
1.6	DURAN MUÑOZ, P., E. ROMÁN MARCOTE. The Spanish multi-species deep-sea fishery at Hatton Bank (North East Atlantic): 1996–2000 (<i>NAFO SCR Doc.</i> No. 120, Serial No. N4508, 20 p.).
1.7	KULKA, D., D. T. THEMELIS, and R. G. HALLIDAY. Distribution and biology of orange roughy (<i>Hoplostethus atlanticus</i> Collette 1889) in Canadian waters (<i>NAFO SCR Doc.</i> , No. 84, Serial No. N4471, 23 p.).
3.1	Invited paper: GORDON, J. D. M. The Rockall Trough, North East Atlantic: an account of the change from one of the best-studied deep-water ecosystems to one that is being subjected to unsustainable fishing activity (<i>NAFO SCR Doc.</i> , No. 101, Serial No. N4489, 30 pages).
3.2	SANTOS, M. N., K. ERZINI, M. B. GASPAR, C. C. MONTEIRO, R. SÁ, L. BENTES, J. M. S. GONÇALVES, P. G. LINO, and J. RIBEIRO. Comparison of long-line and monofilament gill net selectivity for hake (<i>Merluccius merluccius</i>) in the Algarve (Southern Portugal) (<i>NAFO SCR Doc.</i> , No. 96, Serial No. N4484, 7 p.).

Session 2: Greenland Halibut

(Chair: W. R. Bowering)

Paper No.	Author(s) and Title
1.8	HØINES, Å. S., and K. KORSBREKKE. Variation in population structure of Northeast Arctic Greenland halibut (<i>Reinhardtius hippoglossoides</i>) based on data from Norwegian surveys in the period 1992–2000 (<i>NAFO SCR Doc.</i> , No. 118, Serial No. N4506, 13 p.).

* Due to late arrival and/or cancellations, the sequence of presentations may have changed during the Symposium.

Oral Presentations (Continued)

Paper No.	Author(s) and Title
1.9	SIMONSEN, C. S., and M. A. TREBLE. Tagging mortality of Greenland halibut (<i>NAFO SCR Doc.</i> , No. 130, Serial No. N4525, 15 p.).
1.10	HUSE, I., and T. JOHANSEN. Trends in growth parameters analyzed in the light of selection responses to the exploitation of Greenland halibut (<i>NAFO SCR Doc.</i> , No. 159, Serial No. N4553, 11 p.).
1.11	JUNQUERA, S., E. ROMÁN, J. MORGAN, M. SAINZA, and G. RAMILO. Time scale of ovarian maturation in Greenland halibut (<i>NAFO SCR Doc.</i> , No. 124, Serial No. N4512, 11 p.).
1.12	MORGAN, M. J., W. R. BOWERING, A. C. GUNDERSEN, Å HØINES, B. MORIN, O. SMIRNOV, and E. HJØRLEIFSSON. Comparative analyses of Greenland halibut (<i>Reinhardtius hippoglossoides</i>) maturation for populations throughout the North Atlantic (<i>NAFO SCR Doc.</i> , No., 116, Serial No. N4504, 13 p.).
Poster Pursuit	
No.	Author(s) and Title
1-P.1	ALBERT, O. T. Northeast Arctic Greenland halibut (<i>Reinhardtius hippoglossoides</i>) population structure from nursery to spawning area (<i>NAFO SCR Doc.</i> , No. 128, Serial No. N4523, 14 p.).
1-P.2	GUNDERSEN, A. C., O. S. KJESBU, K. H. NEDREAAS, and O. T. ALBERT. Maturity of northeast Arctic Greenland halibut (<i>Reinhardtius hippoglossoides</i>) (<i>NAFO SCR Doc.</i> , 158, Serial No. N4552, 7 p.).
1-P.3	TUENE, S., A. C. GUNDERSEN, W. EMBLEM, I. FOSSEN, J. BOJE, P. STEINGRUND and L. H. OFSTAD. Maturation and occurrence of Atresia on oocytes of Greenland halibut (<i>Reinhardtius hippoglossoides</i> , Walbaum) (<i>NAFO SCR Doc.</i> , No. 166, Serial No. N4561, 12 p.).
1-P.4	GUNDERSEN, A. C., J. BOJE, O. A. JØRGENSEN, E. HJØRLEIFSSON, C. S. SIMONSEN, I. FOSSEN, L. H. OFSTAD, and H.-J. RÄTZ. Variability in fecundity and total egg production for West Nordic Greenland halibut (<i>NAFO SCR Doc.</i> , No. 157, Serial No. N4551, 3 p.).
1-P.5	HØINES, Å. S., and K. KORSBREKKE. Some aspects of a times series of longline catch-per-unit of effort data for Greenland halibut (<i>Reinhardtius hippoglossoides</i>) (<i>NAFO SCR Doc.</i> , 119, Serial No. N4507, 10p.).

Session 3: Deepwater Fisheries (Part 2): Impacts, Assessment and Management (Chair: M. Clark)

Paper No.	Author(s) and Title
2.1	Invited paper: CLARK, M. Deepwater Fisheries and their impact on seamount habitat in New Zealand.
2.2	KOSLOW, J. A., and G. N. TUCK. The boom and bust of deep-sea fisheries: why haven't we done better? (<i>NAFO SCR Doc.</i> , No. 141, Serial No. N4535, 10 p.).
2.3	FOSSÅ, J. H., P. B. MORTENSEN, T. MOLDSKRED, and D. M. FUREVIK. Protection and management of deep-water coral reefs in Norway.
2.4	SARDA, F., J. B. COMPANY, and F. MAYNOU. Deep-sea shrimp <i>Aristeus antennatus</i> Risso 1816 in the Catalan Sea: a review and perspectives (<i>NAFO SCR Doc.</i> , No. 95, Serial No. N4483, 12 p.).

Oral Presentations (Continued)

Paper No.	Author(s) and Title
2.5	GORDON, J. D. M., O. A. BERGSTAD, I. FIGUEIREDO, and G. MENEZES. The deep-water fisheries of the ICES Area (<i>NAFO SCR Doc.</i> , No. 92, Serial No. N4480, 16 p.).
2.6	LARGE, P., C. HAMMER, O. A. BERGSTAD, J. D. M. GORDON, and P. LORANCE. Options for the assessment and management of deep-water species in the ICES area (<i>NAFO SCR Doc.</i> , No. 93, Serial No. N4481, 16 p.).
2.7	CLARKE, M. W., P. L. CONNOLLY, and C. J. KELLY. A life-history approach to stock assessment of deepwater fish in the northeast Atlantic (<i>NAFO SCR Doc.</i> , No. 129, Serial No. N4524, 12 p.).

Session 4: Biology and Life History Chair: J. D. M. Gordon

Paper No.	Author(s) and Title
2.8	BERGSTAD, O. A., Å. D. WIK, and Ø. HILDRE. Predator-prey relations and food sources of the Skagerrak deep-water fish assemblage (<i>NAFO SCR Doc.</i> , No. 132, Serial No. N4527, 20 p.).
2.9	BJELLAND, O., T. MONSTAD, and O. A. BERGSTAD. Trophic ecology of blue whiting (<i>Micromesistius poutassou</i> (Risso), Gadidae) (<i>NAFO SCR Doc.</i> , No. 163, Serial No. N4557 – WITHDRAWN).
2.10	UIBLEIN, F., P. LORANCE, and D. LATROUITE. Interspecific comparison of deep-sea fish locomotion behaviour and habitat selection (<i>NAFO SCR Doc.</i> , No. 127, Serial No. N4522, 5 p.).
2.11	WIGLEY, S. E., and J. M. BURNETT. Preliminary estimates of biological and yield characteristics for deep-water witch flounder (<i>Glyptocephalus cynoglossus</i>) in the Georges Bank-Southern New England Region (<i>NAFO SCR Doc.</i> , No. 114, Serial No. N4502, 17 p.).
2.12	CLARKE, M. W., P. L. CONNOLLY, and J. J. BRACKEN. Biology of exploited deep-water sharks west of Ireland and Scotland (<i>NAFO SCR Doc.</i> , No. 108, Serial No. N4496, 18 p.).
2.13	KULKA, D. W. Distribution and biology of blue hake in Canadian Atlantic waters.
2.14	MURUA, H. Roughhead grenadier (<i>Macrourus berglax</i>) biology and population structure in NAFO Divisions 3KLMN (<i>NAFO SCR Doc.</i> , No. 156, Serial No. N4550, 23 p.).
2.15	ROBINSON, C. J., and J. GOMEZ-GUTIÉRREZ. On the behavior and composition of dense deep scattering layers related to the shelf-break area along the northwest coast of Baja California, Mexico.

Session 5: Redfish (Chair: D. Power)

Paper No.	Author(s) and Title
3.3	SABORIDO-REY, F., D. GARABANA-BARRO, and C. STRANSKY. A review of the population structure and ecology of redfish species in the Irminger Sea and adjacent waters (<i>NAFO SCR Doc.</i> , No. 107, Serial No. N4495, 19 p.).

Oral Presentations (Continued)

Paper No.	Author(s) and Title
3.4	SABORIDO-REY, F. Age and growth of redfish (<i>Sebastes marinus</i> , <i>S. mentella</i> and <i>S. fasciatus</i>) in Flemish Cap (Northwest Atlantic).
3.5	HAREIDE, N.-R., G. GARNES, and G. LANGEDAL. The boom and bust of the Norwegian longline fishery for redfish (<i>Sebastes marinus</i> 'giant') on the Reykjanes Ridge (NAFO SCR Doc., No. 126, Serial No. N4521, 13 p.).

Session 6: Fisheries Ecology (Chair: J. D. M. Gordon)

Paper No.	Author(s) and Title
3.7	LORANCE, P., F. GARREN, and J. VIGNEAU. Age estimation of the roundnose grenadier (<i>Coryphaenoides rupestris</i>), effects of uncertainties on ages (NAFO SCR Doc., No. 123, Serial No. N4511, 15 p.).
3.8	SWAN, S. C., J. D. M. GORDON, and T. SHIMMIELD. Preliminary investigations on the uses of otolith microchemistry for stock discrimination of the deep-water black scabbardfish (<i>Aphanopus carbo</i>) in the North East Atlantic (NAFO SCR Doc., No. 94, Serial No. N4482, 12 p.).
13.9	JOHANNESSEN, A., and T. MONSTAD. Distribution, growth and exploitation of greater silver smelt (<i>Argentina silus</i>) (Ascanius) in Norwegian waters 1980–1983 (NAFO SCR Doc., 110, Serial No. N4498, 17 p.).
3.10	MONSTAD, T., and A. JOHANNESSEN. Acoustic recordings of greater silver smelt (<i>Argentina silus</i>) in Norwegian waters and West of the British Isles, 1989–1994 (NAFO SCR Doc., No. 112, Serial No. N4500, 17 p.).
3.11	MURILLO, M. N. M. Size structure and production in a demersal fish community (NAFO SCR Doc., No. 134, Serial No. N4529, 16 p.).
3.12	MORALES-NIN, B., F. MAYNOU, F. SARDÁ, J. CARTES, J. MORANTA, E. MASSUTÍ, J. COMPANY, G. ROTLANT, A. BOZZANO, C. STEFANESCU, and C. LIRÓ. Size influence in zonation patterns in fishes and crustaceans from the deep-water communities of the western Mediterranean (NAFO SCR Doc., No. 142, Serial No. N4536, 18 p.).

Poster Presentations

- | Poster No. | Author(s) and Title |
|------------|---|
| P.1. | GIL, J., and I. SOBRINO. Studies on reproductive biology of the red (blackspot) seabream (<i>Pagellus bogaraveo</i> (Brünnich, 1678)) from the Strait of Gibraltar (ICES IXa/Atlantic South-west of Spain) (<i>NAFO SCR Doc.</i> , No. 86, Serial No. N4473, 6 p.). |
| P.2. | GUNDERSEN, A. C., A. K. WOLL, and I. FOSSEN. Spawning of Greenland halibut (<i>Reinhardtius hippoglossoides</i>) in East Greenland waters (<i>NAFO SCR Doc.</i> , No. 167, Serial No. N4562, 3 p.). |
| P.3. | BAKAY, YU. I. Results from the analysis of geographical variability in parasite fauna of redfish, <i>Sebastes mentella</i> , from the North Atlantic (<i>NAFO SCR Doc.</i> , No. 153, Serial No. N4547, 5 p.). |
| P.4. | SOBRINO, I., and J. GIL. Studies on age determination and growth pattern of the red (blackspot) seabream (<i>Pagellus bogaraveo</i> (Brünnich, 1678)) from the Strait of Gibraltar: application to the species migratory pattern (<i>NAFO SCR Doc.</i> , No. 87, Serial No. N4474, 5 p.). |
| P.5. | VASCONCELOS, P., and N. R. BRAZ. Proximate composition of the deep-sea crab, <i>Chaceon affinis</i> , from an exploratory fishery off Madeira Island (Portugal – Eastern Central Atlantic) (<i>NAFO SCR Doc.</i> , No. 90, Serial No. N4478, 6 p.). |
| P.6. | VASCONCELOS, P., and N. R. BRAZ. Meat yield of the deep-sea crab, <i>Chaceon affinis</i> , from an exploratory fishery off Madeira Island (Portugal – Eastern Central Atlantic) (<i>NAFO SCR Doc.</i> , No. 91, Serial No. N4479, 6 p.). |
| P.7. | CARBONELL, A., M. GARCÍA, P. PEREDA, A. ESTEBAN, G. POMAR, M. GAZA, A. TORRES, and J. L. PERÉZ GIL. The deepwater red shrimp fishery in the Spanish Mediterranean Sea (<i>NAFO SCR Doc.</i> , No. 85, Serial No. N4472, 8 p.). |
| P.8. | MADURELL, T., and J. E. CARTES. Spatio-temporal patterns in a demersal fish assemblage of the Ionian Sea (Eastern Mediterranean) (<i>NAFO SCR Doc.</i> , No. 133, Serial No. N4528, 6 p.). |
| P.9. | PAIS, C., M. E. COSTA, S. OLIM, and T. C. BORGES. Biodiversity as a result of the by-catch from the commercial trawl fisheries off the southern Portuguese Coast (<i>NAFO SCR Doc.</i> , No. 88, Serial No. N4476, 8 p.). |
| P.10. | COSTA, M. E., S. OLIM, C. PAIS, and T. C. BORGES. The importance of by-catch from commercial trawl fisheries off the South Coast of Portugal (<i>NAFO SCR Doc.</i> , No. 82, Serial No. N4469, 6 p.). |
| P.11. | FOSSEN, I., O. A. JØRGENSEN, and C. GUNDERSEN. Roughhead grenadier (<i>Macrourus berglax</i>) in the waters of East Greenland distribution and biology (<i>NAFO SCR Doc.</i> , No. 145, Serial No. N4539, 12 p.). |
| P.12. | SOBRINO, I., Y. VILA, F. RAMOS and A. MEDINA. Identification and quantification of the age-pigment, lipofuscin, in brains of the deep-water rose shrimp <i>Aristeus antennatus</i> (Risso, 1816) (<i>NAFO SCR Doc.</i> , No. 98, Serial No. N4486, 10 p.). |
| P.13. | KJERSTAD, M., and I. FOSSEN. Utilization of deep-sea sharks at Hatton Bank in the North Atlantic (<i>NAFO SCR Doc.</i> , No. 152, Serial No. N4546, 4 p.). |
| P.14. | DEMESTRE, M., and J. E. CARTES. Estimating secondary production in the deep-water shrimp <i>Aristeus antennatus</i> in Catalano-Balearic Basin (Western Mediterranean) (<i>NAFO SCR Doc.</i> , No. 111, Serial No. N4499, 7 p.). |
| P.15. | POLITOU, C. Y., S. KAVADAS, CH. MYTILINEOU, A. TURSI, P. LEMBO, and R. CARLUCCI. Fisheries resources in the deep waters of the Eastern Mediterranean (Greek Ionian Sea) (<i>NAFO SCR Doc.</i> , No. 104, Serial No. N4492, 12 p.). |

Poster Presentations (Continued)

- | Poster No. | Author(s) and Title |
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| P.16. | LEFKADITOU, E., and G. D'ONGHIA. <i>Loligo forbesi</i> and ommastrephid squid by-catches on the North-eastern Ionian slope: preliminary analysis of stock structure based on exploratory trawling (<i>NAFO SCR Doc.</i> , No. 144, Serial No. N4538, 6 p.). |
| P.17. | MYTILINEOU, CH., P. MAIORANO, S. KAVADAS, G. D'ONGHIA, K. KAPIRIS, and F. CAPEZZUTO. Size structure comparison in some demersal species between two areas of different fishing impact in the deepwaters of eastern-central Mediterranean (Ionian Sea) (<i>NAFO SCR Doc.</i> , No. 125, Serial No. N4513, 7 p.). |
| P.18. | D'ONGHIA, G., C.-Y. POLITOU, F. MASTROTOTARO, CH. MYTILINEOU, and A. MATARRESE. Biodiversity from the upper slope demersal community of eastern Mediterranean: preliminary comparison between two areas with and without fishing impact (<i>NAFO SCR Doc.</i> , No. 135, Serial No. N4530, 11 p.). |
| P.19. | SION, L., G. D'ONGHIA, A. TURI, and CH. MYTILINEOU. First data on distribution and biology of <i>Squalus blainvillei</i> (Risso, 1826) from the eastern Mediterranean Sea (<i>NAFO SCR Doc.</i> , No. 137, Serial No. N4572, 7 p.). |
| P.20. | D'ONGHIA G., R. CARLUCCI, P. MAIORANO, and M. PANZA. Discards from deep-water bottom trawling in the eastern-central Mediterranean Sea and effects of mesh size changes (<i>NAFO SCR Doc.</i> , No. 136, Serial No. N4531, 10 p.). |
| P.21. | MAIERS, L., M. TREBLE, M. McPHERSON, and J. REIST. The potential of microsatellite analysis to discriminate stocks of Greenland halibut (<i>Reinhardtius hippoglossoides</i>) in the Canadian Arctic. |
| P.22. | RINELLI, P., T. ROMEO, T. BOTTARI, and S. GRECO. Maturity and growth of <i>Aristaeomorpha foliacea</i> in Tyrrhenian Sea (central Mediterranean). |
| P.23. | GIORDANO, D., G. FLORIO, T. BOTTARI, and S. GRECO. Occurrence of <i>Histioteuthis bonnellii</i> and <i>Histioteuthis reversa</i> (Cephalopoda: Histioteuthidae) in the southern Tyrrhenian Sea (western Mediterranean) (<i>NAFO SCR Doc.</i> , No. 165, Serial No. N4560, 6 p.). |
| P.24. | DESANTIS S., M. LABATE, F. CIRILLO, G. M. LABATE, P. MAIORANO, and G. D'ONGHIA. Testicular activity and sperm glycoproteins in giant red shrimp <i>Aristaeomorpha foliacea</i> . (<i>NAFO SCR Doc.</i> , No. 138, Serial No. N4532, 10 p.). |
| P.25. | HUSE, I., A. C. GUNDERSEN, Å. HØINES, and A. V. SOLDAL. Unaccounted mortality of Greenland halibut in trawl fishery. |
| P.26. | ERZINI, K., E. PUENTE, J. M. S. GONÇALVES, L. ARREGUI, L. BENTES, P. G. LINO, and J. RIBEIRO. The influence of hook model and size on catch rates, hooking position and by-catch in the hake deep-water semi-pelagic longline fisheries of the Algarve (southern Portugal) and the Cantabrian Sea (Bay of Biscay). |
| P.27. | BIANCHINI, M. L., D. LEVI, and S. RAGONESE. Exploitation levels and management hypotheses in the red-shrimp (<i>Aristaeomorpha foliacea</i>) fishery of the Strait of Sicily (Mediterranean Sea) (<i>NAFO SCR Doc.</i> , No. 102, Serial No. N4490, 14 p.). |
| P.28. | SAMPEDRO, P., A. C. FARIÑA, and J. VALEIRAS. Morphometric analysis of <i>Chaceon affinis</i> (Brachyura: Geryonidae), in the northwest coast of Iberian Peninsula (<i>NAFO SCR Doc.</i> , No. 139, Serial No. N4533, 6 p.). |
| P.29. | BRUNO, I., A. C. FARIÑA, J. LANDA, and R. MORLÁN. The gillnet fishery for anglerfish (<i>Lophius piscatorius</i>) in deep-water in the northwest of Iberian Peninsula (<i>NAFO SCR Doc.</i> , No. 99, Serial No. N4487, 5 p.). |

Poster Presentations (Continued)

- | Poster No. | Author(s) and Title |
|------------|---|
| P.30. | GORDON, J. D. M., S. C. SWAN, A. J. GEFFEN, and B. MORALES-NIN. Otolith microchemistry as a means of identifying stocks of deep-water demersal fishes (OTOMIC) (<i>NAFO SCR Doc.</i> , No. 100, Serial No. N4488, 10 p.). |
| P.31. | CROZIER, P. Distribution and reproductive biology of two deepwater squalid sharks, <i>Centroscymnus coelolepis</i> (Portuguese dogfish) and <i>Centrophorus squamosus</i> (leafscale gulper shark), in the Rockall Trough area of the Northeast Atlantic (<i>NAFO SCR Doc.</i> , No. 105, Serial No. N4493, 5 p.). |
| P.32. | CASTRIOTA, L., S. CAMPAGNULUOS, and F. ANDALORO. Shrimp trawl fishery by-catch in the Straits of Sicily (central Mediterranean Sea) (<i>NAFO SCR Doc.</i> , No. 113, Serial No. N4501, 9 p.). |
| P.33. | TRATHAN, P., A. BRIERLEY, M. BRANDON, and D. BONE. Oceanographic variability and changes in Antarctic krill abundance at South Georgia (<i>NAFO SCR Doc.</i> , No. 140, Serial No. N4534, 7 p.). |
| P.34. | REIS, S., D. SENA-CARVALHO, J. H. DELGADO, and M. AFONSO-DIAS. Historical overview of the black scabbardfish (<i>Aphanopus carbo</i> Lowe, 1839) fishery in Madeira Island (<i>NAFO SCR Doc.</i> , No. 103, Serial No. N4491, 6 p.). |
| P.35. | MORALES-NIN, B. Age determination in deep-water fish. How to validate and verify ages? |
| P.36. | MACHIAS, A., K. I. STERGIOU, and D. VATSOS. Deep-water trawling discards in the western Ionian Sea. |
| P.37. | RIHAN, D., C. P. NOLAN, R. OFFICER, F. GUILFOYLE, M. CLARKE, and J. MURRIN. Ireland's development of deepwater fisheries in the NE Atlantic. |
| P.38. | ANDRADE, C. A. P., and J. R. J. GOMES. Distribution patterns and niche shift in wreckfish <i>Polyprion americanus</i> (Teleostei: Poliprionidae). |
| P.39. | BELCARI P., M. MORI, and C. VIVA. Demographic structure and reproductive biology of <i>Aristaeomorpha foliacea</i> (Risso, 1827) in the northern Tyrrhenian Sea (western Mediterranean). |
| P.40. | SARTOR, P., S. M. SBRANA, B. REALE, and P. BELCARI. Impact on the deep-sea trawl fishery on demersal communities of the northern Tyrrhenian Sea (western Mediterranean) (<i>NAFO SCR Doc.</i> , No. 106, Serial No. N4494, 11 p.). |
| P.41. | SBRANA, M., P. BELCARI, B. REALE, and P. SARTOR. The deep-sea crustacean fishery in the northern Tyrrhenian Sea (western Mediterranean). |
| P.42. | ÁVILA-DA-SILVA, A. O., and M. HAIMOVICI. Demersal fish assemblage structure and diversity of southeastern and southern Brazilian continental outer shelf and upper slope. |
| P.43. | HAIMOVICI, M., A. O. ÁVILA-DA-SILVA, S. L. DOS SANTOS TUTUI, and G. C. C. BASTOS. Distribution and relative abundance of demersal fishes vulnerable to bottom longlines from the outer shelf and upper slope of southern and southeastern Brazil. |
| P.44. | RAMOS, A., L. FERNÁNDEZ, and F. SALMERÓN. Composition of demersal fish assemblages in deep waters of the Western Guinean Gulf (<i>NAFO SCR Doc.</i> , 147, Serial No. N4541, 4 p.). |
| P.45. | RAMOS, A., F. MOYA, F. SALMERÓN, P. GARCÍA, A. CARROCEDA, L. FERNÁNDEZ, J. F. GONZÁLEZ. O. TELLO, J. L. SÁNZ, and M. BALLESTEROS. Demersal fauna on deep seamounts of Sierra Leone Rise (Gulf of Guinea, Africa) (<i>NAFO SCR Doc.</i> , No. 149, Serial No. N4543, 4 p.). |
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Poster No.	Author(s) and Title
P.47.	PETRAKIS, G., and C. PAPACONSTANTINO. Catch composition in an unexploited deep-water area in the western Greek coasts.
P.48.	MELNIKOV, S. P., A. P. PEDCHENKO, and V. N. SHIBANOV. On status of the pelagic redfish aggregations in NAFO Division 1F (<i>NAFO SCR Doc.</i> , No. 115, Serial No. N4503, 8 p.).
P.49.	PIÑEIRO, C. G., M. CASAS, and H. ARAUJO Results of exploratory deep-sea fishing survey in the Galician Bank: biological aspects on some of seamount-associated fish (ICES Division IXb) (<i>NAFO SCR Doc.</i> , No. 146, Serial No. N4540, 7 p.).
P.50.	LEFKADITOU, E., P. MAIORANO, and CH. MYTILINEOU. Cephalopod species captured by deep-water exploratory trawling in the eastern Ionian Sea (<i>NAFO SCR Doc.</i> , No. 131, Serial No. N4526, 9 p.).
P.51.	JUNQUERA, S., P. DURÁN, E. ROMÁN, G. RAMILO, and I. LOUREIRO. Reproductive biology and ovary structure of <i>Alepocephalus bairdii</i> in Hatton Bank (ICES XII).
P.52.	FOCARDIS, S. CORSOLINI, N. ADEMOLLO, T. ROMEO, P. RINELLI, and S. GRECO. Organochlorine hydrocarbons in deep-sea fish from Tyrrhenian Sea.
P.53.	BORDALO-MACHADO, P., I. FIGUEIREDO, S. REIS, S. SENA-CARVALHO, T. BLASDALE, A. NEWTON, and L. S. GORDO. New findings on the reproductive biology of the black scabbardfish (<i>Aphanopus carbo</i> Lowe, 1839) in the NE Atlantic (<i>NAFO SCR Doc.</i> , No. 89, Serial No. N4477, 12 p.).
P.54.	HEESSEN, H. J. L., G. J. RINK, and C. J. KUITER. The fishery for greater argentine (<i>Argentina silus</i>) to the west of the British Isles by pelagic trawlers from the Netherlands.
P.55.	CASAS, J. M., C. PIÑEIRO, and R. BAÑÓN. Maturity and other biological aspects of main deep-water squaloid sharks, in the north and northwest of the Iberian Peninsula (ICES Divisions VIIIc, IXa and IXb) (<i>NAFO SCR Doc.</i> , No. 121, Serial No. N4509, 10 p.).
P.56.	SANTOS, M. N., K. ERZINI, M. B. GASPAR, and C. C. MONTEIRO. FANTARED II – a study on ghost fishing in European waters (<i>NAFO SCR Doc.</i> , No. 97, Serial No. N4485, 2 p.).
P.57.	PEDCHENKO, A. P. The effect of oceanographic conditions on the spatical distribution of redfish in the Irminger Sea (<i>NAFO SCR Doc.</i> , 154, Serial No. N4548, 8 p.).

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