Fisheries and Oceans Canada | Pêches et Océans Canada

2005-06 Science Annual Report

Canada

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Cover Photo Credit: Paul Nicklen

Cover Photo Caption: A Fisheries and Oceans Canada researcher loads a rosette water sampler into the Arctic Ocean from the deck of the CCGS *Louis S. St. Laurent* in order to record factors such as water temperature, salinity, oxygen, nutrients, and alkalinity.

Minister of
Fisheries and Oceans

Ministre des
Pêches et des Oceans

Ottawa, Canada K1A 0E6

As Minister, I am very pleased to introduce Fisheries and Oceans Canada's (DFO) inaugural report on our Science Sector.

Sound science remains the cornerstone on which DFO bases its fisheries and oceans management decisions. Every day, through its key functions — such as research, monitoring, advisory duties, data management and a host of other products and services — the Science Sector helps DFO enhance the strategic outcomes it delivers to Canadians. Those are:

- Sustainable Fisheries and Aquaculture;
- Healthy and Productive Aquatic Ecosystems; and
- Safe and Accessible Waterways.

DFO is a science department and I am firm believer in its role to better inform our decisions in managing Canada's fisheries and oceans. I am committed to renewing our science capabilities to deliver high-quality research and technology that are relevant, effective, affordable and valued by Canadians.

Science is becoming an increasingly collaborative undertaking. The purpose of this report is to provide all Canadians, and our departmental partners and stakeholders, with a comprehensive look at DFO's Science Sector. I hope our report serves to further inform and engage the public on the important scientific work we're accomplishing.

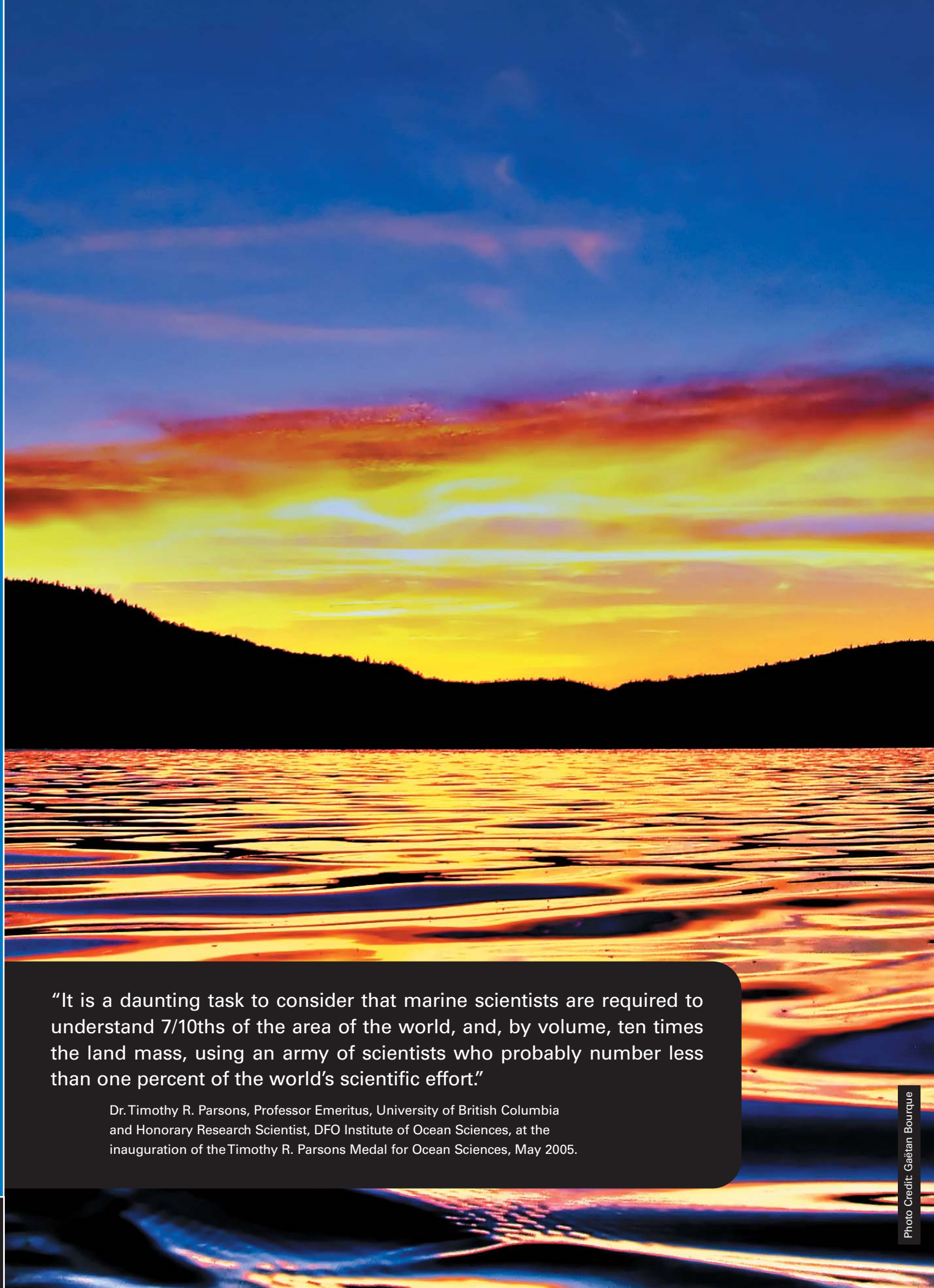
I invite you to explore this publication to learn more about the work of DFO's Science Sector and I welcome your comments.

Sincerely,

Loyola Hearn

The Honourable Loyola Hearn, P.C., M.P.
Minister of Fisheries and Oceans

Canada



"It is a daunting task to consider that marine scientists are required to understand 7/10ths of the area of the world, and, by volume, ten times the land mass, using an army of scientists who probably number less than one percent of the world's scientific effort."

Dr. Timothy R. Parsons, Professor Emeritus, University of British Columbia and Honorary Research Scientist, DFO Institute of Ocean Sciences, at the inauguration of the Timothy R. Parsons Medal for Ocean Sciences, May 2005.

Photo Credit: Gaëtan Bourque

Assistant Deputy Minister's Message

The great majority of the approximately 1,600 Science Sector staff of the Department of Fisheries and Oceans (DFO) work at fourteen institutes and laboratories, where scientists, technicians, hydrographers and other science staff are undertaking projects at the cutting edge of science. Their work, in concert with the work of their national and international partners, offers Canadians important, relevant information about our aquatic ecosystems that is of vital benefit to Canada and the world.

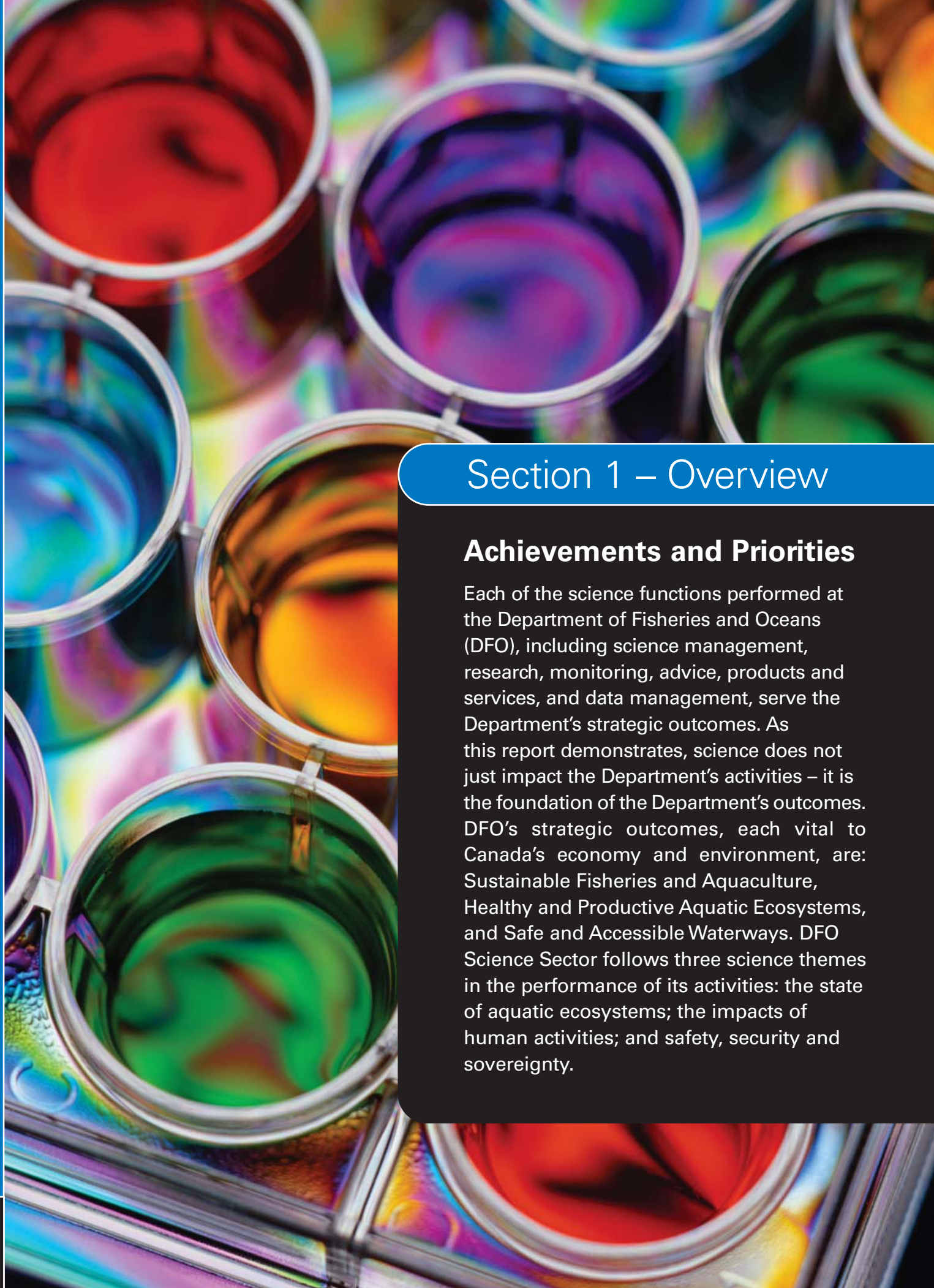
Internationally, and among our scientific peers, DFO researchers have, for some time, been regarded as world leaders in the aquatic sciences. Our institutes throughout the country are top notch. We are breaking new ground in our understanding of northern environments and species. With respect to freshwater, we are doing world-leading research into freshwater cage aquaculture with our Experimental Lakes Area program. In oceanography, respect for our modelling and data interpretation of world oceans is reflected in our many close international linkages. Our Canadian Hydrographic Service is a leader in electronic charting. Many positive changes to policy and legislation have resulted from our work. Yet, despite all of this, at one of the first meetings of our external Science Advisory Council in 2005, a member remarked that the Science Sector of DFO was home to "some of the greatest science stories never told."

It is my intention to improve our ability to tell our science stories, and this annual report is just one reflection of that intention. Some readers of this report will be surprised and perhaps amazed by the work we do. It is my goal that all who read it will see the excellence and relevance of the work.

During 2005 we reviewed our activities, leading to the implementation of a Science Renewal initiative in 2006. In support of Science Renewal and high priority research, the Government of Canada invested $13.5 million in DFO Science during 2006 under the DFO Transformational Plan. Supported by this investment, Science Renewal aims at ensuring that the DFO Science program continues to be based on excellence; that it is relevant to the needs of the Department, the federal government and Canadians; that it is effective and delivers the program through modernized delivery mechanisms; that it is affordable, giving it sufficient long-term sustainability; and that it is valued and understood by decision makers.

DFO Science is an important organization, doing science that matters to Canada — in the field and in the lab. I am therefore proud to present this overview of the work of DFO Science Sector in 2005-2006.

Wendy Watson-Wright, PhD
Assistant Deputy Minister
Science Sector
Fisheries and Oceans Canada



Section 1 – Overview

Achievements and Priorities

Each of the science functions performed at the Department of Fisheries and Oceans (DFO), including science management, research, monitoring, advice, products and services, and data management, serve the Department's strategic outcomes. As this report demonstrates, science does not just impact the Department's activities – it is the foundation of the Department's outcomes. DFO's strategic outcomes, each vital to Canada's economy and environment, are: Sustainable Fisheries and Aquaculture, Healthy and Productive Aquatic Ecosystems, and Safe and Accessible Waterways. DFO Science Sector follows three science themes in the performance of its activities: the state of aquatic ecosystems; the impacts of human activities; and safety, security and sovereignty.

Three major achievements of 2005 will shape the direction of Science in the Department for the balance of the decade. First, and fundamental to science renewal in the Department, was the establishment of the Science Management Board, chaired by the Deputy Minister. The Board identifies issues of importance to achieving mandated objectives of DFO; selects and assesses departmental and government-wide priorities needing Science support; and provides strategic direction on DFO Science operational planning. Second, an ecosystem-based approach to research and monitoring activities was begun. Third, the activities of the Canadian Hydrographic Service (CHS) were focused on collecting more comprehensive hydrographic data and providing data in electronic format. In addition to these key achievements, DFO Science contributed to research and advice on issues of national importance, including northern communities, climate change, the United Nations Convention on the Law of the Sea, biotechnology, and federal interdepartmental priorities such as freshwater.

To facilitate the move to an ecosystem-based approach to science, DFO Science defined a framework for short- medium- and long-term activities, based on these eight priorities:

1. Setting clear ecosystem objectives for monitoring and protection;
2. Developing ecosystem indicators and reporting systems;
3. Developing risk-based frameworks;
4. Generating integrated ecosystem information for fisheries management;
5. Identifying habitats of special importance and sensitivity;
6. Understanding impacts on aquatic biodiversity (species at risk and aquatic invasive species);
7. Understanding pathways of effects driving changes;
8. Understanding climate variability and impacts on resources.

In the field of hydrography, the CHS made strides in the adoption of technological advances such as electronic charting, multi-beam data collection, automated production, database development and internet portals. This year, CHS also began a co-operative arrangement with Natural Resources Canada (NRCan) and Foreign Affairs and International Trade Canada in mapping the seafloor to determine the outer limits of Canadian jurisdiction under the United Nations Convention on the Law of the Sea (UNCLOS). CHS also collected data in collaboration with NRCan for seabed mapping under Canada's Oceans Action Plan. Seabed mapping is focused on providing imagery of the seabed characteristics and features and helps to increase scientific understanding of the physical environment and associated habitats to support integrated management planning and the identification of marine areas in need of protection. During the 2005 season more than 2,300 square kilometres in the St. Lawrence estuary were surveyed using multibeam technology.

In an era of increasingly complex and costly science challenges, partnering is essential to expand the capabilities of DFO Science. Better and stronger programs result through the input of third-party expertise; traditional and local knowledge is acquired this way; world-class scientific and technological innovation is fostered through exposure to Canadian and international leaders; new scientific personnel are trained more effectively and, with partnering, DFO Science is better able to maintain a national and international reputation for science excellence. The move to create Centres of Expertise positions Science Sector to partner effectively by clustering researchers with complementary specialties, interests and missions in aquatic science into either geographic-based or virtual Centres of Expertise.

These achievements, and DFO Science's ongoing work to contribute to national issues of importance, are described more fully in this inaugural annual report of DFO Science Sector. To learn more, visit the DFO Science website at: www.dfo-mpo.gc.ca/science/main_e.htm

Strategic Role of Science in DFO

DFO Strategic Outcomes

- Sustainable Fisheries and Aquaculture **(SFA)**
- Healthy and Productive Aquatic Ecosystems **(HAPAE)**
- Safe and Accessible Waterways **(SAW)**

National Science Themes

State of Aquatic Ecosystems; Impacts of Human Activities; Safety, Security and Sovereignty

Science Functions

- Research
- Monitoring
- Advisory Processes
- Products and Services
- Data Management

- Status of Fishery Resources
- Species at Risk
- Aquatic Invasive Species
- Aquaculture Production
- Aquaculture-Environment Interactions
- Impacts of Development Activities
- State of Ecosystems and Integrated Management
- Role of Oceans in Global Climate
- Genomics and Biotechnology
- Aquatic Animal Health
- Products and Services for Navigation
- Mapping the Ocean Floor (UNCLOS)
- Impacts of Climate Variability and Change

These Science Activities Support the Three DFO Strategic Outcomes

Science Budget 2005-2006

Safe and Accessible Waterways	($ millions)
Providing Products and Services for Navigation	30.1
Claiming the Continental Shelf under the United Nations Convention on the Law of the Sea (UNCLOS) Assessing the Impact of Climate Variability on Navigation	4.5
Other programs and services	1.9
Sustainable Fisheries and Aquaculture	
Assessing the status of fishery resources	90.9
Supporting the assessment and recovery of species at risk	12.4
Preventing and controlling aquatic invasive species Preventing and controlling aquatic animal diseases	17.5
Supporting sustainable aquaculture production Evaluating interactions between aquaculture and the environment	10.5
Applying genomics and biotechnology to aquatic ecosystems	2.1
Contributing to science management in DFO and the Government of Canada (in support of safe and accessible waterways, sustainable fisheries and aquaculture, and healthy and productive aquatic ecosystems)	3.8
Healthy and Productive Aquatic Ecosystems	
Assessing the impacts of development on aquatic ecosystems	21.5
Assessing aquatic ecosystems and supporting integrated oceans management Mapping the ocean floor Integrated management of scientific data	8.6
Determining the role of oceans in the global climate Assessing the impact of climate variability	12.5
Other programs and services	3.8
Total	**220.1**

Note: Amounts shown are allocations.

Actual expenditures are reported in the DFO Department Performance Report, 2005-2006.

Photo Credit: Paul Nicklen

Section 2 – Science in the News

Science News Highlights

Oceans, weather and their impacts were the major news stories of 2005. As the year began, the world struggled to respond to the Indian Ocean tsunami, and at year-end, the legacies of hurricanes Katrina and Rita continued unfolding in the headlines. These events focused global attention on ocean science, especially tsunami and storm prediction, warning and ocean monitoring capabilities. In Canada, Fisheries and Oceans Science made news throughout the year, in stories tied to global trends, in news about the contribution of Science to core functions and services of the Department and in stories that reflected issues of daily importance to Canadians. The following is a chronological round up of news highlights from all regions of Canada.

Giant Squid Examined at Northwest Atlantic Fisheries Centre Wetlab

Research scientist Earl Dawe at the necropsy of the giant squid.

Photo Credit: Kimberley Penney

On January 11, 2005, the media gathered and the wetlab was buzzing with scientists from numerous institutes as well as university and secondary students who gathered for the necropsies of two giant squid, the first such giants recovered in 23 years in the area. The first squid was a mature female, which measured 5.7 metres from tail to tentacle tip and weighed 38.56 kilograms. The second recovered squid was a mature male. It measured 4.05 metres and weighed 32.96 kilograms. It was a rare opportunity to study a species that is virtually unknown and DNA samples were taken to contribute to an ongoing international study. Giant squid have tended to be found in the fall in years when the water was warmer, as it was in 2004. Approximately 30 of the 60 giant squid that have been found in Newfoundland and Labrador waters were recorded during the 1870s. Giant squid were most recently found in the province in 1972, 1981 and 1982.

Science and Seafood

In February, the Government of Canada announced a $59 million investment in the National Aquatic Animal Health Program (NAAHP). This shared initiative, which is led by the Canadian Food Inspection Agency, aims to protect aquatic animals from the harmful effects of diseases and to maintain the seafood industry's competitiveness in international markets. By proactively protecting the health of Canadian aquatic animals, the NAAHP also protects industries such as commercial fishing and aquaculture, which depend on them, and thus contributes to the overall economic health of a region. Under the initiative, Canada is developing a strong monitoring and surveillance program that is a co-operative effort among federal and provincial governments, industry and academia. Key goals of the NAAHP are to enable Canada to meet international standards for aquatic animal health, secure seafood export markets, and secure a national aquatic inspection and certification regime equivalent to the system currently applicable to terrestrial animals. Learn more at www.inspection.gc.ca/english/ anima/aqua/aquaproge.shtml

Aquaculture and Environmental Research Lab

During March, DFO announced a new collaboration for scientific research with the University of British Columbia (UBC). The DFO/UBC Centre for Aquaculture and Environmental Research (CAER) will share DFO's state-of-the-art West Vancouver Laboratory facility. The 2,500 square-metre facility consists of wet and dry labs and an extensive system of water containers for fish rearing and research, as well as a wharf to dock large vessels. CAER is a centre for focused research programs that integrate concepts of ecosystem and conservation with sustainable aquaculture practices and the development of cost-effective strategies for growing aquatic species of global importance.

Atlantic Seal Research

The most downloaded feature story on DFO Science's website during 2005 concerned the Atlantic Seal Research Project (ASRP), which examined seal abundance, distribution and diet. The tagging and satellite

Temporary electronic tags drop off harmlessly during the seal's annual moult.

Photo Credit: Garry Stenson

tracking of approximately 100 seals yielded insights into the mapping of seal routes, dive behaviour and swimming speed that has enabled improved modelling of seals' interactions with Atlantic groundfish. In a world first, researchers showed that the proportion of different fatty acids in seal blubber reflects the proportion of different fish species in its diet. For an overview of the ASRP, see the science feature story at: www.dfo-mpo.gc.ca/science/Story/ seals_e.htm

Improving International Governance through Science in Newfoundland and Labrador

A major Government of Canada announcement in April concerned funding of $20 million over three years for science, advocacy, policy and legal initiatives in support of Canada's international governance of high seas strategy. Over half of this funding ($11 million) was allocated for scientific research. The Newfoundland and Labrador Region received the largest portion of this science funding. Over three years, $7.6 million will support 14 research projects to help DFO develop a better understanding of the Grand Banks ecosystems and straddling fish stocks. Several projects began in 2005, with more coming on stream in 2006. A backgrounder is online, at: www.nfl.dfo-mpo.gc.ca/publications/ backgrounders_fiches0507.asp

Three-spine stickleback (*Gasterosteus aculeatus*) collected from the Broughton Archipelago region of coastal B.C. in 2004. The fish is heavily infected with the salmon louse *Lepeophtheirus salmonis* and another sea lice species, *Caligus clemensi*. The stickleback is a newly discovered host of the salmon louse on the B.C. coast, and may be important in transferring the parasite to other fish.

Photo Credit: Ted Sweeten

DFO Scientist Tops in Smart Gear Competition

Dr. Edward Trippel at the St. Andrews Biological Station preparing barium sulphate gillnet and weak rope for experimental field trials in the Bay of Fundy.

Photo Credit: Suzanne Taylor

Dr. Edward Trippel, a DFO scientist at St. Andrews Biological Station, won first prize in the inaugural International Smart Gear Competition. The win was announced in April 2005 in the competition sponsored by the World Wildlife Fund. He was recognized for his innovative research to increase the reflective properties of gillnets and to design weak rope to reduce the incidence of bycatch of porpoises and whales in commercial fisheries.

Sea Lice

Potential links among sea lice, salmon farms and wild salmon stocks in British Columbia continued to garner media attention in 2005. DFO scientists are actively engaged in monitoring sea lice and in research about sea lice biology and abundance. These parasites are found in all oceans and on many species, and are common to Pacific salmon adults during their return migration in B.C. coastal waters. We know that wild salmon spread sea lice to farmed salmon; however, the involvement of salmon farms as a source of lice infecting wild juvenile salmon is the source of debate. In the absence of treatment, salmon farms can be a source of lice to the surrounding environment. Salmon farmers, however, can treat their fish and control sea lice levels. Results of our research showed that sea lice levels on wild juvenile salmon varied among years. Infections with sea lice may increase mortality during early marine phases of Pacific salmon, but the issue of greatest concern is whether mortality over the life span of the fish increases and threatens the conservation of local populations. During 2004 and 2005, adult returns of

pink and chum increased relative to brood year and approached long term average values. These observations and increased collaborative research with the industry contribute to an emerging view that salmon farms and wild stocks can co-exist. However, the continued presence of sea lice on juvenile salmon in some areas of B.C. is a marine ecosystem puzzle that involves much more than salmon farms. For more about sea lice on the DFO website, go to www.dfo-mpo.gc.ca/media/infocus/2005/200 51011b_e.htm

Dr. Robie Macdonald Honoured by Royal Society of Canada

The Royal Society of Canada announced in May that Dr. Robie Macdonald, FRSC, a senior research scientist at the Institute of Ocean Sciences in Sidney, B.C., was awarded the 2005 Miroslaw Romanowski Medal. The prestigious award recognizes significant contributions to the resolution of scientific aspects of environmental problems or important improvements to the quality of an ecosystem. The Society recognized Dr. Macdonald as a world-class scientist, internationally noted for his work on contaminant pathways in environmental systems.

Timothy R. Parsons Medal Inauguration

The first medals named for Canadian ocean sciences pioneer Dr. Timothy R. Parsons were awarded by DFO Science Sector in May. First recipients of the honour were Dr. Parsons himself, for his unparalleled contributions to a holistic approach to ocean sciences, and Dr. Daniel Ware, for his outstanding contribution to the field of fisheries oceanography.

Timothy R. Parsons Medal

The awards were created by DFO Science Sector, and will be given annually subject to a nomination and selection process. Sadly, Dr. Ware passed away just months after receiving the honour from his peers. Learn more about Dr. Parson, and the medal at: www.dfo-mpo.gc.ca/science/ Awards/Parsons_e.htm

Institute of Ocean Sciences Researchers Honoured

Researcher Svein Vagle was awarded the Medwin Prize in Acoustical Oceanography in May 2005, while his colleague Eddy Carmack was honoured by election as a Fellow of the American Geophysical Union. Both scientists work at the DFO Institute of Ocean Sciences in Sidney, B.C.

Workshop Kicks off Design of Atlantic Storm Surge and Tsunami Warning System

In June, DFO hosted the inter-agency Atlantic Tsunami Warning Workshop at the Bedford Institute of Oceanography in Dartmouth, involving federal and provincial representatives and researchers from the U.S. The goal of the group is to design and test a sustainable Atlantic Canada storm surge and tsunami warning system.

Hydrographer R. Michael Eaton, C.M., Receives Order of Canada Honour

Renowned nationally and internationally as the "father" of the electronic chart, Michael Eaton envisaged a computerized version of the traditional marine chart that is now a common navigation tool contributing to greater marine safety around the world. In June 2005, he was named a member of the Order of Canada for his outstanding contributions to the advancement of hydrography. Now Scientist Emeritus with the Canadian Hydrographic Service, he developed techniques to accurately map frozen bodies of water and combined various positioning systems to more precisely survey ocean waters.

Whale Recovery

In July, a draft Recovery Strategy designed to promote the recovery of certain Pacific populations of blue, fin and sei whale populations in Canada's Pacific waters made news when it was released. DFO scientists contributed to the creation of the recovery strategy, which will outline the goals, objectives, key

knowledge gaps and strategies to address the current threats to the marine mammals. After a period of public consultation, the document was sent to the *Species at Risk Act* Public Registry for further comments. Science Sector also contributed to that effort. For more on the draft recovery plan for blue, fin and sei whales, go to: www-comm.pac.dfo-mpo.gc.ca/pages/release/p-releas/2005/nr055_e.htm

Fin Whale

Photo Credit: Provincial Airlines

State of the Ocean Report for Pacific Shows Record High Temperatures

Also in July, Science Sector released the 2004 Pacific Region State of the Ocean report. It confirmed warm ocean surface waters throughout B.C. in the spring and summer, which scientists attributed to abnormal weather in B.C. and the Gulf of Alaska, as well as to general warming of the global lands and oceans. Other findings showed global land and ocean temperatures were near a record high in 2004. This weather brought record high temperatures to the Fraser River, a contributing factor to the low sockeye spawning numbers observed in 2004.

Canada at Aqua Nor 2005

In August, Canada was the featured country at Aqua Nor 2005, the world's largest international aquaculture tradeshow. "Made-in-Canada" science and technology was featured at the Canada Pavilion along with Canadian efforts in the environmentally sound production of safe, nutritious farmed fish and seafood. Canada hosted seminars highlighting our expertise and our scientists shared ideas with leading aquaculture scientists from around the world. In a move to increase public knowledge and build consumer confidence, Fisheries Ministers for Canada and Norway announced an International Working Group on Cold Water Aquaculture to improve collaboration on food safety and environmental sustainability issues. Learn more at: www.dfo-mpo.gc.ca/media/backgrou/2005/hq-ac70a_e.htm

Swordfish Tagging Goes High-Tech

In September, DFO announced that scientists at the St. Andrews Biological Station are working with the Nova Scotia Swordfish Harpoon Association in a first-ever Canadian high-tech tagging study of swordfish to determine their migration patterns in the Atlantic Ocean. The pop-up satellite tags are tiny waterproof computers, programmed to record the depth of swimming, temperature of the water, and daylight length, while enduring dives to more than 914 metres. In summer 2006, this information will be relayed by the ARGOS satellite communication system when the tag "pops up" to the surface. The information is then downloaded to a computer where scientists use programs to analyze the data to determine migration patterns of the fish. Read more at: www.mar.dfo-mpo.gc.ca/communications/maritimes/news05e/NR-MAR-05-25E.html

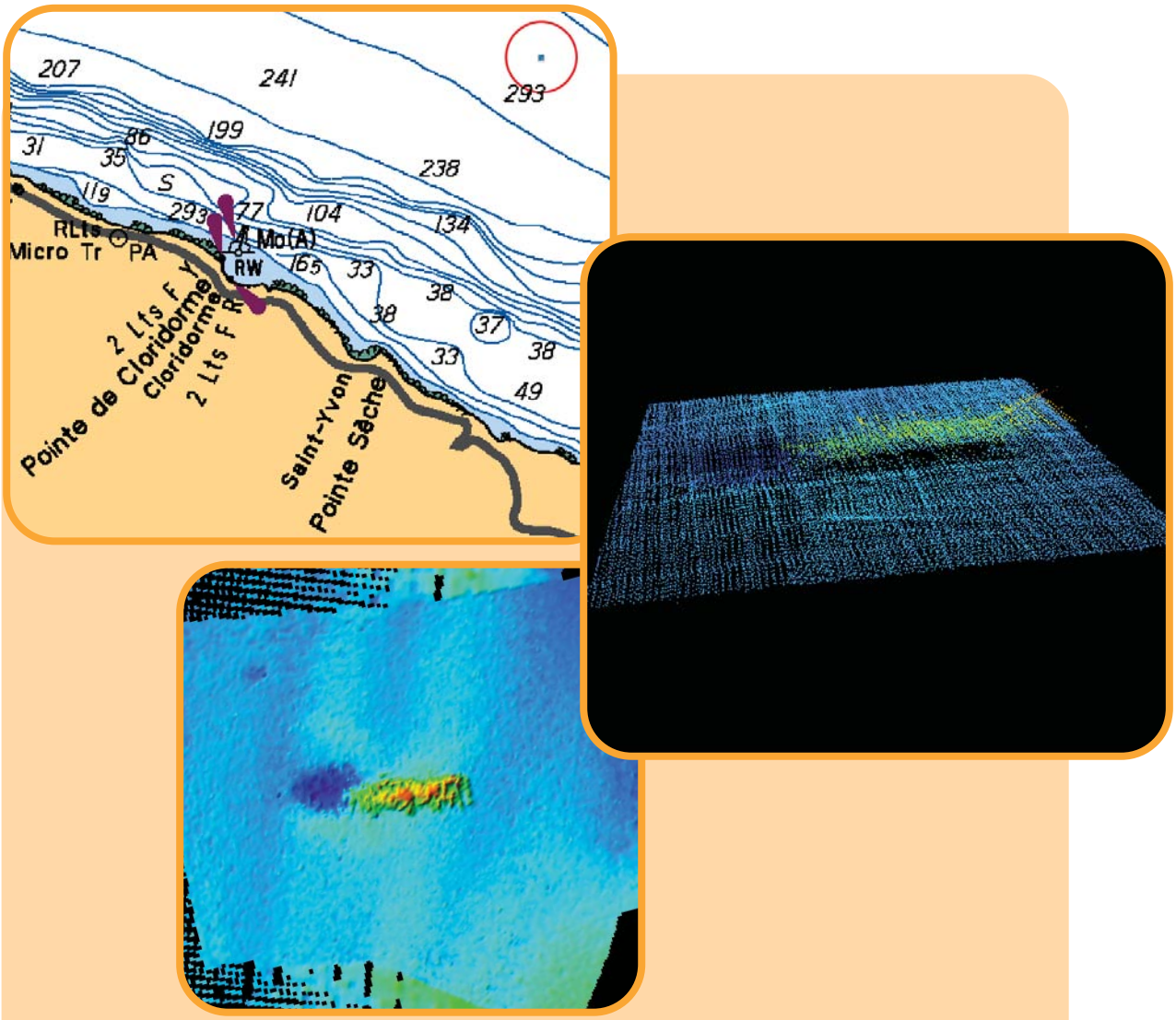
Invasive Species

Aquatic invasive species pose serious threats to native ecosystems and impact fisheries. In 2005, invasive tunicates, or 'sea squirts' were in the news. Invasive tunicates reproduce quickly and interfere with mussel production, increase industry costs and threaten the marine ecosystem around Prince Edward Island (P.E.I). In September, DFO and the P.E.I. Ministry of Agriculture, Fisheries and Aquaculture announced joint funding of $1 million towards the control, treatment and monitoring of invasive tunicates, as well as risk assessment, biological research, and monitoring the incidence of tunicates in P.E.I. In a second project, DFO, the province and its mussel industry are providing funds for a trial

research study on the effectiveness of mitigation measures in removing tunicates from mussels. DFO also funds federal researchers for the monitoring of tunicates and other invasive species in the maritime areas of Newfoundland and Labrador, Nova Scotia, New Brunswick, and Quebec. www.dfo-mpo.gc.ca/media/newsrel/2005/hq-ac83_e.htm

Canadian Hydrographic Service locates WWII Wreck in Gulf of St. Lawrence

In September, while surveying the habitat of the threatened spotted wolffish, the Canadian Hydrographic Service detected what is believed to be the wreck of the *SS Nicoya*. The merchant ship was torpedoed by a German submarine in 1942 off the Gaspé Peninsula coast, close to the village of Cloridorme, and was the first ship sunk by a German U-boat in Canadian waters during the Second World War.



The illustration shows the wreck of the *SS Nicoya* as it lies on the seafloor of the St. Lawrence Estuary. The wreck was detected using a Kongsberg multibeam echosounder EM-1002 onboard the CCGS *Frederick G. Creed*. The illustration was obtained by processing the data using CARIS HIPS software.

Photo Credit: Canadian Hydrographic Service

Solving Arctic Oceanographic Mysteries: Sampling the Unknown Canada Basin

Scientists from the Bedford Institute of Oceanography participated in the international trans-Arctic Beringia expedition on the Swedish ice-breaker *Oden* during September–October 2005. The expedition made oceanographic measurements on a section from the Barents Sea through the North Pole and across the little-sampled Canada Basin to Alaska. It was the first full oceanographic crossing to include the central Canadian Basin of the Arctic Ocean by a surface vessel.

In Franklin Bay, Northwest Territories, a diving specialist positions an ultra-sensitive light meter beneath two metres of Arctic sea ice. A DFO-led initiative sampled and documented the under-side of the sea ice as part of the Canadian Arctic Shelf Exchange Study (CASES). For more, see: www.cases.quebec-ocean.ulaval.ca/fieldwor.asp

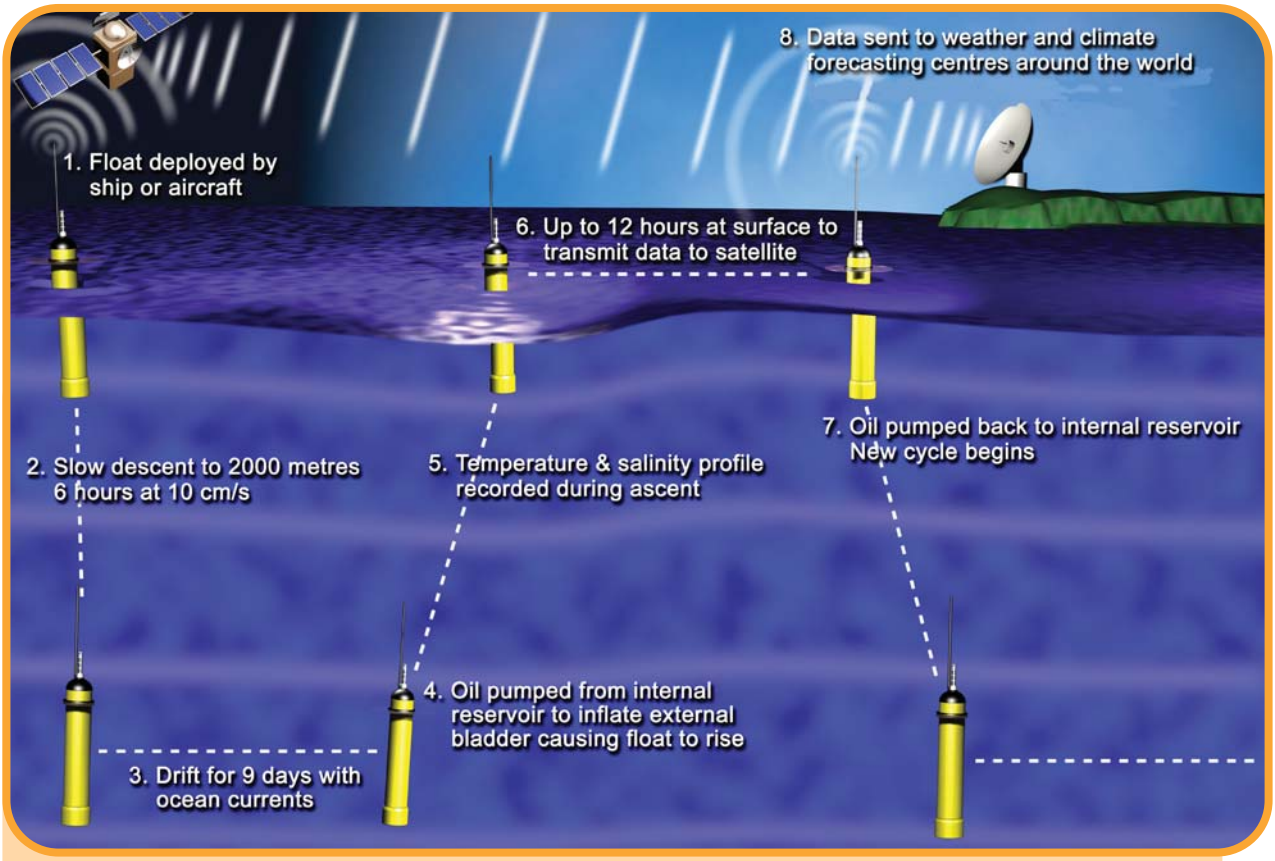
Photo Credit: Jeremy Stewart

Global Ocean Observing System Milestone

Another international milestone concerning oceans observation was announced in Halifax in September. Meteorologists and oceanographers from around the world gained another observation tool with the completion of the first component of the Global Ocean Observing System (GOOS). The GOOS is a network of observing platforms that measure and collect data on the state of oceans worldwide. The network is made up of drifting and moored buoys, profiling floats, tide gauge stations, ship-based systems, and satellites that monitor and document our oceans. With the deployment of the 1250th drifting buoy in the Atlantic Ocean off Halifax, the network of drifting buoys is now complete. The Global Drifter buoys collect data on ocean temperature, currents, wind, and atmospheric pressure. The buoys are an essential contribution to the Global Earth Observation System of Systems (GEOSS). Learn more about GOOS at www.idc.goos.org and about GEOSS at: www.epa.gov/geoss /index .html

Rebuilding Cod Stocks

DFO Science Sector worked for several years to contribute to the release, in November 2005, of the federal-provincial strategy for the rebuilding of Atlantic cod stocks. The various recovery strategies share common elements, many of which will involve DFO Science Sector for years to come, including collection of cod stock status information and examination of key factors affecting rebuilding, including innovation around stewardship. Regardless of whether or not any stocks are listed under the *Species at Risk Act*, the federal-provincial cod rebuilding strategies will assist in the development of management plans and/or recovery strategies as required. An overview document entitled "A Federal-Provincial Strategy for the Rebuilding of Atlantic Cod Stocks" can be found on the Department's website, along with detailed reports of the various Cod Action Teams. Updates can be



Seasonal to decadal climate variability and predictability is a primary focus of the Argo project. Subsurface floats drift at depths between 1 and 2 kilometres, surfacing every 10 days to transmit data (temperature and salinity profiles) to satellites before starting a new cycle. Float trajectories reveal subsurface current velocities.

Image Credit: Schematic courtesy of Southampton Oceanography Centre, United Kingdom.

found among the media releases of the Department, at: www.dfo-mpo.gc.ca/cod-morue/strategy_overview_e.htm

Argo Floats Milestone

By the end of the year, the international collaborative ocean and climate observation initiative, Argo, had deployed 2,400 Argo floats, or 80 percent of the planned target array. DFO scientist Dr. Howard Freeland chairs Canada's Argo program and is co-chair of the international Argo program which has floats gathering data in the Atlantic, Indian, Pacific and Southern oceans. Canada has launched Argo floats and one of the several types of Argo floats is also manufactured in Canada. The floats produce 87,000 ocean profiles per year, which are key to climate and ocean researchers and operational weather and climate centres around the world. Learn more at: www.medssdmm.dfo- mpo.gc.ca/meds/ Prog_Int/Argo/ArgoHome_e.html

Careers in Ocean Sciences on TV: Les métiers de la mer

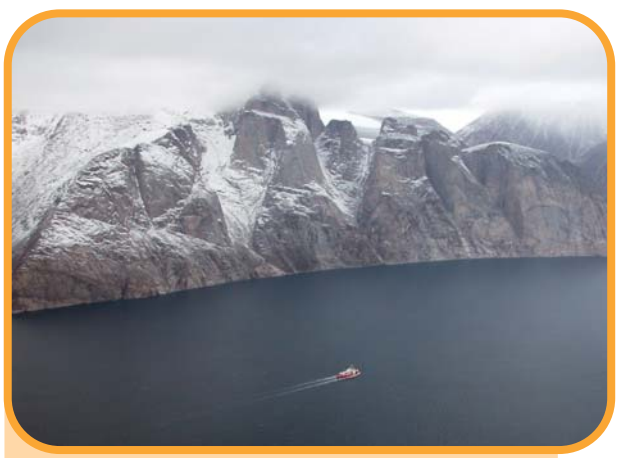
Researchers, biologists and hydrographers working at DFO's Maurice Lamontagne Institute participated in the production of a documentary concerning the more fascinating aspects of their work. "Les métiers de la mer" ran on the TVA network throughout the winter of 2005 and is being presented in schools to illustrate the careers possible in ocean sciences.

Researchers collect samples during a MERICA mission to monitor the Hudson Bay Complex.

Photo Credit: François Saucier

High Tides of December

The high tides of December in the river, estuary and Gulf of St. Lawrence caused concern for coastal residents of Quebec. Unusually severe erosion and particularly high seas meant that the advice of the Canadian Hydrographic Service (CHS) was solicited for advice on tides and water levels. CHS also helped explain these phenomena to the many regional news and weather media seeking an explanation for residents of the area.



At over 98 metres long and with a heli-deck, the science research vessel CCGS *Amundsen* is a large icebreaker, but it is dwarfed by Canada's immense Arctic landscape.

Photo Credit: Martin Fortier

The *Amundsen* Visits the UN Climate Change Conference

The issue of climate change made news all year. In December 2005, the *Amundsen*, a DFO Coast Guard ice breaker and state-of-the-art science vessel, visited Montreal during the "UN Climate Change Conference," more properly known as the United Nations Conference of the Parties to the Climate Change Convention. As DFO Science delegates contributed at the conference, thousands of Canadians visited the *Amundsen* to learn about how it is used for research. During 2005, the *Amundsen* was used to study sea ice variability and changes to the Mackenzie Shelf/Amundsen Gulf in the western Arctic, as part of the multidisciplinary ArcticNet program. It is also used to conduct ocean-floor mapping and shallow marine drilling, to deploy and recover a seven-metre survey boat and to take ocean samples in extreme weather conditions through an access hole in the vessel's bottom hull.

ArcticNet researchers aboard the science research vessel, CCGS *Amundsen* deploy sampling equipment.

Photo Credit: Alexandre Forest

Section 3 – Science at Work

Science Feature Stories

Every month, DFO Science presents new feature stories about its work. The following selections are from some of the most popular stories of 2005-06. Readers can subscribe to the stories, or visit the website to read more about oceanography, marine and freshwater biodiversity, hydrography, aquaculture, marine mammals, genomics, and the science and technology that is changing our understanding of the aquatic world.

Photo Credit: Ellen Kenchington

Forecasting the State of the Ocean

If the land rose and fell with the wind and shifted around daily, one might hesitate to go to work in the morning. But fishermen, sailors, oil explorers, search and rescue specialists, and other seafarers must cope daily with a highly changeable ocean.

More predictability would benefit industry, science, and humanity at large. Dr. Fraser Davidson, a physical oceanographer with the Department of Fisheries and Oceans (DFO) in St. John's, Newfoundland and Labrador, is spearheading an effort to improve ocean forecasting for a major swath of the northwest Atlantic, including the Newfoundland and Labrador shelves.

Read more …
www.dfompo.gc.ca/science/Story/forecasting_e.htm

Biological Station Keeps Innovating in Aquaculture

Atlantic Canada's oldest fisheries-research station is helping to shape a new industry. The St. Andrews Biological Station in Passamaquoddy Bay, New Brunswick, on the Bay of Fundy, began groundbreaking work on salmon aquaculture in the 1970's. Among highlights in following years, researchers developed new methods for farming groundfish such as haddock and halibut. Now, they are looking into the future with polyculture, in which different forms of aquaculture reinforce one another.

Read more …
www.dfo-mpo.gc.ca/science/Story/sabs_e.htm

Charting the World's Longest Coastline

Pleasure boaters, commercial fishermen, seafarers on Canadian ships and others from around the world, all depend on a warehouse near downtown Ottawa. From this chart distribution centre, the Canadian Hydrographic Service (CHS) supplies mariners with nearly a thousand different navigational charts, covering the world's longest coastline, almost a quarter-million kilometres, in all its sinuosities and with all the details of depths, buoys, lighthouses, and hazards to navigation. CHS charts also cover the Great Lakes and other major lakes and rivers.

Read more …
www.dfo-mpo.gc.ca/science/Story/chs_e.htm

Does Seismic Exploration Harm Whales and Fish?

Every swimmer learns the startling efficiency of underwater sound propagation. When someone at a distance taps two rocks together, it seems to be happening next to your eardrums. Many marine creatures make and react to sounds. Whales in particular vocalize to sing, communicate, and navigate.

But what happens when man-made noises mix with those of the ocean? Millions of boat engines, the giant propellers of ships, military and commercial sonar equipment, coastal construction operations, and the drills of offshore oil rigs all pour sounds into the sea. And in recent decades, concern has mounted over oil exploration using seismic methods.

Read more …
www.dfo-mpo.gc.ca/science/Story/seismic_e.htm

Experimental Lakes Solving Mercury Puzzles

What happens within lakes as human activities contaminate them, disrupt their surroundings, or otherwise change their environment? Laboratory experiments can suggest partial reactions, but never give the entire ecological picture. So in 1968, federal fisheries researchers got government approval to set aside, in the Pre-Cambrian shield country of northwestern Ontario, a network of lakes for environmental experiments. This was a world first, and it has yielded world benefits.

The Experimental Lakes Area (ELA) has, for example, proved how certain nutrients foster eutrophication, the over-enrichment of plankton and plant growth that consumes oxygen from lakes and shrinks their biodiversity. This led to bans on phosphorus in detergents, which helped clean up lakes in Canada and internationally. And the ELA's documentation of the alarming effects of acid rain on lake life helped create better controls on some sources of pollution.

Read more ….
www.dfo-mpo.gc.ca/science/Story/ELA_e.htm

Are Seal Herds Damaging Atlantic Fish Stocks?

Canada's northwest Atlantic holds the world's biggest populations of harp, hooded, and grey seals. Harp and hooded seals are subject to a centuries-old, now quota-controlled commercial hunt. After declines during the 18th and 19th centuries, herds have recovered to their highest abundance on record, while stocks of cod and other groundfish fell to their lowest, and still show little sign of recovery.

The Fisheries Resource Conservation Council (FRCC), an advisory group of university scientists, government and fishing-industry representatives, says that seal predation threatens the recovery of some groundfish stocks.

But how exactly do seals affect groundfish? Fisheries and Oceans Canada's Atlantic Seal Research Project has turned up significant new information through techniques old and new, some of it unprecedented and surprising, concerning populations, their habits and the extent of predation by harp, hooded and grey seals on Atlantic cod.

Read more …
www.dfo-mpo.gc.ca/science/Story/seals_e.htm

Fighting Invaders in the Gulf of St. Lawrence

Habitat biologists Nathalie Simard and Michel Gilbert usually researched waters of the Estuary and Gulf of St. Lawrence. Then they found themselves dropping plankton nets in a new location: the ballast tanks of a huge ore carrier plying between Europe and Quebec.

The sampling was part of the struggle to minimize the risk of non-indigenous species invading Canadian waters, via ballast water. In the Great Lakes alone, more than 160 alien organisms have taken hold. The notorious zebra mussel, perhaps transported from the Black Sea in ballast water, covers lakebeds, docks, and boat hulls like a living carpet, and has caused billions of dollars in damage.

For the most part, aquatic invaders are difficult to treat and practically impossible to eradicate. Prevention is the best hope, to keep them out or at least delay their spread, while improving knowledge and searching out methods of control.

Read more …
www.dfo-mpo.gc.ca/science/Story/gulf_e.htm

Researching the Future of Snow Crab

Safeguarding the snow crab harvest is of vital interest to the thousands of people whose livelihoods depend on it.

For this young fishery, which began about four decades ago, many regulations apply, including quotas and seasons. But one idea in particular has shaped management: protecting female crab.

Adult females are smaller than males. The Department of Fisheries and Oceans (DFO) sets size limits and requires mesh sizes in crab traps large enough to let most adult female crab escape. Fishermen must return any remaining females to sea alive.

Read more …
www.dfo-mpo.gc.ca/science/ Story/snow _crab_e.htm

Pacific Salmon Research: Facing the Climate Challenge

Climate change in this century may raise temperatures only a couple of degrees on Canada's west coast, but that will mean more than wearing lighter clothes. British Columbia could suffer worse floods, droughts, and forest fires. And far-reaching changes in the Pacific Ocean will affect both fish and people.

The west coast's foundation fish, Pacific salmon underlay the economy, art, and culture for First Nations. They provided the resources for a great commercial industry and growing sport fishery. But they may face major disruption from climate change.

Read more …
www.dfo-mpo.gc.ca/science/Story/salmon_e.htm

Fighting Invaders in the Gulf of the St. Lawrence: DFO scientist Chris McKindsey with the green alga known as oyster thief or dead man's fingers (*Codium fragile*).

Photo Credit: Philippe Archambault

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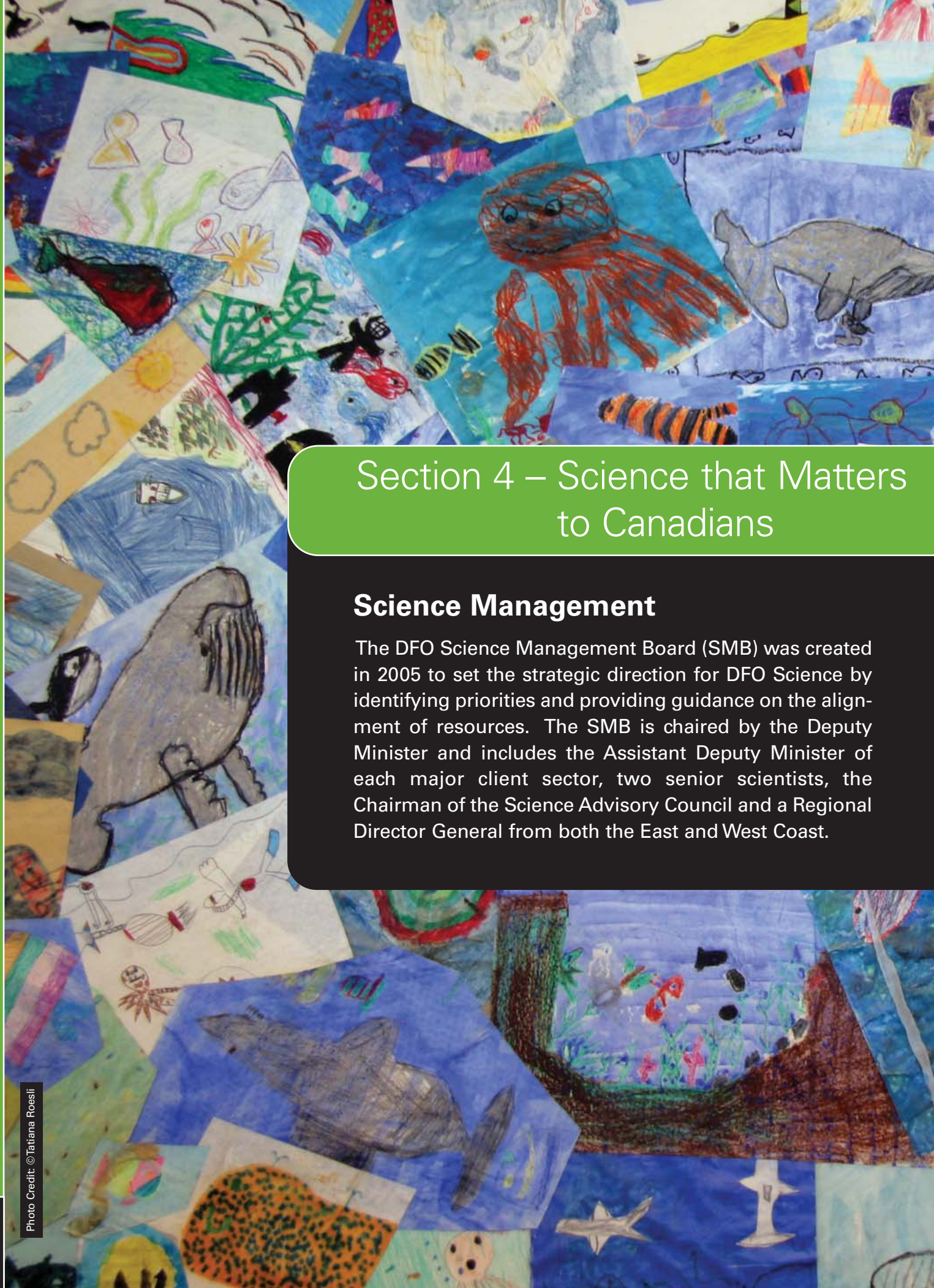
To unsubscribe, enter "**unsubscribe**" in the subject line.

Researching the Future of Snow Crab: Snow crab is the foundation of Canada's valuable crab fishery. DFO scientist Bernard Sainte-Marie is conducting research to learn more about snow crab reproduction.

Photo credit: DFO



Section 4 – Science that Matters to Canadians

Science Management

The DFO Science Management Board (SMB) was created in 2005 to set the strategic direction for DFO Science by identifying priorities and providing guidance on the alignment of resources. The SMB is chaired by the Deputy Minister and includes the Assistant Deputy Minister of each major client sector, two senior scientists, the Chairman of the Science Advisory Council and a Regional Director General from both the East and West Coast.

Photo Credit: ©Tatiana Roesli

At its first meeting, the SMB established that its highest priorities are the adoption of an ecosystem-based approach to science and regenerating its workforce. Ecosystem science is consistent with international trends and is an important and necessary shift in the way DFO provides science advice and support.

Other priorities include science in support of sustainable aquaculture; navigation and sovereignty; Northern aquatic ecosystems; aquatic animal health and the *Species at Risk Act*; as well as issues of high importance to Canadians such as rebuilding cod stocks, Pacific salmon and seals.

Aquatic animal health is a science priority. A joint DFO Science/Habitat 2005 project recorded still and video images of bull trout spawning in Alberta's Sheep River. The handsome member of the char family is native to western Canada and the northwestern USA. In Alberta, changes to its habitat and over-fishing depleted the bull trout and in 1995 a catch-and-release program was instituted as a conservation measure. A decade of federal and provincial science and land management efforts plus public education about habitat, environmental and fishing regulations have assisted the Alberta bull trout to regenerate considerably.

Photo Credit: Jeremy Stewart

Science Advisory Council

The Science Advisory Council (SAC) provides advice to DFO Science management on strategic matters pertaining to science and technology. Membership on the Council consists of about 15 individuals from outside the Department, and 4 ex-officio members from within DFO Science. The Council possesses a diverse range of expertise and experience in fisheries, oceans and freshwater science and technology, communications, and industry-related sectors such as fisheries, oil and gas, aquaculture, shipping, and other areas of interest to DFO. The SAC Chair is a member of the Department's Science Management Board and the federal Council of Science and Technology Advisors. This ensures a link between the different advisory functions, both within the department and government-wide. The Council has been engaged in the renewal of DFO Science since the review of science was initiated in May 2004. SAC has helped to provide an external perspective and insight into the considerations of our science partners and clients.

Centres of Expertise

In 2005, DFO Science expanded the creation of Centres of Expertise (COEs). These centres foster collaboration and partnerships between DFO and other government departments, other levels of government, and academia, industry and international colleagues.

There are two types of Science COEs – virtual and geographic. Virtual COEs bring together geographically dispersed expertise and infrastructure on a project-by-project basis. Geographical COEs combine people and infrastructure in a single research institute to support work in a specialized area.

Four COEs Are Fully Operational

The Centre for Offshore Oil and Gas Environmental Research (COOGER) is a virtual COE that coordinates research efforts into the environmental and oceanographic impacts of offshore petroleum exploration, production and transportation. COOGER is building on the existing expertise available at the Bedford Institute of Oceanography to address specialised issues in oil and gas research. COOGER is also focused on sharing expertise and resources in an international setting. Learn more at www.dfo-mpo.gc.ca/science/cooger-crepge/

To identify if there is an impact zone associated with production water discharges from the Hibernia oil platform, the Centre for Offshore Oil and Gas Environmental Research (COOGER) conducted a research mission on the CCGS *Hudson* to sample the water column, benthic boundary layer and sediment surrounding the gravity base structure. The Hibernia oil field is located 315 kilometres, east southeast of St. John's, Newfoundland and Labrador, in 80 metres of water. Here we see: COOGER Executive Director and Chief Scientist Ken Lee rinsing down bongo nets for collecting larval fish; Catherine Andrews, Research Technician, Chemical Toxicology, of DFO in St. John's, sorting through bongo net samples for larval sand lance to conduct toxicological studies; the SloCorer apparatus being deployed from the foredeck of the *Hudson* with the Hibernia platform and a stand-by vessel in the background.

Photo Credit: Kelly Bentham

The National Centre for Arctic Aquatic Research Excellence (N-CAARE) is a virtual network of experts that focus on increasing knowledge of Arctic marine and freshwater. The N-CAARE secretariat is at the Freshwater Institute in Winnipeg, Manitoba.

The Centre of Expertise on Marine Mammalogy (CEMAM) is a virtual COE that brings together marine mammal experts with a secretariat located at the Maurice Lamontagne Institute in Mont-Joli, Quebec. Researchers work on a wide range of projects to obtain information on the dynamics, ecology and health of marine mammals. See: www.osl.gc.ca/

The Centre for Pesticides is a geographic COE located at the Freshwater Institute in Winnipeg. It coordinates the research of five federal departments in support of regulatory decisions of the Pest Management Regulatory Agency.

Six additional COEs Will Be Operational in 2007

The Centre for Ocean Model Development and Application (COMDA) is a virtual COE based out of the Bedford Institute of Oceanography in Dartmouth, Nova Scotia, that includes experts from Environment Canada and the Department of

National Defence. The purpose is to develop operational, global, coupled atmosphere-ice-ocean assimilation and prediction capability for Canada using hindcast, nowcast and forecast models. COMDA will be part of a national Operational Oceanography system for Canada.

The Centre for Research on Hydropower Impact on Fish and Their Habitat integrates the expertise of DFO and the Canadian Electricity Association. This virtual COE based out of Mont Joli, Quebec will jointly establish the research priorities in both freshwater and marine environments and provide leadership in the area of cumulative impacts.

The Centre of Expertise on Aquatic Animal Health will be a virtual network of experts, hosted at Moncton, New Brunswick with satellite reference labs in Winnipeg, Manitoba, Nanaimo, B.C., and Charlottetown, P.E.I. that will provide the regulatory research necessary to support the federal regulatory program.

The Centre of Expertise for Aquatic Risk Assessment (CEARA) based in Burlington, Ontario, links to the Canadian Aquatic Invasive Species Network, which is funded by the Natural Sciences and Research Council of Canada, DFO, Transport Canada and other agencies. CEARA focuses on the principal pathways that transport aquatic invasive species to freshwater and marine ecosystems in Canada; characterizes the factors that influence establishment success of these species; and constructs risk assessment models that direct future management policies. CEARA develops national standards for conducting biological risk assessments for aquatic invasive species and coordinates and tracks risk assessments as they are developed.

Toxic Chemical Analysis centres are being established to undertake routine analytical services and to support research. Geographic COEs will be located at both the Institute of Ocean Sciences in Sidney, B.C., and the Maurice Lamontagne Institute in Mont-Joli, Quebec.

Aquaculture Centres of Expertise will be both geographic and virtual. Substantial infrastructure already exists at the St. Andrews Biological Station (SABS) in St. Andrews, New Brunswick and the Centre for Aquaculture Environmental Research at the University of British Columbia in Vancouver, B.C. This infrastructure will be linked to evolving research needs.

Targeted Research: Highlights

Pacific killer whales of the resident population designated "threatened," Queen Charlotte Islands, British Columbia.

Photo Credit: Graeme Ellis

Pacific Killer Whale: Species at Risk

Pacific killer whales are protected under Canada's *Species at Risk Act* due to their small population size and recent declines in abundance. Threats to survival and recovery of these populations include environmental pollutants, physical and acoustic disturbance, and reductions in the availability or quality of salmonids, their primary prey. CEMAM researchers examined food limitation as a potential factor in decline, and reviewed 25 years of accumulated data to show that chinook salmon and, to a lesser degree, chum salmon, are important prey for resident killer whales, while other smaller salmonid species are not. Fluctuations in observed versus expected mortality rates showed a strong correlation with changes in chinook salmon abundance, but no relationship to chum salmon abundance. A sharp drop in coast-wide chinook abundance during the late 1990s was closely associated with a significant decline in resident whale survival. The whales likely prefer chinook due

to its relatively large size, high lipid content and year-round presence in their range. Resident killer whales may be especially dependent on chinook during winter, when this species is the primary salmonid available in coastal waters, and the whales may be subject to nutritional stress leading to increased mortality if the quantity and/or quality of this prey resource declines. Chinook salmon is clearly of great importance to resident killer whales, but determining whether the species is the principal factor limiting whale productivity will require ongoing monitoring of both salmon and whale population trends.

Haida Eddies Studies Featured in Deep Sea Research

In April 2005, a special issue of *Deep Sea Research* focused on multidisciplinary research on Haida Eddies. These eddies act as feeding oases as they transport immense volumes of coastal waters and biota from Hecate Strait out into the open Gulf of Alaska. This publication contains eleven scientific papers contributed by DFO Science staff and international collaborators reporting on observations carried out from 1998 to 2003 under the DFO Strategic Science Fund. The research revealed that these eddies contain much of the biological activity in the Gulf of Alaska — everything from plankton to whales. The study also revealed that Haida Eddies transport water and biota to the proposed Bowie Seamount Marine Protected Area (MPA) lending new insights into the "connectedness" of the MPA to coastal ecosystems: www.pac.dfo-mpo.gc.ca/ sci/osap/projects/dsr2/default_e.htm

Tracking Cod Acoustically

DFO scientists studying Gulf of St. Lawrence cod stocks tracked fish using acoustic transmitters or pingers. The study confirmed that at least 60 percent of the Gulf cod population migrates farther out to sea in the winter, to the zone designated by the Northwest Atlantic Fisheries Organization as the 3Ps fishing area. These fish then move back to the Gulf in April. Two hundred and fifty-five codfish from the Gulf were implanted with acoustic transmitters and 80 receivers were arrayed in the waters off Port aux Basques, southeast of Burgeo and on the western side of St. Pierre Bank. While some receivers from farther out in the 3Ps area were unrecoverable, leaving as a mystery where the fish go once they are in 3Ps, the data collected raises questions about the abundance surveys carried out on the 3Ps stocks. One annual survey is done in April when Gulf cod may still be in the area, which could lead to an inflated estimate of cod abundance in the 3Ps area. This new scientific data adds to the information available for future decisions about when to schedule surveying, and about fishing quotas for both areas.

Scientists holding a large Atlantic sturgeon. From left to right: Sandra Hamel (former DFO Summer Student); Pierre Nellis (DFO), Denis Fiset and Pierre-Yves Collin of the Quebec Ministry of Natural Resources and Wildlife.

Photo Credit: Denis Fournier, Quebec Ministry of Natural Resources and Wildlife

Dredging Impacts on Habitat

In response to a specific request from DFO Quebec Region, a multidisciplinary team of scientists made an extensive examination of the impacts of dredging and the deposit of dredged sediment on habitat in the waters of the mid-section of the St. Lawrence Estuary, near Isle Madame. The goal was to gain, for the first time, a thorough understanding of the benthic ecosystem in the estuary's transition zone where fresh and saline waters mix. The results of this study are applicable to the formation of policy recommendations concerning dredging operations and the deposit of sediments in the estuary transition zone. It also revealed important information about habitat that is essential to the Atlantic sturgeon, a species that is of

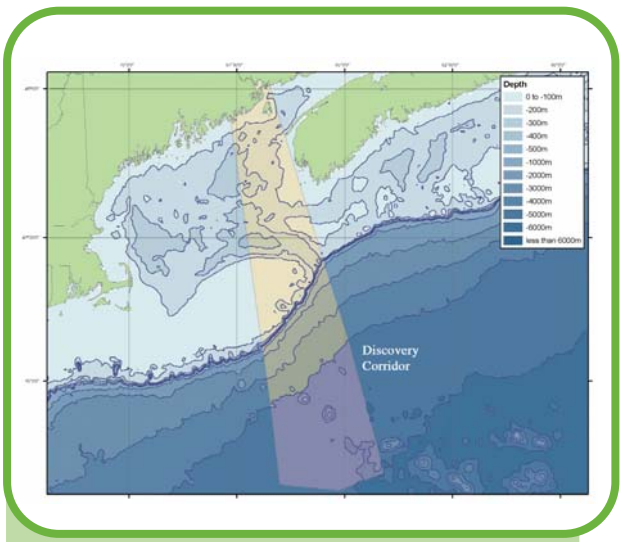
concern for population managers in the Québec Ministry of Natural Resources and Wildlife. The groundbreaking study used novel methods including seabed mapping and computer models of the dispersal of sediments. The project involved DFO scientists, the Canadian Hydrographic Service and the Canadian Coast Guard, as well as scientific colleagues from Environment Canada, the Quebec Ministry of Natural Resources and Wildlife, the Quebec National Institute of Scientific Research, the University of Quebec at Montreal and the Institute of Marine Sciences. The research program will culminate with a review at a symposium on the Atlantic sturgeon species during the annual meeting of the American Fisheries Society.

Discovery Corridor – Understanding Continental Shelf and Deep-water Ecosystems

A discovery corridor is a swath of ocean bottom and the water column above it, encompassing a variety of ecologically inter-linked seascapes/habitats that may support a range of biodiversity and may support previously unknown species and processes. Corridors may cut across gradients of depth, productivity, human activity or any other ecologically relevant variables, and serve as focal points for collaborative scientific studies.

A five-year research strategy established in 2003 (Three Oceans of Biodiversity www.marine biodiversity.ca/en/reports.html), called for the establishment of such corridors, and one was established in the Gulf of Maine in 2004. It encompasses various biogeographic regions, habitats, and gradients (see map below). The Canada-United States boundary approximately bisects the Discovery Corridor, which has been endorsed as one of the foundation projects for the US-based Gulf of Maine Pilot Census of Marine Life. The information collected in the Discovery Corridor will allow scientists to synthesize data from benthic and pelagic realms towards a fuller appreciation of ecosystem functioning.

In June 2005, Dr. Ellen Kenchington, Director of the Centre for Marine Biodiversity, with Dr. Erica Head as Chief Scientist, both from DFO, led a successful mission to the corridor aboard the CCGS *Hudson*. All the specific scientific objectives were met: to collect hydrographic data at Atlantic Zone Monitoring Station 2; to conduct benthic habitat surveys and hydrographic and plankton sampling in Jordan Basin, Crowell Basin, and the Northeast Channel using specialized equipment; and to record sightings of migratory right whales and other cetaceans.



Location of the Discovery Corridor in the Gulf of Maine

The mission used four types of sampling gear. Videograb and Campod, mounted underwater video and still camera systems developed by DFO at BIO, captured images of the seafloor, including this one of sea anemones. BIONESS, a multiple net sampling system, sampled zooplankton from the water column. A conductivity, temperature, and depth recorder was cast overboard to measure physical characteristics of the ocean.

Photo Credit: Ellen Kenchington

Masked against the cold, an ArcticNet researcher is out on the ice collecting samples. The science research vessel CCGS *Amundsen* is in the background.

Photo Credit: Lucette Barber

ArcticNet and Contaminants Research

ArcticNet is a major multidisciplinary research program involving an extensive network of researchers under the co-ordination of Laval University. Senior DFO research scientists Dr. Robie Macdonald of the DFO Institute of Ocean Sciences in Sidney, B.C., and Dr. Gary Stern of the DFO Freshwater Institute in Winnipeg are project leaders on contaminants research under the aegis of ArcticNet. Dr. Stern is the project leader for ArcticNet Theme 3 sub-project 3.4, Carbon and Contaminant Cycling in the Coastal Environment, and co-leader with Dr. Macdonald of the Theme 1 sub-project 1.3, Contaminant and Cycling in the Coastal Environment. Their work is helping to test the effectiveness of international controls on contaminants such as PCBs*, DDT** and PBDEs*** and, within the context of other ongoing research, to understand the effects that climate variation may have on the contaminant levels and the health of fish and marine mammal stocks.

* polychlorinated biphenyls

** dichlorodiphenyltrichlorethane

*** polybrominated diphenyl ethers

Experiment Reveals Hidden Genetic Divergence in Body Shape Between Atlantic Cod Populations

Most recent studies of genetic differences in fishes have focused on differences at the molecular genetic level. However, studies of differences at that level may not accurately reflect divergence in the fishes' adaptive quantitative-genetic traits. Unlike molecular genetic traits, quantitative traits are open to environmental influences. Thus, common-garden experiments, in which fish from different groups are reared in the same laboratory environments, are needed to disentangle genetic and environmental influences on quantitative traits (e.g., growth rate, body shape). A common-garden experiment using cod from four populations in the Northwest Atlantic was conducted by DFO in collaboration with researchers at Dalhousie and Memorial universities. This experiment revealed striking genetic differences in body shape between populations when reared in common laboratory environments, even though no differences were evident between populations in the wild. Genetic differences in body shape appear to have evolved between these populations in order to counteract contrasting environmental effects on shape in the wild. These results suggest that much of the genetic diversity in fish morphology may be hidden, with selection for the same optimal body shape resulting in genetic divergence between populations subject to contrasting environmental influences.

Researching Atlantic Salmon

Some of Canada's most highly prized salmon rivers are in DFO's Gulf Region. Here, DFO is focusing its salmon research activities on the fresh water phase of *Salmo salar* during the first years of life and the return to the river for the big salmon, after their "fattening-up" at sea. In order to do so, DFO's Diadromous Fish Section is using many research tools distributed on the salmon rivers of the region, from sampling nets to electronic tags. In the summer months, the scientific activities essentially consist of estimating the quantity of juvenile salmon in the rivers. This gives a good idea of the success of the reproduction that took

place during past autumns and is also a good indicator of the general health of the species in the system. The sampling regime in place is also essential to monitor and study some of the species that may potentially be considered as species at risk, like the striped bass and shad.

Adult Atlantic salmon are tagged using a trapnet at Millerton, N.B. Shown are Kassie Blackmore, Northumberland Salmon Protection Association student and John Hayward, DFO, holding salmon.

Photo Credit: Shane Matchett

Key Monitoring Successes

The Atlantic Zone Monitoring Program (AZMP) of DFO Science contributes to a sustained, systematic, and long-term observation system that provides basic oceanographic information, and value-added products and services concerning the actual status of the marine ecosystem on the Atlantic coast, in keeping with international standards.

AZMP Data are readily available via the Department's Marine Environmental Data Services (MEDS) internet portal, www.meds-sdmm.dfo-mpo.gc.ca/meds/Home_e.htm. The AZMP has also implemented standard reporting formats including the Ecosystem Status Report, and publishes peer-reviewed research documents such as the AZMP Bulletin, www.meds-sdmm.dfo-mpo.gc.ca/zmp/ main_zmp_e.html

The AZMP program accomplished much in 2005 to broaden knowledge of the ecosystem. First, there was a major increase in biological and chemical sampling, leading to a greatly enhanced description and understanding of the ecosystem. Second, there was a strong, cooperative, coordinated and consistent effort among the Atlantic regions to provide a thorough assessment of environmental conditions across the Atlantic Zone. Third, there were continued efforts to identify and address specific issues of importance in the ecosystem. These issues included the invasion of the Gulf of St. Lawrence by the Pacific phytoplankton species *Neodenticula seminae*; the long-term plankton changes in the Scotian Shelf-southern Newfoundland Shelf region through the Continuous Plankton Recorder program; the relationship between year class success for haddock in southwest Nova Scotia and the timing of the spring phytoplankton bloom, and a major input into the eastern Scotian Shelf ecosystem review.

The AZMP also provides the foundation for Canadian contributions to the Global Ocean Observing System and related national and international ecosystem observation and monitoring networks.

DFO Researchers Detect Flat Oyster Parasite in British Columbia waters

The protistan parasite *Bonamia ostreae* (the cause of an oyster disease of concern listed by the World Organisation for Animal Health – OIE) was found for the first time in flat oysters (*Ostrea edulis*) cultured in B.C. in 2005. Prior to this detection, this parasite was known to occur on both coasts of the United States and caused significant oyster mortalities in Europe. Entry into B.C. is thought to be via flat oyster seed imported from enzootic areas in Washington State. Although flat oyster mortalities were associated with the parasite at one location in B.C., the flat oyster industry is small (< 0.5 percent of all oysters marketed by B.C. producers) and the main culture species, the Pacific oyster (*Crassostrea gigas*), and the native oyster (*Ostrea concaphila*) are resistant to infection. To date, this parasite has not been detected in oysters from Atlantic Canada.

Toxic Algae Monitoring Program

Paralytic shellfish poisoning (PSP) and amnesic shellfish poisoning (ASP) are the most dangerous and widely distributed toxins in Canadian waters. In the Gulf of St. Lawrence system, PSP and ASP poisoning events are respectively related to the blooms of the dinoflagellate *Alexandrium tamarense* and the diatom *Pseudo-nitzschia seriata*. These algae can kill fish, contaminate shellfish with toxins, force harvesting closure at great economic and social cost, and in the worst case, harm human health. The frequency and geographic extent of these toxic algal blooms are increasing worldwide for reasons that are still not clearly understood. Potential causes are increased nutrient enrichment of coastal waters by human activities. The Estuary and Gulf of St. Lawrence is a region recognized as a hot spot for toxic algae, which is why researchers from the DFO Maurice Lamontagne Institute have monitored and studied toxic algal blooms since 1989. This program collects toxic and harmful algal species at 11 monitoring stations around the Gulf, which allows for the acquisition of new knowledge on the dynamics of these algae, and on the environmental conditions that favour their growth. The development of new observation technologies for the rapid detection of toxic algae and of models to allow prediction of algal toxic events are also important activities pursued by DFO scientists. Learn more at: www.osl.gc.ca/ en/info/ publications/monitorage.html

The Hypoxia Problem: Low Oxygen Levels Observed in Marine Coastal Waters

Understanding the impact of hypoxia on Canadian waters in the Gulf of St. Lawrence was a focus of researchers at the Maurice Lamontagne Institute in Mont Joli, Quebec, while researchers at the Institute of Ocean Sciences (IOS) in Sidney, British Columbia, tracked decreasing oxygen trends related to changes in upper ocean ventilation in the northeastern Pacific Ocean.

Studies of the St. Lawrence estuary during 2005 contributed to accumulating evidence that low oxygen (hypoxic) conditions are proliferating in marine coastal environments worldwide, with major ecological and biogeochemical consequences. Hypoxia in coastal areas can be caused by three major phenomena: (1) increases in land-source input of organic matter and nutrients, (2) changes in coastal wind regimes, and, (3) formation and intrusion of open-ocean oxygen-depleted waters in near-coastal areas, through changes in coastal circulation. In the bottom waters of the Lower St. Lawrence Estuary, a combination of factors (1) and (3) has caused a decrease in oxygen concentration. The major causes are a progressively decreasing proportion of oxygen-rich Labrador Current Water in the water mass entering the Gulf of St. Lawrence from the Northwest Atlantic, compounded by manmade stresses affecting the local organic carbon budget. Ecological impacts range from large-scale animal mortality to variations in species distribution, changes in biodiversity, physiological stress and other sub-lethal effects, such as reduced growth and reproduction.

On the Pacific coast, researchers at IOS investigated a 20 oxygen time series at Ocean Station Papa, which reveals a decreasing trend that appears related to changes in upper ocean ventilation. Ocean Station Papa, also known as Station P, is in the Gulf of Alaska at 50°N and 145°W. Lower oxygen levels in the open ocean may, in turn, bring some coastal and shelf ecosystems that once were just above the critical threshold defining hypoxia below this threshold, thus contributing to an increased frequency and prevalence of hypoxia worldwide. The decreasing oxygen trend at Ocean Station Papa represents a potentially important ecological threat for benthic and demersal animals on the upper continental slope off Vancouver Island.

Oxygen sensors deployed in 2004 on four Canadian Argo floats continue to help DFO monitor oxygen conditions in the northeast Pacific and in the northwest Atlantic in real-time. In 2006, DFO will deploy six new Argo floats with oxygen sensors in the northeast Pacific, and five in the northwest Atlantic, in an effort to better monitor changes in upper ocean ventilation and in the functioning of the oceanic carbon pump.

Ocean Data Profiles from Argo Float Program

Thirty countries deploy free-floating Argo buoys to profile oceanographic measurements at different depths. By the end of 2005, there were 2,400 floats in operation. They produce 87,000 ocean data profiles per year for use by climate researchers, for use in climate and weather forecasting, in fishery planning and other applications, www.meds-sdmm.dfo-mpo.gc.ca/meds/Prog_Int/Argo/ArgoHome_e.html

Oceanographic Buoys and Satellite Imagery

With funding assistance from the Canadian Space Agency, DFO researchers completed the installation of five oceanographic buoys powered by solar-panels in the Estuary and Gulf of the St. Lawrence to collect meteorological and oceanographic data including chlorophyll, surface water temperature, salinity, surface winds and surface humidity. The primary purpose of these data is to validate other types of information obtained from satellite remote sensing. The data are transmitted in near real time to the Maurice Lamontagne Institute and become immediately available on a web page of the St. Lawrence Observatory portal (www.osl.gc.ca/thermographes/en/index.html).

A rosette sampler is used to record temperature and salinity, and to collect water samples at different depths in the water column.

Photo Credit: François Saucier

Hudson's Bay Complex – Gigantic in Area and Sensitive in Nature

Another sensitive area under monitoring scrutiny in 2005 was the Hudson Bay Complex. The area comprising Hudson Bay, Hudson Strait, Foxe Basin and Ungava Bay is one of the continent's largest drainage basins, a significant contributor to the Labrador Current, and a major oceanographic feature influencing the hydrography and biological productivity of the northeast Atlantic shelves of Canada and the U.S. Approximately half of the Inuit populations of Nunavut and Nunavik live in the area and use it for hunting and fishing, for transportation of supplies and goods during the ice-free season, and for fostering economic development. The region's high biodiversity reflects the significant influence of both Arctic and Atlantic waters.

DFO Quebec region initiated an Observing/Modelling program, aimed at a minimal description of the current state of this region, as part of the MERICA program (études des MERs Intérieures du CAnada – MERICA) with sampling missions in 2003, 2004 and 2005. This monitoring program involved scientists from various DFO regions (Quebec, Central and Arctic, and Maritimes), a number of Quebec Universities (l'Institut des sciences de la mer de l'Université du Québec à Trois-Rivières, l'Université du Québec à Montréal, and Laval) and various other organizations (Woods Hole Oceanographic Institute, Québec-Oceans), and was conducted using ship time provided by the Canadian Coast Guard on an opportunistic basis. The MERICA program also integrated the northern component of the DFO Quebec region *Species at Risk Act* program, and represented an important component of the DFO N-CAARE (National Centre for Arctic Aquatic Research Excellence) program. Key oceanographic and living resource data sampled included variables such as temperature, salinity, current, nutrients, oxygen, the abundance and biodiversity of living organisms, contaminants, and more. The long-term objective of the program is to establish an integrated observation and modelling system for detecting, following and predicting ocean and ecosystem changes in the Hudson Bay Complex. Data accumulation under the MERICA sampling station

program focused on answering key questions related to the impact of climate change on the carbon production cycle and the evolution of biodiversity in the Hudson Bay Complex under a general climate warming scenario.

Local hunters and trappers assist ArcticNet researchers with monitoring and other tasks that make research missions in the Far North possible.

Photo Credit: Owen Owens, ArcticNet

ArcticNet – Community-based Monitoring

This major multidisciplinary northern research program involving a large network of researchers has many facets involving DFO. In one monitoring aspect of the program, DFO is collaborating with the University of Manitoba and northern residents on a community-based monitoring (CBM) program on sea-ice climate variability and change. It includes participation by the Northern Ecosystem Initiative, the Aurora Research Institute, and communities including Tuktoyaktuk, Sachs Harbour, Paulatuk, Holman Island and Sanikiluak. Surface meteorology stations established on first-year sea-ice were placed close to the communities. These telemeter data to the local Hunters and Trappers Committee (HTC) offices or area schools for data archiving. Every two weeks, HTC members visit the stations and collect snow and sea ice samples, and take photos. The information is transmitted to the University of Manitoba where it is put up on a website dedicated to the CBM program. To learn more about ArcticNet, visit the ArcticNet website: www.arcticnet-ulaval.ca

Identifying and Mapping Bottom Fish Assemblages in Davis Strait and Baffin Bay

To study abundance and gain new data on fish assemblages, DFO worked on a jointly funded research project with a variety of Nunavut partners. The Greenland Institute of Natural Resources research vessel *Paamiut* was used to study fish assemblages in Davis Strait and southern Baffin Bay, a relatively isolated body of deep polar water, unique among the Arctic seas. Using the *Paamiut* enabled researchers to compare results across the whole stock area as the same ship was used to assess Canadian and Greenland waters. DFO hopes to continue such multi-species surveys to acquire long-term data that is required to track fish population trends.

Water Level Fluctuations: Balancing Ecological and Energy Needs

A team composed of scientists and engineers from DFO, the Ontario Ministry of Natural Resources and Brookfield Power Corporation Ltd. are collaborating on a long-term Adaptive Environmental Assessment and Management experiment to test whether regulating the rate of change of water flow (known as ramping rates) through hydro dam turbines can provide a more favourable environment for fish, while allowing energy production to be maximized. The Before-After-Control-Impact Pair design is being utilized to provide the most reliable scientific results in this ecosystem-level experiment. The site is near Wawa, Ontario, on the 40 kilometre stretch of the Magpie River between Steephill Falls and Magpie Falls generating stations. The reference river is the unregulated Batchawana River, approximately 60 kilometres north of Sault Ste. Marie, Ontario. The before stage of the study is complete. Key components of the study are: physical habitat parameters, fluvial geomorphology, fish community characteristics, fish forage base and invertebrate drift, brook trout behaviour, food web dynamics, and an economic analysis of the cost of ramping at facilities in Ontario. Once baseline conditions were established on both rivers, ramping restrictions were removed. Monitoring during the 'after', or experimental phase, will continue through 2007. If an effect is detected, restrictions on ramping may be incrementally

reinstated in an attempt to balance ecological and energy needs during the evaluation phase. Results will be incorporated into provincial and federal water-power guidelines and policy, facilitating science-based decisions regarding ramping at hydro-electric facilities. Methodologies developed will be incorporated into effectiveness monitoring programs for Water Management Plans at existing and newly developed hydroelectric generation facilities in Ontario.

Counting Pacific Salmon with Sonar

A DIDSON imaging sonar system was successfully deployed between August and October 2005 to estimate the escapement of sockeye salmon (*Oncorhynchus nerka*) in the Horsefly River, part of the Quesnel Lake system in the Fraser River watershed, in B.C. The Horsefly River was chosen for the first deployment because 2005 was a dominant year in the cycle of this stock and because a mark and recapture program was also conducted, facilitating comparisons between these methods of escapement estimation. Based on analysis of visual counts versus DIDSON counts, it was concluded that the DIDSON escapement numbers were not biased by undetected fish and are as accurate as visual counts. The DIDSON system will enable stock assessment staff to monitor spawning escapement 24 hours per day throughout the entire spawning run in turbid/clear and light/dark viewing conditions. With two to three staff reviewing files, daily escapement estimates can be provided one day after recording. The 2005 program illustrates a highly successful approach towards technology transfer from evaluation and testing of new methodologies and equipment to operational status through interdepartmental training of staff. The DIDSON system provides a practical and cost-effective approach for estimating sockeye salmon escapement in some terminal areas within the Fraser River watershed.

Sockeye salmon returning to the Horsefly River were directed through an 11 metre wide opening in a weir. Manual counts of high-frequency acoustic images were collected. Maximum sockeye salmon passage observed was approximately 8,000 fish per hour during the season.

Photo Credit: Rob Dolighan, B.C. Ministry of Environment

Biotechnology and Genomics

DFO scientists are generating information and applying biotechnology tools and techniques for the development of management tools and science advice, including: precise and rapid stock identification for real-time fisheries management decisions; sensitive tools for the detection and development of treatment/mitigation approaches for aquatic animal diseases; precise identification of populations of management concern, including species at risk; tools to meet biodiversity goals; metagenomics analysis with application in bioremediation (the use of microorganisms to degrade toxic chemicals in the aquatic environment) and understanding ecosystem components; identification and monitoring of physiological responses to environmental changes; and, research to support the development and implementation of regulations for aquatic animals with novel traits. DFO Science's Aquatic Biotechnology and Genomics Research and Development Program has identified four strategic research themes where the application of innovative and enabling technologies can be integrated in order to provide enhanced precision, sensitivity, and timely information for the provision of scientific advice and management tools. The four interrelated strategic research themes are: Biotechnology and Aquatic Resource Profiling; Biotechnology and Aquatic Animal Health; Biotechnology and Aquatic Ecosystem Health; and, Regulatory Science for Aquatic Animals with Novel Traits.

Advice Highlights

Science Advisory Process and Publications

The Canadian Science Advisory Secretariat (CSAS) coordinates the DFO Science Advisory process in collaboration with the regional Centres for Science Advice. This coordination network is responsible for maintaining high standards of excellence in the provision of peer-reviewed scientific information and advice in support of sound decision-making. During the last year, more than 70 advisory meetings (peer reviews and workshops) were conducted and more than 200 scientific publications (Science Advisory reports, Research Documents and Proceedings) were produced. These covered standard stock assessment issues but they also addressed an increasing number of emerging issues, such as ecosystem assessments, species at risk, invasive species, aquaculture impacts, and others. During 2005, several particularly notable advisory reports were released through CSAS, including reports on cod, snow crab and other species of particular interest, and framework reports dealing with species at risk and ecosystem overviews. CSAS publications and research documents, and the CSAS calendar of activities, can be found at: www.dfo-mpo.gc.ca/ csas/Csas/Home-Accueil_e.htm.

Science in Support of the *Species at Risk Act*

DFO Science participated in 14 science peer-review activities involving over 70 species in 2005. DFO information holdings on priority species are peer-reviewed prior to their assessment by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Seven species were subject to this type of review in 2005, including the American eel and several Pacific rockfish species. COSEWIC species status reports are also peer-reviewed. Over 40 such status reports were reviewed by regional scientists in 2005.

A key aspect of science advice in support of the *Species at Risk Act* (SARA) involves assessment of the recovery potential for species that have been assessed by COSEWIC, and for which listing under SARA is being considered. Thirty species were subject to this type of review. The majority of these were freshwater species, but also included were some marine species including winter skate, striped bass (diadromous), and the beluga whale.

DFO Science also undertakes workshops that further develop scientific tools and techniques that assist the Department with implementing SARA. There were two such workshops in 2005: one for developing a framework for assessing allowable harm to freshwater species and issuing habitat authorizations under SARA; and a second to determine the characteristics of a recovered population in order to develop recovery targets and objectives for listed species. To find out more about peer-reviewed Science advice provided in support of SARA and other departmental priorities in 2005, visit the CSAS advisory schedule at: www.meds-sdmm.dfo-mpo.gc.ca/csas/applications/Events/event_e.asp To learn more about the aquatic species listed under the *Act*, visit: www.dfo-mpo.gc.ca/species-especes/permits/Species37_e.asp .

Atlantic Seal Population Increases

During 2005, CEMAM researchers participated in the $6 million Atlantic Seal Research Program (ASRP), which examined seal abundance, distribution and diet. The harp seal is the most abundant pinniped in the North Atlantic and is harvested commercially. The last review of its population abundance indicated that the population has likely stabilized and currently numbers around 5.8 million animals, its highest level since the 1970s. The grey seal population had increased to about 250,000 animals in 2005. Advice on allowable harvest levels provided to fisheries management allowed opening of the first commercial harvest for this species. A survey of hooded seal pup production was carried out and the data are being analyzed, with peer review scheduled in 2006. The grey and harp seal assessments were peer reviewed in May 2005 and the results are in the CSAS publication series. Distribution of the three species is being determined using satellite telemetry. This component continues — both in terms of analysis of the data collected under the ASRP and the collection of additional data under

the International Governance Program (and a proposal to International Polar Year, 2007-2008). Data on grey seals have been published in scientific literature and data on all three species have been presented to a number of scientific and public meetings.

The ASRP is improving our understanding of the potential role that harp, hooded and grey seals may be having on cod. The diet component of the ASRP consisted of exploring the use of fatty acids to determine diets and to improve sampling of harp and hooded seals in offshore areas (a major data gap identified in the cod assessments). Our ability to determine diets from fatty acid signatures has been shown and the model used to quantify the diet using fatty acids has been published in the scientific peer review literature.

Another component of the ASRP was a pilot study to determine the feasibility of seal exclusion zones. Preliminary results of this study were presented during an international workshop on Seal Exclusion zones. The report of this meeting is available on the CSAS website: www.dfo-mpo.gc.ca/csas/Csas/Home-Accueil_e.htm

Science Advice Leads to Turbot Quota Increases for Nunavut

Research conducted in 2005 by DFO and funded in partnership with the Government of Nunavut, Nunavut Wildlife Management Board, Nunavut Tunngavik Incorporated, Indian and Northern Affairs Canada, Baffin Fisheries Coalition and DFO resulted in an increase to the turbot quota for Nunavut. The research work resulted in the Northwest Atlantic Fisheries Organization (NAFO) Scientific Council recommendation of a quota increase of 5,000 metric tons in NAFO fishing zones 0A + 1A in 2006, resulting in a total turbot quota of 13,000 metric tons. Greenland and Canada have a 50 percent sharing arrangement, which will result in Nunavut getting half of the quota or 6,500 metric tons. This will increase Nunavut's share of turbot quota from 60 percent to 68 percent and increase Nunavut's overall offshore fisheries quota for turbot and shrimp, from 38 percent to 41 percent. Nunavut received the entire increase of 2,500 metric tons of the 2006 Canadian turbot quota in zone 0A located in northern Baffin Bay. The science-based advice was welcomed in Nunavut as it promises job creation and increased economic development.

Analysis Shows Eastern Arctic Bowhead Whales Form a Single Population

CEMAM researchers reviewed bowhead whale stocks in the Eastern Arctic during the year. There is a very limited subsistence harvest of these whales, whose numbers were depleted by commercial whaling that ended in the early 1900s. Eastern Arctic bowhead whales had been considered to form two populations, a Hudson Bay/Foxe Basin stock and a Davis Strait/Baffin Bay stock, based on inferences from commercial whaling records and physical land and ice barriers. Recent genetic work and monitoring of bowhead movements using satellite telemetry do not confirm the two population hypothesis, and instead, the advice is that Eastern Arctic bowhead could be considered as a single stock. Aerial surveys of this stock suggest a minimum abundance of around 7,000 animals.

Near Kekerton Island, NU in the summer of 2006, two bowhead whales surface near a small freighter canoe piloted by Levis Quanaq of Igloolik. Biologist Larry Dueck stands on the bow to attach a satellite monitoring tag to a bowhead's back. The project involved placing eight satellite tags and collecting 32 DNA samples from bowheads, which are Canada's largest Arctic marine mammals.

Photo Credit: DFO

Traditional Ecological Knowledge about Belugas Compared with Satellite Telemetry

During 2005, CEMAM researchers made a comparison of eastern Hudson Bay beluga movements and aggregation patterns using satellite telemetry and Nunavik Traditional Ecological Knowledge (TEK). TEK consists of the collective ecological knowledge, experience and values of subsistence communities. Both approaches provide important ecological information but few studies have attempted to compare

the two knowledge sources. The study revealed that both data sets can provide complementary information and that they both also suffer from weaknesses caused by limitations in data collection – weaknesses that need to be recognized when such data is applied to advice regarding resource management issues.

Oil and Gas Program - Northern Research

Throughout 2005, DFO conducted research to provide science-based advice and decision making in support of its regulatory responsibilities regarding the protection of fish and fish habitat with respect to the proposed Mackenzie Gas Pipeline (MGP) development. The MGP has the potential to have environmental impacts on the Canadian North due to pipeline construction, and related oil and gas activities. DFO reviews, and provides recommendations on the Environmental Impact Statement and conducts scientific research in order to ensure adequate monitoring and assessment of potential negative environmental impacts of induced oil and gas activities. DFO scientists are conducting onshore and offshore studies, and research to address information gaps identified during community workshops. Studies are being conducted on marine and anadromous fish species, seasonal use of the Beaufort Sea, and important migration routes. Beluga tagging studies are determining seasonal use of the Beaufort Sea and annual migration routes. Late winter and early spring seal studies are examining the potential impacts of offshore oil and gas activities on the abundance, denning and pupping behaviour, and annual migration of Beaufort seals. DFO scientists are also participating in the multi-agency Beaufort Sea Coastal habitat mapping program, which is examining all aspects of the marine ecosystem to identify areas that may require added precaution or avoidance during the planning of future offshore oil and gas development. This extensive set of Northern research programs are described at length on the Department's website.

Agricultural Drains Act as Fish Habitat

DFO's Fish Habitat Management sector requested advice on whether agricultural drains could be considered fish habitat. DFO scientists contributed guidance to a University of Guelph research study conducted to determine if there were differences in fish diversity, abundance, life stages and habitat between 25 warm-water agricultural drains in southwestern Ontario and 25 paired water courses not subject to drain maintenance. The study found no significant differences in any of the variables measured and concluded that agricultural drains do act as fish habitat. Habitat and drain managers will use the findings to develop drain management guidelines that consider the needs of agriculture, while preserving fish diversity and habitat.

Scuba sampling of American lobster provided valuable information about early growth.

Photo Credit: DFO

Sizing up the Growth of the American Lobster

The American lobster has supported a commercial fishery since the middle of the 19th century. Landings were at, or near, historic highs during the 1990s and into the early 2000s, following a steep and unforeseen increase through the 1980s. In 2005, scientists from the Quebec Region published a study on the growth of juvenile American lobster off the Magdalen Islands. In addition to scuba sampling of lobster during two periods (1995-2001 and 2003-2004), the study critically reviewed current concepts about lobster early growth, emphasizing the scarcity of fine-resolution studies of growth of early benthic stages of the animals. The work contributes to the understanding of the variability of size-at-age and age at recruitment, which is a first step towards understanding the settler-to-recruit relationships – knowledge that assists effective management of the fishery.

Sea Scallop Fishery — Nova Scotia Benthic Mapping Project

The sea scallop fishery in southwest Nova Scotia, located in scallop fishing area 29, is unique in a number of ways. This new fishery has had full monitoring in terms of annual surveys, observer coverage, catch sampling and satellite monitoring systems since it began in 2001. In 2002, DFO entered into a three-year joint project agreement with the fishing fleets and Natural Resources Canada and all parties provided funds to conduct multibeam sonar acoustic mapping of the seafloor and associated scientific work. Access to fishing in the area was conditional on contributing to funding the project.

Maps of high-resolution bathymetry, acoustic backscatter strength and surficial geology have been produced from this project. In addition, benthic data were collected using photographic and video equipment for the analysis of the distribution of benthic assemblages in relation to bottom type. Video and data from the observer program show sea scallops were found in most areas but were most abundant on flat gravel lag and stable sands. Restricting dragging for scallops on the flat gravel lag or in sand could improve catches, minimize gear losses and greatly reduce bycatch and damage to species that live on or near the bottom of the ocean which are the most abundant on bedrock outcrops and till. The bathymetry maps were used in the last three years for planning survey tows, and as a result, greatly reduced gear damage during the annual survey. The 2005 survey was redesigned using surficial maps and preliminary results indicated that this new design resulted in more precise estimates of biomass. Finally, the commercial catch per unit effort was analysed using the surficial geology maps and the results suggested that current catch rates are being maintained by moving to previously unfished areas. The results of the 2005 survey were presented and reviewed with the stakeholders at a workshop early in 2006.

Scotian Shelf Fish Habitat Project Reveals Information about Haddock

A collaborative research program between the DFO Maritimes and Newfoundland and Labrador Regions that began in 2001, investigated how ocean bottom habitat space is used by deep water fish occupying habitat at the bottom of the Scotian Shelf. The focus was to determine the preferred habitat for juvenile haddock. This information is needed to manage both fisheries and habitat within an ecological context. In 2005 the ambitious field program concluded successfully. It was carried out at six 10 x 10 kilometre study sites, originally selected using historical DFO trawl survey data to determine high and low probability preferred areas. A cruise on the CFAV *Quest* collected high resolution multibeam data at three of the study sites. Seabed features down to 0.5 m could be resolved. The CCGS *Needler* conducted trawl surveys at all six study sites which will provide further information on the composition of fish communities and major benthic prey. The CCGS *Hudson* carried out extensive benthic habitat and community surveys at all study sites using a wide variety of equipment including sidescan sonar, Biosonics DT acoustics, Towcam (a towed video platform) and Videograb. This equipment will provide information on seabed structures, sediment composition, fish distribution in relation to habitat, and the composition of benthic communities. The large number of physical and biological data sets collected systematically at the same study sites is a unique aspect of this DFO project. Data analysis is now under way and the integrated results will be presented at a workshop in March 2007.

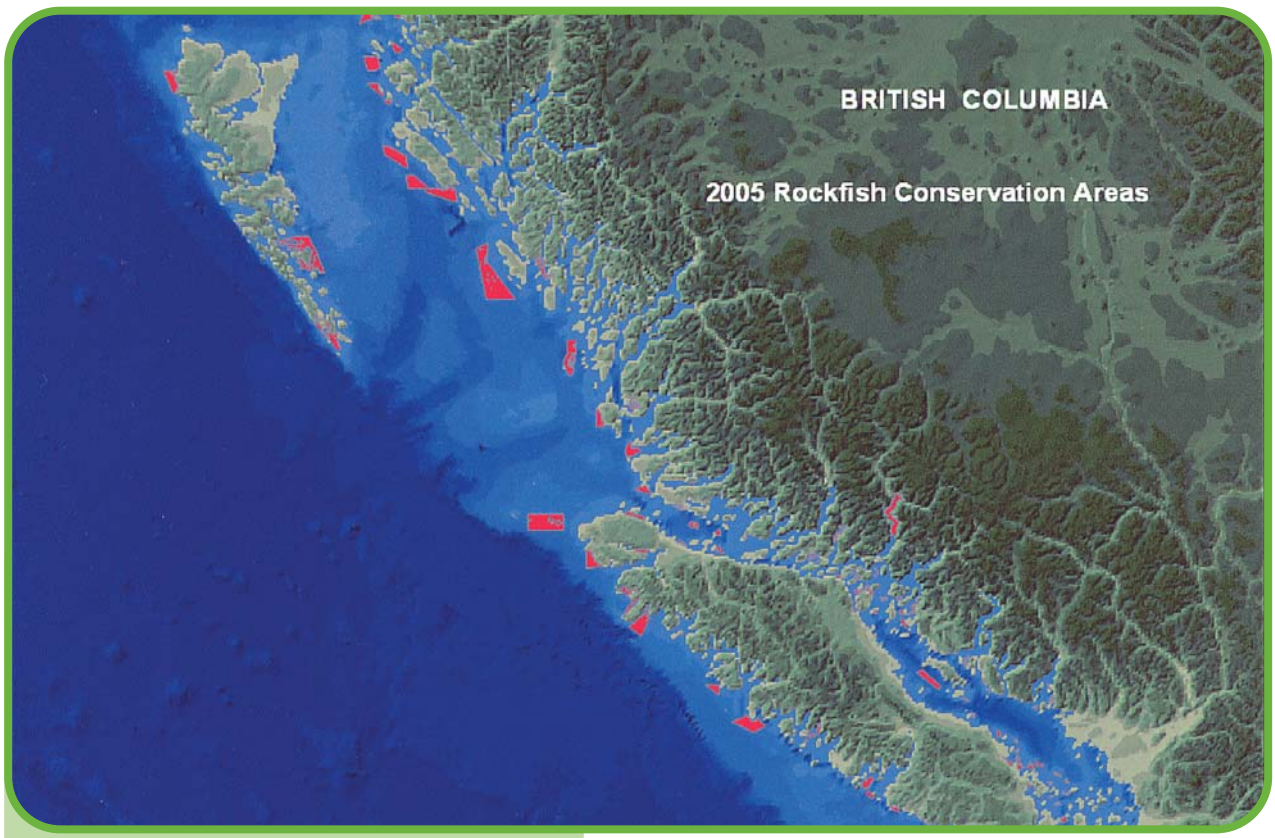
A Banner Year in 2005 for Maritimes Regional Advisory Process

During 2005, eleven Regional Advisory Process (RAP) meetings were held in the Maritimes to address issues from the stock assessment of eastern Scotian Shelf snow crab to the review of ecological overviews of the Bras d'Or Lakes. Consistent with the trend observed over the last number of years, RAP is increasingly being used to review Oceans, Habitat and *Species at Risk* issues in addition to those of fisheries stock assessment. An important RAP meeting in 2005 saw the establishment of an approach to the classification of benthic communities on the Scotian Shelf, based on their sensitivity to human impacts. This classification approach will be used by DFO Oceans in its efforts to manage the full range of human activities (from fishing to oil and gas

exploration) impacting the bottom communities. Regarding the *Species at Risk Act*, the RAP meetings to review the recovery potential of porbeagle shark and winter skate were highlights for 2005. These reviews represent the most in-depth analyses of these populations conducted to date and will be important to the recovery plans of these species. Regarding fisheries assessment, the review of the Georges Bank yellowtail assessment model was another highlight. It was one of the most thorough investigations of a stock assessment conducted thus far. It uncovered issues with the assessment that will lead to improvements in scientific advice on this resource in the long term. Overall, 2005 was a banner year for RAP in the region.

35 New Rockfish Conservation Areas for British Columbia

Consultations with the commercial industry, recreational, and Aboriginal fishing sectors, local and provincial governments, as well as coastal communities and the general public have been conducted since 2002 to develop the network of Rockfish Conservation Areas (RCAs) in B.C. After these extensive consultations, 35 RCAs were implemented during the 2005 fishing season. Spatial analyses using fishery catch and bathymetry data were conducted to identify areas coastwide that could be considered "rockfish habitat." This rockfish habitat layer was then used as a basis for selecting RCA candidate sites and to measure the closed habitat area targets. The 35 RCAs meet DFO's target of 20 percent closed rockfish habitat for the coastwide offshore area outside of the Strait of Georgia. Further consultations on new RCA candidate sites proposed for the inside of the Strait of Georgia began in 2005. Implementation of these new areas in 2006 will result in a total of 120 RCAs and will meet the target of 30 percent closed rockfish habitat for inside the Strait of Georgia. The 35 new RCAs implemented in 2005 for the coastwide area outside of the Strait of Georgia are closed to all trawl and hook-and-line fishing for the recreational and commercial fishing sectors.



Rockfish Conservation Areas

Photo Credit: DFO

Salmon Egg Research Provides Practical Data

The British Columbia Atlantic salmon farming industry depends almost entirely for its egg source on brood fish reared in British Columbian waters. Hence, collaborative research with DFO and the salmon farming industry was conducted, starting in 2003 to the present, on numerous factors affecting egg to fry development and survival (i.e., gamete handling, storage, fertilization procedures, and incubation temperature), as well as factors that influence the latter part of maturation prior to spawning (i.e., dissolved oxygen and temperature). The research yielded useful practical fish culture information for the salmon farming industry and data for the scientific community.

Magnified salmon egg

Photo Credit: Karin Davis

Management of Data and Information

The Marine Environmental Data Service (MEDS) is DFO's oceanographic data management and archive centre. MEDS acquires data collected by researchers from Canada and abroad, converts them to common data structures, ensures they are of a consistent quality and provides these data to others. MEDS is a member of an international consortium of data centres, some of which manage data in real-time and coordinate their efforts through the Joint Commission on Oceanography and Marine Meteorology (JCOMM). Others manage delayed mode data through the Intergovernmental Oceanographic Data and information Exchange (IODE). MEDS is a strong player in both JCOMM and IODE, a position that is unique in the world.

During 2005, as it has for many years, MEDS managed many different sorts of Canadian data, such as readings from tide gauges, ocean temperature and salinity readings from Argo floats, and many other ocean environmental variables, as well as data acquired through acoustic tracking of fish, data on invasive species distributions and much, much more.

Modern oceanographic research such as that undertaken by MEDS requires international linkages and the co-operation of many partners to be both affordable and increasingly effective. A large percentage of data contributed to MEDS comes from international sources. For some data, MEDS acts as a global data centre while for other kinds it only acquires data from waters around Canada. For certain data, MEDS distributes all that it receives to researchers at data centres in six other countries, and, in effect, issues the contents of its archives six times annually.

For several years, MEDS has supplied access to real-time data to the Global Ocean Data Assimilation Experiment (GODAE), an initiative to learn how to build and operate coupled ocean-atmosphere-ice models. Through links forged in IODE, MEDS entered into an agreement to supply French modellers contributing to GODAE with real-time data. In 2005, Canadian researchers also began a modelling effort and settled on using the French model. As part of a close working relationship with the data centre

in France, Canada acquired a copy of the French-developed software used to prepare the data for assimilation into the model. MEDS continues to supply data to France and is also building the necessary software to provide the data to Canadian modellers.

Also during 2005, MEDS started a pilot project with the DFO Institute of Ocean Sciences to attach a "bar code" to the data collected at each ocean location. This is attached at the creation of the data and follows along whenever the data is moved. The bar code addresses the need to identify data that may be received multiple times by the DFO data system.

One of the key issues with respect to data is the lack of standardization among national and international data types and the challenges that presents to interoperability. DFO undertook a national workshop in 2005 to address the topic of "Service-oriented Architecture" (SOA) which seeks to harmonize standards. The outcome was a national commitment to the need for SOA, and the recognition that SOA is required for DFO Science Sector to achieve maximum use of its data archives, and in turn, to service Canadians, and its international commitments effectively.

Data, Products and Services

Canadian Hydrographic Service

The Canadian Hydrographic Service (CHS) is the division of DFO Science responsible for surveying and charting Canadian waterways for safe and efficient navigation. During 2005-06, the CHS distribution offices distributed 153,779 charts and 92,637 publications through the 800 authorized dealers across Canada and USA. CHS produced 129 New Editions and New Charts in paper and 106 new Electronic Navigational Charts in S57 format including 85 New Editions. Fifty-two raster navigational charts were released including six New Charts. There were over one million visitor sessions on the Tidal web site requiring tidal information, and over 3,500 calls received at the toll-free number for water levels and tidal information during 2005. For more about the CHS and its many products, go to its online portal, at www.charts.gc.ca/pub/

Atlantic Zone Monitoring Program Indices and Bulletins

In addition to the CHS, other branches of DFO Science are also directly responsible for the production of numerous data outputs, products and services which are used daily by Canadians and international users involved in transportation and industry as well as recreation. For example, the annual Atlantic Zone Monitoring Program (AZMP) provides direct access to a compendium of oceanographic data, climate indices, plankton data, sea level data, remote sensing data and meteorological data. All of this information is publicly available from the MEDS section of the department's website (www.meds-sdmm.dfo-mpo.gc.ca). The AZMP also publishes an annual Bulletin that is available from the following link: www.meds-sdmm.dfo-mpo.gc.ca/zmp/ main_zmp_e.html

Online Delivery of Oceanographic Data

With the help of a university partner (ISMER-Institut des sciences de la mer de Rimouski) DFO completed the first phase of an oceanographic buoy network in the St. Lawrence during 2005. Available in near real-time through a website (www.osl.gc.ca/thermographes/en/), the data from this network are used to validate images of sea surface temperature that are made available through the remote sensing laboratory website (www.osl.gc.ca/teledetection/en/). This network, which is part of the AZMP, is a key component of the development of better quality remote sensing products to address DFO scientific and management issues.

Operational Oceanography in the Gulf of St. Lawrence

During 2005, the Maurice Lamontagne Institute (IML) laboratory continued to be at the forefront of the development of useful ocean information products for commercial, social and scientific interests. The IML forecasting system is based on research models migrated to the operational level. Daily Ocean Forecasts for the Gulf of St. Lawrence system are freely available on the St. Lawrence Observatory website, www.osl.gc.ca/previsions-oceaniques/en/menu-previsions.jsp

The IML microcosm demonstrates the large range of activities and benefits associated with operational oceanography. In partnership with other agencies that collect related information (e.g., the Meteorological Service of Canada, Canadian Ice Service ice charts, Canadian Hydrographic Service water level observations, the Great Lakes outflow forecast from Environment Canada, the flow forecast from the Ottawa River Board Secretariat) IML maintains programs to make additional routine observations of the marine environment. IML use this information, together with coupled ocean-atmosphere-sea ice forecast models, to provide operational services for specific end users and others through web-based dissemination.

Examples of services include: the Gulf of St. Lawrence daily forecast of surface currents; sea ice concentration and thickness for ship routing for the Canadian Coast Guard Environmental Emergency Service, to use in oil-spill trajectory forecasts and for Search and Rescue Systems; 30-Day water level forecast for the St. Lawrence River; and fresh water flow nowcasting at Quebec City. The system provides an excellent example of what is being done in operational oceanography and how it benefits Canadians.

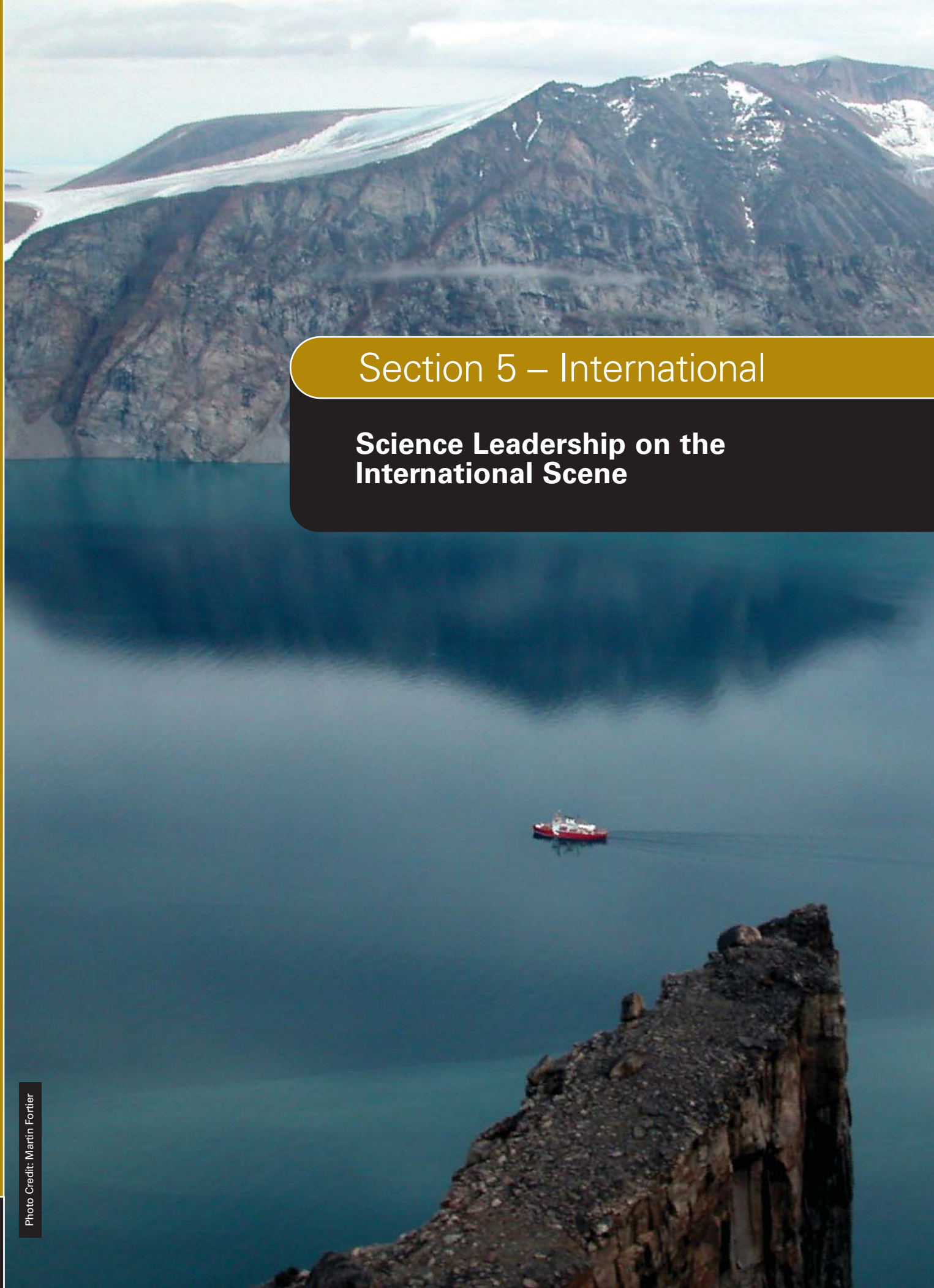
Online Scientific Data and Information

The DFO Science home page is found at: www.dfo-mpo.gc.ca/science The Science online clientele has been steadily growing over the years and is increasingly interested in, and dependent on, DFO aquatic science data and products. The rapid evolution of web technologies constantly brings a range of new possibilities allowing DFO Science to explore and develop additional data integration mechanisms in order to increase data accessibility within DFO and also to achieve interoperability between DFO and its external collaborators.

Under its national umbrella, DFO Science operates several unique web portals catering to specialized science interests. For example, since January 2000, the St. Lawrence Observatory (OSL) Internet Portal (www.osl.gc.ca) has been providing access to scientific data and information about a variety of topics such as ecosystem modelling, biodiversity, climate and environment, experimental biology, remote sensing, and fisheries research. Although mainly focused on the St. Lawrence ecosystem, the OSL portal also features elements reaching beyond the regional boundaries, including web products and applications such as dynamic web access to the national sea surface temperature map archives and the results and models of an ecosystem comparative dynamics program for the Northwest Atlantic. Access to the Centre of Expertise on Marine Mammal Research is also achieved through the OSL portal. Work is now under way inside DFO Science to increase the web presence of the Centres of Expertise and to make information about their research more accessible to national and international partners.

Strategic Science Outreach

DFO Science operates a Strategic Science Outreach unit which is instrumental in building awareness of the importance of DFO's scientific work as an aid to building a science culture in Canada. The unit manages external alliances and partnerships among federal and provincial partners related to science conferences and exhibits at national science centres, outreach activities with non-governmental organizations that contribute to science learning and curricula, and activities involving staff such as internal and external lectures on science. It helps to implement advice from the external Science Advisory Council, a group of ex-officio science and science communications experts who advise the DFO Science management team during the year. It contributes to internal science communication, provides guidance on science activities for external communications and prepares many presentations and reports on DFO Science, such as this annual report. A particular success of the unit is its popular series of science feature stories, which anyone in the public can subscribe to online: www.dfo-mpo.gc.ca/science/ Story/feature_e.htm



Section 5 – International

Science Leadership on the International Scene

Photo Credit: Martin Fortier

DFO Science has leadership roles in international organizations that play an influential role in freshwater and ocean sciences. These include the Intergovernmental Oceanographic Commission (IOC), the Joint World Meteorological Organization-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), the International Council for the Exploration of the Seas, the North Pacific Marine Science Organization, the Northwest Atlantic Fisheries Organization, the Great Lakes Fishery Commission, the World Organization of Animal Health, and the International Hydrographic Organization, among others.

Sea Lamprey Decreases in Great Lakes

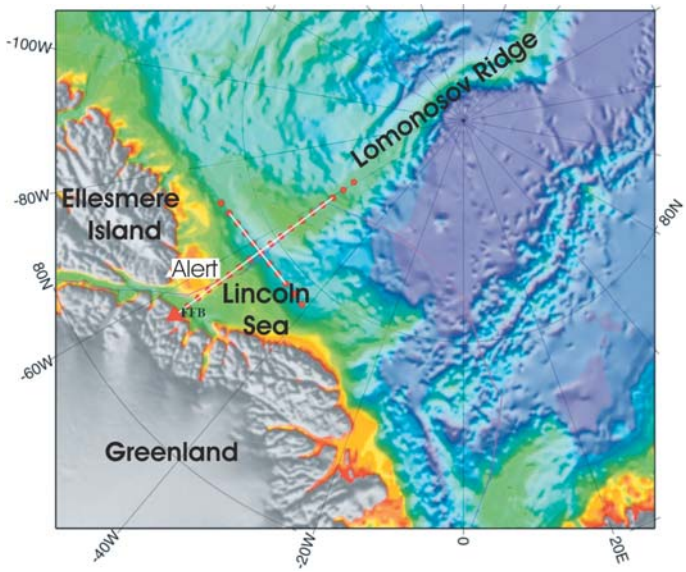
Assistant Deputy Minister, Science, Dr. Wendy Watson-Wright, and Special Advisor to the Deputy, Dr. John Davis, served as Canadian commissioners for the Great Lakes Fishery Commission (GLFC), as part of DFO's commitment to manage populations of the invasive sea lamprey. The GLFC is responsible for reducing sea lamprey populations — an invasive species that has devastated lake trout populations — as well as coordinating fishery research in the Great Lakes. The Sea Lamprey Control program has resulted in a 90 percent decrease of lampreys, enabling the restoration of lake trout and other species. The GLFC pioneered the Partnership in Ecosystem Research and Management which funds researchers at the University of Guelph and Michigan State University in the development of innovative methods for sea lamprey control. In 2005, GLFC funded research to describe the structure and function of unique pheromones used by sea lampreys to locate suitable streams for spawning and to attract females to nests. Work began to find unique areas in the lamprey genome that can be exploited in the development of new control methods. The integration of stock assessment, traditional control methods and new methods developed by the science program are expected to further reduce populations to target levels by 2010. www.dfo-mpo.gc.ca/regions/CENTRAL/science/sea-mer/index_e.htm

The Northwest Atlantic Fisheries Organization (NAFO)

In 2005, Canada achieved a major fisheries management goal, and NAFO marked a significant milestone towards an ecosystem-based approach to fisheries management, when its members unanimously agreed to reform NAFO and improve management of the fisheries outside Canada's 200-mile limit. DFO Science participates in the NAFO Scientific Council, which gives advice upon request on the status of fish stocks in the NAFO Convention Area to Fisheries Commission and Coastal States. The NAFO Scientific Council publishes the NAFO Journal of Northwest Atlantic Fishery Science.

Sea lamprey

Photo Credit: DFO



In support of the UNCLOS CLSC effort, The Lomonosov Ridge Test of Appurtenance (LORITA) is a collaborative Canadian-Danish project to acquire bathymetric data about this submarine mountain ridge. The survey team will be based at Canadian Forces Base Alert on Ellesmere Island. A seismic station at Frankfield Bay on Greenland is indicated by "FFB". The lines show the plan for acquisition of received seismic refraction data. The red dots are the planned seismic shots. Learn more at http://a76.dk/expeditions_uk/lorita-1_uk/index.html

Image Credit: Courtesy LORITA

Canadian Hydrographic Service and United Nations Convention on the Law of the Sea

Canada ratified the United Nations Convention on the Law of the Sea (UNCLOS) in November 2003 and has until the end of 2013 to submit evidence to the United Nations Commission for the Limits of the Continental Shelf (CLCS) to support the establishment of the outer limits of its continental shelf. Foreign Affairs and International Trade Canada is responsible for preparing the Canadian submission. The Canadian Hydrographic Service (CHS), (a division of DFO) and the Geological Survey of Canada, (a division of Natural Resources Canada) are performing surveys to determine the limits of Canada's Arctic and Atlantic continental shelves that lie beyond the 200-nautical-mile exclusive economic zone. Because of the technical challenges of data collection in the remote ice-covered areas of the Arctic Ocean, the Geological Survey of Canada (in consultation with Foreign Affairs and Interntional Trade Canada) negotiated with the Geological Survey of Denmark and Greenland to collaborate on surveys in the area north of Ellesmere Island and the Labrador Sea. This will not only reduce the cost for both countries, but also lead to a joint interpretation of the collected information, thereby reducing the possibility of overlapping claims and disputes. An agreement has been developed for a joint Arctic field program on the ice, starting in March 2006. On the Atlantic side, the surveys have been initiated using charted vessels, whereas in the Pacific, as the shelves are narrow, there will be no opportunity to claim areas beyond the 200 mile limit under the UNCLOS.

Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM)

Canada, and DFO Science, played a leading role in the development of JCOMM. Dr. Savithri Narayanan, Director General of Ocean Sciences and the Canadian Hydrographic Service, served as co-president for four years from 2001, when she was elected during JCOMM's first assembly, until its second assembly held in Halifax in September 2005. DFO will continue to steer JCOMM through participation in its Management Committee and advisory bodies. This intergovernmental body of experts provides the coordination, regulation and management mechanism for the operation of an oceanographic and marine meteorological observing, data management and services system. JCOMM is highly relevant to Canada, as Canada's Oceans Action Plan is dedicated to managing ocean activities in a holistic, integrated way, and DFO's work to manage Canada's fisheries demands the best observations and data management possible. The recent and devastating ocean-generated natural disasters including the Indian Ocean tsunami, Hurricane Katrina and the subsequent storm surge, focused participants on the importance of JCOMM's data gathering and interpretation role. There was

strong support for JCOMM input to the development and maintenance of marine multi-hazard warning systems, in view of its existing expertise and facilities in waves and storm surges, maritime safety service formulation and delivery, and deployment and maintenance of ocean observing platforms.

International Tsunami and Storm Surge Warning System Developments

During 2005, DFO Science worked with the Canadian International Development Agency (CIDA) to complete a detailed plan for capacity building programs for assisting in the development of a tsunami warning system in Sri Lanka. Through CIDA, Canada also contributed $500,000 to the IOC for the implementation of the regional Indian Ocean Tsunami Information Centre in Jakarta, Indonesia. DFO Science coordinated this action as part of its IOC activities. DFO directly contributes to the IOC Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the Pacific. Fred Stephenson, DFO Pacific Region CHS, is the vice-chair. Learn more at: ioc3. unesco .org/indotsunami/

Also during the year, DFO Science worked to ensure that existing West Coast and proposed East coast components to the Canadian tsunami/storm surge warning systems and plans were integrated with the Global Tsunami Warning Systems, and chaired an interdepartmental task team to develop an Atlantic Tsunami-Storm Surge warning system.

Another key DFO Science contribution on this subject was "The Global Reach of the 26 December 2004 Sumatra Tsunami", a pivotal paper published in *Science*, co-authored by Dr. Richard Thomson of the DFO Institute of Ocean Sciences with colleagues at the U.S. National Oceanic and Atmospheric Administration, and the Russian Academy of Sciences. For the first time, this paper described the global propagation of the tsunami and its analysis provided essential verification of models used to predict tsunami run-up and inundation. The research made novel use of satellite altimetry and the global network of sea level gauges. Learn more at: www.sciencemag.org/cgi/content/full/309/5743/2045

Pacific Ocean Regime Shift Research

The North Pacific Marine Science Organization (PICES) is an international scientific organization established to promote and coordinate marine research in the North Pacific. In 2003, PICES received its first formal request for scientific advice from the National Marine Fisheries Service of the United States. The request was for recommendations on the science and management implications of a potential 1998 climate-ocean regime shift for North Pacific fisheries. Previous climate-ocean regime shifts have had serious implications for ecosystems and consequently for fish populations and the fishing industry. PICES convened an international Study Group (Fisheries and Ecosystem Responses to Recent Regime Shifts - FERRRS), comprised of 21 scientists from PICES member countries to formulate the scientific advice to the U.S. government. DFO Pacific Region provided substantial participation and the Study Group was chaired by Dr. Jackie King of DFO's Pacific Biological Station. The Study Group's advice outlined recommendations for incorporating regime shift concepts into fishery management activities. The report of the FERRRS Study Group was presented to the U.S. government in January 2005. Recommendations made by the Study Group have implications for DFO science, stock assessment and management mandates. Read more at: www.pices.int/publications/scientific_ reports/Report28/Rep_28_default.aspx

Integrated Monitoring in the North Atlantic

The International Council for the Exploration of the Sea (ICES) coordinates and promotes marine research in the North Atlantic with contributions from scientists in 19 member countries. During 2005, Canadian scientists worked with other ICES researchers on themes of major importance to Canada, including the survival and management of cod stocks, development and implementation of an ecosystem approach to fisheries management, and development of ecosystem indicators in support of the European Water Framework Directive (WFD). ICES member states signed an accord to achieve maximum sustainable yield for the world's fish stock by 2015 and to implement an ecosystem approach to

fisheries management by 2010. The WFD requires European member states to achieve "good ecological and chemical status" of surface waters by 2015. While the initial focus is on river basins, the WFD also applies to estuarine, coastal and other marine waters. This WFD goal is analogous to the habitat ecosystem objectives being pursued through the development of integrated management plans in Canada. ICES is participating in the identification of indicators and the development of an integrated monitoring program that includes both chemical and biological effects measurements. These are only a few examples of the benefits Canada receives from the participation of scientists and science managers in a selected number of the more than 100 ICES working groups, science and advisory committees. www.ices.dk/indexfla.asp

International Reviews of Marine Ecosystem Science in Other Nations

DFO also contributed expertise to reviews of marine ecosystem science undertaken by other national jurisdictions. In Australia, having recently merged its Oceans and Atmosphere divisions, the Commonwealth Scientific and Industrial Research Organisation of Australia appointed a five-member task team to review all the science plans from the new merged organisation. The evaluation was to address both quality and policy-relevance of the science being done, and the extent to which the research plans took advantage of the potential synergies of a combined oceans and atmosphere research unit. In the U.S.A, the National Oceanic and Atmospheric Administration (NOAA) formed an eight-member external Ecosystem Task Team charged to evaluate and provide recommendations on two issues. First, is the mix of ecosystem science activities conducted or supported by NOAA appropriate to its mission needs and regulatory responsibilities? Second, how should NOAA organize its ecosystem science and research enterprises? Dr. Jake Rice, Director of Assessment and Advice for DFO Science was invited to participate in both review panels.

The United Nations Climate Change Conference, Montreal (COP 11)

The Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC – COP11) met for the eleventh time in Montreal in December 2005. There were about 10,000 participants from 189 nations, and 700 reporters on hand for the event. DFO participated with regard to its work in the collection of improved data to understand the Earth's oceans and showcased its work to understand, assess, predict, and mitigate climate change and variability in marine ecosystems, so we can better adapt to these changes. Three staff members from DFO Policy and Science were observers on the Canadian delegation. Read more online at: www.montreal2005.gc.ca/

The visit of DFO's CCGS *Amundsen* to Montreal for the event was very popular. The icebreaker, which was re-commissioned and refitted for northern research in 2003, was visited by over 1,700 members of the public as well as the media. The tours sparked dozens of TV, radio and newspaper stories around the world, spotlighting Canada's northern science work.

At the Canada Pavilion, Dr. Ken Denman, a senior DFO research scientist, made a world-class presentation during the Science for Solutions lecture series on the science of the carbon system in climate change. He is the Coordinating Lead Author for a chapter in the next UN report on climate change. DFO Science also contributed to presentations at the Group on Earth Observations side event, and the Global Climate Observing System session.

International Monitoring and Data Gathering Undertakings

DFO assists in and contributes to many scientific data gathering and oceanographic monitoring programs and plays a leading role in the following high profile and internationally significant research and monitoring programs:

Global Earth Observation System of Systems (GEOSS)

Canada's contribution to the Global Earth Observation System of Systems (GEOSS) earth observations (EO) are oceanic, terrestrial, atmospheric or space-based measurements that allow us to understand the earths systems – its weather, climate, land, oceans, ice, geology, natural resources, ecosystems and hazards. Superior EO data supports the mandate and priorities of DFO, including the Oceans Action Plan, management of fisheries and aquaculture, Coast Guard operations and monitoring the impact of climate change on marine and freshwater resources. www.earthobservations.org

The Global Ocean Observing System (GOOS):

GOOS is a permanent global system for observations, modelling and analysis of marine and ocean variables to support operational ocean services worldwide. www.ioc-goos.org.

ArcticNet

ArcticNet is a Canadian Network of Centres of Excellence involving over 90 researchers from 23 Canadian universities and five federal departments in collaboration with research teams in the U.S.A., Japan, Denmark, Sweden, Norway, Poland, the United Kingdom, Spain, Russia, Greenland and France. www.arcticnet-ulaval.ca.

Argo

Argo is a global array of 3,000 free-drifting profiling floats that measure the temperature and salinity of the upper 2,000 metres of the ocean. For the first time, continuous monitoring of the temperature, salinity, and velocity of the upper ocean will be possible, with all data being relayed and made publicly available within hours after collection. Effectively, Argo monitors the pulse of the global heat balance. Over 90 percent of the observed increase in heat content of the air/land/sea climate system over the past 50 years occurred in the ocean. Argo improves our understanding of the ocean's role in climate, and spawns an enormous range of valuable ocean applications. For information on Canadian tracked Argo data, visit: www.meds-sdmm.dfo-mpo.gc.ca/meds/Prog_Int/Argo/Canadian_Info/A_Can_e.asp

Surface Ocean Lower Atmosphere Study (SOLAS)

SOLAS (Surface Ocean - Lower Atmosphere Study) is an international research initiative, "To achieve quantitative understanding of the key biogeochemical-physical interactions and feedbacks between the ocean and atmosphere, and of how this coupled system affects and is affected by climate and environmental change." SOLAS is part of the Earth System Science Partnership and involves more than 250 scientists from 22 different countries. Go to: www.uea.ac.uk/env/solas/welcome.html

Joint Western Arctic Climate Study (JWACS)

This collaboration involving the Japan Marine Science and Technology Center (JAMSTEC) and the Institute of Ocean Sciences of Fisheries and Oceans (IOS/DFO) began in 2003. JWACS is part of an ongoing co-operative effort between Japan and Canada to study ocean-ice processes and climate change in the western Arctic Ocean using moorings and bio-geochemical hydrographic surveys. The Canada Basin Climate Study project was conducted aboard the CCGS *Louis S. St. Laurent*. Data collected will address questions of freshwater storage in the Beaufort Gyre, circulation, inter-annual variability of water mass properties, and the distribution and concentration of biota. Learn more at: www.jamstec.go.jp/arctic/ index_e.htm