Journal of Northwest Atlantic Fishery Science



Volume 42 2009–2010

The Role of Marine Mammals in the Ecosystem in the 21st Century

> Printed and Distributed in June 2010 Northwest Atlantic Fisheries Organization P. O. Box 638, Dartmouth, Nova Scotia Canada B2Y 3Y9 Tel.: (+1 902) 468–5538 Email: journal@nafo.int • Website: www.nafo.int

Journal of Northwest Atlantic Fishery Science

Scientific publications by ICNAF and NAFO have been in existence since ICNAF began in 1949 with the ICNAF Special Publication series dealing with proceedings of scientific symposia. The *ICNAF Research Bulletin* was started in 1964 to provide a means of publishing results of scientific research relevant to ICNAF. The ICNAF Research Bulletin was terminated in September 1979 after the issue of Number 14. The first volume of the NAFO *Journal of Northwest Atlantic Fishery Science* was published in December 1980, after NAFO came into force replacing ICNAF in 1979.

The Northwest Atlantic fisheries have a rich history, and a great deal of research has been sponsored and encouraged by NAFO and its predecessor ICNAF. NAFO has been a leader in international organizations in the application of science to fishery management and in the regulation of fisheries. 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 NAFO Scientific Council Studies, which contains unrefereed papers of topical interest and importance to the Scientific Council. Lists of these and other NAFO publications are given on the back of this issue.

Editorial Policy

The Journal provides an international forum for the primary publication of original research papers, with emphasis on environmental, biological, economic and social science aspects of fisheries and their interactions with marine habitats and ecosystems. While the Journal is intended to be regional in scope, papers of general applicability, and methodological and review papers, irrespective of region, are considered. Space is available for notes and letters to the editor to facilitate scientific discussion of published papers. Both practical and theoretical papers are eligible. All papers are peer-reviewed to determine their suitability for primary publication. Associate Editors arrange for the peer-reviews and ensure that the papers accepted for publication meet the high standards required for the Journal. Manuscripts approved for publication are accepted with the understanding that they are not copyrighted, published or submitted elsewhere except in abstract form. There are no page charges.

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Co-convenors and Symposium Editors

The success of this symposium "*The Role of Marine Mammals in the Ecosystem in the 21st Century*" can be largely credited to the two hard working and dedicated co-convenors who also assumed the role of symposium editors for this volume – Garry Stenson and Tore Haug. Their editorial work was supported by a number of independent reviewers who freely gave their time and expertise in making suggestions to improve the manuscripts and to ensure that information was accurate, well analysed and with sound conclusions.



Photo credit: Torun Sandal

Tore Haug

Dr Tore Haug is a research scientist with the Institute of Marine Research, Tromsø, Norway; since 2004 the head of the Marine Mammals Research Group. He is also a professor at the Institute of Arctic and Marine Biology, University of Tromsø. Dr Haug is appointed Norwegian member in the NAMMCO Scientific Committee (since 1993, chairman 1995-1997) and in the IWC Scientific Committee (since 1992), the past Chair (1999-2005) of the Joint ICES/NAFO Working Group on Harp and Hooded Seals, and scientific adviser to the Joint Norwegian-Russian Fisheries Commission (since 1995). His research has been devoted to fish and fish communities in Norway and the Arctic, current focus is on the studies of abundance, biology and ecology of whales and seals in Norwegian and adjacent waters.

Garry Stenson

Dr. Garry Stenson is a research scientist with the Canadian Department of Fisheries and Oceans, Science Branch and head of the Marine Mammal Section in St. John's. Newfoundland. He is also an Adjunct Professor in the Biology Department, Memorial University of Newfoundland, a member of the Committee on the Status of Endangered Wildlife in Canada Marine Mammal Subcommittee and past Chair of the Joint ICES/NAFO Working Group on Harp and Hooded Seals. Dr. Stenson has been studying marine mammals in the North Atlantic for 25 years where his current research focuses upon the population dynamics, foraging ecology and habitat use of pinnipeds. Dr. Stenson is also actively involved in research related to the interactions between marine mammals and commercial fisheries throughout the area.

Reviewers

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Foreword

The Symposium "*The Role of Marine Mammals in the Ecosystem in the 21st Century*" was held on 29 September – 1 October 2008 in Dartmouth, Canada. The symposium was attended by some 70 scientists from 10 countries interested in the field of marine mammals, many of whom remembered the earlier NAFO/ICES sponsored 1995 symposium "*The Role of Marine Mammals in the Ecosystem*". The current symposium presented new findings on the syntheses of information on ecosystem components, on biological and physical aspects of the environment, and on new research approaches to understanding the role of marine mammals. The symposium was organised in four theme session, each session starting with an invited key-note speaker and followed by both contributed oral and poster presentations from participants. Details of each session, together with a list of oral and poster presentations, are given in the meeting report that follows on pages vi-xii.

The symposium was one of the most friendly that we, at the NAFO Secretariat, have had the pleasure to organise. This was in part due to the relaxed surroundings provided at the theatre venue of "The Alderney Landings Cultural Convention Centre" due to the special nature and unique qualities of marine mammal scientists. The symposium was also a chance for participants to talk about a particular group of animals that thrive in an environment that is typically not seen as mammal-friendly – the sea. However, the presentations highlighted the many wonderful adaptations that, along with appropriate management and control measures, have allowed this group of air-breathers to flourish. Most of us only see marine mammals when they are out of or at the surface of the water. We consider ourselves fortunate and often pay considerable sums of money for this privilege. Participants at this meeting were shown under-water video footage during several of the presentations, along with experienced commentary, that showed just how graceful these large animals can be in their "natural" aquatic environment. Perhaps my greatest memory of this symposium is an appreciation that marine mammals are hugely important to the functioning of the whole marine ecosystem, and have much to offer in keeping the seas healthy.

We are proud to publish in this volume of the *Journal of Northwest Atlantic Fishery Science* a selection of the oral and poster presentations made during the symposium. We appreciate that many of the presentations have been published in other scientific journals, and encourage readers to search for these and enjoy their reported findings. We are also grateful to the sponsors NAFO, ICES and NAMMCO, who made this symposium possible.

June 2010

Anthony Thompson General Editor, Journal of Northwest Atlantic Fishery Science

Conte	ents
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Introduction, Policy and Board
Symposium Co-convenors and Editors
NAFO Convention Area Map
Foreword
Contents
Report of the joint NAFO/ICES/NAMMCO Symposium
ANDERSEN, J. M., Y. F. WIERSMA, G. STENSON, M. O. HAMMILL, and A. ROSING-ASVID. 2009. Movement Patterns of Hooded Seals (Cystophoracristata) in the Northwest Atlantic Ocean During the Post-Moult and Pre-Breed Seasons
TAMURA, T., and K. KONISHI. 2009. Feeding Habits and Prey Consumption of Antarctic Minke Whale (Balaenoptera bonaerensis) in the Southern Ocean
KONISHI, K., T. TAMURA, T. ISODA, R. OKAMOTO, T. HAKAMADA, H. KIWADA, and K. MATSUOKA. 2009. Feeding Strategies and Prey Consumption of Three Baleen Whale Species Within the Kuroshio-Current Extension
KÖNIGSON, S., SG. LUNNERYD, H. STRIDH, and F. SUNDQVIST. 2009. Grey Seal Predation in Cod Gillnet Fisheries in the Central Baltic Sea
BRODIE, P., and G. VIKINGSSON. 2009. On the Feeding Mechanisms of the Sei Whale (Balaenoptera borealis)
ORPHANIDES, C. D. 2009. Protected Species Bycatch Estimating Approaches: Estimating Harbor Porpoise Bycatch in U. S. Northwestern Atlantic Gillnet Fisheries
ROSSMAN, M. C. 2010. Estimated Bycatch of Small Cetaceans in Northeast US Bottom Trawl Fishing Gear During 2000–2005
ØIGÅRD, T. A., T. HAUG, K. T. NILSSEN, and A. B. SALBERG. 2010. Estimation of Pup Production of Hooded and Harp seals in the Greenland Sea in 2007: Reducing Uncertainty Using Generalized Additive Models
POMEROY, P., S. MOSS, S. TWISS and R. KING. 2010. Low and Delayed Recruitment at Two Grey Seal Breeding Colonies in the UK
HAMMILL, M.O., M. RYG and D. CHABOT. 2010. Seasonal Changes in Energy Requirements of Harp Seals
MURPHY, S., G. J. PIERCE, R. J. LAW, P. BERSUDER, P. D. JEPSON, J. A. LEARMONTH, M. ADDINK, W. DABIN, M. B. SANTOS, R. DEAVILLE, B. N. ZEGERS, A. METS, E. ROGAN, V. RIDOUX, R. J. REID, C. SMEENK, T. JAUNIAUX, A. LÓPEZ, J. M. ALONSO FARRÉ, A. F. GONZÁLEZ, A. GUERRA, M. GARCÍA-HARTMANN, C. LOCKYER, and J. P. BOON. 2010. Assessing the Effect of Persistent Organic Pollutants on Reproductive Activity in Common Dolphins and Harbour Porpoises
NAFO Publications
Manuscript Preparation

Report of the joint NAFO//ICES/NAMMCO Symposium

The Role of Marine Mammals in the Ecosystem in the 21st Century

The role of marine mammals in the ecosystem, and particularly how they interact with human activities, has been a topic of great interest for a long time. In many parts of the world, marine mammals have been exploited and continue to be hunted for commercial or subsistence. Populations have also been controlled because they were perceived to be competitors for fish. Meanwhile, there are concerns that populations are being adversely affected by incidental catches, contaminants or reduce food supplies due to overfishing. In recent years, the recovery of many marine mammal populations, overfishing, the lack of recovery of numerous fish stocks and climate change, has made questions about how marine mammals are affected by their environment and how they influence other components of their ecosystem critical.

In 1995 NAFO and ICES sponsored a very successful symposium on ecological role of marine mammals. Many of the papers presented were published in an issue of the J. Northwest Atlantic Fisheries Science in 1997. Since that time, significant new research has been carried out to address many of the knowledge gaps identified. In 2006, NAFO Scientific Council recommended that another symposium on the same topic be held to review the current state of our knowledge. They approached ICES who agreed to co-sponsor the symposium. The North Atlantic Marine Mammal Commission (NAMMCO) also expressed an interest in the topic and agreed to become the third sponsor. The NAFO Secretariat agreed to supply logistical support for the symposium.

The Symposium "*The Role of Marine Mammals in the Ecosystem in the 21st Century*" was held on 29 September – 1 October 2008 in Dartmouth, Canada. G. Stenson (Canada) and T. Haug (Norway) were identified as the co-convenors and were assisted by a scientific committee that included M. Hammill (Canada), P. Hammond (UK) and A. Thompson (NAFO). The objective of this Symposium was to bring together scientists from a variety of fields to examine the gains that we have made over the past 13 years in understanding the role of marine mammals in the ecosystem.

A total of 54 abstracts were submitted to the steering committee for consideration. Of these 53 (34 oral, 19 poster) were accepted. A total of 46 (32 oral, 14 poster) papers were presented at the symposium. Approximately 70 scientists from 11 countries attended representing Australia, Canada, Faroe Islands, Iceland, Japan, Norway, Russia, Spain, Sweden, UK and USA. The wide range of countries present reflects the global nature of the questions addressed at the symposium.

The symposium presented new findings on the syntheses of information over ecosystem components, on biological and physical aspects of the environment, and on new research approaches to understanding the role of marine mammals. It was organised in four theme session, each session starting with an invited key-note speaker and followed by both contributed oral and poster presentations from participants. The session chairs were G. Stenson, T. Haug, C. Lockyer and M. Hammill.

Session 1: Biological and environmental factors affecting life history traits

The keynote talk in this session, "Factors affecting Life History Traits" was presented by Dr. Mark Hindell (University of Tasmania, Australia) who examined the complex interplay between phylogenetic history and environmental factors in shaping life history traits in marine mammals. The session included 6 oral and 2 poster presentations that addressed issues ranging from trends in reproductive parameters and recruitment in hooded and grey seals to patterns of mortality of harbour seals. The results of research on growth rates and sexual maturity of captive and wild beluga whales, and the effects of contaminants were also presented.

Of particular importance to the NRA is the observation that reproductive rates of northwest Atlantic hooded seals appear to be declining, possibly as a result of environmental changes (Frie *et al.*) Also, a simulation study exploring the impact of pup mortality due to poor ice conditions in Northwest Atlantic harp seals (Hammill and Stenson) showed that mortality can have a significant effect on future populations. However, due to the way in which abundance is estimated, the impact may not be identified for 15–20 years, by which time a significant reduction in the population may have occurred.

Session 2: Foraging strategies and energetic requirements

The second session addressed research related to how much energy marine mammals require and what strategies they use to obtain it. Dr. Dan Costa (University of Santa Cruz, USA) provided the key note talk, entitled 'Foraging Ecology and Energetics of Pinnipeds: Conservation Implications', where he asked what would be the management and conservation implications of species specific foraging strategies and energetic requirements. Contributed papers in this session explored foraging behavior, strategies and ecology of baleen whales and dolphins and habitat use and seasonal changes in energy intake and body condition in seals.

A comparison between the detailed energy model developed by Hammill Ryg and Chabot to a simple model indicated that temporal variation in energy requirements must be incorporated into consumption models in order to accurately reflect the amount of prey eaten, particularly in cases where diets vary seasonally. Using satellite transmitters to monitor movements of diving behaviour of northwest Atlantic hooded seals (Anderson *et al.*) has provided the first estimates of seasonal habitat use for this population. Preliminary modelling indicates that depth, and to a lesser extent ice cover, were important factors affecting distribution of hooded seals. A comparison between the condition of harp and hooded seals collected in the northwest Atlantic during the 1980s and 1990s (Chabot and Stenson) found that condition of both species was less in the more recent time period.

Session 3: Marine mammal - fisheries interactions

Session 3 explored the impact of marine mammals on fisheries, as well as the impact of fisheries on marine mammals. The keynote speaker was Dr. John Harwood (University of St Andrews, UK) who used his talk, 'Quantifying Marine Mammal-Fisheries Interactions' to discuss how such interactions can be incorporated into the ecosystem approach to fisheries. The session included 9 oral and 5 poster presentations, addressing bycatch, direct interactions between seals marine mammals and particular fisheries, and the consumption of resources of interest to fishers by marine mammals. The wide range of locations where these observations took place (e.g. US, UK, South Atlantic, Baltic, Spain, Canada) illustrates the wide ranging impact of marine mammals.

In the northwest Atlantic, Traditional ecological knowledge (TEK) was used to determine the likelihood of harp seals impacting salmon in Newfoundland (Lemky and Sjare). They found that the likilhood of an interaction was high in approximately one half of the rivers examined. However, they also found that although information from resource users suggested that the potential for harp seal predation on salmon had increased since the mid-to late 1990s, diet observations of stomach contents indicated that seals were feeding on prey species and not necessarily on salmon when these species co-occurred. Lawson and Gosselin presented estimates of cetacean abundance along the Canadian continental shelf form Hudson Strait to the Scotian Shelf based upon a recent sighting survey. Preliminary estimates of consumption, in the order of 1.7 million tones, indicated that cetaceans could have significant controlling effects on the biomass of other consumers as well as the prey.

Session 4: Theoretical considerations on apex predators and multispecies models

In his key-note address, 'Marine Mammals and the Theoretical Considerations Associated with Apex Predators and Multi-Species Models', Dr. Andrew Trites (University of British Columbia, Canada) suggested that, although it is evident that the interaction between marine mammals and their prey influence the structure and dynamics of marine ecosystems and, similarly, that predators and prey have shaped each other's behavior and life history traits, there is little empirical evidence of these influences. However, ecosystem models are valuable tools to better understand these problems. The session included 7 oral and 5 poster presentations including papers describing methods of estimating diets, prey selection, spatial distribution, uncertainty in abundance estimation and multispecies modeling.

Buren and colleagues presented a method of estimating the diet of harp seals in 2J3KL using a multinomial regression approach to fill in sampling gaps. Comparing the diets of Atlantic cod, Greenland halibut and harp seals using this approach, they found that all three predators relied heavily on capelin, but the cod diet showed a higher consistency over time, suggesting that cod has less trophic plasticity than Greenland halibut and seals. This lack of trophic flexibility could not only be a contributing factor in the lack of recovery of cod, but also suggest that other generalist predators like Greenland halibut, and possibly seals, may be better positioned to utilize a changing resource base. Research in Norway on methods to estimate prev selection by harp seals (Lindstrøm *et al.*) and quantify competition between baleen whales and pelagic fish in the Barents Sea (Mauritzen *et al.*) are providing interesting techniques that may be applied to similar situations in the NRA. Finally, a study in the southern Ocean (Lavery and Mitchell) illustrated the importance of marine mammals to transfer nutrients within marine systems.

The symposium ended with a general discussion where the participants identified the progress that had been made in the past 13 years and discussed future research that will advance our understanding of the role of marine mammals in the ecosystem. The participants agreed that we have improved our understanding of the role marine mammals, particularly cetaceans, have in the ecosystem. The scale at which marine mammals function has been found to be much larger than previously considered and often exceeds that of the fisheries of interest. Much of the improvement in our understanding has been a result of new technologies such as satellite telemetry and new methods of estimating diets. Generally, there is a more holistic approach to the questions being asked and the studies undertaken. Also, the statistical approaches being used are much more sophisticated and improve the way in which uncertainty is incorporated. Multi-disciplinary studies, especially studies including oceanographers, have advanced our understanding significantly. However, in many areas, significant progress is still needed to involve fisheries scientists in collaborative projects.

After the symposium all contributors were invited to submit final papers which, if accepted after peer review, will be published in a special symposium issue of the Journal of Northwest Atlantic Fishery Science. To date, 12 papers have been submitted and sent out for review. Of these 2 have already been accepted for publication. A few authors have asked for an extension to the deadline for submission of papers and it is anticipated that we may received 2–3 more papers. The final deadline for submission is now 1 September 2009.

The Co-conveners wish to thank the participants for their contributions and in making this a most informative and enjoyable Symposium. We also wish to thank the sponsors and the on-site support given by the NAFO Secretariat.

SYMPOSIUM SCHEDULE

The Role of Marine Mammals in the Ecosystem in the 21st Century

Monday, 29 September 2008				
0830-0900	Registration, set-up Posters and load presentations			
0900-0915	Introduction (Scientific Council Chair, Convenors)			
Session 1.	Biological and environmental factors affecting life history traits (Garry Stenson)			
0915-1000	Mark Hindell Keynote - Factors affecting Life History Traits			
1000-1020	A. K. FRIE, V. SVETOCHEV, G. STENSON and T. HAUG. Trends in reproductive paramet metabolites on harbor seal (<i>Phoca vitulina</i>) immune cells.			
1230-1400	SESSION 2. Foraging strategies and energetic requirements (Tore Haug)			
1400-1445	Dan Costa keynote - Foraging Ecology and Energetics of Pinnipeds: Conservation Implications			
1445-1505	T. TAMURA, K. KONISHI. Foraging Ecology and Energetics of Pinnipeds: Conservation Implications.			
1505-1525	G. A. VÍKINGSSON. Feeding ecology of common minke whales (Balaenoptera acutorostrata) in Icelandic waters.			
1525-1555	Break			
1555-1615	T. S. STEVENS and J. W. LAWSON. Using recent distribution and behavioural data for killer whales (<i>Orcinus orca</i>) in Atlantic Canada to assess the influence of predation pressures on the movement and social patterns of minke whales			
1615-1645	M. O. HAMMILL, M. RYG and D. CHABOT. Seasonal Changes in Energy Requirements of Harp Seals.			
1700-1830	Reception/Poster Display			
	Tuesday, 30 September 2008			
0900-0920	G. B. STENSON, M. KOEN-ALONSO and A. D. BUREN. Recent Advances on the Role of Seals in the Northwest Atlantic Ecosystem			
0920-0940	J. M. ANDERSEN, Y. WIERSMA and G. STENSON. Habitat Selection By Hooded Seals (<i>Cystophora cristata</i>) In A Dynamic Marine Ecosystem.			
0940-1000	K.T.A. DAVIES, C. T. TAGGART and K. SMEDOL. The role of physical oceanography and zooplankton in controlling the spatiotemporal distribution of the North Atlantic right whale.			
1000-1050	Break			
1050-1110	K. KONISHI, T. TAMURA, T. ISODA, R.OKAMOTO, K. MATSUOKA, T. HAKAMADA. Prey consumptions and feeding strategies of three baleen whale species around the Kuroshio-current extension.			
1110-1130	P. BRODIE and G.VIKINGSON. Observations of the feeding mechanics of the Sei whale (<i>Balaenoptera borealis</i>), based on the examination of hunted specimens off Nova Scotia and Iceland.			
1130-1150	A. I. MACKAY and P. C. STEPHENSON. An assessment of the foraging behaviour of bottlenose dolphins interacting with a bottom trawl fishery.			
1150-1320	Lunch			
	SESSION 3. Marine mammal – fisheries interactions (Christina Lockyer)			
1320-1405	JOHN HARWOOD, J. MATTHIOPOULOS and S. SMOUT. <i>keynote</i> - Quantifying marine mammal-fisheries interactions			
1405-1425	C. D. ORPHANIDE. Comparison of Methods for Estimating the Bycatch of Protected Species: Estimating the Bycatch of Harbor Porpoise (<i>Phocoena phocoena</i>) in U.S. Gillnet Fisheries in the Northwest Atlantic			
1425-1445	MY. LEE. Whale-watching and Herring Fishing: Joint or Independent?			
1445-1505	S. GOETZ, G. HERNANDEZ-MILIAN; C. VARELA-DOPICO, J. RODRIGUEZ-GUTIERREZ, J. ROMÓN, J. R. FUERTES-GAMUNDI, E. ULLOA, N. J. C. TREGENZA, A. SMERDON, M. G. OTERO, V. TATO, J. WANG, M. B. SANTOS, A. LÓPEZ, R. LAGO, J. PORTELA, G. J. PIERCE. Results of a Short Study of Interactions of Cetaceans and Longline Fisheries in Atlantic Waters: Environmental Correlates of Catches and Depradation Events			
1505-1525	I. Payá and P. BRICKLE. Changes of fishing gear design for reducing whale interference: Impacts on stock assessment and management of toothfish off Falkland Islands.			

1525-1605	Break			
1605-1625	T. AHO, A. GÅRDMARK, K. LUNDSTRÖM and J. PÖNNI. Effects of grey seals on the herring population i the Baltic Sea area.			
1625-1645	S. GUNNAR LUNNERYD, S. KÖNIGSON and K. LUNDSTRÖM. The grey seal- fishermen cod competition i the Baltic Sea.			
1645-1705	C. LENKY and B. SJARE. Interactions between harp seals and salmon in coastal habitats of Newfoundland and Labrador.			
1705-1725	F. L. READ, J. MARTÍNEZ-CEDEIRA, Á. F. GONZÁLEZ, A. LÓPEZ, B. S. and G. J. PIERCE. Understanding marine mammal and fisheries interactions in Galicia, north-west Spain: Past, present and future.			
1725-1745	J.W. LAWSON and JF. GOSSELIN. Don't Ignore The Whales: Cetacean Biomass Consumption Estimates Based On The Recent TNASS Aerial Survey of Atlantic Canada			
	Wednesday, 1 October 2008			
SESSION 4.	Theoretical considerations on apex predators and multispecies models (Mike Hammill)			
0900-0945	Andrew Trites <i>keynote</i> Marine Mammals and the Theoretical Considerations Associated with Apex Predators and Multi-Species Models			
0945-1005	U. LINDSTRØM, K.T. NILSSEN, L.M.S. PETTERSEN and T. HAUG. Use and selection of prey by harp seals in the northern Barents Sea.			
1005-1025	A. D. BUREN, M. M. KOEN-ALONSO, G. B. STENSON. Reconstructing diet composition using a multinomial regression approach			
1025-1055	Break			
1055-1115	L. MORISSETTE, K. KASCHNER, J. L. MELGO and L. GERBER. Declining fish stocks: are whales the culprits?			
1115-1135	T. A. ØIGÅRD, T. HAUG, K. T. NILSSEN and AB. SALBERG. Reducing uncertainty in estimated harp and hooded seal pup production using Generalized Additive methods: Results from aerial surveys in the Greenland Sea in 2007.			
1135-1155	T. J. LAVERY and J. G. M. MITCHELL. Marine Mammals Stir the Ocean.			
1155-1325	Lunch			
1325-1345	M. MAURITZEN, E. JOHANNESEN, P. FAUCHALD, A. BJØRGE, E. OLSEN and N. ØIEN. Large-Scaled Distribution Of Baleen Whales In The Barents Sea: The Role Of Competitive And Trophic Inteactions With Pelagic Fish.			
1345-1405	A. D. BUREN, M. KOEN-ALONSO, K. S. DWYER and G. B STENSON. Is there room for competition among fish top predators and harp seals in the Northwest Atlantic (NAFO Div. 2J3KL)?			
1405-	General Discussion			
	How have we improved our understanding in the past 13 years?			
	What is our current understanding of the role of marine mammals?			
	What needs to be done next to improve our understanding?			

POSTERS

Session 1

M. HAMMILL and G. B. STENSON. Potential impacts of ice related mortality on trends in the northwest Atlantic harp seal abundance.

T. STEVENS and J. LAWSON. Distribution and Movement patterns of killer whales (Orcinus orca) in the northwest Atlantic.

Session 2

B. H. WITTEVEEN and K. M. WYNNE. Consumption and prey removals by humpback whales (*Megaptera novaeangliae*) near Kodiak Island, Alaska: A revision of previous estimates.

Session 3

M. ROSSMAN. Estimated Bycatch of Small Cetaceans in Northeast U.S. Bottom Trawl Fishing Gear During 2000–2005.

- G. PIERCE, S. GOETZ, S. LENS, U. PENA, S. GOETZ, M. LAPORTA, J. L. DEL RÍO, J. PORTELA, S. IGLESIAS. Observer programmes to record marine mammal and seabird distribution and interactions with fishing operations in Southwest Atlantic waters.
- D. Belden, G. T. Waring, J. R. Gilbert, A. VanAtten and D. L. Palka. Characteristics of phocid seal bycatch in New England fisheries.
- A. CASKENETTE, M. HAMMILL, S. CRAWFORD, and D. DUPLISEA. Grey seal and Atlantic cod interaction in the southern Gulf of St. Lawrence.
- W. LEDWELL, S. BENJAMINS, J. HUNTINGTON and C. HOOD. Incidental entrapments of large whales in Newfoundland Region from 1999–2007.

Session 4

- H. MURASE, T. KITAKADO, K. MATSUOKA, T. HAKAMADA, S. NISHIWAKI and M. NAGANOBU. Predator-prey relationship in spatial context -Is the distribution pattern of krill the determinant factor of the distribution pattern of Antarctic minke whale?
- T. J. LAVERY, B. ROUNDNEW, S. GOLDWORTHY. J. MIDDLETON, L. SEURONT and J. G. MITCHELL. Seals transport nutrient rich water across the thermocline.
- S. LENS, M. B. SANTOS, D. OÑATE, A. MIRANDA., G. CASAS, A. CAÑADAS, J. M. CABANAS, M. IGLESIAS, R. FERNÁNDEZ and J. A. VÁZQUEZ. Distribution of fin whales and krill aggregations off the Galician coasts observed during the CODA-IEO survey.
- C.C.A. MARTINS, P. LAMONTAGNE, L. PARROTT, J. A. LANDRY, D. MARCEAU, C. CHION, S. TURGEON, R. MICHAUD, N. MENARD, S. DIONNE, and G. CANTIN. Conceptualizing an individual-based model to simulate marine mammal behaviour in the Saint Lawrence Estuary, Canada
- K. A. HART, H. D. MARSHALL, G. B. STENSON, D. MCKINNON, E. A. PERRY. Molecular identification of prey species in the stomach content of harp seals (Pagophilus groenlandicus) using species-specific oligonucleotides.
- B. BRANTON and M. MURRAY. Data management development plan for the Ocean Tracking network.

CONVENORS

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