

## Annual Report 2007-2008



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# 1. Director's Report

This is the final annual report that will be written during my tenure (2004-2009) as Director of the Ocean Sciences Centre (OSC). It has been an honour and privilege for me to serve as the Director, and to work with an outstanding group of staff, students and faculty. The accomplishments over this period are very much a reflection of their joint efforts to make the OSC a leading international centre for research on cold oceans.

The OSC is one of Canada's largest marine laboratories and a leader in biological aspects of marine science in Canada. By virtue of its location, the OSC provides scientists in Newfoundland, throughout Canada and abroad with access to the unique flora and fauna of the northwestern Atlantic Ocean. The facility is located at Logy Bay (approx. 10 km from the main campus of Memorial University) and provides unique and ready access to a wide range of shallow-to-deep environments, including the rocky intertidal zone, the continental shelf and the sub-zero deep waters of the inshore branch of the Labrador Current. It meets the special needs of researchers in five important areas: (1) the capacity to hold marine organisms, from bacteria to seals, for physiological and behavioural experimentation; (2) the capacity to support and participate in large, oceanographic expeditions making use of state-of-the-art field equipment; (3) the capacity to collect, maintain and study sub-Arctic, Arctic and deep-sea species at a well-equipped, land-based marine facility; (4) the capacity to explore and develop the aquaculture potential of marine organisms in cold waters; and (5) the capacity to conduct a wide variety of sample analyses (from oceanographic to molecular). The continuing strategic goal of the OSC is to carry out world-class research that focuses on organisms and processes in cold oceans, and to provide associated educational and training opportunities, particularly at the graduate level. Core programs central to the internationally recognized research include oceanography, aquatic ecology and aquaculture, and the physiological, biochemical, genomic, evolutionary and behavioural processes that are central to these themes.

The past academic year (September 2007 – August 2008) was one of continued excellence in research and education at the OSC. We were delighted to welcome the new Dean of Science, Dr. Mark Abrahams, as a joint appointment between the OSC and the Department of Biology in February 2008. Mark brings expertise in predator-prey interactions involving aquatic organisms and how they are affected by the physical environment.

There were 60 graduate students, eight of which graduated, and three postdoctoral fellows supervised by OSC faculty in 2007-2008. The joint efforts of OSC faculty, students and staff resulted in 36 publications and an additional 28 publications in press. This work was supported by nearly \$4 million in research funding administered through the OSC. Towards year end, we also received exciting news that a large NSERC Strategic Network grant (Snelgrove) had been awarded and was to be directed out of the OSC. Entitled the Canadian Healthy Oceans Network and involving 65 researchers from 15 universities and multiple federal research laboratories across Canada, it will focus on research to improve management of living marine resources and to develop tools to enhance sustainable development of the oceans. The OSC also received a \$1 million strategic investment by

the Government of Newfoundland and Labrador towards the development of a deeper seawater source for the facility.

As in past years, we had a diversity of researchers and students from outside the Centre make use of its research facilities and expertise, including individuals from across Canada and from Argentina, Chile, France, Mexico, Portugal, United Kingdom and the United States.

This report summarizes the activities and accomplishments of the joint efforts of the staff, students and faculty of the Ocean Sciences Centre.

## 2. Personnel

### *Faculty*

Dr. Mark Abrahams- Professor (Dean of Science)- B.Sc (Hons.) University of Western Ontario, M.Sc Queen's University, PhD Simon Fraser University.

Dr. Donald Deibel - Professor (Research) – B.Sc Bucknell Univ. USA, PhD Univ. of Georgia, USA.

Dr. William Driedzic - Professor – B.Sc (Hons.) York, M.Sc. Toronto, PhD. British Columbia. Canadian Research Chair Tier I - Marine Bioscience.

Dr. Ian A. Fleming - Associate Professor (Director OSC) – B.Sc Queen's Univ., M.Sc Simon Fraser Univ., PhD. Univ. of Toronto.

Dr. Patrick Gagnon- Assistant Professor- B.Sc Laval University, MSc Laval University, PhD Laval University.

Dr. Kurt Gamperl - Assistant Professor – B.Sc (Hons.) Univ. of Guelph, M.Sc Univ. of Guelph, PhD Dalhousie Univ.

Dr. Chris Parrish - Professor (Research) – B.Sc Univ. College of Swansea, UK, PhD Dalhousie Univ.

Dr. Annie Mercier - Assistant Professor – B.Sc Université de Sherbrooke, M.Sc. Université du Québec à Rimouski, Ph.D. Université du Québec à Rimouski.

Dr. Matthew Rise - Assistant Professor - B.Sc. Whitworth College, M.Sc. Boston College, Ph.D. University of Victoria

Dr. Richard Rivkin – Professor (Research) - B.Sc. City College of New York, USA, M.Sc. City College of New York, USA., Ph.D. Univ. of Rhode Island, USA.

Dr. David Schneider - Professor - B.Sc. Duke, Durham, NC, USA, Ph.D. SUNY, Stony Brook, Long Island, NY, USA.

Dr. Paul Snelgrove - Associate Professor - B.Sc. Hon. Memorial Univ., M.Sc. McGill., Ph.D. Massachusetts Institute of Technology/Woods Hole Oceanographic Institution. Canadian Research Chair Tier II - Boreal and Cold Ocean Systems

Dr. Raymond Thompson - Professor (Research) - B.Sc. Univ. Bristol, UK, Ph.D. Univ. of Leicester, UK

Dr. Joseph Wroblewski - Professor (Research) - B.Sc. Univ. of Illinois, USA, M.Sc.  
Florida Univ., USA, Ph.D. Florida State Univ., USA.

### ***Cross – Appointees***

Dr. Fereidoon Shahidi - Biochemistry Dept.  
Dr. William Montevicchi- Psychology Dept.  
Dr. Helene Volkoff - Biology Dept.

### ***Adjunct Professors***

Dr. Dave Cote - Terra Nova National Park  
Dr. Elizabeth Deblois- Jacques Whitford Environment Ltd.  
Dr. Brian Dixon- University of Waterloo  
Dr. Michelle Hale-(University of Portsmouth)  
Dr. Atef Mansour - Department of Fisheries and Oceans  
Dr. Cynthia McKenzie- Department of Fisheries and Oceans  
Dr. Robert McKinley - University of British Columbia  
Dr. Joanne Morgan - Department of Fisheries and Oceans  
Dr. Patrick O'Reilly- Diadromous Fish Division, Department of Fisheries and Oceans  
Dr. P. Pepin - Department of Fisheries and Oceans

### ***Emeritus Professor***

Dr. Garth Fletcher

### ***Research Specialist***

Dr. Michele DuRand

### ***Postdoctoral***

Dr. Blair Adams (Fleming)  
Dr. Jason Bailey (Gamperl)  
Dr. Jeremy Mitchell (Abrahams)

### ***Research Assistants and Science Technicians***

Danny Ings - Research Assistant II (Fleming/Department)  
Daryl Jones - Research Assistant I (Seals/Department)  
Kate Jones - Research Assistant II (Schneider)  
Madonna King - Research Assistant II (Department)  
Jennifer Hall - Research Assistant II (Driedzic)  
Brenda Oake - Research Assistant I (Snelgrove)  
Margaret Shears- Research Assistant II (Fletcher)  
Connie Short - Research Assistant II (Driedzic/Department)  
Candice Way- Research Assistant I (Rivkin)  
Jeanette Wells - Research Assistant I (Parrish)  
Peter Ashfield- Science Technician II (Fleming)  
Gregory Brown- Science Technician II (Snelgrove/Schneider)  
Terry Bungay- Science Technician I (Snelgrove/Schneider)  
Corinne Conway- Science Technician I (Fleming)  
Sean Dolan- Science Technician III (Fleming)  
Jeremy Durling- Science Technician II- (Fleming)  
Megan Goobie- Science Technician I (Seals/Department)  
Christine Vickers - Science Technician III (Department)

### ***Administrative and Computer - Support Staff***

Marc Bolli - Research Computer Specialist  
John Evely- Research Marketing Manager  
JoAnn Greening- Intermediate Clerk Steno  
Maureen James - Intermediate Clerk Steno (LTD)  
Ken Langdon - Computer Support Technician  
Danielle Nichols - Research Marketing Manager (Maternity leave Sept/07-Sept/08)  
Winnie Sparkes - Intermediate Secretary  
Delores Wheeler - Administrative Staff Specialist II

### ***Aquaculture Research Development Facility (ARDF)***

Danny Boyce - Business Manager  
Chris Canning- Science Technician III  
Corey Coldwell- Science Technician  
Francine Fortune - Science Technician III  
Rodney Healey - Research Assistant II  
Jennifer Monk - Science Technician III  
Lori Thorne - Research Assistant I  
Denise Tucker - Science Technician III

## ***Genome Atlantic***

Marlies Rise- Genome Atlantic Project Manager  
Nellie Cormier- Research Assistant II (LTD)  
Tasha Harold- Research Assistant II

## ***Field Services***

Renee Boland - Dive Technician I (Finished December 2007)  
William Coffey- Dive Technician I (Started May 2008)  
Robert O' Donnell - Dive Technician II  
Philip Sargent - Research Assistant /Dive Technician

## ***Laboratory and Technical Services***

Danny Au - Laboratory Facility Technician I  
Robert Cadigan- Facilities Custodian  
Randy Cahill - Facility Custodian  
Michael Carrigan - Facility Custodian  
James Devereaux - Laboratory Services Supervisor  
Tony Druken- Electrician/Technical Services (Started March 2008)  
Jerry Ennis - Laboratory Facility Technician I  
Jim Fowler – Delivery Person(LTD)  
Terry Harris (Retired March 2008)  
Jim Hopkins- Facilities Custodian  
Matthew Pittman- Laboratory Facilities Technician I  
Jason Vokey- Delivery Person (Finished November 2007)  
Walter Martin- Delivery person (Started November 2007)  
Damien Whitten - Laboratory Facility Technician II

## ***Facilities Management***

Ian Churchill  
John Dunn  
Stan Moores  
Rick Walsh

## ***Student Assistants***

Pamela Burke- (Evely)  
Terry Bungay (K. Jones)  
Alicia Campbell (Rivkin)  
Elizabeth Dohey (JBARB)  
Rebecca Doyle (D. Jones)  
Meghan Goobie (Evely)  
Emily Keating (Evely)  
Noelle Laite (D. Jones)  
Nikita Laite (D. Jones)

Tannis Milley (K. Jones)  
Rebecca Mouland (Rivkin)  
Ashley Noseworthy (D. Jones)  
Julia Pantin (Schneider)  
Meredith Schofield (Evely)  
Cruise Slater (Parrish)

### ***MUCEP***

Andrew Cameron (D. Jones)  
Elizabeth Dohey (Gamperl)  
Jennifer Dawe (Wroblewski)  
Jessica Flight (Evely)  
Megan Goobie (D. Jones)  
Stephanie Ivany (Thompson)  
Emily Keating (Evely)  
Chantelle Lafitte (Deibel)  
Nikita Laite (Mercier)  
Michael McKenzie (Bolli)  
Rebecca Mouland (Rivkin)  
Megan Norris (D. Jones)  
Julia Pantin (Ings)  
Mitchell Randell (Boyce)  
Holly Smith (D. Jones)  
Crusie Slater (Parrish)

### ***C S J Program - 2007***

Adam Fitzpatrick (Fleming)  
Chantelle LaFitte (D. Deibel)  
Rebecca Mouland (R. Rivkin)

### ***NSERC- USRA – 2007***

Cheryl Barron (Fletcher)  
Maria Stapleton (Gagnon)

### ***WISE – Students***

Kendra Clarke (Fleming)  
Katy Langdon (D. Jones)  
Carla Penny (Boyce)  
Shauntelle Turnbull (D. Jones)  
Sarah Katelyn Turner (Evely)

***Volunteers - Seals***

Becky Doyle

Cynthia Mercer

Ashley Noseworthy

Stephanie Stack

James Stenson

Katie Stenson

Jennifer Walsh

Margaret Warren

Peter White

### **3. Administrative Structure, Facilities and Services, Departmental Committees**

#### ***Departmental Administration***

Director	Dr. Ian A. Fleming
Associate Director	Dr. Don Deibel (2003-2007)
Associate Director	Dr. Kurt Gamperl (2007-2013)
Intermediate Secretary	Mrs. Winnie Sparkes
Administrative Staff Specialist II	Mrs. Delores Wheeler
Intermediate Clerk Steno	Ms. JoAnn Greening
Research Marketing Manager	Mr. John Evelyn

#### ***Facilities and Services***

Animal Husbandry	Mr. Daryl Jones
Dr. Joe Brown Aquatic Research Building	Mr. Danny Boyce
Computing services	Mr. Marc Bolli
Field Services	Ms. Connie Short
Image and Data Analysis Facility	Mr. Marc Bolli
Laboratory (Workshop) Services	Mr. Jim Devereaux
Marine Public Education Program	Mr. John Evelyn
Seal Research Facility	Mr. Daryl Jones
Technical Services	Mr. Tony Druken

## **Committees**

Promotion and Tenure:

Dr. K. Gamperl  
Dr. P. Snelgrove  
Dr. C. Parrish  
Dr. D. Schneider  
Dr. J. Wroblewski

Space Committee:

Dr. K. Gamperl  
Mr. John Evely

Safety Committee:

Mrs. C. Short  
Dr. R. Thompson

Search Committee:

Dr. K. Gamperl  
Dr. R. Thompson  
Dr. C. Parrish  
Dr. A. Mercier  
Dr. J. Wroblewski

Executive Committee:

Dr. I. Fleming  
Dr. K. Gamperl  
Mr. John Evely  
Mr. J. Devereaux

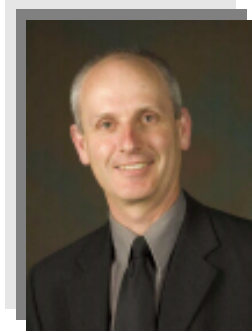
OSC Tours

Mr. John Evely  
Mr. D. Boyce (JBARB)

## 5. Faculty

### **Dr. Mark Abrahams**

#### *Research Interests*



Dr. Abrahams research focuses on predator-prey interactions involving fishes. Current research examines several questions. How do fish integrate information from multiple senses when making decisions involving the risk of predation? For a fish as a predator to consume its prey, it must normally be much larger than its prey. What are the physiological and ecological costs associated with this variation in size, and how does it affect their ability to use different microhabitats? Dr. Abrahams is also working with genetically modified fish that have had their growth rates dramatically altered. These animals are very useful for gaining insight into the costs and benefits associated with different growth rates. This research area also allows him to begin studying the potential environmental risk posed by these animals.

#### *Other Activities (Memorial)*

- Acting supervisor, PhD student
- Supervisor- Postdoctoral Fellow
- Dean of Science (2008-2013)

#### *External Activities*

- Assessment committee for the Dean of Student Services (2008), University of Manitoba
- Advisory Committee for the Canadian Institutes of Health Regional Partnerships Program (2004-2008), University of Manitoba
- Associate Deans (Research)/Research Liaison Officers Committee (2004-2008), University of Manitoba
- Senate Committee of Admission Appeals (2000-2007), University of Manitoba
- Senate Infrastructure Committee (2004-2007), University of Manitoba
- Local Animal Users Committee (2004-2007), University of Manitoba
- Senate Committee on Animal Care (2004-2007), University of Manitoba
- Graduate Studies Faculty Council (1991-1995, 2004-2008), University of Manitoba
- Founder and organiser of the University of Manitoba Ecology and Evolution Research Group (participating members include faculty and students from the departments of zoology, botany, and entomology, faculty from the University of Winnipeg, and scientists and students from the Department of Fisheries and Ocean's Freshwater Research Institute and the Agriculture Canada research station on campus).

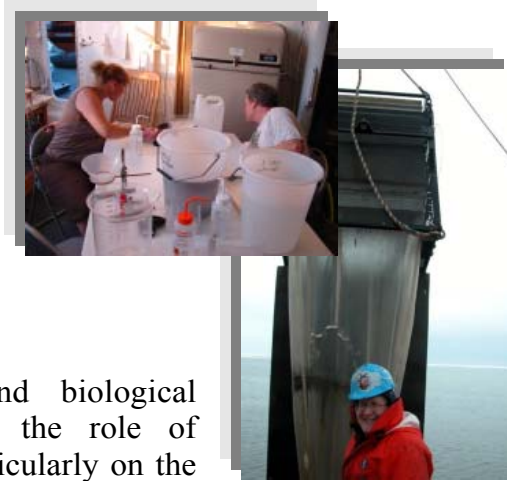
- Supervisor, Graduate students, University of Manitoba
- Member of the Board, Atlantic Environmental Science Network (2008-2013)
- Member of the Board, Atlantic Association for Research in the Mathematical Sciences (2008-2013)
- External examiner, Concordia University, McGill University, University of Calgary.
- Fishery task force (working group for the Premier's Economic Advisory Committee)
- Science advisor to the Lake Winnipeg Science Committee
- Canada Foundation for Innovation College of Reviewers

*Invited Lectures and Conference Presentations*

*Invited Lectures*

- **Abrahams, MV** (2007). Predator-prey interactions: prey characteristics and changing environments. Memorial University, St. John's, Newfoundland.

## **Dr. D. Deibel**



### *Research Interests*

Dr. Deibel is a zooplankton ecologist and biological oceanographer who focuses on determining the role of mesozooplankton in biogeochemical cycles, particularly on the role of copepods and pelagic tunicates in the cycles of carbon, nitrogen and phosphorus in the arctic. Much of his work in the Arctic is as part of international, multi-disciplinary research programs into the affects of global climate change on the Arctic Ocean. He has worked in three arctic polynyas (i.e. the Northeast Water, Northwater and St. Lawrence Island polynyas) and this year will be undertaking a year - long expedition to the Beaufort Sea Shelf. For about 20 years, their local work has been focused upon the physiological ecology of gelatinous suspension feeders known as appendicularian tunicates. This research has provided novel information on the fluid mechanics of particle collection, on lipid storage and on population demographics. This work has evolved into an examination of the role of appendicularians in collecting terrestrial source particles originating from arctic rivers.

### *Teaching*

- Plankton Dynamics 7540 (Guest Lecture- February 2008)

### *Other Activities (Memorial)*

- Supervision, graduate students
- Supervision, undergraduate students
- Co - supervision, graduate students
- Supervision, science technician
- Associate Director, OSC (2003 -2008)
- Executive Committee member, OSC (2003-2008)

### *External Activities*

- Special Session Co-Chair. American Society of Limnology and Oceanography, Orlando (2008)
- Aquatic Invasive Species Advisory Committee, Newfoundland Aquaculture Industry Association (2007- present)
- Associated Professor, ARCTOS Centre of Excellence, Univ. of Tromsø, Norway (2006- present)
- Editorial Advisor, *Marine Ecology Progress Series* (1995-)
- Chair, Program Committee Avalon Chapter of Sigma Xi (2005-present)
- Scientific Steering Group, Arctic Ocean Census of Marine Life, University of Alaska (2004- present)
- National & International Steering Committee, Canadian Arctic Shelf Exchange

Study (2000-07)

- Theme Leader, Canadian Arctic Shelf Exchange Study (CASES) (2000-07)

### *Invited Lectures and Conference Presentations*

#### *Conference Presentations*

- Callahan, A.G.; **Deibel, D.**; **Rise, M.L.**; Hall, J.; McKenzie, C.H. (2008). Development of species-specific primers to aid in the identification and monitoring of potentially invasive ascidians in Newfoundland. Am. Society of Limnology & Oceanography Meeting, St. John's, Newfoundland (June 8-13, 2008).
- McKenzie, C.H.; Moulant, D.; Baines, T.; Macneil, S.; Drover, D.; **Deibel, D.** (2008). European green crab (*Carcinus maenas*); Current status in Newfoundland and Labrador & disinfection protocols for field gear and aquaria waste. NOAA Green Crab Technical Meeting, Vancouver. (March 2008).
- Baines, T.; McKenzie, C.H.; Moulant, D.; **Deibel, D.** (2008). An introduction to aquatic invasive species. Coastal Area Management Meeting, Corner Brook, Newfoundland. (January 15-16, 2008)
- Baines, T.; McKenzie, C.H.; Sargent, P.; Callahan, A.; **Deibel, D.** (2007). Status of non-native colonial tunicates in Newfoundland waters; follow-up to detection of *Botryllus schlosseri* & introduction to another non-native ascidian, *Botrylloides violaceus*. Newfoundland & Labrador Aquatic Invasive Species Workshop, St. John's.
- Baines, T.; McKenzie, C.H.; Moulant, D.; **Deibel, D.** (2007). An introduction to aquatic invasive species. Newfoundland Harbour Authorities Conference, Gander, Newfoundland.
- McKenzie, C.H.; Baines, T.; Boland, R.; Dawe, E.; **Deibel, D.** & 10 others. (2008). The European green crab, *Carcinus maenas*, in Placentia Bay, Newfoundland Aquatic Invasive Species Survey (2007). Newfoundland & Labrador Aquatic Invasive Species Workshop, St. John's, Newfoundland

#### *Overview and Highlights 2007 – 2008*

- Dr. Deibel obtained additional funding to study invasive species in Newfoundland harbours. Collaborative research with Dr. Cynthia McKenzie.
- PhD Student, Dr. Nami Choe successfully defended her thesis on the population ecology of three species of planktonic tunicates in Newfoundland coastal waters. Dr. Choe's first thesis chapter was accepted for publication in the Journal of Plankton Research, and they achieved a cover picture of her study organism on the cover of the journal issue in which their paper appeared.

## **Dr. William Driedzic**

### *Research Interests*



Research activities continue to focus on how fish not only survive but flourish under conditions of low water temperature or at low oxygen (hypoxia). Our research is contributing to a fundamental understanding of how animals work, is providing an intellectual connect between physiology and ecology, and is setting the stage for practical and powerful applications in the area of marine biomedicine.

**Antifreeze mechanisms in fish:** Rainbow smelt (*Osmerus mordax*) live at water temperatures in winter that approach the freeze point of sea water. They are able to avoid death by accumulating glycerol which serves as an antifreeze. Glycerol is a small molecule similar to chemicals that are added to car radiators in the winter. The metabolism of glycerol is also important on another front. There is a growing body of information in the medical literature dealing with glycerol production as this metabolic process is that target of recent therapies for type II diabetes. Our studies which address how glycerol production is activated and controlled will be important in understanding the physiological ecology of rainbow smelt, an important species in the marine food web, and in medical therapies.

**Resistance to oxygen limitation in fish:** Some species of fish are extremely resistant to low oxygen levels. This resistance is achieved through a combination of i) increased levels of anaerobic energy metabolism that involves the conversion of glucose to lactic acid, and ii) decreases in the rate of energy demand to essentially stretch out the available oxygen and anaerobic resources. Our current work addresses how anaerobic metabolism is regulated especially at the level of glucose entry into cells and the first step in the metabolic pathway. In addition, we are examining how decreases in protein synthesis, one of the most energetically demanding cellular processes, is achieved.

### *Teaching*

- Biochemistry 4120, Winter 2008 (25%)

### *Other Activities (Memorial)*

- Supervision, graduate students
- Co - supervision, graduate students
- Supervision, research assistants

### *External Activities*

- Member, Science Advisory Committee for the Department of Fisheries and Oceans. (2003-2007)
- External examiner, PhD candidates, Dalhousie University (2007)

- Referee, *Journal of Experimental Biology*, *Journal of Experimental Zoology*, *American Journal of Physiology*, *Fish Biology*, *Fish Physiology and Biochemistry*, *Journal of Thermobiology*, and *Comparative Biochemistry and Physiology*.
- 2007 External reviewer for Ont. Council of Grad. Studies for graduate program at Trent University.

#### *Invited Lectures and Conference Presentations*

##### *Conference Presentations*

Treberg, J.R.; **Driedzic, W.R.** (2008). Estimation of the in vivo rate of uptake for the organic osmolyte trimethylamine oxide in the winter skate (*Leucoraja ocellata*) Experimental Biology, San Diego April 5-9, 2008.

Lewis, J.M.; **Driedzic, W.R.** (2008). Mitochondrial protein synthesis is defended in gill but not heart of the cunner (*Tautoglabrus adspersus*) in response to acute hypoxia and hypothermia. Physiology Section, American Fisheries Society, Portland, Oregon, May 4-8, 2008.

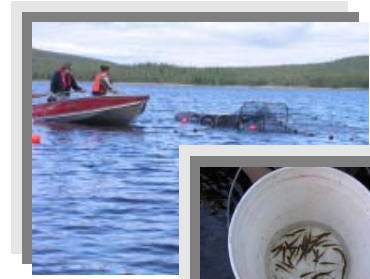
##### *Research Overview and Highlights 2007 - 2008*

A great deal is known about how “cold blooded” vertebrates such as fish, frogs and turtles can survive low oxygen availability in winter in association with low temperature. But very little is known of the “tricks” developed by fish that live at constant warm temperature. This motivated a study of *Astronotus ocellatus*, a fish that lives in the Amazon and is highly adapted to a hypoxic environment. Low oxygen resulted in decreases in oxygen consumption and was accompanied by a 50–60% decrease in liver, heart and gill protein synthesis, but only a 30% decrease in brain protein synthesis. The results indicate that this species has mechanisms to decrease rates of costly protein synthesis without concomitant decreases in body temperature and in addition has a mechanism to partially defend brain protein synthesis in the face of oxygen limitation.

Rainbow smelt accumulate high levels of glycerol in winter that serves as an antifreeze. We have determined the rates of glycerol and glucose production by isolated hepatocytes. Cells from fish held at 0°C and incubated at 0°C were metabolically quiescent but hepatocytes isolated from fish maintained at 8°C and incubated at 8°C produced glucose. Glycerol production was activated in cells isolated from these fish and incubated at 0°C without substrate or when glucose, aspartate or pyruvate was available. Incubation at 0°C without substrate resulted in similar rates of glucose and glycerol production in concert with glycogen mobilization. Rates of glycerol production were not enhanced with hormonal stimulation under any condition. As such, low temperature alone is sufficient to activate the glycerol production mechanism and results in a shift from glucose to a mix of glucose and glycerol production. This study presents a potentially valuable model in which to investigate the control mechanisms of glycerol production that are inherent to the cell and rapidly influenced by low temperature exposure alone.

## ***Dr. Ian Fleming***

### *Research Interests*



Behavioural and evolutionary ecology of fishes, with an emphasis on breeding system evolution, life history diversity, maternal effects, survival strategies and habitat, cultured and wild fish interactions, fisheries, and conservation. Interest in marine and anadromous fishes, with a focus on salmonids and groundfish.

### *Teaching*

- 2007 Guest lecture: Aquaculture & the Environment (AQUA 6201, AQUA 4111)
- 2008 Guest lectures: Aquaculture and the Environment (AQUA 4111) and Master of Marine Studies 6001, 6201; Biology/Geography 4650; Behavioural Ecology (Biology/Psychology 6351)

### *Other Activities (Memorial)*

- Supervision, graduate students
- Supervision, post - doctoral fellow
- Supervision, research assistant
- Supervision, science technicians
- Supervision, WISE student
- Supervision, undergraduate and highschool students
- Director, Ocean Sciences Centre, MUN (2004-present)
- Cross appointed, Department of Biology, Memorial University (2004-present)
- Graduate student thesis committee
- Thesis examiner, honours student
- Internal examiner, MSc candidate
- Comprehensive examiner, PhD Candidates
- Executive Committee member, OSC

### *External Activities*

- Scientific Advisory Team, State of the Salmon Program, Portland, Oregon, USA. (2008-10)
- External Examiner, Atso Romakkaniemi, University of Helsinki, Finland. (2008)
- Invited Participant, Biodiversity Facility Review, Fisheries and Oceans Canada, Ottawa, Canada (10-12 March). (2008)
- Steering Committee, Cod Genome Project, Genome Atlantic. (2008-2009)
- Courtesy Faculty, Department of Fisheries and Wildlife, Oregon State University, 104 Nash Hall, Corvallis, Oregon 97331-3803, USA.

- Scientific Adviser/Adjunct Professor, Norwegian Institute for Nature Research (NINA), Tungasletta 2, NO-7485 Trondheim, Norway.
- Scientific Advisor, Section of Applied Ecology, Department of Environmental Science, University of Siena, via Mattioli 4, 53100 Siena, Italy.
- Invited Participant, National Academies workshop on Genetically Engineered Organisms, Wildlife, and Habitats, Irvine, USA.(2007)
- Panel Member, Atlantic Salmon Review, Sustainable Ecosystems Institute.(2007)
- Invited Panel Member, Technical Working Group on Escapes, Salmon Aquaculture Dialogue, World Wildlife Fund. (2006-2007).
- Aquaculture Collaborative Research and Development Program Regional Committee of the Department of Fisheries and Oceans Canada.(2006-2008).
- Associate Editor, Transactions of the American Fisheries Society.(2004-2007)

#### *Presentations Invited*

- **Fleming, I.A.** (2008). Department of Biology, University of Montreal, Canada (22 April, 2008)
- **Fleming, I.A.** (2008) *Keynote*, Joint Atlantic Provinces Council of the Sciences Conference – Atlantic Undergraduate Biology Conference (AUBC) & Atlantic Universities Aquaculture Conference (AUAC), St John’s, Canada (8 March, 2008).
- **Fleming, I.A.** (2008). Department of Integrative Biology, University of Guelph, Canada. (24 January, 2008)

#### *Conference Presentations*

- Thorstad, E.B.; **Fleming, I.A.**; McGinnity, P.; Ryan, J.; Soto, D.; Wennevik, V.; Whoriskey, F. (2008). Incidence and impacts of escaped farmed Atlantic salmon *Salmo salar* in nature. - Salmon Aquaculture Dialogue Meeting, Barcelona, Spain. (31 January-1 February, 2008)
- Ings, D.W.; Westley, P.A.H.; **Fleming, I.A.** (2008) A meta-analysis of spatial and temporal scales of brown trout interactions with Atlantic salmon. Canadian Conference for Fisheries Research, Halifax, Canada (January 3-5, 2008).
- Westley, P.A.H.; Ings, D.W.; **Fleming, I.A.** (2008). Toward unraveling the invasion paradox: evolutionary ecology of introduced brown trout in Newfoundland. Canadian Conference for Fisheries Research, Halifax, Canada (January 3-5, 2008).
- Adams, B.; Cote, D.; **Fleming, I.**; Knight, T.; Caissie, A. (2008). A stochastic life history-based population model for brook trout (*Salvelinus fontinalis*): predicting population responses to exploitation. Canadian Conference for Fisheries Research, Halifax, Canada (January 3-5, 2008).
- Moreau, D.T.R.; Conway, C.; Ings, D.W.; **Fletcher, G.L.**; **Fleming, I.A.** (2008). The interaction of transgenic and non-transgenic Atlantic salmon siblings across multiple environments. Canadian Conference for Fisheries Research, Halifax, Canada (January 3-5, 2008).

- Wilke, N.; **Fleming, I.A.**; O'Reilly, P.O. (2008). Populations in decline: early life history response of endangered Atlantic salmon populations to inadvertent selection during conservation breeding. Canadian Conference for Fisheries Research, Halifax, Canada (January 3-5, 2008).
- Bachan, M.M.; **Fleming, I.A.**; Trippel, E.A. (2008). Maternal effects of egg quality on progeny morphology, survival, and growth in larval Atlantic cod. Canadian Conference for Fisheries Research, Halifax, Canada (January 3-5, 2008).
- Poole, R.J.; **Fleming, I.A.**; Reddin, D.G.; Gibson, R.L. (2008). Lacustrine habitat use and its influence on Atlantic Salmon parr populations in Southern Labrador. Canadian Conference for Fisheries Research, Halifax, Canada (January 3-5, 2008).
- **Fleming, I.A.** (2007). Shapes of selection during breeding: alternative reproductive tactics to MHC-based mate choice. Biology Department, Memorial University of Newfoundland (October, 2007)
- Bachan, M.M.; Trippel, E.A.; **Fleming, I.A.** (2007). Maternal effects of egg quality on progeny morphology, survival and growth in larval Atlantic cod (*Gadus morhua*). Symposium on Reproductive and Recruitment Processes of Exploited Marine Fish Stocks, Lisbon, Portugal (October, 2007)

#### *Research Overview and Highlights 2007 – 2008*

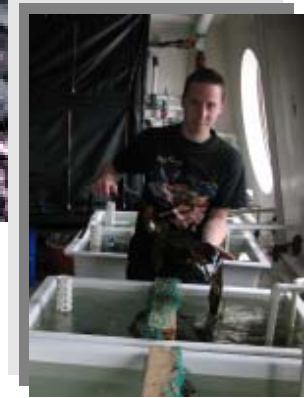
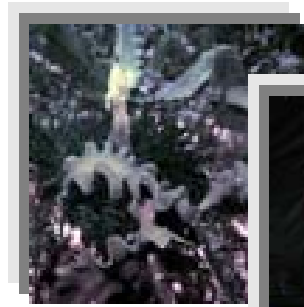
- ***Mating system evolution*** – This long-standing component of my research program has shown fishes, with their diverse mating systems, to be excellent models for the study of mating system evolution, particularly in the face of environmental variability and anthropogenic disturbance. Using a pluralistic approach, combining controlled laboratory and field experimentation phylogenetically-based comparative methods, molecular paternity analyses and other innovative techniques the work has addressed central issues within mating systems. These have included identifying the important role of females in shaping mating systems quantifying forms of selection shaping the evolution secondary sexual traits and alternative reproductive phenotypes, and elucidating the role of sperm competition in fish mating systems. This work has not only unravelled key aspects of the ecological and evolutionary significance of mating systems, but also provided insight into how anthropogenic change impacts mating structure and thus the response of fish populations.
- ***Maternal Effects*** – Collaborative research with a former student, Sigurd Einum, has resolved long-standing issues surrounding the evolutionary significance of maternal effects on offspring performance and population dynamics. We confirmed the theoretical, but untested framework for the evolution of egg size (Smith & Fretwell 1974) and showed that females of highly fecund species maximize maternal fitness by sacrificing offspring survival. Moreover, by examining norms of reaction to environmental quality in egg size, we refuted the long-standing assumption that oxygen availability constrains egg size in aquatic organisms, shown that patterns of within-population variation in egg size reflect the potential for the maternal phenotype to determine offspring environment and

modeled the evolution of within-clutch variation in egg size in unpredictable environments to assess the potential roles of conservative versus diversified bet-hedging. The work has also revealed that management practices using population numbers or biomass to estimate recruitment potential can be misleading when the contribution of female phenotype to reproductive performance is ignored.

- ***Reproductive Allocation*** – Resource allocation to offspring is a central theme of life history evolution and the research in my laboratory has attempted to resolve not only long-standing controversies about “optimal” egg size, but also identify the relation between reproductive investment and the semelparity/iteroparity continuum. Our work has also shown that population stability in response to exogenous forces can be more a function of population size and complexity than a product of resource allocation to offspring production<sup>22</sup>. Moreover, phenotypic heterogeneity resulting from variability in egg size appears to neither reduce intraspecific competition nor buffer against temporal environmental variation.

## **Dr. Patrick Gagnon**

### *Research Interests*



Research in Dr. Gagnon's lab (Cold Ocean Benthic Ecology Lab, COBEL) aims at elucidating the mechanisms that determine the structure and function of marine ecosystems, especially the role of predation, competition, and facilitation between native and invasive benthic invertebrates, fish, and primary producers (seaweeds and plants), and how variations in the physical environment affect species interactions and the observed community patterns. The approach focuses on merging ecological data across scales and levels of biological organization from complementary field and microcosm (laboratory) experiments with organisms, as well as field surveys of benthic populations and communities from below (using scuba diving) and above (using remote sensing and GIS) the sea surface.

### *Teaching*

Biology of Invertebrates- Biology 2122

### *Other Activities (Memorial)*

- Supervision, undergraduate student
- Supervisory Committee, MSc student
- Internal reviewer, Honours student
- Comprehensive Examiner, Ph.D. student
- Internal Thesis Examiner, BSc Honours and MSc students
- Graduate student committee member
- Member, OSC Promotion and Tenure Committee
- Member, OSC Graduate Program Delivery Committee
- Member, Committee revising the course structure of the undergraduate marine biology stream at the Department of Biology
- Cross-Appointed, Department of Biology, MUN

### *External Activities*

- Reviewer: *Marine Ecology Progress Series*, *Marine Biology*, *Botanica Marina*, *ICES Journal of Marine Science*, *Journal of the Marine Biological Association of the United Kingdom*, *Aquatic Living Resources*, and *Estuarine, Coastal and Shelf Science*
- Undergraduate teaching, Dalhousie University (General Ecology, Plant Diversity and Ecology and Invertebrate Ecology).
- Postdoctoral co-supervisor of multi-month research internships, Dalhousie University.

- Peer review of research proposals and draft manuscripts for colleagues in the private sector, universities, and governmental agencies; statistical support and advice for students and colleagues (2007-present)
- Postdoctoral Research Associate, Department of Biology, Dalhousie University (2006-2007).
- Member, Ecological Society of America (2007-present)
- Member, Phycological Society of America (2007-present)
- Member, Fisherman and Scientists Research Society (2004-present)
- Alliance for Marine Remote Sensing (2004-present)
- Professional Association of Diving Instructors (1997-present)
- Bay of Fundy Ecosystem Partnership (2004-2007)

### *Invited Lectures and Conference*

#### *Presentations Invited*

- **Gagnon P.** (2008). Top down vs. bottom-up controls in marine benthic communities: the emergence of a new paradigm. Memorial University of Newfoundland - Department of Biology, and Ocean Sciences Centre seminar series. St. John's, NL, Canada.
- **Gagnon P.** (2008). Invasion dynamics and impacts of the introduced bryozoan *Membranipora membranacea* on kelp bed communities of Newfoundland and Labrador. Northwest Atlantic Fisheries Centre (Department of Fisheries and Oceans Canada, DFO), Newfoundland and Labrador Aquatic Invasive Species Advisory Committee Meeting. St. John's, NL, Canada.
- **Gagnon P.** (2007). From individual to seascape ecology: pattern and process in the rocky subtidal ecosystem of eastern Canada. Ocean Sciences Centre, Memorial University of Newfoundland - Interview Seminar. St. John's, NL, Canada

#### *Conference Presentations*

- **Gagnon P.** & Scheibling R.E. (2008). Integrating interactions between the green sea urchin, *Strongylocentrotus droebachiensis*, and the brown alga *Desmarestia viridis* into models of subtidal community organization in the northwest Atlantic. 37<sup>th</sup> Annual Benthic Ecology Meeting (BEM). Providence, Rhode Island, USA.
- Scheibling R.E. & **Gagnon P.** (2008). Temporal fluctuations in abundance of an invasive bryozoan (*Membranipora membranacea*) in kelp beds: environmental mediation and consequences for subtidal ecosystem dynamics. 2008 ASLO Summer Meeting. St. John's, NL, Canada.

## *Research Overview and Highlights 2007 - 2008*

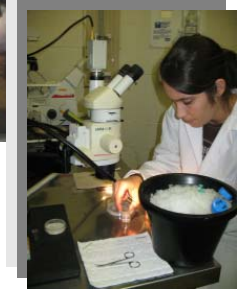
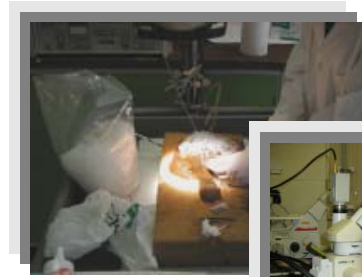
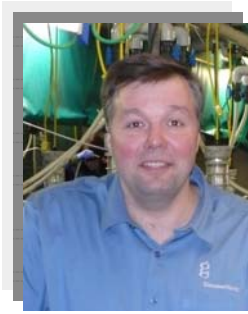
Dr. Gagnon's research program at the OSC aims to identify biotic and abiotic interactions that regulate the structure and function of temperate and subarctic rocky subtidal ecosystems. In particular, it investigates how changes in environmental factors such as wave action, water temperature, and light affect the survival, behavior, and interactions (predation, competition, and facilitation) between dominant invertebrates and seaweeds (both native and invasive), and how these regulate population, community, and ecosystem patterns. The approach combines laboratory and field experiments with organisms, as well as field surveys of populations and communities from below (scuba diving) and above (remote sensing) the sea surface. His fundamental and applied research over the last ten years has significantly advanced our knowledge of the structure and function of Canada's subtidal benthic ecosystems. The eight papers he published since 2003 in high ranking and top marine ecological, algal, and remote sensing journals such as *Marine Ecology Progress Series* (three publications including two as "Feature articles"), *Journal of Phycology*, and *International Journal of Remote Sensing* have been cited 57 times (ISI® Science Citation Index; mean=8.1). With recent approval of major research and equipment grant proposals by NSERC (Discovery Grant) and the Canada Foundation for Innovation (Leaders Opportunity Fund), and the development of new research collaborations with local government scientists (e.g. DFO St. John's) and academic researchers (e.g. OSC and Department of Biology at MUN), he fully expects his multidisciplinary work will continue to expand rapidly while at the OSC.

Besides obtaining funding from CFI and NSERC, Dr. Gagnon has developed a research partnership with Dr. Cynthia McKenzie (DFO St. John's) and Dr. Robert Hooper (Dept. of Biology at MUN) to study the invasion dynamics and ecosystem impacts of the bryozoan *Membranipora membranacea* in coastal Newfoundland and Labrador. As the Principal Investigator, he secured funding (\$33K) through the Institute for Biodiversity, Ecosystem Science and Sustainability (IBES) which entirely covers the stipends of one M.Sc. student currently working on the project. This project further attracted the interest of the Department of Fisheries and Aquaculture (DFA) which provided additional funding (\$2K) towards the operation costs of the project. This research, conducted under the umbrella of CURRA (a SSHRC-funded multidisciplinary research alliance), involves fish harvesters from ten (10) localities along the West Coast of Newfoundland and the southern tip of Labrador. Dr. Gagnon should also acquire the equipment requested in his CFI application, including a boat, 4x4 truck, and diving and underwater sampling equipment will substantially ease things. Furthermore, he has developed research collaboration with one faculty at the OSC, Dr. Annie Mercier, with whom he co-supervises a third M.Sc. student working on the reproductive cycle of the daisy brittle star, *Ophiopholis aculeata*.

The remote sensing and GIS-based aspect of his research is probably the most innovative. To undertake this research requires equipment he was unable to acquire through his CFI proposals. However, he recently completed an NSERC Research Tools and Instruments (RTI Cat. 1) grant proposal for submission to the 2008-2009 competition. If successful, he will be able to purchase the necessary equipment which consists of a submersible hyperspectral spectroradiometer system and a high resolution sonar/DGPS package.

## **Dr. Kurt Gamperl**

### *Research Interests*



Dr. Gamperl is a fish physiologist whose main research interest is to understand how environmental and physiological variables interact to affect fish biology. Central to this research are the role that blood oxygen transport, cardiac function, stress catecholamines, cortisol, the adrenergic system, stress proteins) and hormonal and/or biochemical factors play in mediating fish "performance" (swimming ability, growth, reproductive success, metabolic capacity etc.) under varied environmental conditions. He uses a variety of marine and freshwater fishes in his research, and the questions he addresses often have implications for fish ecology and/or aquaculture.

### *Teaching*

BIOL 3401: Comparative Animal Physiology- co-taught with Dr. Volkoff  
AQUA 7702: Finfish Aquaculture (3 lectures)

### *Other Activities (Memorial)*

- Supervision, graduate students
- Supervision, undergraduate student
- Supervision, postdoctoral fellows
- Supervision, Research Assistant
- Associate Director OSC (2007- present)
- Memorial University Animal Care Committee (2008)
- Space Committee, Ocean Sciences Centre

### *External Activities*

- Guest Associate Editor special module of Aquaculture Research (Feb 2007-September 2007)
- Lead Scientist for the Newfoundland component of the Cod Genome Project (total funding \$18.1 million over 4 years). (September 2005 – Present)
- External Reviewer for NSERC Strategic and Discovery grants, NSF grants, and grants from the Great Lakes Fishery Commission, AquaNet, the British Antarctic survey/NERC, and the Earth & Life, Sciences Council (Netherlands) (2000-2006).
- Manuscript Reviewer for the *J. Exp. Biol.*, *Amer. J. Physiol.*, *Fish Physiol. Biochem.*, *Comp. Biochem. Physiol.*, *J. Comp. Physiol. B*, *Physiological and Biochemical Zoology*, *J. Fish Biol.*, *Proc. of the Royal Society of London:B*, and others. (2002 – Present)

## *Invited Lectures and Conference*

### *Presentations Invited*

- Gamperl, A.K. (2007). AIF Sponsored Symposium on Cod Aquaculture, St. John's Newfoundland. Title: Implications of Water Temperature for Cod Aquaculture in Atlantic Canada. (October 2007).
- **Gamperl, A.K.**; Pérez-Casanova, J.C.; Afonso, L.O.B.; Currie, S.; Canada, P.; Petersen, L.H.; Gollock, M.J. 2007. The Acute Temperature Tolerance of Atlantic Cod (*Gadus morhua*): A Comprehensive Examination Using Multiple Indices. World Aquaculture Society meeting. San Antonio, TX. February, 2007.

### *Conference presentations*

- **Gamperl, A.K.**; Swafford, B.; Rodnick, K.J. (2008). Impact of elevated water temperature and zatebradine-induced bradycardia on cardiovascular function in male and female rainbow trout. Society for Comparative and Integrative Biology, San Antonio. TX, Jan., 2008.
- Hori; T.S.F.; Kimball, J.; Johnson; S.C.; Afonso, L.O.B.; Bowman, S.; Hubert, S.; **Gamperl, A.K.**; Rise, M.L. (2008). Heat shock-responsive genes identified and validated in Atlantic cod (*Gadus morhua*) using genomic techniques. Plant and Animal Genome, San Diego, CA. Jan. 2008.

## **Dr. Annie Mercier**

### *Research Interests*



Dr. Mercier's research is primarily focused on the fundamental and applied aspects of benthic invertebrate ecology. While her studies are centered on echinoderms (particularly sea cucumbers and sea stars), she is also interested in molluscs, crustaceans and cnidarians from tropical and cold waters. Dr. Mercier especially enjoys combining laboratory and field experiments, and mixing investigations at the behavioural level with microscopic/molecular analyses and environmental assessments. Her specific areas of expertise include: 1) the chronobiology of reproduction with emphasis on the role of exogenous and endogenous factors and inter-individual chemical communication in the fine-tuning of gametogenesis and spawning; 2) other aspects of the reproductive cycle: spawning, gamete dispersion, larval development, settlement cues, juvenile growth and ecology; 3) interactions such as pairing and aggregative patterns, prey-predator responses, parasitism, symbiosis; 4) the effects of contaminants on the reproduction and symbiotic relationships of marine invertebrates; and 5) the development of aquaculture and stock enhancement programs. Dr. Mercier has recently extended her research to deep-sea invertebrates (i.e. corals, echinoderms, molluscs). Besides studying preserved specimens from bathyal depths, she is investigating the biology and reproductive ecology of live animals maintained in the laboratory.

### *Teaching*

Biology 7933: Advanced Topics in Marine Invertebrates (Graduate Level) - 100%

Biology 4122: Advanced Topics in Marine Invertebrates (Undergraduate Level) - 100%

### *Other Activities (Memorial)*

- Supervision, graduate students
- Supervision, honours students
- Supervision, undergraduate students
- Graduate Officer, Ocean Sciences Centre (2005 - 2008)
- Cross-appointed Faculty member, Department of Biology, Memorial University
- Member, PhD supervisory and examination committees, Memorial
- Member, Search Committee (2007-2008)
- Member, MFA Resource Committee (2007-present)

### *External Activities*

- *Co- founder of the Society for the Exploration & Valuing of the Environment (SEVE)*, dedicated since 1995 to scientific research and public education, focusing on marine ecology, wildlife, and environmental issues.
- Member of PhD supervisory & examination committees (Univ. Mons-Hainault, Boston Univ.)
- Member of an international scientific committee appointed by the Food and Agriculture Organization of the United Nations (FAO), studying commercially-exploited sea cucumbers on a broad scale (2006 to present).
- Ad hoc referee for peer-reviewed journals; *Mar. Ecol. Progr. Ser., J. Exp. Mar. Biol. Ecol., Invert. Reprod. Develop., Aquaculture, Mar. Fresh. Res., J. Mar. Biol. Assoc. UK, Mar. Fresh. Behav. Physiol.*
- Reviewer for grant agencies (*NSERC, US Sea Grant and Land Grant, USDA*). Editor of *Trochus Information Bulletin*, dedicated to molluscs. Published by the South Pacific Commission:  
<http://www.spc.org.nc/coastfish/News/Trochus/Troc.htm>.
- Member of the *International Society of Invertebrate Reproduction & Development* and the *International Society of Chemical Ecology*.

### *Invited Lectures and Conference*

#### *Invited Lectures*

- **Mercier, A.;** Hamel, J-F. (2008). Global overview of sea cucumber fisheries and resource assessment, with a focus on the specificities of *Cucumaria frondosa*. Workshop on Canadian Science and Management Strategies for Sea Cucumber (*Cucumaria frondosa*), Bedford Institute of Oceanography, Dartmouth, N.S., Canada, 17-18 June 2008. *keynote speaker*.
- **Mercier, A.** (2008). La biodiversité benthique : de l'écologie chimique aux applications pratiques. 76<sup>th</sup> ACFAS Congress, Quebec, QC, Canada, 7 May 2008. *keynote speaker*.
- **Mercier, A.** (2008). Coral reefs: coral reproduction. St. George's University, Grenada, 16 April 2008.
- **Mercier, A.** (2008). Fundamental and applied aspects of marine benthic invertebrate reproduction. St. George's University, Grenada, 16 April 2008.
- **Mercier, A.;** Hamel, J-F. (2007). Temperate sea cucumber fisheries in the northern hemisphere. International workshop on "sustainable use and management of sea cucumber fisheries," Puerto Ayora, Galápagos Islands, 19 - 23 November 2007.
- **Mercier, A.** (2007). La reproduction des invertébrés marins: de la recherche fondamentale aux applications pratiques (Reproduction of marine invertebrates: from fundamental to applied research). 25 October 2007, Université de Mons-Hainaut, Belgium.

### Conference presentations

- **Mercier, A.;** Hamel, J-F. (2008). Life history of the deep-sea asteroid *Henricia lisa*. Fifth North American Echinoderm Conference, Florida Institute of Technology, USA, 20-25 July 2008.
- So, J.J.; Hamel, J-F; **Mercier, A.** (2008). Growth rate and predation pressure as key factors in the management of *Cucumaria frondosa* (Holothuroidea) in eastern Canada. Fifth North American Echinoderm Conference, Florida Institute of Technology, USA, 20-25 July 2008.
- So, J.J.; Uthicke, S.; Hamel, J-F.; **Mercier, A.** (2008). Mitochondrial DNA gene flow analysis in North Atlantic populations of the sea cucumber *Cucumaria frondosa* (Holothuroidea: Echinodermata). Fifth North American Echinoderm Conference, Florida Institute of Technology, USA, 20-25 July 2008.
- Sun, Z.; Hamel, J-F.; **Mercier, A.** (2008). Planula release, settlement and development of deep-sea soft corals. 11<sup>th</sup> International Coral Reef Symposium, Ft. Lauderdale, FL, USA, 7-11 July 2008.
- Sun, Z.; Hamel, J-F.; **Mercier, A.** (2008). Reproductive cycle of the deep-sea coral, *Drifa glomerata* (Octocorallia: Alcyonacea), in the NW Atlantic. 11<sup>th</sup> International Coral Reef Symposium, Ft. Lauderdale, FL, USA, 7-11 July 2008.
- So, J.J.; Uthicke, S.; Hamel, J-F.; **Mercier, A.** (2008). Science before the fishery – growth rates, predation and gene flow of the sea cucumber, *Cucumaria frondosa*. Workshop on Canadian Science and Management Strategies for Sea Cucumber (*Cucumaria frondosa*), Bedford Institute of Oceanography, Dartmouth, N.S., Canada, 17-18 June 2008.
- Sun, Z.; Hamel, J-F.; **Mercier, A.** (2008). Settlement preferences and planula behaviour in deep-sea soft corals. ASLO Summer Meeting, St. John's, NL, Canada, 8-13 June 2008.
- So, J.J.; Hamel, J-F.; **Mercier, A.** (2008). Growth and predation pressure as key factors in the management of *Cucumaria frondosa* (Holothuroidea) in the North Atlantic. ASLO Summer Meeting, St. John's, NL, Canada, 8-13 June 2008.

### Research Highlights 2007 – 2008

#### 1. Exogenous and endogenous control of the reproduction in marine invertebrates:

A. Chemical communication: Most of our knowledge on chemical signalling through metabolites, such as pheromones, comes from the study of plants and insects, although marine chemical ecology has developed vigorously over the last 25 years, primarily with respect to foraging and defence mechanisms. Chemical exchanges have also been shown to play a role in mate recognition, aggregation, courtship, spawning and settlement of marine invertebrates. Dr. Mercier has made it a research focus since she believes that knowledge of inter and intra-specific chemical communication is critical to the advancement of knowledge in invertebrate reproductive ecology, and that such information will allow for a better understanding of human impacts on marine habitats;

especially the effect of disturbance (e.g. fisheries, pollution) on the perception of chemical cues. Using experimental trials, they demonstrated the existence of chemical communication in sea cucumbers. This was the first evidence of a “dialog” that allowed synchronous gametogenic development in marine invertebrates, and subsequent experiments have revealed that mucus and perivisceral coelomic fluid have potent bioactivity with regards to gametogenic synchrony and the sex and species-specific induction of spawning. These findings, which were published in premier journals (e.g. *Ecology*) and are now presented in several textbooks (e.g. *Echinodermata-Progress in Molecular and Subcellular Biology Series*. Springer 2005; *Marine Chemical Ecology*, CRC Press, 2001) have shed new light on the inter-individual fine-tuning of maturation processes, on the interaction between shallow and deep-water populations, and on the occurrence of synchronous spawning events. They may be of particular significance in those species living at depths where environmental factors (generally proposed as spawning cues) display little or no variation. Consequently, one of Dr. Mercier’s graduate students is currently studying the effect of localized aggregations on the synchronicity of gametogenesis and spawning in brittle stars.

B. Environmental factors: Apart from chemical communication, important aspects of Dr. Mercier’s work focus on the other endogenous and exogenous stimuli that govern gamete synthesis, gamete release, settlement, recruitment, growth and activity cycles in marine invertebrates. For instance, they have recently found evidence of strong lunar and diel components in the spawning and foraging activities of holothurians and gastropods and of depth-related shifts in life history traits of a bathyal sea star. Furthermore, She has studied larval settlement cues using multiple-choice experiments and investigated the early juvenile ecology of several species. These findings are particularly significant because, prior to her work, juveniles of most sea cucumbers were only found accidentally and nursery habitats were in turn largely unidentified. This further clarified the daily feeding and burrowing cycles of boreal and tropical species with respect to various environmental factors and the mechanisms involved in holothurian oogenesis. One of her MSc students has nearly completed her thesis on the reproductive patterns of deep-sea corals as a function of season, location and depth; whereas a visiting student has recently concluded her work on the factors that affect synchrony in the reproductive cycle of three deep-sea echinoderms.

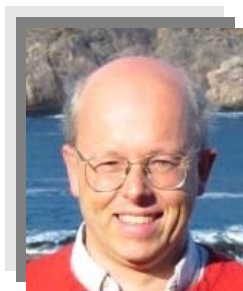
## 2. Biology and conservation of commercially important marine invertebrates:

An extension of my research on the reproductive strategies of echinoderms has been contributing to sea cucumber fishery, aquaculture and restocking programs. In the midst of the worldwide overfishing crisis, knowledge of holothurian biology and ecology was sorely lacking for numerous commercial species, and Dr. Mercier’s expertise was critical for developing several applied techniques; including reliable spawning induction and larval rearing methods, and the closing of the life cycle of some species. In 2001, she was invited, with my colleagues, to publish a review on one of the key commercial species in *Advances in Marine Biology*. She was also invited by the Food and Agriculture Organisation of the United Nations (FAO), as a leading world expert, to act as Session Editor during a workshop on *Advances in Sea Cucumber Aquaculture and Management* held in Dalian (China) in October 2003. Contributions to this session have been published.

Dr. Mercier is currently co-leading a vast international review of the biology and commercial exploitation of sea cucumbers, within which she co-authored two chapters. Technical guidelines prepared at a workshop held in November 2007 will also be published shortly. The project of another of her MSc students is focused on assessing growth, predation, distribution, and population gene flow of commercially valuable sea cucumbers in Atlantic Canada. It will help the Department of Fisheries and Oceans (DFO) in Newfoundland ascertain the sustainability of the stocks and determine how they could best be managed.

## **Dr. Chris Parrish**

### *Research Interests*



Dr. Parrish's work is focused at the interface of chemistry and biology in the area of aquatic lipid research. The marine lipid group seeks to determine production, transport, fate and effects of lipids in marine ecosystems, and to apply this information in an aquaculture setting. Lipids are of particular interest in marine research as they are very important energy sources in ocean (especially cold ocean) ecosystems, and some (e.g., polyunsaturated fatty acids) are essential for normal cellular function. Some lipids are also toxic to marine organisms, and all lipids are potential solvents for lipophilic pollutants like PAHs, PCBs, and DDT. They can thus provide a means of transporting pollutants through the water column and into and through food webs.

### *Teaching*

- Environmental Science 6001: Earth and Ocean Systems (taught 33%)
- Environmental Science 6009: Environmental Science Project (taught 33%)
- Environmental Science 6010: Environmental Seminar

### *Other Activities (Memorial)*

- Supervisor, graduate students
- Supervision, research assistant
- Student advisory committees
- Thesis examiner, graduate students
- Chair, Interdisciplinary Program in Environmental Science
- M. Sc. Aquaculture Administrative Committee, 1993 - present
- Board of Study, Environmental Science Program, 1993 - present

### *External Activities*

- Ad. Hoc. Reviewer: J. Exp. Mar. Biol. Ecol.; Limnol. Oceanogr.; Lipids; Mar. Chem.; Microbial Ecol.; US Fisheries Research Program research grant applications
- APICS Environmental Studies Committee (June 2005 - present).

### *Invited Lectures and Conference Presentations*

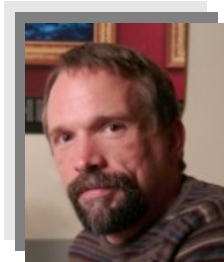
#### *Invited*

- **Parrish, C.** (2008). Unidad de Investigacion de Ecologia de Pesquerias, Universidad Veracruzana, Mexico, 2008.

*Research Over-view and Highlights 2007-2008*

- 8 refereed publications on cod, haddock and scallop nutrition; 1 edited book and 3 book chapters on food security, and another book chapter on knowledge, uncertainty and wisdom.
- Westelmajer-Bowie, S., (2008). M.Sc. Thesis, Aquaculture Program, Memorial University of Newfoundland. Awarded title of Fellow of the School of Graduate Studies in recognition of her outstanding academic achievement
- Sarah Westlemjer- Bowie, Marsha Clarke, and Matthew Logan, M.Sc. students, graduated in 2007-2008.
- **Parrish, C.C.**, Whiticar, M.; Puvanendran, V. (2007). Is  $\omega$ 6 docosapentaenoic acid an essential fatty acid during early ontogeny in marine fauna? *Limnol. Oceanogr.* 52: 476-479. Reviewer's comment: "This is a very well written MS on a very interesting topic. Based on a dramatic increase in the relative  $\omega$ 6DPA content of cod larvae from day 1 to day 11 post-hatch these authors suggest this fatty acid is essential. Further, the author's application of a GC-MS approach to tease out the relative dietary contribution for specific fatty acids is a very interesting example of this promising technique."

## **Dr. Matt Rise**



### *Research Interests*

Dr. Rise develops and uses genomic resources, including microarrays, in studies related to fish health. DNA microarrays allow a researcher to analyze relative expression levels of thousands of genes simultaneously. In Dr. Rise's laboratory, experiments involving genomic techniques are used to identify the key genes involved in biological processes such as reproduction, development, growth, and immune responses to pathogens. He also studies the transcriptomic and behavioural responses of fish exposed to environmental stressors including toxicants (e.g. pesticides, heavy metals). Some of the genomic techniques that he utilizes include DNA microarray hybridizations, quantitative reverse transcription - polymerase chain reaction (QPCR), and high - complexity cDNA library construction and characterization.

### *Teaching*

- Genomics (Biology 4215 undergraduate, Biology 7938 graduate) (100%)
- Environmental Toxicology (Environmental Science 6002) (3 guest lectures)

### *Other Activities (Memorial)*

- Supervision, honours students
- Supervisor, graduate students
- Co - supervision, graduate student
- Graduate student committee member
- Cross-appointed, Department of Biology, Memorial University
- Tier 2 Canada Research Chair, Marine Biotechnology
- Member, Animal Care Committee, Memorial University

### *External Activities*

- Collaborator: Genome Canada/Genome Atlantic Funded Cod Genome Project
- Conference organizing: Milwaukee SETAC 2007 Program Committee member
- Theme Co-leader for "Aquatic and Terrestrial Animal Genomics: Leading and Enhancing Canadian Animal Health and Productivity to 2025", a position paper submitted to Genome Canada July, 2008. Successful position papers will be submitted to Industry Canada for funding.
- Reviewed proposals for NSERC, the US-Israel Binational Agricultural Research and Development Fund, the Great Lakes Fishery Commission, and the Oregon State Univ. Marine and Freshwater Biomedical Sciences Center Pilot Project Program.
- Review papers for the following journals: *Aquaculture*, *BMC Genomics*, *Comparative Biochemistry and Physiology*, *Diseases of Aquatic Organisms*,

*Developmental and Comparative Immunology, Environmental Toxicology and Chemistry, Journal of Great Lakes Research, Journal of Molecular Endocrinology, Marine Biotechnology, Molecular Genetics and Genomics, Physiological Genomics.*

- Member of the American Society for Cell Biology (1998 to present)
- Member of the American Fisheries Society (2004 to present)
- Member of the Society of Environmental Toxicology and Chemistry (2005 to present).
- Member of the Editorial Board for the journal *Marine Biotechnology* (2006 to present).
- Founding member of the University of Wisconsin - Milwaukee Center for Functional and Environmental Genomics Steering Committee (2004-2006)

#### *Invited Lectures and Conference Presentations*

##### *Invited Lectures*

- **Rise, M.L.** (2008) Genomic research for improving fish health. VIII<sup>th</sup> International Congress on the Biology of Fish, Portland, Oregon. July 2008.
- **Rise, M.L.** (2007) Rise M, Miller SL, Goetz G, and Carvan MJ. Molecular biomarkers of chlorpyrifos exposure identified in juvenile trout. Society for Environmental Toxicology and Chemistry (SETAC) North America 28<sup>th</sup> Annual Meeting, Milwaukee, Wisconsin, November 2007.

##### *Conference Presentations*

- Hori, T.S.; Kimball, J.; Johnson, S.C.; Afonso, L.; Bowman, S.; Hubert, S.; **Gamperl, A.K.; Rise, M.L.** (2008) Heat shock-responsive genes identified and validated in Atlantic cod (*Gadus morhua*) using genomic techniques. International Congress on the Biology of Fish, Portland, Oregon, July 26 – August 1, 2008.
- Pérez-Casanova, J.C.; Dixon, B.; **Rise, M.L.**; Afonso, L.; Hall, J.R.; **Gamperl, A.K.** (2008). The stress and immune responses of Atlantic Cod to long-term increases in water temperature. Poster presented at the International Congress on the Biology of Fish, Portland, Oregon, July, 2008.
- Feng, C.Y.; Bowman, S.; **Gamperl, A.K.**; Hall, J.R.; Hori, T.; Hubert, S.; Kimball, J.; Rise M.; Johnson, S.C.; **Rise, M.L.** (2008). Identification and analysis of differentially expressed genes in the immune tissues of Atlantic cod (*Gadus morhua*) challenged with formalin-killed atypical *Aeromonas salmonicida*. Oral presentation by Charles Feng (M.Sc. student supervised by M.L. Rise) at a Graduate Student Symposium at Memorial University, April 30, 2008.
- Feng, C.Y.; Bowman, S.; **Gamperl, A.K.**; Hall, J.; Hori, T.; Hubert, S.; Johnson, S.C.; Kimball, J.; Rise, M.; **Rise, M.L.** (2008). Functional genomic study of juvenile Atlantic cod (*Gadus morhua*) immune tissue responses to a bacterial antigen. Oral presentation at The Canadian Society of Zoologists Annual Meeting, Mount Saint Vincent University, Halifax, NS, May 19-23, 2008.

### *Research Overview and Highlights 2007-2008*

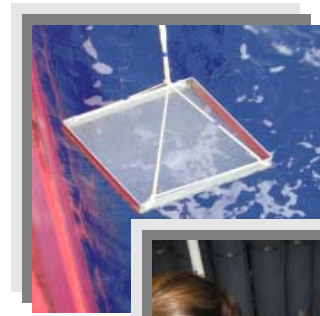
Dr. Rise started his Assistant Professorship and CRC at the OSC in July, 2006. In the next two years, he set up his marine biotechnology laboratory funded by the Canada Foundation for Innovation (CFI) and the Industrial Research and Innovation Fund (IRIF; Government of Newfoundland and Labrador). His CFI and IRIF spending is complete, and his Marine Biotechnology Laboratory is now fully operational. This facility and associated infrastructure are being used by to generate high-quality genomic resources and data that are crucial to the success of several research projects.

Dr. Rise is integrally involved in the Genome Canada-funded Atlantic Cod Genomics and Broodstock Development Project. As a Research Element Leader (research area: genomics) and member of the Scientific Management Team for this project, he has overseen the construction of targeted cDNA libraries for the discovery of cod genes involved in stress and immune responses. He has trained graduate students and technicians in genomic techniques including suppression subtractive hybridization (SSH) cDNA library construction, quantitative reverse transcription – polymerase chain reaction (QPCR) assay development, and sequence database mining. The first publication from this research (Rise et al. 2008) dramatically improved the characterization of Atlantic cod interferon pathway genes, and revealed that this species has a RIG-I-like RNA helicase viral recognition pathway. Cod anti-viral genes discovered in libraries constructed in his laboratory are being scanned for single nucleotide polymorphisms (SNPs) that may be suitable molecular biomarkers for selecting broodstock that are naturally resistant to pathogens and other stressors. Over the next two years, they will publish additional, important papers on Atlantic cod functional genomic research. Because of the success of the CGP-related research, we are now leading the world in the area of large-scale discovery and study of Atlantic cod genes involved in responses to pathogens and thermal stress. He has been instrumental in the development of the CGP's Atlantic cod expressed sequence tag (EST) database (containing greater than 160,000 ESTs), the largest collection of cod gene sequences in the world. Additionally, he is playing a central role in the design and development of a 20,000-gene (20K) cod DNA microarray to be printed later in 2008. This microarray platform, along with the GRASP microarrays that he helped to develop, play important roles in my continuing research on fish responses to pathogens and environmental stressors.

## **Dr. Richard Rivkin**

### *Research Interests*

Dr. Rivkin has internationally recognised research programmes studying the microbial food web dynamics and their influence on biogeochemical cycling of climate active properties and ocean-climate interactions. His research combines field studies (in the Arctic, Antarctic, North Pacific and Atlantic, Mediterranean Sea and Newfoundland coastal waters) with large-scale data base development and meta-analysis to quantify and model the role of the microbial food web in controlling biogenic carbon cycling in the upper and mesopelagic layers of the World Ocean. This research is central to understanding, characterizing and predicting air-sea fluxes of climate active gasses and ocean-climate interactions in the contemporary and future ocean.



### *Other Activities (Memorial)*

- Supervision, graduate students
- Supervision, research assistant
- Supervision, student assistants
- Supervision, MUCEP students
- Memorial University Faculty Association (MUNFA) Executive Committee
- MUNFA-MUN Collective Agreement Negotiations Committee
- MUNFA-MUN Joint Occupational Health and Safety Committee
- University Radiation Safety Committee

### *External Activities*

- Editorial Advisor, Aquatic Microbial Ecology (1996-Present)
- Co-supervision, external graduate students
- External reviewer, *Limnol. And Oceanogr.*, *Journal of Phycol.*, *CJFAS*, *Science*, *Nature*, *JGR*, and others.
- Canadian Surface Ocean and Lower Atmosphere Scientific Steering Committee
- Scientific Advisory and Scientific Steering Committees for several international climate change programs (JGOFS, International North Water Polynya program, Canadian SOLAS program Arctic GOTRACES IPY, Arctic SOLAS IPY)
- Advisory Committee; Canadian Polar Commission.
- Task Team for the Global International and Analysis and Modeling program of the International Geosphere, Biosphere program
- Hertzberg Gold Metal Committee member
- GSC 18 Reallocation Committee member
- Selection committee, Parsons Award
- SCOR/IGBP Global Analysis, Integration and Modeling Task Team

## *Invited Lectures and Conference Presentations*

### *Invited*

- **Rivkin, R. B.;** Legendre, L. (2008). Marine microbial interactions in an evolving Polar environment. NATO-RUSSIA ARW, 40th International Liège Colloquium. Influence of climate change on the changing Arctic and Subarctic conditions. Liege Belgium, May 2008.
- Legendre, L.; **Rivkin, R. B.** (2008). Control of biogeochemical cycles by polar microbes. NATO-RUSSIA ARW, 40th International Liège Colloquium. Influence of climate change on the changing Arctic and Subarctic conditions. Liege Belgium, May 2008.
- Legendre, L.; **Rivkin, R.B.** (2008). How do the very small- sized aquatic microbes influence the very large-scale biogeochemical cycles? American Society of Limnology and Oceanography Meeting. St. John's, Newfoundland, June 2008.

### *Conference Presentations*

- **Rivkin, R.B.;** Legendre, L. (2008). Microbial dynamics and response to a changing polar ocean climate. International Symposium on the Effects Of Climate Change On The World's Oceans, Gijón, Spain, May 2008.
- **Rivkin, R.B.** (2008). Microzooplankton in the world ocean: comparisons of response during mesoscale iron enrichment experiments to a global synthesis. American Society of Limnology and Oceanography Meeting. St. John's, Newfoundland, June 2008.
- Murphy, R. J.; Penney, S.; **Rivkin, R.B.** (2008). Spatial variation in the structure and function of marine microbial communities resulting from predicted climate change in the Labrador Sea. American Society of Limnology and Oceanography Meeting. St. John's, Newfoundland, June 2008.
- Seiden, J. M.; Way, C.; **Rivkin, R.B.** (2008). Bacteria as an invasive species: bacterial dynamics in ballast water during trans-Pacific Voyages of bulk carriers. American Society of Limnology and Oceanography Meeting. St. John's, Newfoundland, June 2008.
- Sun, B.; Way, C.; **Rivkin, R.B.** (2008). Bacteria as an invasive species: bacterial abundance and composition in ballast water discharged into Canadian harbors. American Society of Limnology and Oceanography Meeting. St. John's, Newfoundland, June 2008. Hale, M. S.; **Rivkin, R.B.;** Li, W. K.W.; Fileman, E.; Tarran, G. A. (2008). Meridional patterns of microzooplankton grazing preferences in contrasting biogeochemical provinces of the temperate and subtropical Atlantic Ocean American Society of Limnology and Oceanography Meeting. St. John's, Newfoundland, June 2008.
- Keats, K. F.; Hale, M. S.; **Rivkin, R.B.** (2008). Effects of temperature and nutrient amendments on bacterial growth and community structure in biogeochemical provinces of the Atlantic Ocean. American Society of Limnology and Oceanography Meeting. St. John's, Newfoundland, June 2008.
- Legendre, L.; **Rivkin, R.B.** (2008). Effects of zooplankton faecal pellet production on the export of organic matter and on its remineralization within the euphotic

zone. American Society of Limnology and Oceanography Meeting. St. John's, Newfoundland, June 2008. Moore-Gibbons, C. E.; Ziegler, S.; Anderson, M. R.; **Rivkin, R.B.**; Keats, K.; Whalen, R. 2008. The influence of riverine input on dissolved organic matter cycling and microbial communities in the Lake Melville estuary, Labrador, Canada. American Society of Limnology and Oceanography Meeting. St. John's, Newfoundland, June 2008.

- Lizotte, M.; Levasseur, M.; Merzouk, A.; Scarratt, M.; Michaud, S.; Gosselin, M.; Pommier, J.; **Rivkin, R.B.** (2008). Seasonal and spatial patterns of microbial dmsp cycling in the northwest Atlantic Ocean. American Society of Limnology and Oceanography Meeting. St. John's, Newfoundland, June 2008.

#### *Research Overview and Highlights 2007 - 2008*

- Dr. Rivkin is a principle investigator in the Canadian Aquatic Invasive Species Network (CAISN- Natural Sciences and Engineering Research Council {NSERC}) funded Research Network that is studying the introduction and fate of these aquatic species in both Canadian lakes and marine waters on the east and west coast of Canada. Dr. Rivkin is studying the composition, physiology, introduction and survivorship of non - pathogenic microorganisms in the ballast water of commercial ships that originate in the United States, Europe and (in collaboration with colleagues in British Columbia) Asia, and discharge their ballast water in Canadian ports.
- Dr. Rivkin received funding support for the International Polar Year. His project entitled "Geotraces: multi-tracer investigation of the effect of climate change on nutrient and carbon cycles in the Arctic Ocean" that will operate from 2006/7 to 2010/11 and is approved to a maximum total of \$2 million.
- Dr. Rivkin also received funding support from the International Polar Year for Canadian SOLAS Network, which he is a co-applicant on. The funding is to run from 2006/7 to 2010/11 and is approved to a maximum total of \$400 thousand.

## Dr. Dave Schneider



### Research Interests

The problem of scaling up from surveys and experiments (necessarily at small scales) to questions of regional or global importance continues to be one of the most pressing theoretical issues in ecology. Students are encouraged to develop projects of interest to them that include scaling.

### Teaching

- Website for course in statistics for biologists (BIOL4605, BIOL7220) updated with review material and improved lecture notes.

### Other Activities (Memorial)

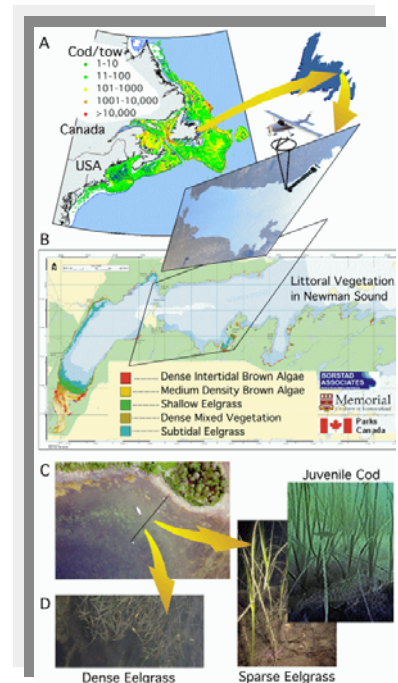
- Supervisor, undergraduate students
- Supervisor, honours students
- Supervisor, graduate students
- Supervisor, research assistant

### External Activities

- Scientific Review Committee, Institute for Environmental Monitoring and Assessment, Happy Valley Goose Bay, Labrador, Canada. 1998-present.
- Canadian Meteorological and Oceanographic Society.
- Sigma Xi Scientific Honorary Society.
- Reviewer: *Marine Biology*, *Marine Ecology Progress Series*, *Journal of Experimental Marine Biology and Ecology*, and *Canadian Journal of Fisheries and Aquatic Sciences*
- Co-Director (with R. Omar), Institute for Social Ecological Research

### Research Overview and Highlights 2007-2008

- Preparation of 2nd edition of *Quantitative Ecology, Spatial and Temporal Scaling* (1st edition 1994, Academic Press)
- Elizabeth Bennett, Maria Thistle, Mark Renkawitz, and Stephen Mayor (M.Sc. Students) graduated in 2007-2008.



## **Dr. Paul Snelgrove**

### *Research Interests*



Dr. Snelgrove's interests include marine community ecology, larval ecology of invertebrates and fish, ecology of benthic vertebrates; hydrodynamic effects on benthic communities and populations, deep-sea ecology, coral reef ecology, biodiversity, disturbance and anthropogenic impacts

### *Teaching*

- Co-teaching Biology 2600 (Ecology)
- Co-taught Biology 3712 (Ecology of Open Waters)
- Fisheries Science 6001 (Master of Marine Studies program)

### *Guest Lectures*

- Biology/Geography 4650 –2 guest lectures
- Marine Environmental Technology (MI) - 1 guest lecture
- Biophysics (guest lecture, winter 2006, MUN)

### *Other Activities (Memorial)*

- Supervisor, B.Sc. honours student.
- Supervision, graduate students
- Supervision, research assistant
- Supervision, MUCEP student
- Supervision, student assistants
- Thesis Committees
- Internal Thesis Examiner
- Honours Dissertation Examination Committee (Biology)
- Ph.D. Comprehensive Examination Committee (Biology)
- Graduate Studies Committee- Biology Department 2002-present
- Chair, Graduate Studies Committee, 2005-present
- Biology/OSC Seminar Series Co-Organizer- Biology Department, 2003-present
- Canadian Research Chair, Boreal and Cold Ocean Systems ( 2003-2007)
- Search Committee, Marine Biology/Ecology Faculty position, MUN 2006-present
- Academic Council Executive, School of Graduate Studies, MUN 2006-present

### *External Activities*

- NSERC Focus Group on Discovery Grant Review, March 2008
- Census of Marine Life (CoML) National/Regional Implement. Committee, Invited Speaker May 2008
- CoML Scientific Steering Committee/Synthesis Group Meeting, Hangzhou China May 2008 Member, American Society of Limnology and Oceanography
- Natural Sciences and Engineering Research Council of Canada representative for Memorial University of Newfoundland (2006 – present)
- Reviewer: *Applied Geochemistry*, *Benjamin Cummings Press*, *Biological Bulletin*, *Biodiversity & Conservation*, *BioScience*, *Cahiers de Biologie Marine*, California Coastal Environmental Quality Initiative Program, Canadian Foundation for Innovation, *Canadian Journal of Fisheries & Aquatic Sciences*, *Conservation Biology*, *Deep-Sea Research*, *Ecology*, *Ecology Letters*, *Encyclopedia of Biodiversity* (Academic Press), *Estuaries*, *Estuarine, Coastal and Shelf Science*, *Hydrobiologica*, *ICES Journal of Marine Science*, *Fisheries Oceanography*, Inter-American Institute for Global Change Research. *Journal of Experimental Marine Biology & Ecology*, *Journal of Fish Biology*, *Journal of the Marine Biological Association of the U.K.*, *Journal of Marine Research*, *Journal of Marine Systems*, *Journal of Shellfish Research*, *Limnology & Oceanography*, *Limnology and Oceanography: Methods*, *Marine Biology*, *Marine Ecology (Statione Naples)*, *Marine Ecology Progress Series*, *Marine and Freshwater Research*, Marsden Foundation (New Zealand), Natural Environmental Research Council (NERC) - UK, National Oceanographic Partnership Program, National Science Foundation (Biodiversity and Inventories Biological Oceanography, Chemical Oceanography, Equipment and Facilities, International Fellowships, Geology and Geophysics, and Polar Programs)-USA, Natural Sciences and Engineering Research Council of Canada (NSERC) - Discovery Grants, Strategic Grants, Idea to Innovation, *Nature*, NOAA/National Undersea Research Program (West Coast, Connecticut, North Carolina and Mid-Atlantic Bight Centers, USA), NOAA Ocean Explorer Program, *Oecologia*, *Quart. Review of Biology*, Sea Grant Program (Hawaii), Sloan Foundation.
- Editorial Board - *Biodiversity and Conservation* - (2000-present)
- Editorial board – *Endangered Species Research* (marine invertebrates) (2004 – present)
- Review Editor, *Marine Ecology Progress Series*. May (2005 – present)
- Editorial Board – *Marine Ecology*. (March 2005 – present)
- Editorial Board – *Journal of Experimental Marine Biology and Ecology*, Oct. (2005 – present)
- Board of Directors, Canadian Scientific Submersible Facility (CSSF) (December 2005 – present)
- Chair, Census of Marine Life Canada Steering Committee, (October 2004 – present)
- Chair, Census of Marine Life 2010 Framework Advisory Committee, (2006 – present)
- Chair, NEPTUNE Canada Science Advisory Committee, (2006 – present)

- Committee Member - Ocean Observation Systems subcommittee of the Oceans Advance Board (Newfoundland Industry/University Partnership)
- President – Massachusetts Institute of Technology / Woods Hole Oceanographic Institution Joint Program Alumni/Alumnae Association
- Member of the Corporation (Ex-officio) –Woods Hole Oceanographic Institution

### *Invited Lectures and Conference Presentations*

#### *Conference Presentations*

- Stanley, R.; **Snelgrove, P.**; Guan, L. (2008). If only I were longer! The relationship between morphology, behavior and hydrodynamics in dispersal of early life history of coastal Newfoundland fishes, Larval Biology Meeting, Lisbon, Portugal, 2008
- **Lillis, A.; Snelgrove, P.V.R.** (2008) The role of flow in settlement and habitat selection by postlarval american lobster. Lisbon, Portugal
- **Snelgrove, P.V.**; Bentzen, P.; deYoung, B.; Bradbury, I.R.; DiBacco, C.; Gregory, R.; Morris, C.; Oake, B.; Pike, D.A.; Ryan, M.; Stanley, R.; Zou, Y.(2008). Connectivity of marine fishes in coastal Newfoundland. American Society of Limnology and Oceanography (ASLO) Summer Meeting, 2008
- Stanley, R.R.; **Snelgrove, P.V.R.**; deYoung, B.; Gregory, R.; Morris, C. (2008). Evaluating connectivity in early life history stages of atlantic cod in Trinity Bay, Newfoundland, American Society of Limnology and Oceanography (ASLO) Summer Meeting, 2008.
- **Ryan, M.R.**; Gregory, R.; Snelgrove, P.V. (2008). Why did the fish cross the gap? Between-patch movement of juvenile atlantic cod, *Gadus morhua*. American Society of Limnology and Oceanography (ASLO) Summer Meeting, 2008.
- Bradbury, I.R.; **Snelgrove, P.V.**; Bentzen, P.; deYoung, B.; Gregory, R.S.; Morris, C. (2008). Structural & functional connectivity of marine fishes within a semi-enclosed Newfoundland fjord. American Society of Limnology and Oceanography (ASLO) Summer Meeting, 2008.
- Zou, Y.; Pike, D.A.; Bradbury, I.R.; **Snelgrove, P.V.**; Bentzen, P. (2008) Rainbow smelt in Newfoundland - a graph theory approach. American Society of Limnology and Oceanography (ASLO) Summer Meeting, 2008.
- Stanley, R.; Snelgrove, P.V.R. (2007). Morphometric tools as predictors of kinematic capabilities in larval fish Larval Fish Conference of Amer. Fish. Soc., 2007.
- Bradbury, I.R.; Laurel, B.J.; **Snelgrove, P.V.R.**; Bentzen, P.; Campana, S.E. (2008) Drifting into the light: illuminating global trends in marine dispersal.

#### *Research Highlights 2007-2008*

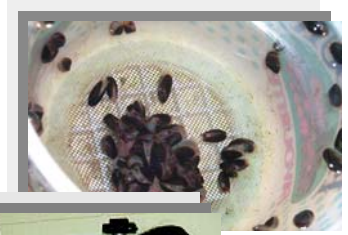
- Dr. Snelgrove was awarded an NSERC grant for \$1,002,517 to support The Canadian Healthy Oceans Network, which is a strategic partnership between university researchers and government. This Network will address a need for

scientific criteria for conservation and sustainable use of marine biodiversity resources.

- Dr. Snelgrove was also awarded an additional \$97,988 towards a \$633,313 project to help investigate biodiversity loss and deterioration of oceans.
- Krista Boland, B.Sc. Honours, graduated in 2007-2008.

## **Dr. Ray Thompson**

### *Research Interests*



Dr. Thompson's interests centre on the physiological ecology of marine invertebrates, particularly bivalve mollusks, such as mussels and scallops. The major focus is the response of the organism to a food supply that varies both seasonally and over the short - term (e.g., tidal cycles and storm - driven changes). Such variation is reflected in physiological rate processes such as feeding, digestion and respiration, and in the partitioning of available energy between growth and reproduction. Future work will be directed towards more sensitive estimates of the diet, especially qualitative factors that have thus far received little attention. Dr. Thompson is also collaborating with biological and physical oceanographers at the OSC in a study of the formation and fate of the spring bloom in a large Newfoundland bay. Results to date indicate that, in some years, much of the phytoplankton production sinks to the bottom and is available to the benthos, whereas, in other years, pelagic grazers use most of the primary production, so that the organic material reaching the benthos is considerably modified. This presumably influences the nutrition of benthic invertebrates, and he is therefore investigating the energy storage and reproductive cycles of representative infaunal bivalves in order to determine whether or not events in the water column are coupled with those in the benthos.

### *Other Activities (Memorial)*

- Supervision, graduate students
- Supervision, students assistants
- Graduate Students Committee, Biology Department
- Director Safety Committee, OSC
- Faculty of Science Library Committee

### *External Activities*

- Canadian Editor, *Marine Biology*, 1991 - present
- Journal and grant proposal reviewer: NSERC, US Sea Grant, FONDECYT Chile
- Canadian Editor, "Marine Biology", 1991-2007

### *Research Highlights 2007-2008*

- Brooding in the Chilean oyster *Ostrea chilensis*: This is a series of papers arising from an integrated study of reproduction in an oyster that broods its young for the entire developmental period. Brooding is an important yet poorly understood mode of reproduction in bivalves and is associated with a reduced feeding rate, resulting in a

significant energy cost to the parent, although there are some compensatory mechanisms such as an increase in food absorption efficiency. The digestive system of the larva is less efficient than that of the adult. The ciliary tracts of the brooded larva are considerably modified from the usual bivalve form, reflecting the very short planktonic phase. Dr. Thompson carried out radiocarbon and chloropigment analyses, which could not be completed in Chile. He participated in the conception, design and the execution of several of these experiments, and played a major role in the interpretation of the data and the writing.

- The hyperbenthic community: Despite its importance in the transfer of energy in many marine systems, the hyperbenthos has received much less attention from researchers than the benthos or the upper water column, largely due to sampling difficulties. We examined the population dynamics and particularly the nutrition of some dominant crustaceans in the permanently cold (<0C) hyperbenthos of Concepcion Bay. Some species rapidly utilise material from the sinking spring diatom bloom, whereas others are slower to respond or may not respond at all; many of them are rich in lipids and essential fatty acids that are consumed by predators such as commercially important groundfish.

## ***Dr. Joe Wroblewski***

### *Research Interests*



Dr. Wroblewski's research interests include fisheries oceanography, global ocean ecosystem dynamics, and physical – biological oceanographic modeling. For the past decade Dr. Wroblewski and his students have been studying the Atlantic cod population living in Gilbert Bay, Labrador, which was designated a Marine Protected Area by the Government of Canada to protect these genetically - distinctive, golden - coloured cod. He teaches fisheries ecology and fisheries resource management with the viewpoint that fishers and their knowledge should be part of the management process.

### *Teaching*

Teaching during Winter Semester 2008 (January-April 2008):

- Biology 4750 Fisheries Ecology (30 undergraduate students enrolled)
- Biology 7551 Fisheries Resource Management (4 graduate students enrolled)
- Science 1000 Introduction to Science I (53 undergraduate students enrolled; 6 lectures and a one-hour exam)

Teaching during Spring Semester 2008 (May-August 2008):

- Biology 3714 Estuarine Fish Ecology (11 undergraduate students enrolled) a field course, taught with Dr. David Methven (50% teaching contribution) at the Bonne Bay Marine Station, Norris Point

### *Other Activities (Memorial)*

- Supervisor, graduate students
- Supervisor, undergraduate students
- Supervisor, honours student
- Committee member, Ph.D. Candidate
- Committee member, MSc Candidate
- Chair, Honours thesis committees, Biology Department
- Comprehensive examination committee member, Ph.D. Candidates, Department of Mathematics and Statistics and Faculty of Engineering and Applied Science.
- Chair, final Oral Examination and PhD thesis defence.
- Steering Committee Member, “Community-University Research for Recovery Alliance (CURRA)”, funded by SSHRC (2006- present)
- Chair, OSC Promotion and Tenure Committee (2007-2008).
- Programme Committee member and Admissions Committee Member, Masters of Marine Studies Programme, Marine Institute.
- Chair of the Search Committee, Tenure-track faculty position in Marine

Aquaculture, Ocean Sciences Centre, MUN, April 2006- November 2007.

- Member, Search Committee, Tenure-track faculty position in Marine Aquaculture, Ocean Sciences Centre, MUN (January 2008- present).

#### *External Activities*

- Steering Committee member (non-voting), Gilbert Bay as a Marine Protected Area, Oceans Act, Government of Canada
- Editorial Board member, Journal of the Marine Biological Association of the United Kingdom
- Peer-reviewer, Journal *Northeastern Naturalist* and Journal *Open Oceanography*.

#### *Invited Lectures and Conference Presentations*

##### *Invited*

- **Wroblewski, J.S.** (2007). Research on the Iceland scallop fishery in Gilbert Bay, Labrador. presentation at the Gilbert Bay MPA Steering Committee meeting, Port Hope Simpson, Labrador, November 6, 2007.
- **Wroblewski, J.S.** The future of the Graduate Programme in Environmental Sciences at Memorial University, St. John's. Search for the Chair of the Graduate Programme in Environmental Sciences at Memorial University, 31 July 2008.

##### *Conference Presentations*

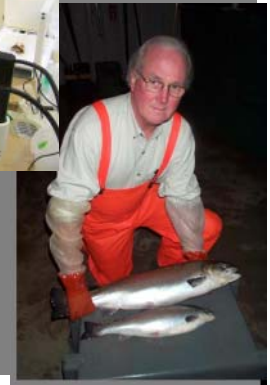
- **Wroblewski J.S.**; Nelson, R.J.; Rose, G.A.; Simms, J.S. (2008). Connectivity of sedentary and migratory populations of Atlantic cod at the boundary of the Gilbert Bay MPA. Regional MPA Update and Science Workshop. St. John's, NL., February 26, 2008.
- Liu, S.; **Wroblewski, J.S.** (2008). Comparison of the growth rate of Iceland scallop in Gilbert Bay, Labrador with the scallop growth in the northeastern Gulf of St. Lawrence and in the Nuuk area of West Greenland. Regional MPA Update and Science Workshop. St. John's, NL., February 26, 2008.

#### *Research Overview and Highlights 2007 - 2008*

- Presentation on research on the Iceland scallop fishery in Gilbert Bay, Labrador. Gilbert Bay MPA Steering Committee meeting, Port Hope Simpson, Labrador, November 7, 2007
- Liuming Hu, M.Sc. student, and Joanne Stares, Honours student, graduated in 2007-2008.

## ***Emeritus Faculty***

### ***Dr. G. Fletcher***



#### ***Research Interests***

Dr. Fletcher's primary research interests are with fish antifreeze proteins and with transgenic salmonids. His program requires the collection of fish species from the wild by divers at all times of the year and winter in particular. His transgenic salmon research requires an extensive number of aquaria supplied with both fresh water and sea water. Many of the experiments require fish to be held under controlled temperatures, some below zero Celsius. His research also requires extensive analytical instrumentation for protein purification and characterization, and for molecular biology. The work conducted by his group is totally dependent upon the OSC infrastructure such as divers, facility custodians, and adequate supplies of fresh and sea water.

#### ***Other Activities (Memorial)***

- Supervision, SWAP student
- Supervision, graduate students
- Supervisory committee, graduate students
- Professor Emeritus, OSC (2004 - present)
- Selection Board, Genesis Centre, MUN (1996-2007)

#### ***External Activities***

- Board of Directors, Aqua Bounty Canada, Inc. (2000 - Present)
- Board of Directors, A/F Protein Canada 2000, Inc.(2000 - Present)
- Co - Founder, Member, Board of Directors and Vice - President R&DA/F Protein, Inc. Boston USA (1992 - Present).
- NSERC Advisory Committee on University Industry grants (ACUIG) (2004-2007)
- CCAC Biotechnology sub committee (1999-present)

#### ***Research Highlights 2007-2008***

- **Fletcher, G.L.**, C.L. Hew and P.L. Davies. (2007). Microinjection procedures for gene transfer. Canadian Patent # 1,341,553
- Heather Young, M.Sc. Student awarded title of "Fellow of the School of Graduated Studies" in May 2008, awarded *The Novartis Award for 1<sup>st</sup> Place Finish in Graduate Presentations* at the Atlantic Universities Aquaculture Conference, St. John's, NL in March 2008, and awarded the Special Scholarships for Students to Pursue Graduate Studies Related to Resource Development in September 2007.
- Rod Hobbs, PhD Student, awarded the Special Scholarship for students to Pursue Graduate Studies Related to Resource Development" in 2006 and in 2007.

- Marieve Desjardins, PhD Student, awarded the NSERC CGS D Graduate Fellowship Sept 2006-Sept 2009.

## 6. Graduate Students

### ***M.Sc. Theses***

***Hind Elloukal - Biology - M.Sc. (D. Deibel/R.Thompson)***

Ecology of ascidian tunicates

***Ashley Callahan- Environmental Science- M.Sc. (D. Deibel)***

Ecology of invasive ascidian tunicates

***Jason Robinson- Biology-M.Sc. (W. Dreidzic)***

Smelt glycerol metabolism

***Michelle Simms - CABE - M.Sc. (I.A. Fleming)***

Evolution of fish early life history

***Rebecca Poole - Biology - M.Sc. (I.A. Fleming/D. Reddin - DFO)***

Lacustrine and Fluvial Habitat use by Atlantic salmon parr in Labrador

***Sarah Ross - Biology - M.Sc. (I.A. Fleming/R. Gregory - DFO)***

Early recruitment of Atlantic cod (*Gadus morhua*)

***Michelle Bachan - Biology - M.Sc. (I.A. Fleming)***

Paternal Effects of Egg Quality on Progeny Performance in Atlantic cod (*Gadus morhua*)

***Heather Young - Biology - M.Sc (G. Fletcher)***

Differences in expression of Growth hormone receptors and downstream factors in transgenic salmon when compared to control salmon

***Scott Caines- Biology- MSc. (P. Gagnon)***

Invasion dynamics of *M. membranacea* in coastal Newfoundland

***Kyle Matheson- Biology- MSc. (P. Gagnon)***

Interactions between native and invasive crabs in coastal Newfoundland

***Courtney MacSween- Biology- M.Sc. (K. Gamperl)***

Metabolic physiology of cunner

***Abdullah Al-Zaid- Biology- M.Sc. (K. Gamperl)***

Cunner metabolic and stress response

**Justin So- Biology- M.Sc. (A. Mercier)**

Biology and geneflow of sea cucumber (*Cucumaria fondosa*)

**Zhao Sun- Biology- M.Sc. (A. Mercier)**

Reproductive biology of deep sea corals

**Gina Doyle- Biology- M.Sc. (A. Mercier/P. Gagnon)**

Reproductive cycles of daily brittle stars

**Marie George- Environmental Science- M.Sc. (C. Parrish)**

Environmental footprint of marine fish aquaculture

**Nicole Rowsell- Biology- MSc (C. Parrish)**

Use of krill protein in the feeding of Atlantic cod larvae

**Catherine Andrews - Environmental Science - M.Sc. (M. Rise/J. Payne - DFO)**

Identification of a responsive gene set to evaluate the potential impact of seismic exposure on fish.

**Charles Feng- Biology-MSc (M.Rise)**

Atlantic cod immune gene expression response to viral mimic

**Ryan Murphy - Biology - M.Sc. (R. Rivkin)**

Spatial and Temporal Variation in Community Structure and Function of bacterioplankton in the North Atlantic

**Bei Sun - Environmental Science - M.Sc. (R. Rivkin)**

Introduction, dynamics of microbial populations and structure in ballast water of oceangoing transport vessels.

**Roanne Collins - CABE - M.Sc. (D. Schneider/J.Lein)**

Effect of MPA closures on lobster egg production

**Kelly Carter - Biology - M.Sc. (P. Snelgrove/ P. Pepin - DFO)**

Environmental and biological influences on larval fish diversity

**Victoria Burdett-Coutts - Biology - M.Sc. (P. Snelgrove)**

Lobster Larvae and Juvenile Recruitment

**Michael Kelly - Biology - M.Sc. (P. Snelgrove)**

Benthic - pelagic coupling: Food supply and macrofaunal diversity

**Mary Ryan - CABE - M.Sc. (P. Snelgrove/R. Gregory - DFO)**

Gap crossing by juvenile fishes and connectivity

***Ryan Stanley - Biology - M.Sc. (P. Snelgrove)***

Egg transport and population connectivity in coastal fishes

***Ashlee Lillis- Biology- M.Sc. (P. Snelgrove)***

Larval Settlement in Marine invertebrate larvae

***Shanshan Lui, Environmental Science- M.Sc. (R.Thompson/J.Wroblewski)***

Biology of Iceland scallop (*Chlamys islandica*) in Gilbert Bay, Labrador: a Marine Protected Area

## **Ph.D theses**

***Tara Connelly - Biology - Ph.D (D. Deibel)***

Biogeochemistry of the benthic boundary layer of the Beaufort Sea shelf: a zooplankton - centered approach

***Tara Businski - Biology Ph.D (D. Deibel)***

Arctic zooplankton ecology

***Joy Stacey - Biology - Ph.D. (W. Driedzic)***

The physiology of metal accumulation by ascidians

***Simon Lamarre - Biology - Ph.D. (W. Driedzic)***

Physiological processes of juvenile growth in spotted wolffish

***Jennifer Hall- Biology- Ph.D. (W. Driedzic/ M. Rise)***

The use of molecular tools to study glycerol production in rainbow smelt.

***Genevieve Bilodeau- Biology- Ph.D (W. Driedzic)***

Hexokinase activities in fish

***Erin Raynard- Biology- Ph.D. (W. Driedzic)***

Glucose turnover in fish

***Delphine Ditlecadet- Biology- PhD. (W. Driedzic)***

Control of glycerol levels in smelt

***Kathryn Smith - Biology - Ph.D. (I.A. Fleming/P. Pepin - DFO)***

Comparative larval fish life history

***Darek Moreau - Biology - Ph.D. (I.A. Fleming/G. Fletcher)***

Competitive interactions of wild vs. transgenic Atlantic salmon parr in a modified stream environment

***Nathan Wilke- Biology- Ph.D. (I.A. Fleming)***

Conservation of endangered populations

***Peter Westley Biology- Ph.D. (I.A. Fleming)***

Invasion and impacts of exotic brown trout in Newfoundland

***Rodney Hobbs - Biology - Ph.D. (G. Fletcher)***

Purification and characterization of antifreeze

**Marieeve Desjardins Biology - Ph.D. (G. Fletcher)**  
Antifreeze Proteins in Wolffish Spp

**Isabel Costa - Biology – Ph.D. (K. Gamperl)**  
Cardiac Function and microvascular control in flatfish

**Juan Casanova - Biology - Ph.D (K. Gamperl)**  
Metabolic Digestive and Feeding Physiology of Cod and Haddock.

**Paula De Costa Mendonca - Biology - Ph.D. (K. Gamperl)**  
Cardiovascular function of flatfishes.

**Lene Hebsgard Peterson - Biology - Ph.D. (K. Gamperl)**  
The interactive effects of food deprivation and chronic hypoxia on exercise capacity and cardiovascular function in marine fishes: an inter - specific comparison in north Atlantic fishes.

**Tiago Hori - Biology - Ph.D. (K. Gamperl/L. Afonso - NRC)**  
Physiological and genomic responses of Atlantic cod to stress.

**Manjursir Wijekoon - Biology - Ph.D. (C. Parrish/A. Mansour - DFO)**  
Gastric dilation and air sacculitis syndrom (GDAS) in farmed steelhead trout *Oncorhynchus mykiss*.

**Kimberley Keats - Biology - Ph.D. (R. Rivkin)**  
Spatial scales of bacterial biogeography: Relationships to upper - ocean biogeochemical processes

**Liang Qu- Biology- Ph.D. (R. Rivkin)**  
Bacterial mediation of polar geochemical transformations

**Kelly Johnson - Biology - Ph.D. (D. Schneider)**  
Bioavailability of metals in soil

**Patrick Abgrall - CABE - Ph.D. (D. Schneider)**  
Design and application of a step - by - step protocol to model critical habitat of marine mammals using large rorquals in Newfoundland and Labrador waters

**Erin Carruthers - Biology - Ph.D. (D. Schneider/B. Neis)**  
Pelagic fishery by - catch in the Northwest Atlantic

**Corey Morris - Biology - Ph.D. (P. Snelgrove/R. Gregory - DFO)**  
Behavioural interactions among juvenile Gadoids along the north east coast of Newfoundland

***Krista Baker - Biology - Ph.D. (P. Snelgrove/ E. Edinger)***

Deep - sea diversity and conservation off Newfoundland and Labrador

***Guangzu Liu - Biology - Ph.D. (R. Thompson/D. Innes)***

Genetics of *Mytilus* hybrid zone

***Ben Lowen - Biology - Ph.D. (R. Thompson/D. Innes)***

Ecological genetics of blue mussels (*Mytilus edulis* and *M. trossulus*).

***Sandra Pereda - Biology - Ph.D. (R. Thompson)***

Nutrition of mussels.

***Wang Jue- Biology- Ph.D. (R. Thompson)***

Ecological genetics of of mussels *Mytilus* spp.

## **Degreed Students**

***Nami Choe - Marine Biology - Ph.D. (D. Deibel)***

Age determination and cohort analysis of *Oikopleura vanhoeffeni* in Logy Bay.

***Matthew Logan - Biopsychology - M.Sc (C. Parrish)***

Diet and possible influences of anthropogenic hydrocarbons on Leach's Storm - petrels (LHSP)

***Marsha Clarke - Biology - M.Sc. (C.Parrish)***

Egg lipids as a predictor of larval survival in cod

***Sarah Westelmajer - Biology - MSc (C. Parrish)***

Lipids and stress in larval cod

***Mark Renkawitz - Biology - M.Sc. (D. Schneider)***

Heincke's Law: Cod growth relative to water depth

***Elizabeth Bennett - Environmental Science - M.Sc. (D. Schneider)***

Annual changes in spatial aggregations of Atlantic cod, *Gadus morhua*, age classes in Divisions 2J3KL and 4RS from 1978 - 2000.

***Stephen Mayor - Biology - M.Sc. (D. Schneider/J. Schaefer)***

The spatial structure of caribou habitat selection.

***Maria Thistle - Biology - M.Sc. (D. Schneider)***

Distribution and risk sensitive foraging of juvenile gadids in relation to fractal complexity of eelgrass habitat.

## 7. Research funding inventory

*Grants received in the 2007 - 08 fiscal year*

### **NSERC Operating Grants**

J. Brown	\$22,000.00
D. Deibel	\$41,000.00
W. Driedzic	\$57,180.00
I. Fleming	\$32,000.00
G. Fletcher	\$60,300.00
K. Gamperl	\$41,700.00
C. Parrish	\$36,000.00
P. Pepin	\$17,800.00
R. Rivkin	\$53,300.00
D. Schneider	\$36,090.00
P. Snelgrove	\$21,170.00
R. Thompson	\$23,100.00
	<b>\$441,640.00</b>

### **NSERC Discovery**

A. Mercier	\$16,500.00
M. Rise	\$29,203.00
	<b>\$45,703.00</b>

### **NSERC Strategic**

P. Snelgrove	<b>\$175,300.00</b>
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### **NSERC MFA Grant**

I. Fleming	<b>\$279,000.00</b>
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### **NSERC STPGP**

I. Fleming	<b>\$31,300.00</b>
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### **NSERC RTI**

K. Gamperl	\$19,343.00
C. Parrish	\$56,106.00
	<b>\$75,449.00</b>

## Other Grants

### *Internal Awards*

R. Rivkin	University Research Professorship	\$4,000.00
J. Wroblewski	MUN Research Pool	\$2,400.00
		<b>\$6,400.00</b>

### *External Awards*

D. Deibel	DFO	\$9,700.00
W. Driedzic	CIHR	\$42,068.00
W. Driedzic	Genome BC(C-Grasp)	\$50,000.00
I. Fleming	Parks Canada	\$25,000.00
I. Fleming	USDA	\$75,679.32
I. Fleming	CFI (IOF)	\$27,343.00
I. Fleming	ACOA/AIF	\$811,250.00
I. Fleming	CRC (M. Rise)	\$100,000.00
I. Fleming	NB Wildlife Trust Fund	\$12,500.00
I. Fleming	Dept. Envir. & Conser.	\$16,923.00
I. Fleming	Northern Scientific Training	\$3,000.00
I. Fleming	DFO	\$9,500.00
K. Gamperl	Genome Atlantic	\$875,000.00
A. Mercier	CCFI/DFA	\$50,375.00
A. Mercier	DFO	\$13,600.00
A. Mercier	DFO	\$13,300.00
C. Parrish	DFO	\$2,333.00
C. Parrish	DFO	\$6,125.94
C. Parrish	DFO	\$3,800.00
C. Parrish	DFO	\$8,400.00
C. Parrish	DFO	\$9,600.00
C. Parrish	DFO	\$3,920.00
M. Rise	IRIF	\$22,520.00
R. Rivkin	CAISN	\$21,750.00
R. Rivkin	CAISN	\$26,250.00
R. Rivkin	CAISN	\$4,500.00
R. Rivkin	Eur-Oceans/UEM	\$7,371.00
R. Rivkin	U. Laval/NSERC-IPY	\$12,000.00
R. Rivkin	UBC/NSERC- Gov. Canada- IPY	\$94,000.00
D. Schneider/P. Snelgrove	DFO	\$38,859.00
D. Schneider/P. Snelgrove	Northern Scientific Training	\$3,700.00
P. Snelgrove/ D. Schneider	DFO	\$6,200.00
P. Snelgrove/D. Schneider	NEPTUNE	\$171,495.00
P. Snelgrove/D. Schneider	NEPTUNE	\$117,111.00
P. Snelgrove/D. Schneider	DFO	\$35,809.00

P. Snelgrove/D. Schneider	IOF	\$97,988.00
P. Snelgrove/D. Schneider	CFI	\$65,325.00
J. Wroblewski	DFO	\$4,936.00
		<b>\$2,899,231.26</b>

**Total OSC Research Funding** **\$3,954,023.26**

## **Grants Administered Through Other Departments, Organizations, Institutions, Etc.**

**Abrahams, M.** (2004-2008) NSERC Collaborative Research Development. An evaluation of current strategies to mitigate the impact of hydroelectric activity on Lake Sturgeon (with Drs. Steve Peake & Gary Anderson) - \$878,200

**Abrahams, M.** (2004-2008). University of Manitoba, Flexible Research Funding- \$15,000 per annum

**Abrahams, M.** (2005-2007). Manitoba Hydro Research and Development. Factors affecting habitat selection decisions by Lake Sturgeon- \$98,200

McKenzie, C.; **Deibel, D.** (2008) Aquatic Invasive Species Survey, Department of Fisheries and Oceans (DFO), 50% of \$34,000 (20hrs/week).

**Abrahams, M.** (2003-2008) NSERC grant. Predator-prey interactions in aquatic Communities- \$29,000 per annum

Cote, D.; **Fleming, I.A.**; et al (2005-2008). Building the road to proactive and scientifically sound management of fish populations in Canada's National Parks. Parks Canada, Ecological Integrity Innovation and Leadership Funds, 44% of \$35,000 (2006), 34% of \$73,000, and 71% of \$35,500 (2007) (5 hours/month).

Hallerman, E; **Fleming, I.A.**; et al (2006-2008). Environmental risk assessment parameters for growth hormone transgenic Atlantic salmon, *Salmo salar*. US Department of Agriculture, Biotechnology risk assessment research grants program, 25% of \$162,000 (2006), 25% of \$162,000 (2007), and 25% of \$162,000 (20 hours/month).

Boulding, E.; Schulte, P.; **Fleming, I.A.** (2006-2008). Conservation genomics of Atlantic salmon towards understanding adaptive trait differences for the management of endangered populations. NSERC, Strategic Grants Program, 33% of \$166,326 (2006), 15% of \$145,000 (2007), and 22% of \$145,000 (20 hours/month).

Neis, B.; **Fleming, I.A.**; et al (2007-2011). Community-University Research for Recovery Alliance Social Sciences & Humanities Research, Community-University Research Alliances Council, 2% of \$200,000 (2007) and 10% of \$200,000 (2008) (10 hours/month).

Symonds, J.; **Gamperl, A.K.**; et al. (2006-2009). Atlantic Cod Genomics and Broodstock Development, Genome Atlantic, DFO. 3% of \$4,500,000 (2006), 3% of \$4,500,000 (2007), 3% of \$4,500,000 (2008), 3% of \$4,500,000 (2009). (20 hours/month).

Levasseur, L.; **Rivkin, R. B.**; et al (2007-2011). Microbial cycling of DMS in the Arctic Ocean. Canadian IPY/NSERC, 100% of \$ 24,000 (10 hours/month).

Francios, R.; **Rivkin, B. B.**; et al. (2007-2012). Role of microbes in elemental cycling in the Arctic Ocean, Canadian Geotraces IPY/NSERC, 100% of \$90,000 (15 hours/month).

Anderson, M. R.; **Rivkin, R. B.**; Ziegler, S (2007-2009). Influence of Riverine Inputs on the Trophodynamics of the Lake Melville Estuary. Newfoundland Hydro/Department of Fisheries and Oceans - 30% of \$28,200 (5 hours/month)

Anderson, M. R.; **Rivkin, R. B.**; and Ziegler, S. (2008 2010). Influence of Riverine Inputs on the Trophodynamics of the Lake Melville Estuary. Seasonal characteristics Newfoundland Hydro/Department of Fisheries and Oceans -40% of \$45,000 (5 hours/month)

**Schneider, D.** (2006-2006). U.S. National Park Service. Statistical advice on Pacific monitoring programs, \$10,000.

Scott, S.; **Snelgrove, P.**; et al. (2005-2007). Access to ROPOS (Remotely Operated Platform for Ocean Science) by CSSF, NSERC, MFA, 5% of \$400,000 (2006) and 5% of \$400.00 (2007) (2 hours/month).

Gilkinson, K.; **Snelgrove, P.**; et al. (2006-2007). The ecology of deep-sea corals of Newfoundland and Labrador waters: biogeography, life history, biogeochemistry, and role as critical habitat. DFO, International Governance Program, 5% of 47,500 (2006) 10% of \$144, 500 (2007) and 10% of 140,500 (2007) (5 hours/month).

Tunnicliffe, V.; **Snelgrove, P.V.R.**; et al. (2007-2011). VENUS: Victoria Experimental Network Under the Sea NSERC, MRS 2007 5% of \$681,930, 2008 5% of \$681,930 (5 hours/month).

Neis, B.; **Snelgrove, P.**; et al (2007-2008). Community-University Research for Recovery Alliance, SSHRC, Community-University Research Alliances, 100% of \$34,150.00 (2007), 100% of \$23,650 (2008).

Juniper, K.; **Snelgrove, P.**; et al (2008-2010). Access to the Canadian Scientific Submersible, NSERC MRS. 5% of \$363,900 (2008).

Barnes, C.; **Snelgrove, P.**; et al (2008-2011). NEPTUNE Canada cabled ocean observatory, NSERC MRS, BC Govt, CFI as equal partners. 1% of \$3,100,000 (2008).

Innes, D.J.; **Thompson, R.J.** (2006-2008). The species composition of mussel spat (*Mytilus edulis*, *M. trossulus*, hybrids) settling at different time periods, depths and sites in Newfoundland. Department of Fisheries and Oceans, 2006 \$6,000 (50%), 2007 \$6,000 (50%), 2008 \$6,000 (50%) (Contract 10 hours/month).

Bell, T.; Edinger, E. **Wroblewski, J.**; Devillers, R. (August 2006 to March 2007). Habitat mapping in Gilbert Bay, Labrador, A Marine Protected Area, Phase II. Contract with Fisheries and Oceans Canada, \$24,948

Edinger, E.; Bell, T.; **Wroblewski, J.**; Devillers, R. (August 2007-March 2008). Marine habitat mapping in Gilbert Bay, Labrador, A Marine Protected Area, Phase III. Fisheries and Oceans Canada, \$25,000

Neis, B.; **Wroblewski, J.**; **Schneider, D.**; et al. (2007-2012). “Community-University Research for Recovery Alliance (CURRA)”, funded by CURA program of SSHRC. Subcomponent budget \$100,000 total over five years. Local Cod Stocks/Juvenile Cod Critical Habitat Subcomponent.

## Publications

### Publications appearing in the 2007 - 08 academic year

**Abrahams, M.V.;** Mangel, M.; Hedges, K. (2007). Predator-prey interactions and changing environments: who benefits? *Philosophical Transactions of the Royal Society* 362: 2095-2104

Biro, P.A.; **Abrahams, M.V.;** Post, J.R. (2007). Direct manipulation of behaviour reveals a mechanism for variation in growth and mortality among prey populations. *Animal Behaviour* 73: 891-896

Bradbury I.R.; Laurel, B.; **Snelgrove, P.V.R.;** Bentzen, P.; Campana, S.E. (2008) Geographic, taxonomic, and life history bias in marine dispersal estimates. *Proc. Roy. Soc. Lond.* 275, 1803-1809.

Chaparro, O.R.; Matus, P.R.; **Thompson, R.J.;** Segura, C.J.; Pardo, L.M. (2008). Gametic, morphological and physiological variables influencing clutch size in the Chilean oyster (*Ostrea chilensis* Philippi, 1845). *J. Exp. Mar. Biol. Ecol.* 359: 18-25.

Chaparro, O.R.; Montiel, Y.A.; Segura, C.J.; Cubillos, V.M.; **Thompson, R.J.;** Navarro, J.M. (2008). The effect of salinity on clearance rate in the suspension-feeding estuarine gastropod *Crepidula dilatata* under natural and controlled conditions. *Estuar. Coast. Shelf Sci.* 76: 861-868.

**Driedzic, W.R.;** Short, C.E. (2007). Relationship between food availability, glycerol and glycogen levels in low temperature challenged rainbow smelt (*Osmerus mordax*) *J. Exp. Biol.* 210: 2866-2872.

**Gagnon P.;** Scheibling, R.E.; Jones, W.; Tully, D. (2008). The role of digital bathymetry in mapping shallow marine vegetation from hyperspectral image data. *Int J Remote Sens.* 29:879-904.

Garcia, A.S.; **Parrish, C.C.;** **Brown, J.A.** (2008). Growth and lipid composition of Atlantic cod (*Gadus morhua*) larvae in response to differently enriched *Artemia franciscana*. *Fish Physiol. Biochem.* 34: 77-94.

Garcia, A.S.; **Parrish, C.C.;** **Brown, J.A.** (2008). A comparison among differently enriched rotifers (*Brachionus plicatilis*) and their effect on Atlantic cod (*Gadus morhua*) larvae early growth, survival and lipid composition. *Aquaculture Nutrition* 14: 14-30.

Garcia, A.S.; **Parrish, C.C.**; **Brown, J.A.** (2008). Use of enriched rotifers and *Artemia* during larviculture of Atlantic cod (*Gadus morhua*, Linnaeus, 1758): effects on early growth, survival and lipid composition. *Aqua Res* 39: 406-419

Guan, L.; **Gamperl, A.K.**; **Snelgrove, P.V.R.** (2008). Ontogenetic changes in the critical swimming speed of cold-water marine fish larvae and the role of temperature. *J. Exp. Mar. Biol. Ecol.* 360: 31-38.

Hamel, J.-F.; Sargent, P.; **Mercier, A.** (2008). Diet, reproduction, settlement and growth of *Palio dubia* (Nudibranchia: Polyceridae) in the north-west Atlantic. *Journal of the Marine Biological Association of the UK* 88(2): 365-374.

Hamel, J.-F.; Becker, P.; Eeckhaut, I.; **Mercier, A.** (2007). Exogonadal oogenesis in a temperate holothurian. *Biological Bulletin* 213: 101-109.

Hobbs, R.S.; **Fletcher, G.L.** (2008) Tissue specific expression of antifreeze protein and growth hormone transgenes driven by the ocean pout (*Macrozoarces americanus*) antifreeze protein OP5a gene promoter in Atlantic salmon (*Salmo salar*). *Transgenic Research* 17:33-45

Jaramillo, J. R.; **Thompson, R.J.** (2008). The reproductive response of the protobranch bivalve *Yoldia hyperborea* to an intermittent flux of phytodetritus: an experimental approach. *J. Exp. Mar. Biol. Ecol.* 357: 57-63.

Levesque, H.M.; Shears, M.A.; **Fletcher, G.L.**; Moon, T.W. (2008). Myogenesis and muscle metabolism in Juvenile Atlantic salmon (*Salmo salar*) made transgenic for growth hormone. *J. Exp. Biol.* 211:128-137

Keats, K. F.; Hale, M. S.; **Rivkin, R.B.**; **Schneider, D. C.** (2008). Effects of long-term sample storage on the detection of bacterial cells using fluorescence *in situ* hybridization. *Limnology and Oceanography Methods*, 5: 379-383.

Killen, S.S.; **Brown, J.A.**; **Gamperl, A.K.** (2008). Lack of metabolic thermal compensation during the early life stages of ocean pout *Zoarces americanus*: A benthic, cold-water marine species. *J. Fish Biology.* 72:763-772.

Killen, S. S., **Gamperl, A. K.**; **Brown, J.A.** (2008). Ontogeny of threat-sensitive foraging and routine metabolism in larval shorthorn sculpin: Evidence for increased costs of reduced foraging under predation threat. *Marine Biology.* 152: 1249-1261.

King Heiden, T.C.; Struble, C.A.; **Rise, M.L.**; Hessner, M.J.; Hutz, R.J.; Carvan, M.J. (2008). Molecular targets of 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin (TCDD) within the zebrafish ovary: Insights into TCDD- induced endocrine disruption and reproductive toxicity. *Reproductive Toxicology* 25, 47-57.

Koseki, Y.; **Fleming, I.A.** (2007). Large-scale frequency dynamics of alternative male phenotypes in natural populations of coho salmon (*Oncorhynchus kisutch*): patterns, processes, and implications. *Canadian Journal of Fisheries and Aquatic Sciences* 64: 743-753.

**Mercier, A.**; Hamel, J-F. (2008). Reproductive biology of deep-sea octocorals (*Primnoa resedaeformis*, *Keratoisis ornata* and *Anthomastus grandiflorus*) around Newfoundland & Labrador. Final Internal DFO Report for Deep-Sea Corals Research Project, Oceans Branch, St. John's, NL, Canada.

**Mercier, A.**; Hamel, J-F. (2008). Nature and role of newly described symbiotic associations between a sea anemone and gastropods at bathyal depths in the NW Atlantic. *Journal of Experimental Marine Biology and Ecology* 358: 57-69.

Milke, L.M.; Bricelj, V.M.; **Parrish, C.C.** (2008). Biochemical characterization and nutritional value of three *Pavlova* spp. in unialgal and mixed diets with *Chaetoceros muelleri* for postlarval sea scallops, *Placopecten magellanicus*. *Aquaculture* 276: 130-142.

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## 9. Dr. Joe Brown Aquatic Research Building (JBARB)

The 2007 – 2008 year proved to be a very successful year within the Dr. Joe Brown Aquatic Research Facility (JBARB). Additions within the JBARB have included a new UV's for larval rearing and broodstock systems, plus oxygen making systems for the facility.

JBARB continues to invest in OSC/JBARB infrastructure and recently contributed towards the purchasing of an identified real-time, quantitative polymerase chain reaction (QPCR) as an increasingly important and versatile research technique that is inadequately supported by current OSC infrastructure.

The JBARB is composed of a core staff of 16 people at both the OSC and cod research cage site in Bay Bull's and North West Cove. Furthermore, during the last year the facility has had, 4 MUCEP positions and 4 work - term students.

During the past year the ARDF has provided research based tours for 460 visitors, including researchers, government officials, and industry members from Canada, USA, Malaysia, Germany, Scotland, China, South Africa, Europe, Norway, Spain, Japan, Tokyo, France, Italy, India, Falkland Islands, Russia, Portugal, Iceland, Denmark and Ireland.

We were also involved in an ARTE documentary about cod with a group based out of Germany.

### Programs:

#### *Atlantic Innovation Fund (AIF) Project- Commercialization of Atlantic Cod*

##### Performance Goals and Deliverables

1. The long-term objective was to develop cost effective, on-growing methods for Atlantic Cod, which results in a quality product;
2. We continued to develop a halibut broodstock and supply eggs to industry partners;



3. We provided substantial training of highly qualified personnel through graduate education and “on the job” work experience. Engagement of these individuals were highly visible throughout industry as it continues to develop;
4. We supported and continue to support yearly production of juveniles for cage trials. Cage research will occur on the commercial sites of industry partners as well as on a “demonstration cage site” situated next to the commercial site.

### Executive Summary

The AIF Project was a very successful project over the past 5 (2002-2007) years for Memorial University, supporting agencies and our industrial partners. All progress and yearly reports have highlighted the research successes, new research collaborations, HQP's and new monies generated as a result of this project.

Notable results of the AIF begin here at the Ocean Sciences Centre with the hiring of a new World Class Researcher/Faculty Member - Dr. Matt Rise who is a Canadian Research Chair in Marine Biotechnology. We also have attained funding through such programs as the ACRDP-DFO-Atlantic Cod Broodstock Program, Cod Genomics and Broodstock Development Project and various others.

This project has highlighted some benchmarks or commercialization challenges for cod aquaculture in this province:

- The identifiable product is the pre-commercial development of a new industry in the province,
- The project has developed some best practices or processes around how to raise cod to provide the greatest return on investment by commercial players,
- No Formal Commercialization Plan is in place from this project,
- The project has moved to the point where The Department of Fisheries and Aquaculture through work performed by the Newfoundland Aquaculture Industry Association (NAIA) has announced “The Terms of Reference” for private companies to set up a “Cod Demonstration Farm” in the province. “The objective of the RFP is to elevate cod aquaculture in Newfoundland and Labrador to the next step towards commercialization.”
- The key challenges may be moving into a 10 fold scale up towards commercialization,
- We need to demonstrate predictability of operations to attract commercial scale funding

- A minimal of 10- 15 million dollars cash is required for the start – up of a commercial size cod hatchery, associated grow-out sites and equipment.
- We feel confident we have education, experience and training, but not the investors' cash to date.

Newfoundland needs to:

- Grow-out significant #'s of fish to 'market size'
- Demonstrate a predictable growth and production model
- Continue to REFINE
  - Growth models with real production data
  - Dietary considerations
  - Husbandry techniques
  - Logistics
  - Environmental and ethical knowledge
- Continue to Recognize the importance of people and training
- Develop appropriate technologies (feeding systems, pumps, lights?) for our conditions and to reduce stress at all stages of growth
- Continue to study Fish health and be pro-active as well as reactive
- Work with the Genome (CGP) project in the development of 'best' broodstock
- Develop commercial-scale Harvest practices and technology
  - Harvest protocols and product development, equipment etc.
- This requires large numbers of fish in 'commercial' setup, separate from research projects but which can be done in conjunction with

#### Final Harvest Results

Over 13,000 fish of market size were processed, giving over 45,000 pounds (20,000 kg = 20 metric tonnes) of HOG cod, yielding 15,000 pounds (6800 kg) of trimmed and skinned cod fillets.

During discussion with harvesters and processing personnel, the following points were raised which have implications for future operations:

1. Techniques for harvesting cod were modified from those for salmon due to their different behaviour in net pens, especially in diving to the bottom of the net. However,

with experience and the right equipment comes great ease in seining and handling large numbers of fish without damage. Large nets require adequate lifting equipment – in fact 2 barges were used at most harvests. Natures Sea Farms Inc. very generously provided the use of their equipment and personnel and the project would not have been able to be completed without their assistance.

2. As compared with wild cod, the farmed cod was more difficult to hand-fillet, especially as they enter rigor quickly. Filleters said they were firmer than wild cod and were more difficult to fillet. People trimming the fillets also found the flesh more difficult and time-consuming to trim. However, one experienced (35 years +) filleter thought that the farmed cod were good candidates for machine filleting and would result in a better yield than hand filleting, and thought that it was an excellent product. The flesh being firmer was seen as an advantage in this case.

3. The mechanical skinner used on the last day of processing did a good job and was very quick. However the degree of ‘silver lining’ on the fillet was more apparent than in wild cod. There was some response from the marketers that customers thought it looked like hake rather than cod. Education and efforts in marketing the product would likely correct this.

## **Project Major Milestones and Activities - Research**

### Activity 1: Larval Rearing Protocols

1. The effect of varying light intensity and tank background on growth, survival and foraging behaviour. Jennifer Monk M.Sc. Candidate (J.A.Brown and V. Puvanendran)

The aim of this study is to investigate pertinent questions as they relate to the mass production of cod on a commercial level. It is important to examine all aspects of growth in order to determine the optimal lighting conditions to rear larval cod to obtain maximal growth and survival from hatching through to metamorphosis.

a). An Investigation of the effect of three different light regimes on growth and foraging behaviour of larval cod (*Gadus morhua*).

In recent years Atlantic cod (*Gadus morhua*) has been identified as a species that has great potential for commercial production. Currently one of the problems encountered with intensive production is inconsistent growth and survival from hatch through to metamorphosis this could be attributed in part to a poor understanding of the optimal culture conditions required for large- scale commercial production. Studies to date have indicated that cod larvae reared under high light intensities perform better than larvae reared under low light intensities. However, it has been hypothesized that a low light intensity may be better during later larval stages. Our study examined the growth, survival and foraging behavior of Atlantic cod larvae reared under varying light conditions in the later larval stages. In this experiment, larvae were stocked at 50 larvae/ liter in six 3000 liter tanks and subjected to three different light intensity regimes;

Treatment 1 - high light from 3-58 days post-hatch (dph), treatment 2 - high light from 3-28 dph and low light from 29-58 dph and treatment 3 - high light from 3-40 dph and low light from 41-58 dph. Weekly length and weight measurements were taken, and foraging behaviour was recorded twice a week. The results show that larvae reared in treatment 2 showed better growth rates in terms of standard lengths and dry weights than the larvae reared in treatments and 3 (Fig. ). Larvae reared in treatment 2 were also more efficient foragers than the other two treatments. However, there were no differences in the survival between the three treatments.

Conclusion: Results of this experiment indicate that the light intensity on cod larval tanks can be reduced earlier than previously thought and the growth of larval cod would be enhanced. This experiment has been completed and was published in *Aquaculture* (257(2006):287-2930. Based on the results of this experiment, light regime of JBARB production protocols have been changed.

b). The effect of tank bottom colour on growth, survival and foraging behaviour of larval cod.

This experiment was undertaken to determine what effect the tank bottom color has on the early growth and survival of larval Atlantic cod. Four 3000 liter tanks (two light bottom and two dark bottom) were setup as per standard JBARB larval rearing protocols and stocked with larvae at 50/liter. Weekly samples of 20 larvae were taken for morphometric measurements and 40 larvae for dry weights. Foraging behaviour was monitored twice a week just after feeding and the fish were observed for the occurrence of four behaviours, length of time spent swimming, the number of attempts to capture prey and the number of times they were successful in their attempts. Results show no significant difference in growth or survival between larvae from the two treatments. Similarly, no significant differences were also found in swimming or foraging behaviour of larvae from the two treatments.

Conclusion: Results of this experiment show no difference in growth, survival and foraging behaviours when the larvae were reared in dark or light coloured bottom tanks. This indicates that larval foraging ability was not affected by the tank bottom colour and thus the growth and survival. However, it is very easy to work with light colour bottom tanks as larvae and prey could be seen easily. As the foraging and growth of the larvae was not affected, the rearing protocol was changed to accommodate light bottomed tanks at the JBARB.

**2.** The ontogeny of the cortisol stress response in larval Atlantic cod and the effect of different commercial live-food enrichment diets on the stress response. Sarah K.M. Westelmajer. (MSc Candidate) – (J.A. Brown and C. Parrish)

The nutritional components of larval live-food enrichment diets, particularly highly unsaturated fatty acids (HUFAs), have been shown to influence larval post-stress survival and cortisol kinetics. Studies to date have found that altering the relative ratio of three specific HUFAs, eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) and

arachidonic acid (ArA), in larval diets has a significant effect on the stress response of several teleost species. Most commercial live-food enrichment products currently available differ greatly in their nutritional compositions and HUFA ratios.

The primary objective of this study was to determine the effect of three different dietary regimes on the growth, survival, and lipid composition of larval Atlantic cod during rearing as well as larval survival and whole-body cortisol kinetics following an acute air-exposure stress. The products being used for the enrichment of both rotifers and *Artemia* brine shrimp include Advantage®, Algamac®, algae paste (*Pavlova sp.*) and INVE's Selco® products.

The ontogeny of the cortisol stress response in larval cod was also being investigated. Pre- and post- acute handling stress tissue samples were analysed for cortisol content at various stages of development starting at hatch and continuing through metamorphosis and weaning. Pooled samples of resting and stressed (30 second air exposure) larvae were taken at 9 different intervals at specific developmental stages. The stages under investigation were:

1. Two days before hatch (-2 days post hatch)
2. Hatch (0dph)
3. First feeding (3dph)
4. End of green-water (13dph)
5. Mid rotifers (30dph)
6. Introduction of *Artemia* (39dph)
7. End of rotifers (47dph)
8. Start of weaning (50dph)
9. End of weaning (59dph)

Pooled samples of whole larvae were homogenized and extracted before analysis using a commercially available enzyme-linked immunoassay (ELISA) kit. The results indicate that the hypothalamus-pituitary-interrenal axis in larval cod is able to respond to external stressors, through the release of corticosteroids, as early as at hatch.

The experiment involving the effect of three different dietary treatments on the stress response of Atlantic cod larvae was completed in August 2005. Larvae fed live-food enriched with a combination of AlgaMac® and *Pavlova sp.* algae paste were larger in standard length and faster growing than the groups fed either Advantage® or INVE products. Differences in growth were seen as early as 160dd (~14dph). Significantly higher post-stress survival was observed in the AlgaMac® + *Pavlova sp.* treatment compared with both of the other dietary treatments after groups of larvae were given a 15 second air exposure stress and transferred in smaller aquaria.

Since the completion of this experiment, whole body corticosteroid levels sampled 30 minutes, 1 hour and 2 hours following a 15 second air exposure stress have been analysed using the same ELISA kits as for the ontogenetic samples. All treatment groups showed classic post-stress cortisol kinetics, which is characterized by an immediate rise in concentration after 30 minutes followed by the start of a decrease after 2 hours. Repeat

sampling from the tanks also caused a rise in cortisol, as seen in the kinetics of the unstressed larvae, but in the Advantage and INVE groups this increase was much less pronounced than the larvae that were given the stress (Fig 41b&c). In contrast, the unstressed larvae from the AlgaMac® + *Pavlova sp.* treatment showed a large increase in cortisol at 30 minutes post-stress that was very similar to the response of the stressed larvae (Fig 41a). Please note, these results are preliminary and quantitative statistics in order to determine significance have not yet been performed.

Samples of live-food and larvae are currently being analysed for total lipid content and fatty acid profiles. The results of this analysis will hopefully be able to explain some of the differences in survival and corticosteroid responses observed in the three treatment groups. Correlations between specific fatty acids known to be involved in the stress response pathway and post-stress corticosteroid levels as well as survival will be performed.

### ***Activity 2: Larval Stocking Density***

Experiments were carried out in Summer-Fall 2006 with 25 (low), 50 (current) and 100 larvae per L. However, due to poor larval quality we have experienced high mortality in all treatments and the experiment was terminated within 3 weeks. Later, after a consultation with the industry, it was decided that this experiment is not a priority anymore.

### ***Activity 3: Weaning***

Can Atlantic cod (*Gadus morhua*) larvae be weaned faster onto dry feed at higher temperatures? Amanda L Burt – BSc (Hons.) Candidate – (J.A Brown and V. Puvanendran)

Live feed production is costly, labour intensive, and comprises a large proportion of the hatchery production cost. The cost of live food production required to culture marine finfish larvae such as Atlantic cod (*Gadus morhua*) can be reduced by a shorter and more efficient weaning period. In this study, hatchery reared cod larvae were exposed to different temperatures while being weaned from *Artemia* (brine shrimp) to dry food from 45 days post-hatch (dph). In the first experiment, two temperatures were used; 11.5°C and 7.5°C. During weaning, the amount of *Artemia* fed to the larvae was gradually decreased while the dry feed was increased. Larval foraging behaviour and mortality were monitored. The growth rate and mortality of the larvae were not significantly different between the two treatments. However, the larvae in the 11.5°C treatment showed a significant increase in the intake of dry feed. Thus, a second experiment was conducted at 11.5°C and 14.5°C to examine if weaning could be further improved. Results showed that the growth rate of larvae between the two temperatures did not differ significantly,

however, mortality rate in 14.5°C treatment was significantly higher than 11.5°C treatment. Larval orientation towards and ingestion of dry feed were not significantly different in experiment two.

Conclusion: In conclusion, no significant difference in growth or dry feed acceptance by larvae in 11.5 and 14.5°C treatments was found but mortality was significantly higher in the 14.5°C treatment. On the other hand, a significant difference was found in dry feed acceptance by the larvae weaned at 7.5 and 11.5°C, however, no difference was found in growth or mortality. Results of this experiment showed that increasing the temperature during weaning to 11.5°C would enhance the weaning process and reduce the weaning time and the cost of live feed. Results also suggest that a possible optimal weaning temperature for larval cod between is 11.5 and 14.5°C.

#### ***Activity 4: Juvenile Growth and Energetics***

Feeding Behaviour and Digestive Physiology of Atlantic Cod and Haddock, Juan Casanova - Ph.D. Candidate (A.K. Gamperl, J.A. Brown)

Mr. Juan Casanova was exploring whether decreasing diet protein content improves food consumption, accelerates the return of appetite, and lowers the cost of digestion; thereby increasing the amount of energy available for growth. These experiments are being performed at 11, 6 and 2°C, using two isocaloric diets [40% (LP) and 55% (HP) protein]. At 11°C, feeding the LP diet to Atlantic cod juveniles resulted in a higher metabolic cost of digestion (SDA). This result is opposite to what we would expect based on data for salmonids at 15°C, and may point to differences in the digestive physiology between salmonids and gadids. However, this higher SDA did not have a significant effect on growth (size at end of experiment, Fig. 60A). At 6°C, the protein:fat content of the diet had no significant effect on SDA or growth of Atlantic cod juveniles, although fish fed the HP diet had a significantly better FCR (Food Conversion Ratio, Fig. 61). At present, it is difficult to predict how feeding the HP vs. LP diets will affect growth rate at 2°C. If the current trend between temperature, and FC (food consumption), SDA and FCR continues, we expect SDA to be lower and FC to be higher, but FCR to be poorer, in fish fed the LP diet.

As expected, temperature had a major influence on the growth and digestive physiology of the two species: For example: food consumption of haddock was reduced dramatically at 2°C (by 80% as compared with 11°C); 2) it took approx. 2.5x longer to complete digestion at 2°C when the amount of food eaten was taken into account (ie. when the duration of SDA is expressed as  $\text{h g}^{-1}$  food ); and 63) growth rate of haddock was extremely small at 2°C due to both a reduction in food consumption and an increase in FCR.

Although, diet (40% protein; 18% fat vs. 55% protein, 12% fat) had little effect on the digestive/ metabolic physiology of the two species, it was apparent from the haddock experiments that specific growth rate was reduced slightly with the low protein diet due to a poorer FCR. Although the effect of diet on SGR and FCR at 6 or 11°C for cod was not

as clear, we are awaiting the results from the 2°C trial.

When the two species are compared, it is apparent there were no major inter-specific differences in digestive physiology/metabolism. In contrast, experiments at 11°C show that: 1) haddock grow approx. twice as fast as cod due to much greater food consumption and a better FCR. Again, we are awaiting the 2°C growth trial on cod so that comparisons can be made at this temperature.

In summary, these studies to date show that: 1) getting fish to feed more at low temperatures is a critical issue for the Newfoundland cod aquaculture industry, and that alterations in the protein/fat ration of the feed are unlikely to be of significant benefit with regard to feeding behaviour, digestive costs, or time required for digestion; 2) growth/FCR is better with the high protein diet.

The chronic thermal experiments were not performed on the cod due to renovations associated with the cod genome project, and are now ongoing using fish from the Cod Genome Project. However, the final experiment (2°C cod) in our examination of the interactive effects of temperature and diet on haddock/cod growth, metabolism was completed.

The results confirm that food consumption and growth are highly temperature dependent in cod and haddock, but show that the magnitude of this temperature sensitivity is quite different. For example, growth rate decreases by 70% in cod, but by > 90% in haddock, between 11 and 2°C. This difference was related to a significant decrease in haddock feed conversion efficiency and food consumption, as compared with only food consumption in cod. With respect to the examination of whether lowering dietary protein levels at cold temperatures would enhance growth rate, this research indicates that there is no benefit to feeding low protein diets. Decreasing dietary protein content does not reduce maximum post-feeding oxygen consumption (SDAMAX) or the metabolic costs associated with digestion, and specific growth rate, food consumption, feed conversion efficiency and gastric evacuation rate are either similar or decreased.

## **Other Studies**

**Influence of Lighting Regime on the Sexual Maturation of Cage Cultured Atlantic Cod (*Gadus morhua* L.).** Anne Kellett (M.Sc. student) – Late Joe Brown, Atef Mansur, V.Puvanendran, Cyr Courtier

Abstract: The early maturation of cage cultured Atlantic cod (*Gadus morhua* L.) is a concern in the development of commercial aquaculture. Photoperiod manipulation has been shown to have significant effects on delaying maturation in cod in tanks, however the results in sea cages are not clear. We are investigating the effects of continuous light on early maturation of Atlantic cod in sea cages on the south coast of Newfoundland. Two experimental groups of 2000 cod, each in two cages, were exposed to continuous light (LL; 24 hrs a day) from two 900 lux submerged bulbs. Control fish in two other cages

received only the natural photoperiod (NL). This experiment was started at the summer solstice when the cod juveniles were 16 months old. Samples of 15-30 fish per cage were taken 5 times between June 2005 and May 2006. Experimental fish exposed to LL had lower gonadosomatic and higher hepatosomatic indices which could be an indication of a difference in their level of maturity. Growth was significantly different for females ( $p=0.027$ ), but not for males ( $p=0.474$ ), between the experimental and control groups for May 2006 sample. A swim bladder abnormality found predominantly in LL treatment fish may explain a lower overall growth rate. Our results indicate that supplying continuous light could be effective in delaying early maturation in Atlantic cod in sea cages

Conclusion: The results thus far analysed indicate that exposure of 16 month old Atlantic cod in sea cages to continuous light (LL) from midsummer to late fall (4 months) successfully delayed maturation in cod beyond spring spawning season. GSI values were significantly lower in the continuous light treatment, however differences in growth were smaller than expected. Female cod were significantly larger when reared under continuous light, whereas growth in male cod was similar between LL and NL groups. The abnormal swim bladder inflation observed in fish from continuous light cages could have had a negative impact on growth. Further investigation is needed to determine the cause of swim bladder abnormalities in Atlantic cod.

### **The Atlantic Cod Genomics and Broodstock Development Project (CGP) Project Progress ([www.codgene.ca](http://www.codgene.ca))**

The objective of the CGP is to develop a breeding program and a set of fundamental genomics tools that will be used to supply the developing Atlantic cod (*Gadus morhua*) aquaculture industry in Canada with elite broodstock. The CGP is an \$18.1 Million Project with University, Industry, Not-for-Profit and Government Partners. This project is vital to solving several key issues that have hindered the development of the cod aquaculture industry in Canada. End point deliverables for the CGP include elite cod broodstock selected for performance in industrial-scale aquaculture production as well as a set of cod genomic markers and a genetic map that can be applied to accelerate the enhancement of cod broodstock.

Traditionally, Atlantic cod aquaculture has depended on unselected wild cod stocks for production which has limited progress in the industry. The CGP's captive selective breeding program is a first step towards domestication of this species. At the end of the project, ownership of elite cod broodstock developed by the CGP will be transferred to the founding industry partners in New Brunswick and Newfoundland and Labrador. The CGP has successfully completed selection of cod broodstock in New Brunswick and Newfoundland and Labrador. These broodstock have been selected based on Estimate Breeding Values calculated from pre-harvest and harvest data collected on the first year classes of family fish generated by the project. These two broodstocks represent the first captive selected broodstocks for cod in Atlantic Canada.

A major factor limiting the directed improvement of cod broodstock has been the scarcity

of molecular tools available for this species. Within 18 months of project inception, 94% of publicly available DNA sequence information for cod was contributed by the CGP, and at present the CGP remains the leading contributor of genomics information for the species worldwide. To date, the CGP has generated approximately 158,000 DNA sequences and has started building a 20,000 element microarray, a high-throughput Illumina SNP genotyping platform, as well as a cod genetic map which will be used by the CGP to identify quantitative trait loci (QTLs) and to develop genomic markers applicable in Marker Assisted Selection (MAS). MAS will enable rapid enhancement of cod broodstock in Canada, and is an approach that has been the cornerstone of recent advancements realized in other animal production systems (e.g. chicken, swine, dairy cows, and beef cattle). The CGP will give Canada a competitive edge in the developing cod aquaculture industry by ensuring that Canadian producers will have tools to improve the quality and volume of their product.

Through the CGP, a number of individuals have gained experience in various aspects of cod aquaculture, and several of these persons were attracted to the Atlantic region by the project. It is expected that these individuals will continue to be involved in cod aquaculture after completion of the CGP, and will persist as a tremendous resource for the growing cod industry. By uniting the collective energies, talents and resources within the region, Atlantic Canada has the potential to be recognized globally as the leader in genetic marker validation in cod aquaculture and, in turn, establish the region as the world's premier supplier of cultured product.

### *Broodstock Development*

Since project inception in January 2006, the CGP has established family-based breeding programs in Newfoundland and New Brunswick / New Hampshire. The first three major spawning seasons have been completed. Between the fish being evaluated as part of the CGP and surplus cod, over 100,000 juvenile cod were placed in sea cages in the Atlantic region by November 2006. An estimated 94,000 more were available for transfer to sea cages by the end of 2007. Juveniles from the third spawning season were reared at the Ocean Sciences Centre, Memorial University of Newfoundland and at the newly constructed hatchery at the Huntsman Marine Science Centre in St. Andrews, NB during 2007 until the fish were transferred either to sea cages or to land-based rearing facilities for broodstock maintenance. In September 2008, the fourth major spawning season was started in NL, and this process will also commence in NB in December.

As part of the broodstock development aspect of the project, once CGP family fish reach an average weight of 15 grams, they are tagged and assessed. Throughout the spring and summer, staff at rearing facilities track family performance related to growth, survival and the overall health of the progeny. Significant variation in growth between the families has been observed, and the heritability estimates are high, indicating that the breeding programs will be successful at improving growth rates of cod for aquaculture.

### *Genomics*

The CGP has dramatically improved the availability of genomic resources for this species. Within the first 18 months of project inception, 96% of publicly available DNA sequence information for cod was contributed by the CGP. To date, just over 158,000 sequences have been submitted to GenBank – a publicly accessible genetic sequence database.

Sequences are being used within the CGP for gene discovery and the development of gene linked markers. Marker identification has yielded >4,700 “predicted informative” SNPs (single nucleotide polymorphisms) and 150 microsatellite markers. The resources being developed by the CGP will be invaluable for analyzing quantitative trait loci (QTL), identifying genes of potential importance in Canadian cod aquaculture and enabling marker assisted selection (MAS) within cod breeding programs. MAS will enable rapid enhancement of cod broodstock in Canada, and is an approach that has been the cornerstone of recent advancements realized in other animal production systems including beef, pork and chicken production.

#### *Other Project Activities*

The CGP includes ongoing studies of the stress response in cod and performance differences between haemoglobin genotypes, as well as studies that examine the cod’s response to thermal challenges and immunogenic stimuli that simulate disease challenges. Results have shown that there is considerable variation among cod families with respect to their tolerance to elevated temperatures and stress; thus, there is great potential to select fish that will perform well under variable aquaculture conditions. The project has also identified many genes that have altered expression when cod are exposed to immunogenic stimuli. The majority of these genes will be represented on a ‘gene chip’ or microarray that is currently being generated.

The CGP also includes research on ethical, economic, environmental, legal and social issues associated with the science of genomics (GE<sup>3</sup>LS). The GE<sup>3</sup>LS research team is developing solution-oriented legal and policy options regarding: legal ownership of commercially valuable research results, the status of elite cod broodstock under Canadian environmental law and Canada’s international obligations, and ethical and legal options regarding benefit sharing and improved methods of consultation with the affected publics.

#### **DFO-NL Aquaculture Collaborative Research and Development Program (ACRDP)**

For many years, the fishing industry in Atlantic Canada has been a major contributor to the region’s cultural identity and economy. Declining fish stocks have brought many challenges to this industry and to those dependent on the revenue it generated. The subsequent growth of the Salmon aquaculture industry helped to revitalize the local economy but the aquaculture industry in the Atlantic Region would benefit from diversification in order to sustain growth.

While diversifying to other finfish species such as Atlantic cod seems a logical step, aquaculture often relies on wild populations for broodstock which do not always respond well to culture conditions. Therefore, the aquaculture industry would benefit significantly from strategies that allow selection of Atlantic cod that perform well in terms of growth, resistance to disease and stress, and other economically important factors, while ultimately giving good product quality. The Atlantic Cod Genomics and Broodstock Development Project (CGP), in partnership with the aquaculture industry, will identify and select these elite broodstock through the application of selective breeding and genomics. The establishment of family-based selective breeding programs in New Brunswick and Newfoundland and Labrador will ensure that local stocks can be used for the benefit of the provincial industries. Valuable traits for the aquaculture industry will be measured and evaluated such as growth, health, sexual maturation, stress tolerance, fillet quality and yield. In addition, the feasibility of incorporating specific traits in future breeding programs to ensure fast growing, healthy, high quality Atlantic cod, will be determined. In parallel, thousands of cod genes will be sequenced to look for differences in these genes between individual fish. This will allow the identification of a set of molecular markers for use in cod, and to associate these markers with fish that perform well or badly under aquaculture conditions. A major factor limiting the directed improvement of cod broodstock is the scarcity of molecular tools currently available for this species. The CGP will dramatically increase the genomic resources available. Sequences generated will be used to identify variation in Canadian broodstock, develop gene-linked markers for use in broodstock management, for comparative genomics, and generate tools for expression analysis. Researchers will work closely with CGP scientists and industry partners to examine ethical, environmental, economic, legal and social issues related to CGP research results (GE3LS). These researchers will examine ethical questions related to benefit sharing among research and commercialization partners, and other questions related to the status of elite Atlantic cod broodstock under Canadian environmental law.

## 10. Public Education Program

Since 1988 the Ocean Sciences Centre has organized and played a continuous role in public awareness in marine sciences through public and marine science programs. The current public education program (PEP) is a complimentary interactive and interpretive outdoors activity for tourists, school children and local visitors. Features of the program include an outdoor touch tank, where visitors can experience a never - ending variety of local marine life; an out - door observation platform for viewing our captive population of harp seals; and marine interpreters (MUN summer students) to answer questions and explain current research initiatives at the facility. The program operates seven days a week from June 1<sup>st</sup> to Labour Day weekend. This past summer the program successfully welcomed over 15,000 visitors, which included individuals, groups (i.e. school children, daycare kids, summer camps and bus tours), and organized educational programs (i.e. Shad Valley).

The OSC PEP has been directly involved in marine science programs offered to high - school students within Canada. Since 2003, the OSC has played an important role in Shad Valley Memorial, which host 50 of the brightest and most enterprising senior high school students from across the country. As part of their program at Memorial, the students were given the opportunity to spend a day exploring the Ocean Sciences Centre and learning about current research initiatives in the areas of oceanography, fish physiology, evolutionary ecology, aquaculture and biotechnology.



## 11. Seal Research Facility

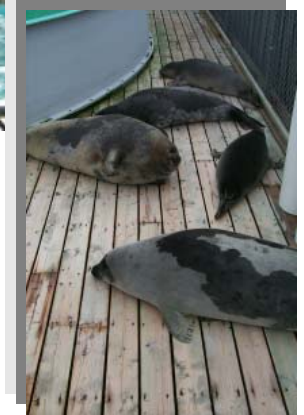
The behaviour research program continues with the Match to Sample training. This allows the seals to select objects which they perceive to be the same, which will allow us to research the perceptual capabilities (colour vision, visual acuity under and above water, hearing ability for detection of prey and predators) as well as the cognitive abilities of the harp seals.

Other research projects include the profile of vibrissae loss and re - growth during moulting in harp seals and assays of the thyroid hormones to determine the physiological trigger of this moult. The annual profiles of steroid hormones of the harp seals are continuing.

Harp seal blood samples were supplied for Biology teaching labs (Animal Physiology) again this year.

The training of the seals and these research initiatives has been achieved by the ongoing participation in experiential learning programs and with the help of volunteers, (High school co-operative programs, Women In Science and Engineering, and Memorial's Undergraduate Career Experience Program). The existing Seal Volunteer Program continues, with volunteers providing seal care and feeding on weekends, and with additional volunteers assisting with weekday training and husbandry during the summer.

Our ongoing participation in extension and education included the development of scripts and training of the Marine Interpreters for the Public Education Program, as well as responding to the varied requests from the media (Kids CBC, CBC radio, NTV News, Gazette (MUN), MUSE (MUN) and the general public). Seal biology and research was one facet of the Shad Valley Memorial enrichment program again this year. Presentations were also made at Water Day and Oceans Day events.



## 12. Field Services Unit

Throughout the period of September 2007 to August 2008 the Field Services Department of the Ocean Sciences Centre has again provided numerous services to various researchers, departments, and organizations. As in previous years, Field Services regularly provided collections of fish, invertebrates and algae for teaching purposes for the lab component of Introductory Biology, Botany, Biology for Students of Earth Sciences, Invertebrate Biology, Cell Biology, and Animal Physiology courses as well as for continuing research of faculty and graduate students of the OSC. In addition, Field Services has collected specimens for teaching purposes and research at the Marine Institute, and has made regular deliveries of seawater for their aquaculture facility. Each spring, the Field Services Unit travels to MUN's Bonne Bay Marine Field Station in Norris Point to collect a variety of specimens for display in their aquarium. During the summer months they made similar collections for the touch tank for the Public Education Program at the OSC.



Since 2004 Field Services have assisted in the initial set-up of an elaborate underwater oceanographic station inside the sill of the east arm of Bonne Bay that was connected directly to the Field Station by a fibre-optic cable. Due to malfunctions their services were required in fall 2006 for retrieval and replacement of system components and cleanup of the station site. Once the components were reinstalled the oceanographic station became operational. However, due to continuing problems with the connections to the station they returned in summer 2007 to remove all the components from the station.

Previously, Field Services completed a series of dives in the Marine Institute's flume tank to test placement of several different screen configurations to improve water flow within the tank. During the fall of 2006, and spring 2007, some of these screens needed to be reattached as they had become partially dislodged. They also assisted in setting up for their 2007 ROV student competition in the flume tank.

The Field Services Unit also provide services beyond Memorial University. They regularly collected and ship specimens for a saltwater aquarium display in the Ontario Science Centre. As in previous years, in the summer of 2007 they collected seabutterflies for international researchers, shipping some to Paris, France and Madrid, Spain. This past summer, the Field Services Unit assisted visiting researchers from the University of Toronto by acting as guides and dive tenders while they collected coralline algae specimens for their climatology research. Using the Field Services Unit dive truck, which is equipped with a 2500 L tank and oxygen cylinders with diffusers, the team were able to transport specimens vast distances, including the collection and delivery of specimens for the DFA Agri-Foods Show in Mount Pearl (Spring 2007) and Harbour Grace (Fall 2008).

Starting in the fall of 2006, Field Services has been directly involved with a collaborative project between Cynthia McKenzie (DFO) and Don Deibel (OSC), and in association with DFA, entitled “Early Detection and Monitoring of Aquatic Invasive Species in Newfoundland and Labrador in High Risk Areas”. The purpose of this project is to determine the presence and abundance of non-native species in Newfoundland coastal waters, and whether such species pose ecological or economic threats in this province and is part of the Government of Canada’s Action Plan to Address the Threat of Aquatic Invasive Species (AIS). During the first year we surveyed harbours in Botwood, Port aux Basques, Bay of Islands, and Argentia and discovered in this last harbour the invasive colonial tunicate, Golden Star, *Botryllus schlosseri*. After finding this species the Field Services Unit were requested by DFA to follow up with surveys in adjacent areas near mussel aquaculture sites. This included some ice diving near wharves in the Bay of Islands in the winter of 2007. The following summer (2007), all sites were revisited. However, fishermen had discovered another invasive species, green crab, *Carcinus maenas* in North Harbour, Placentia Bay. The Field Services Unit were then requested to aid in more extensive surveys in Placentia Bay to determine the distribution of the golden star and green crab. A portion of this initial work was filmed for CBC news. Following the fall surveys, DFO graciously paid for one of the Field Services Unit team members to attend the 2nd International Invasive Sea Squirt Conference in Brudenell, PEI with other Newfoundland representatives in order to gain more knowledge in taxonomy and biology of invasive sea squirts. The fall 2007 surveys were greatly expanded to cover many new areas we had not checked previously. During these surveys on the west coast the team discovered a (non-invasive) species of fish previously unrecorded in Newfoundland waters. Then during the survey of the south coast region the team discovered another invasive colonial tunicate, the violet tunicate, *Botrylloides violaceus* in Belloram. Field Services have also attended many of the provincial AIS meetings and workshops regarding possible mitigation of these problematic species. In the spring of 2008, they were hired by DFO to act as site managers during an eradication experiment to remove the violet tunicate in Belloram. As such they acted on behalf of DFO to oversee the removal of this species by commercial divers and document and film before and after events of this removal. One of the team members was also interviewed by a reporter from the local newspaper and also CBC News to describe the work being conducted. Follow-up surveys were conducted across the island in the summer (2008) in which the site in Belloram was carefully inspected for regrowth of violet tunicate.

The Field Services Department at the Ocean Sciences Centre as always continues to provide the aforementioned services and other assorted duties to Memorial University and outside researchers and interested parties. The Field Services Unit hope to expand and grow with the changing needs of the research community. In the future we wish to work more closely with OSC researchers to assist their work and have further collaborations with OSC researchers to advance the scientific knowledge of our oceans.

## 14. Facilities and Services

### *1. Animal Husbandry*

Animal Husbandry is one part of a greater service that includes Fish Health and the Management of the resident seals. This service is responsible for maintaining all freshwater and seawater tank space, aquaria, and the feeding, care and health of contained animals. It takes a coordinated effort to manage animal husbandry. Many volunteers help with the care of the resident seals so that they are available for seal research and for public education and viewing.

Services and tanks include:

- Flow through systems for seawater and freshwater
- Seawater system is temperature controlled (heated/chilled)
- Freshwater egg incubator (re-circulation and flow-through) systems
- Aeration lines, air stones and temperature monitoring
- Up-welling silos from 0.5 to 12 m<sup>3</sup> for marine larval fishes

### *2. Field Services Unit*

Field Services maintains a variety of Scuba gear for cold-water year-round diving, benthic trawls and drags, seines, plankton nets, niskin bottles, CTD, underwater video camera and a portable air compressor and generator. The unit operates a 4 m zodiac, 7 m Boston Whaler and 5 ton multi-purpose vehicle with aeration and recirculating seawater holding tanks (2500 L) suitable for transporting live specimens long distances.

### *3. Computer Services*

OSC Information Technology Services (OSCIt) is responsible for maintaining all computer and related ancillary systems within the scope of the Ocean Sciences Centre facilities and associated satellite facilities (e.g. 4 Clarke Place). OSCIt provides broad consultative services with respect to diverse computational research needs and acts as an information technology liaison service between the OSC and the Department of Computing and Communications as well as other external organizations requiring access to OSC related computing facilities.

Typical services are:

- I. Network server environment: The OSCit production server environment provides a virtualized, multiply redundant, multi core, high availability set of primary, secondary and edge server devices designed to provide researchers, administrators and graduate students with single sign on authentication, high availability redundant data storage services, intra- and Internet web capability, research programming environment and computational analysis platforms, network printing services, and a central information management system (CIMS) suite of tools.
- II. Personal computing and laboratory support services: Apart from standard personal computer support, OSCit also provides support services for analytical laboratory equipment with embedded or attached computing systems providing data capture, logging & analyses. This includes research equipment such as CTDs, gamma counters, HPLC, and GC-Mass Spectrophotometers.
- III. Network connectivity and integration: In conjunction with the Department of Computing and Communications, OSCit provides liaison services regarding equipment access to Memorial University's network. In addition, OSCit also operates an independent layer 2 gigabit network for internal server connectivity and high capacity laboratory data storage.
- IV. Research computing consultation services: OSCit provides a suite of tools and platforms to generate systems and programming solutions for diverse research computational needs involving but not limited to large scale data capture and computational analysis.
- V. World wide web and remote data access: OSCit provides a liaison service to web tools provided by the Department of Marketing and Communications as well as a suite of web systems designed specifically for OSC administrative- and research use. OSCit also provides tools and consultation of the design, development and deployment of web services and graphics. Systems designed to allow for secure external access to research data facilitate support to interdisciplinary projects.
- VI. Multimedia classroom services: In conjunction with the Department of Distance Education and Learning Technologies (DELT), OSCit operates and maintains an electronic classroom which includes current state of the art collaborative systems. OSCit also provides training and instruction in the

use of available classroom systems.

VII. Image and Data Analysis Facility (IDAF): This facility provides a suite of systems and tools designed to enable and aid researchers in the analysis of large scale research imagery and numerical data. Sophisticated image capture tools such as low light digital microscopy cameras are available. This facility is currently undergoing redesign in order to improve its capability.

#### *4. Laboratory Equipment*

##### Analytical Equipment:

- Shimadzu TOC-Vcph/cpn Total Organic Carbon Analyzer
- Perkin Elmer CHN Analyzer - PE2400 Series II
- Image Pro Plus image analysis system
- Autotitrator
- Iatroscan
- Varian 3400 GC
- Varian GC/MS
- HP GC
- Velp extractor
- Enviroflow nutrient analyzer
- Rotovap
- Real Time PCR
- PCR
- HPLC
- Spectrophotometers
- Plate reader
- Beta counter
- Gamma counter
- Water baths
- Incubators/shakers
- Chillers
- Electrophoretic equipment
- Floor and benchtop centrifuges
- UV visible and fluoresces
- Micro balances
- Variety of microscopes (Stereo, compound, UV, etc)
- Vapor pressure osmometer
- Flame photometer
- Walk-In Cold Rooms, with Running or Filtered Seawater

- Portable Cold room with Dry Area
- BioRad Model 2110 Fraction Collector
- Neslab
- Temperature controlled respirometers and associated oxygen measurement equipment (polarographic, galvanic and fiber optic)
- Doppler and Transonic meters

Oceanographic Equipment:

- Video Plankton Recorder, which includes SBE 19 Sealogger
- CTD's
- Various Plankton Nets (Bongos, Tucker Trawl, Ring Nets, Neuston Nets) and Cod Ends
- Plankton Pumps
- Sonicator
- Niskin Bottles
- Fluorometers
- Flume Tank
- Multi-corer
- Box Corer
- Acoustic sounding equipment
- Acoustic telemetering temperature/depth profiler

*5. Laboratory and Technical Services*

Laboratory Services performs a variety of semi-skilled and manual work to support research and training at the Ocean Sciences Centre. These services include on-site minor construction; major infrastructure project co-ordination; development and construction of specialized research equipment and aid in project design and implementation.

Furthermore, the Ocean Sciences Centre has on-site electrical and electronic repair, design, construction, and maintenance services.

## 15. OSC Visiting Researchers

### *Visiting Scientists*

Dr. Anver Cnaani Department of Fisheries and Wildlife Sciences College of Natural Resources Virginia Polytechnic Institute and State University	Collaborations with Dr. Garth Fletcher October 22-26, 2007
Dr. Ewen McLean Director Virginia Tech Aquaculture Centre Department of Fisheries and Wildlife Sciences College of Natural Resources	Collaborations with Dr. Garth Fletcher October 22-26, 2007
Mr. Carlos A. Ravest Presa Marine Biologist Chile	Collaborations and training with the Dr. Joe Brown Aquatic Research Building January 15, 2008- March 4, 2008
Mr. Edmundo Pérez Vergara Marine Biologist Chile	Collaborations and training with the Dr. Joe Brown Aquatic Research Building February to March 2008
Mr. Jorge A. Del Angel- Rodriguez Scientists Centre of Biological Research of Norwest Mexico	Collaborations with Dr. Chris Parrish's Laboratory June 16- October 17, 2008
Ms. Laura Carreón Scientists Centre of Biological Research of Norwest Mexico	Collaborations with Dr. Chris Parrish's Laboratory June 16- October 17, 2008

### **Visiting Students**

Ms. Paulette Penton M.Sc. Candidate Department of Zoology University of Manitoba	The adaptive significance of two spawning strategies in capelin ( <i>Mallotus villosus</i> ) in coastal Newfoundland July 2008-September 2008
Sandrine Baillon MSc Candidate University of Western Brittany France	Gametogenic synchrony with respect to time, depth and location in three species of deep-sea echinoderms- Dr. Annie Mercier's Laboratory January- June 2008
M.I. Martinez PhD Candidate Museo Argentino de Ciencias Naturales Argentina	Gametogenesis of holothurians from temperate waters- Dr. Annie Mercier's Laboratory January 2008
Mr. Sandro Filipe Padeiro Pereira Student Escola Superior de Tecnologia do Mar- Ploytechnics Institute Portugal	Collaborations and Training at the Dr. Joe Brown Aquatic Research Building January 5, 2008- April 5, 2008
Ms. Héloïse Lavigne Graduate Student AgroParisTech, France	Collaborations with Dr. Richard Rivkin's Laboratory January 2009-June 2009

## 16. OSC Seminars

### Biology/OSC Seminar Series 2007 – 2008

Dr. Hugh Whitney Provincial Government of Newfoundland and Labrador	Rabies in Newfoundland and Labrador September 14, 2007
Dr. Karen Kidd University of New Brunswick	Is the birth control pill an effective for of birth control in fish (and other aquatic organisms)? September 21, 2007
Dr. Kathy Hodgkinson Genetic Counsellor/Research Associate, Provincial Medical Genetics Program, Eastern Health	Human Genetic Research in Newfoundland: a World Class Founder Population September 28, 2007
Dr. William Montevecchi Biology Department, Memorial University	Tracking the Movement Ecology of North Atlantic Seabirds October 5, 2007
Dr. Diane Cowen The Lobster Conservancy, Maine, USA	Community-Based Lobster Science October 12, 2007
Dr. Ian Fleming Director, Ocean Sciences Centre, Memorial	Shapes of selection during breeding: alternative reproductive tactics to MHC-based mate choice October 19, 2007
Dr. Douglas Campbell Canadian Research Chair in Environmental Science, Mount Allison University	Niche Partitioning in a Variable Ocean: Photoinactivation and Repair Rate in Phytoplankton November 2, 2007
Dr. Jay Foster Department of Philosophy, Memorial University	Testimony in Science: The Significance of Credibility and Judgment November 16, 2007

Dr. Scott Grant Centre for Sustainable Aquatic Resources, Marine Institute, Memorial University	Exploratory fishing surveys and biological resource assessment of Atlantic hagfish ( <i>Myxine glutinosa</i> ) on the southwest slope of the Newfoundland Grand Bank February 1, 2008
Dr. Geoff Veinott Research Scientist, Northwest Atlantic Fisheries Centre	Renews River Salmonid Project: Salmon, Seals, and Seabirds: An Attempt at the "ecosystem approach" February 22, 2008
Dr. Paul Snelgrove Canadian Research Chair in Boreal and Cold Ocean Systems, OSC, Memorial University	Scientific Criteria for Conservation and Sustainable Usage of Marine Biodiversity in Canada's Oceans: The Canadian Healthy Oceans Network February 29, 2008
Vicki Friesen Queens University	New Insight into Seabird Ecology, Evolution and Conservation Provided by Molecular Markers March 7, 2008
Dr. John Fryxell Professor, University of Guelph	Spatial Processes and Predator-Prey Dynamics in the Serengeti March 29, 2008

### OSC Seminars 2007-2008

Dr. Neil Metcalfe Head of the Division of Environmental and Evolutionary Biology, Institute of Biomedical and Life Sciences, University of Glasgow	Why are salmon so badly designed for feeding at night. September 7, 2007
Dr. Avner Cnaani Postdoctoral Fellow, Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University	Genetics of Sex Determination in Tilapia October 25, 2007
Dr. Ewen McLean Director, Virginia Tech Aquaculture Center	A Synopsis of Research on Cobia: a Species New to Aquaculture October 25, 2007
Dr. Rob Campbell Post-doctoral Fellow, Prince William Sound Science Center, Cordova, Alaska	The Ups and Downs of the Plankter October 31, 2007
Wendy Michaud PhD Candidate, University of Waterloo, Ontario	Ecological Driven Divergence Over Contemporary and Post-Glacial Time Periods Among Marine Charr, <i>Salvelinus alpinus</i> February 4, 2008
Dr. Julie Ambler Professor of Biology, Millersville University, Millersville, Pennsylvania	'Biological and Physical Conditions for Blooms of Cladocerans and Tunicates in Virginia Coastal Waters' May 27, 2008
Dr. Keith Tierney Dept. of Biological Sciences, University of Windsor	Integrating Molecular to Behavioural Olfactory Responses in Fishes July 3, 2008
Dr. Neel Aluru Dept. of Biomedical Sciences, University of Guelph	Molecular Mechanisms of Toxicant Action: Insights from Hypothalamus-Pituitary-Interrenal (HPI) and Somatotropic Axis In Trout July 7, 2008

Dr. Luis Afonso Genome Atlantic	Physiological Changes in Stressed Fish: Endocrine, Metabolic and Cellular Responses July 10, 2008
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## Appendix

