



Annual Report 2006- 2007



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# 1. Director's Report

The Ocean Science Centre (OSC) continues to strive to be a leading centre for marine research in Canada and globally. It is one of Canada's largest marine laboratories. 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 academic year 2006-2007 was one of continued success and growth at the OSC. In July, we were delighted to welcome Dr. Patrick Gagnon to the OSC as a tenure-track faculty member in Marine Ecology. Pat brings expertise in the structure and function of marine benthic ecosystems. He merges approaches across differing scales from complementary field and microcosm experiments with marine organisms to field surveys of benthic populations and communities using scuba and remote sensing and GIS. Pat's addition brings the OSC's faculty complement to 13.

OSC faculty supervised 59 graduate students in 2006-2007, 14 of which graduated, and five postdoctoral fellows. Fifty-eight undergraduate students also worked at the OSC on various projects. The joint efforts of OSC faculty, students and staff resulted in 45 publications and an additional 42 publications in press. This work was supported by more than \$5.6 million in research funding administered through the OSC, including a large grant (Gamperl and Rise) from Genome Canada that was recently funded to develop a breeding program and a set of fundamental genomics tools for Atlantic cod.

Researchers and students from across Canada and from Korea, Spain, Sweden, United Kingdom and the United States also made use of the research facilities and expertise of the OSC this past year.

Another highlight of this past year was the renaming of the Aquaculture Research and Development Facility (ARDF) in honour of Dr. Joe Brown, who passed away in 2005.

The dedication of the Dr. Joe Brown Aquatic Research Building (JBARB) occurred on 9 July during a wonderful ceremony reflecting on Joe’s legacy. This legacy included internationally-recognized and award-winning research, his mentorship of students and “his passionate sense of humour, humanity and empathy.”

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. Donald Deibel - Professor (Research) - B.Sc. Bucknell Univ. USA, Ph.D. Univ. of Georgia, USA.

Dr. William Driedzic - Professor - B.Sc. (Hons.) York, M.Sc. Toronto, Ph.D. 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., Ph.D. Univ. of Toronto.

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

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

Dr. Chris Parrish - Professor (Research) - B.Sc. Univ. College of Swansea, UK, Ph.D. 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 - 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. Luis Afonso - National Research Council  
Dr. John Anderson - Department of Fisheries and Oceans  
Dr. Dave Cote - Terra Nova National Park  
Dr. Elizabeth Deblois- Jacques Whitford Environment Ltd.  
Dr. Vanya Ewart - National Research Council  
Dr. Michelle Hale-(University of Portsmouth)  
Dr. Stewart Johnson - National Research Council  
Dr. Atef Mansour - Department of Fisheries and Oceans  
Dr. Robert McKinley - University of British Columbia  
Dr. J. 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  
Dr. Stephen Walsh - Department of Fisheries and Oceans

### ***Professor of Emeritus***

Dr. Derek Burton  
Dr. Garth Fletcher

### ***Research Associates***

Dr. V. Puvanendran

### ***Research Specialist***

Dr. Michele DuRand

### ***Postdoctoral***

Dr. Blair Adams (Fleming)  
Dr. Michelle Hale (Rivkin)  
Dr. Erik Heibo (Fleming)  
Dr. Grant Murray (Schneider/Neis)  
Dr. Piotr Trela (Deibel)  
Dr. Yusuke Koseki (Fleming)

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

Corina Busby - Research Assistant II (Gamperl)  
Danny Ings - Research Assistant II (Fleming)  
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)  
Connie Short - Research Assistant II (Driedzic/Department)  
Candice Way- Research Assistant I (Rivkin)  
Jeanette Wells - Research Assistant I (Parrish)  
Lana Combdon- Science Technician I (Seals/Department) (April 1, 2007)  
Sean Dolan- Science Technician III (Fleming)  
Matt Pittman- Science Technician I (Seals/Department) (Finished March 12, 2007)  
Stephanie Stack- Science Technician I (Deibel- Dec/07)  
Christine Vickers - Science Technician III (Department)

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

Marc Bolli - Research Computer Specialist  
Maureen James - Intermediate Clerk Steno  
Ken Langdon - Computer Support Technician  
Danielle Nichols - Research Marketing Manager  
Winnie Sparkes - Intermediate Secretary  
Delores Wheeler - Administrative Staff Specialist II

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

Danny Boyce - Business Manager  
Francine Fortune - Science Technician III  
Darrell Green - Science Technician III (Finished Jan, 2007)  
Rodney Healey - Research Assistant II  
Jennifer Monk - Science Technician III  
Lori Thorne - Research Assistant I  
Denise Tucker - Science Technician III (finished March, 2006)  
Cathy Williams - Science Technician III

## ***Pools Cove Cod Grow - Out Site***

Daniel May - Science Technician I  
Sheldon Perham - Science Technician I  
Courtney Williams - Science Technician I (Finished December, 2006)

## ***Field Services***

Renee Boland - Dive Technician  
Robert Guest - MUN Safety Diving Officer I  
Robert O' Donnell - Dive Technician II  
Philip Sargent - Research Assistant /Dive Technician

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

Danny Au - Laboratory Facility Technician I  
Randy Cahill - Facility Custodian  
Michael Carrigan - Facility Custodian  
James Devereaux - Laboratory Services Supervisor  
Jerry Ennis - Laboratory Facility Technician I  
Jim Fowler – Deliveryman (LTD)  
Terrance Harris - Electronics  
Jim Hopkins - Facility Custodian  
Wayne Morrissey - Facility Custodian  
Matthew Pittman- Laboratory facilities Technician I (Started March 12, 2007)  
Jason Vokey- Deliveryman (Started January 2007)  
Damien Whitten - Laboratory Facility Technician II

## ***Facilities Management***

Rick Walsh  
Ian Churchill

## ***Student Assistants***

Cheryl Barron - G. Fletcher  
Krista Boland - P. Snelgrove  
Chad Brinston- D. Schneider  
Samantha Burry- D. Nichols  
Ryan Butler – D. Nichols  
Corinne Conway – I. Fleming

Jessica Fry – P. Snelgrove  
Elizabeth Dohey – D. Boyce  
Rebecca Doyle – D. Jones  
Esther Keddie – P. Snelgrove  
Jordon Keats – D. Nichols  
Noelle Laite – D. Jones  
Nikita Laite – D. Jones  
Tannis Milley-D. Schneider  
Chris Negrijn, Chris – A. Mercier  
Ashley Noseworthy– D. Jones  
Allison Oliver – D. Schneider  
Sabrina Penney – R. Rivkin  
Melanie Quinlan – P. Snelgrove  
Candice St. Germain – P. Snelgrove  
Don Saunders – D. Schneider  
Cody Stuckless – P. Snelgrove  
Margaret Warren – D. Jones  
Claire Woodworth – P. Snelgrove

## ***MUCEP***

Lindsay Blades– R. Thompson  
Morgan Boyde – D. Deibel  
Scott Caines– D. Boyce  
Lana Combdon- D. Jones  
Gina Doyle– A. Mercier  
Rebecca Doyle – D. Jones/D. Nichols  
Yu Feng – J. Wroblewski  
Janine B. Hawkins - V. Puvanendran  
Stephanie Ivany - Dr. R. Thompson  
Gary Pardy, – I. Fleming  
Karyn Rowsell– M. Rise  
Karla Short– P. Snelgrove  
John Walsh- M. Bolli  
Julia Wheeler– D. Nichols

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

Sabrina Penny – R. Rivkin  
Chantelle LaFitte - D. Deibel  
Rebecca Mouland - R. Rivkin

## ***NSERC- USRA – 2007***

Cassandra Rideout – D. Schneider

## ***WISE – Students***

Samantha Green-D. Jones

Melanie Hurley- D. Jones

Sara Inder- D. Nichols

Clare Lewis- I. Fleming

Lisa Saunders- D. Boyce

## ***Work-term and Co-op Students***

Samatha Bosman- Work-term

Thom McGrath- Work-term

Ashley Pedigrew-Booth Memorial- Co-op

## ***Volunteers - Seals***

Gabrielle Beaulieu

Becky Doyle

Larina Carroll

Cynthia Mercer

Stephanie Morris

Ashley Noseworthy

James Stenson

Jennifer Walsh

Peter White

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

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

|                                    |                      |
|------------------------------------|----------------------|
| Director                           | Dr. Ian A. Fleming   |
| Associate Director                 | Dr. Don Deibel       |
| Intermediate Secretary             | Ms. Winnie Sparkes   |
| Administrative Staff Specialist II | Ms. Delores Wheeler  |
| Intermediate Clerk Steno           | Ms. Maureen James    |
| Research Marketing Manager         | Ms. Danielle Nichols |

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

|   |                      |
|---|----------------------|
| Animal Husbandry                              | Mr. Daryl Jones      |
| Aquaculture Research and Development Facility | Mr. Danny Boyce      |
| Computing Services                            | Mr. Marc Bolli       |
| Field Services                                | Ms. Danielle Nichols |
| Image Analysis Facility                       | Mr. Marc Bolli       |
| Laboratory (Workshop) Services                | Mr. Jim Devereaux    |
| Marine Public Education Program               | Ms. Danielle Nichols |
| Seal Research Facility                        | Mr. Daryl Jones      |
| Technical Services                            | Mr. Terry Harris     |

## ***Committees***

Promotion and Tenure:

Dr. W. Driedzic  
Dr. K. Gamperl  
Dr. R. Thompson  
Dr. D. Deibel

Space Committee:

Dr. K. Gamperl  
Ms. D. Nichols

Safety Committee:

Ms. 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. D. Deibel  
Ms. D. Nichols  
Mr. J. Devereaux

OSC Tours

Ms. D. Nichols  
Mr. D. Boyce (JBARB)

## 5. Faculty

### ***Dr. D. Deibel***

Dr. Deibel is a zooplankton ecologist and biological oceanographer who's research is focused 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, his 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*

- Comparative Vertebrate Anatomy- Guest Lecture (Feb 2007)

#### *Other Activities (Memorial)*

- Supervision, graduate students
- Supervision, student assistants
- Co - supervision, graduate students
- Supervision, undergraduate students
- Supervision, post - doctoral fellows
- Supervision, science technician
- Associate Director, OSC (2003 - present)
- Executive Committee member, OSC
- MFA Equipment Policy Committee

#### *External Activities*

- Chair, Program Committee Avalon Chapter of Sigma Xi (2005-present)
- Editorial Advisor, *Marine Ecology Progress Series*, 1995 - present
- Scientific Steering Group, Arctic Ocean Census of Marine Life, University of Alaska (04 - present)

## *Invited Lectures and Conference Presentations*

### *Conference Presentations*

- Connelly, T. & **D. Deibel**. (2007). Quantity, quality and source of organic matter in near-bottom waters of the Beaufort Shelf, Arctic Ocean. CMOS/CGU Meeting, St. John's, Newfoundland.
- Trela, P. & **D. Deibel**. (2007). Fine-scale diurnal distribution of zooplankton and Arctic cod in Franklin Bay, Canadian Arctic, recorded with underwater video. CMOS/CGU Meeting, St. John's, Newfoundland.
- **Deibel, D.**, C.C. Parrish & R.J. Thompson. (2007). Effect of the spring phytoplankton bloom on lipid class and fatty acid content of benthic boundary layer invertebrates at sub-zero water temperatures. American Society of Limnology & Oceanography. Meeting, Santa Fe, U.S.A.
- Choe, N.; **D. Deibel**. (2007). Use of the statolith as an age indicator for the study of the life history of appendicularians. American Society of Limnology & Oceanography Meeting, Santa Fe, U.S.A.
- Callahan, A., T. Baines, P. Sargent, R. Boland, R. O'Donnell, S. Kenny, C. Vickers, C.H. McKenzie; **D. Deibel**. (2007). Harbour Survey for Invasive Species in Newfoundland, Canada. International Invasive Species Conference, Boston.
- Callahan, A., **D. Deibel**, C.H. McKenzie; P. Sargent. (2007). Monitoring the distribution of indigenous and non-indigenous ascidians and macroinvertebrates in harbours around Newfoundland. International Invasive Sea Squirrels Conference, Brudenell, Prince Edward Island.
- Eloukkal, H., **D. Deibel; R.J. Thompson**. (2007). The effect of temperature and viscosity on the feeding of the ascidian *Halocynthia pyriformis*. Canadian Society of Zoologists, Montreal, Canada.
- **Deibel, D.**, H. Eloukkal; R.J. Thompson. (2007). Viscosity and invertebrate behaviour at polar water temperatures. Arctic Frontiers International Meeting, ARCTOS Network, Univ. of Tromsø, Norway. McKenzie, C.H., T. Baines, R. Boland, E. Dawe, D. Deibel & 10 others. 2007. The European green crab, *Carcinus meanas*, in Conception Bay, Newfoundland during the Aquatic Invasive Species survey 2007. Aquatic Invasive Species Newfoundland Workshop. St. John's.

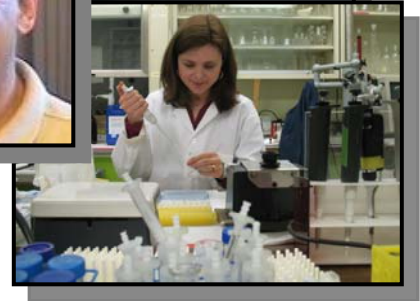
*Overview and Highlights 2006 – 2007*

- Seasonal energy storage and diets of zooplankton using fatty acid biomarkers: Together with collaborator Dr. C.C. Parrish, Dr. Deibel has been working for many years on seasonal energy storage and fatty acid diet markers in Arctic and Newfoundland fjord zooplankton. Recognition for their contributions culminated in an invitation to attend an international workshop on zooplankton lipids in Germany and to contribute to a major review paper reporting on the workshop (Kattner et al. 2007). Furthermore, Dr. Deibel chaired the 'climate change' working group at this workshop and led writing of the climate change section of the final publication. They were able to determine the production and vertical flux rates of lipids and fatty acids during the spring diatom bloom in Newfoundland and documented the vertical flux of high quantities of energy rich (i.e. lipid rich) material to the bottom of Newfoundland fjords (Parrish et al. 2005).
- Dr. Deibel finished his project work on the Canadian Arctic Shelf Exchange Study (CASES) and his service on the national and international steering committee for this program.
- Discovered several species of invasive ascidian tunicates in Newfoundland harbours in collaborative research with Dr. Cynthia McKenzie from the Department of Fisheries and Oceans (DFO)

## **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). His laboratory's 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.

### *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)
- Advisory Board, Canadian Journal of Zoology (1996-2006)
- 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*

- Stacey, J.E.; **Driedzic W.R.** (2006) Seasonal vanadium and iron contents, and coelomic cell composition and G6PDH activity in North Atlantic ascidians. 5<sup>th</sup> International symposium on the chemistry and biological chemistry of vanadium. San Francisco, CA, Sept. 10-14, 2006
- Lamarre, S.G.; Blier, P.U.; LeFrancois, N.R.; **Driedzic, W.R.** (2007). Thermal sensitivity of physiological growth processes of juvenile spotted wolfish. Annual Meeting Canadian Society of Zoologist Montreal May 21-25, 2007
- Costa, I.; Corkum, C.P.; **Driedzic, W.R.; Gamperl, A.K.** (2007). Metabolic depression in the cunner (*Tautoglabrus adspersus*): plasticity and potential tradeoffs. Annual Meeting, Canadian Society of Zoologist Montreal, May 21-25, 2007.
- Stacey, J.E.; **Driedzic, W.R.** (2007). Ecophysiology of vanadium accumulation by North Atlantic ascidians (Tunicata: Ascidiacea). Annual Meeting, Canadian Society of Zoologist. Montreal May 21-25, 2007
- Treberg, J.R.; **Driedzic, W.R.** (2007). Methylamine metabolism in elasmobranch fish: Betaine the 'forgotten' trimethylamine. Annual Meeting, Canadian Society of Zoologist. Montreal May 21-25, 2007
- **Driedzic, W.R.**; Short, C.W.; Ewart, K.W. (2007). Relationship amongst Food Availability, Glycerol Production and Glycogen Levels in Low Temperature Challenged Rainbow Smelt (*Osmerus mordax*) Third North American Workshop on Rainbow Smelt Halifax, N.S. June 22-23, 2007
- Gong, H.; Abbott, K.; **Driedzic, W.R.**; Ewart, K.V. (2007). Modulation of Rainbow Smelt (*Osmerus mordax*) Antifreeze Protein Activity by Glycerol. Third North American Workshop on Rainbow Smelt Halifax, N.S. June 22-23, 2007
- Gong, H.; Abbott, K.; **Driedzic, W.R.**; Ewart, K. V. (2007). Modulation of activity and conformation of a smelt (*Osmerus mordax*) protein by endogenous glycerol. Nutrisciences and Health 2007: *Bioprospecting for Neuroprotectants*, Charlottetown, Prince Edward Island, Canada, July 10 -12, 2007.
- **Driedzic, W.R.** (2007). Feeding is necessary for glycerol production and survival in low temperature challenged rainbow smelt (*Osmerus mordax*). 7th International Congress of Comparative Physiology and Biochemistry, August 12<sup>th</sup> to August 16<sup>th</sup>, 2007, Salvador, Bahia, Brazil.

## *Research Overview and Highlights 2006 - 2007*

- *Control of glycolysis and performance in hypoxic fish hearts:* Earlier work in this area established the importance of glucose to maintenance of cardiac function in hypoxic fish (e.g. Rodnick et al. JEB 200:2871, 1997; Bailey et al. CJZ 77:683, 1999; West et al. CJZ 77:690, 1999; Bailey et al. JEZ 286: 699, 2000; Bailey et al. JEZ 286: 707, 2000). Glucose uptake increases in the hypoxic heart of Atlantic cod (Clow et al. 2004). Glucose uptake is dependent upon a family of transporter proteins. They have cloned, sequenced, determined tissue distribution, and quantified transcript level by qPCR of the four major Na-independent glucose transporters in Atlantic cod (Hall et al., 2004, 2005 & 2006). Currently, they are now assessing how transcript levels change under hypoxia and correlating this with protein levels. In parallel they are investigating rates of glucose uptake by the chronically hypoglycemic shorthorn sculpin (plasma glucose < 0.5 mM) which are comparable to species with much higher glucose levels (MacCormack & Driedzic 2007). They are making an intellectual connect between glucose uptake and contractility that goes beyond simple energy balance. They are extending their understanding of the mechanisms of anoxic resistance by examining the interplay between glucose, calcium transients, and K<sub>ATP</sub> channels. They were also the first to publish evidence that the fish heart has active mitochondrial K<sub>ATP</sub> channels (MacCormack & Driedzic 2002; MacCormack et al. 2003) that appears to play a role in the controlled down regulation of force under anoxia. Most recently, they have shown that hexokinase binds to subcellular fractions under anoxia (Treberg et al., 2007) and are now in the process of linking hexokinase binding to mitochondria ion channel regulation.
- *Glycerol production as an antifreeze agent in Rainbow smelt:* Smelt produce high levels of glycerol that serves as an antifreeze. Smelt continually lose glycerol across the epithelia and therefore vigorous metabolic processes must continue to function at low temperature. Liver is a site of glycerol production from glucose and amino acids. Glucose and alanine are incorporated directly into glycerol as shown by <sup>13</sup>C tracking of neighbouring atoms (Walter et al. 2006). The process is triggered by low temperature alone and is associated with the activation of glycerol-3-phosphate dehydrogenase and possibly glycerol-3-phosphatase (Driedzic et al., 2006; Liebscher et al., 2006; Driedzic & Short 2007). The biochemical wiring to produce glycerol is so strong that in contrast to other species a combination of starvation and reduced temperature is lethal within days even at temperatures above 0°C. This has potentially profound ecological consequences that are currently being addressed.

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

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*

- Guest lecture: Aquaculture & the Environment (AQUA 6201, AQUA 4111), Behavioural Ecology (Biology/Psychology 6351)

### *Other Activities (Memorial)*

- Director, Ocean Sciences Centre, MUN
- Supervision, graduate students
- Supervision, post - doctoral fellow
- Supervision, research assistant
- Supervision, WISE student
- Supervision, undergraduate and high school students
- 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*

- 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)

- Co-organizer, 31<sup>st</sup> Annual Larval Fish Conference, St. John's, Canada. (9-12 July, 2007).
- Invited Participant, Speaking for Salmon – Summit of Scientists on Aquaculture and the Protection of Wild Salmon on the British Columbia Coast. (25-28 January, 2007)
- Invited Panel Member, Technical Working Group on Escapes, Salmon Aquaculture Dialogue, World Wildlife Fund.(2006-2007).
- External Examiner, Linda Anett Hansen, Ph.D. dissertation, University of Tromsø, Norway.(2006)
- Expert Reviewer, Center for Independent Experts (CIE), Status Review for Anadromous Atlantic Salmon (*Salmo salar*) in the United States.(2006).
- Aquaculture Collaborative Research and Development Program Regional Committee of the Department of Fisheries and Oceans Canada.(2006-2008).
- Organizer, Symposium on *From Individual to Population Processes in Fish* at the International Congress on the Biology of Fish. St. John's, Canada (July 18-22, 2006).
- Invited External Reviewer, Department of Fisheries and Oceans Workshop on Conservation Status Report for Atlantic Salmon. Moncton, Canada. (Feb 13-17, 2006).
- Associate Editor, Transactions of the American Fisheries Society.(2004-present)

#### *Presentations Invited*

- **Fleming, I.A.** (2007) Plenary Session. 31<sup>st</sup> Annual Larval Fish Conference, St. John's, NL. (July 2007)
- **Fleming, I.A.** (2007). Symposium on Gamete Evolution and Ecology, Meeting of the Canadian Society of Ecology and Evolution. University of Toronto, Canada. (17-20 May, 2007).
- **Fleming, I.A.** Keynote Speaker. Darwin Initiative, 1<sup>st</sup> International Workshop on Reducing the Impact of Exotic Aquaculture on Native Aquatic Biodiversity, Puerto Montt, Chile (January 2007)
- **Fleming, I.A.** (2006). Norwegian Institute for Nature Research, Trondheim, Norway. (December 4, 2006)

#### *Conference Presentations*

- Moreau, D.; Hobbs, R.; Cnaani, A.; **Fleming, I.A.**; **Fletcher, G.**; McLean, E.; Hallerman, E. (2007). Environmental risk assessment parameters for growth hormone transgenic Atlantic salmon, *Salmo salar*. Transgenic Animal Research Conference, University of California Davis, USA. (August 2007)
- Bachan, M.M.; **Fleming, I.A.**; Trippel, E.A. (2007). Maternal effects of egg quality on progeny morphology, survival and growth in larval Atlantic cod (*Gadus morhua*). 31<sup>st</sup> Annual Larval Fish Conference, Memorial University of Newfoundland, St. John's, Canada (July 2007)
- Simms, M.D.; **Fleming, I.A.**; Adams, B.K. (2007). Maternal effects on early life history performance and interactions between offspring of anadromous and

ouananiche Atlantic salmon (*Salmo salar*) mothers. 31<sup>st</sup> Annual Larval Fish Conference, Memorial University of Newfoundland, St. John's, Canada (July 2007)

- Hindar, K.; Jonsson, N.; Gammelsæter, M.; Dønnum, B.O.; **Fleming, I.A.**; Karlsbakk, E.; Sægrov, H. (2007). Rainbow trout in Norway: Occurrence, reproduction and establishment. Annual Meeting of the Fisheries Society of the British Isles. University of Exeter, UK (July 2007).
- Karlsbakk, E.; Gammelsæter, M.; Dønnum, B. O.; Sægrov, H.; **Fleming, I. A.**; Jonsson, N.; Hindar, K.(2007). Lack of establishment of rainbow trout in Norway: a role for parasites? Annual Meeting of the Fisheries Society of the British Isles. University of Exeter, UK (July 2007).
- Thorstad, E.B.; **Fleming, I.A.**; McGinnity, P.; Ryan, J.; Soto, D.; Wennevik, V.; Whoriskey, F. (2007). The state of information on salmon aquaculture escapes and the environment - overview and research gaps. Aquaculture 2007, Science for Sustainable Aquaculture, World Aquaculture Society Meeting, San Antonio, Texas, USA (Feb 2007)
- Boulding, E.G.; Ang, K.P.; Berg, P.R.; **Fleming, I.A.**; Glebe, B.; Lien, S.; MacDonald, D.; Moràn, P.; O'Reilly, P.; MacDonald, D.; Moen, T.; O'Reilly, P.; Schulte, P.M. (2007). Conservation Genomics of Atlantic salmon: Towards understanding Adaptive trait differences for the Management of Endangered populations. Plant and Animal Genome XV Conference, San Diego, USA (January 2007).

#### *Research Overview and Highlights 2006 – 2007*

- Mercer Patriarche Award for the Best Paper in the North American Journal of Fisheries Management (2007). Henning, J.A., Gresswell, R.E. and **Fleming, I.A.** 2007. Use of seasonal freshwater wetlands by fishes in a temperate river-floodplain. *Journal of Fish Biology* 71: 476-492.
- Chris Lewis, MSc student, graduated in 2006-2007.
- **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 in Dr. Gagnon's lab (Cold Ocean Benthic Ecology Lab, COBEL) aims at elucidating the mechanisms that determine the structure and function 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.



### *Other Activities (Memorial)*

- Supervisory Committee, MSc student
- Internal reviewer, Honours student
- Cross-Appointed, Department of Biology, MUN
- Graduate student committee member

### *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 (1997-2006)
- Invited participant to the organization of the 35th Annual Benthic Ecology Meeting (>300 participants), co-chair for the committee to judge student presentations, and session chair (Ecology at Large Spatial and Temporal Scales) (Québec, Qc). (2005-2006)
- Scientific collaborator with researchers in various universities of eastern Canada. Implementation of research projects; design, supervision and conduct of marine field work; data analysis; writing of scientific papers.(2004-2006)
- 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)
- Corporation Explos Nature (1999-2003)
- Québec-Océan (formerly GIROQ) (1997-2003)
- NSERC Postdoctoral Industrial Research and Development Fellowship (IRDF) - \$90 000 (2004-2006)

### *Invited Lectures and Conference*

#### *Presentations Invited*

- **Gagnon P.** (2006). Potential of airborne hyperspectral remote sensing for monitoring eastern Canada's shallow marine habitats and resources: where do we sit? Bedford Institute of Oceanography (Department of Fisheries and Oceans Canada, DFO) - Seminar Series. Dartmouth, NS, CANADA.
- **Gagnon P.** (2006). The changing face of shallow vegetated communities in eastern Canada: A multiscale investigation of the green menace *Codium fragile* ssp. *tomentosoides*. DFO-Dartmouth and FSRS Workshop on Inshore Ecosystems and Significant Areas of the Scotian Shelf. Dartmouth, NS, CANADA.

#### *Conference Presentations*

- **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 - Seminar Series. St. John's, NL, CANADA.
- **Gagnon P.** (2006). Stability of subtidal algal assemblages in the northern Gulf of St. Lawrence: temporal patterns, structuring forces, and scale effects. 35<sup>th</sup> Annual Benthic Ecology Meeting (BEM). Québec, Qc, CANADA. (March 8-12, 2006)

### *Research Overview and Highlights 2006 - 2007*

#### **Dynamics of shallow rocky subtidal ecosystems:**

My studies of biotic and abiotic factors and processes that directly and indirectly regulate key seaweed-herbivore and predator-prey interactions (e.g. urchins, kelps, sea stars, mussels) both in the northern Gulf of St. Lawrence and along the Atlantic coast of Nova Scotia have unveiled fundamental latitudinal differences in the nature of the mechanisms that govern community phase shifts and the dynamics of algal assemblages. These studies also introduced new ecological perspectives that challenge classical ecological paradigms and our understanding of these ecosystems, and stressed the importance of broadening the

spatial and temporal scales of marine ecological studies to advance our understanding of global ecosystem functioning. The cost-effective wave tank I developed to imitate back-and-forth flow caused by waves enabled me (and other researchers who have used it since) to elucidate important mechanisms involved in the foraging of key benthic herbivores and predators.

**Facilitation in communities of native and invasive species:**

The role of facilitation as a structuring mechanism is increasingly emphasized and integrated in theoretical models of intertidal community organization. I have taken an active lead in studying facilitation in eastern Canada's subtidal benthic communities and showed that both ephemeral and long-lasting biological associations reduce consumer pressure and environmental stress, which greatly enhances recruitment and survival of native seaweed species. I revealed important biological aspects and elucidated defense mechanisms in grazing-resistant seaweeds, identified novel seaweed-seaweed-invertebrate interactions, and mitigated the role of predation and competition in community dynamics. I have elevated the community importance of overlooked seaweed species by showing how these affect succession and biodiversity in intensely-grazed areas. Facilitation between invasive seaweeds and invertebrates was also identified as a prime mechanism for invasion success.

**Broad scale mapping and ecology of subtidal ecosystems:**

Conceptual and operational breakthroughs are required to advance our understanding of subtidal ecosystem functioning and to further develop effective coastal resources management strategies. As a former research scientist in the private sector, I developed (and published) a cutting-edge optical remote sensing methodology for broad scale mapping of eastern Canada's shallow subtidal habitats. The methodology employs very high spectral and spatial resolution airborne hyperspectral imagery of shallow seabed, acoustic bathymetry, and underwater imagery of benthic assemblages as core data inputs, and the analytical power of Geographic Information Systems (GIS) to deliver classification maps of shallow benthic assemblages. Using this methodology, I mapped the horizontal and vertical distribution of native and invasive seaweeds over large tracts of seabed with accuracy similar to that of maps created in the clearest tropical water environments. This practical research provides an excellent framework on which to further develop reliable methodologies that will increase the capacity of scientists and coastal managers to acquire novel ecological data and assess ecosystem health.

## ***Dr. Kurt Gamperl***

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

BIOL 3202: Comparative Vertebrate Anatomy (4 lectures)

AQUA 7702: Finfish Aquaculture (3 lectures)

### *Other Activities (Memorial)*

- Supervision, graduate students
- Supervision, undergraduate student
- Supervision, postdoctoral fellows
- Supervision, Research Assistant
- Memorial University Animal Care Committee
- Space Committee, Ocean Sciences Centre
- Member, MFA Equipment Policy Committee

### *External Activities*

- Guest Associate Editor special module of Aquaculture Research (Feb 2007-present)
- Symposium Co-Organizer for Aquaculture 2007. Title: Physiological Insights Towards Improving Fish Culture. (September 2006-February 2007)
- Lead Scientist for the Newfoundland component of the Cod Genome Project (total funding \$18.1 million over 4 years). (September 2005 – Present)
- Lead-Organizer, 7<sup>th</sup> International Congress on the Biology of Fish. July, 2006. (Sept. 2004 – Aug. 2006)
- President, American Fisheries Society-Physiology Section. (Sept. 2004 – Aug. 2006)

- Symposium Organizer, 6<sup>th</sup> International Congress on the Biology of Fishes, July 1998, Manaus, Brazil. Title: Plasticity in Fish Cardiovascular Design and Function (Sept. 2002 – Aug. 2004)
- 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.** (2006). It's a Tough World: Environmental Challenges Faced by Marine Fishes. Dept. of Biochemistry, Memorial University of Newfoundland. April 2006.
- **Gamperl, A.K.** (2007). Aquaculture Research Institute, University of Idaho. Title: The Atlantic Cod, a Fisheries Tragedy: The Role of Physiology, Genomics and Aquaculture (June 2007)

##### *Conference presentations*

- Killen, S. S.; Costa, I.A.S.F.; Brown, J. A.; Gamperl, A. K. (2006). Metabolic scaling in marine teleosts: implications for aerobic scope throughout ontogeny. American Physiological Society Intersociety Meeting. Virginia Beach, Virginia, USA. October, 2006.
- Lurman, G.; Petersen, L.H.; Pörtner, H.O.; **Gamperl, A.K.** (2007). Cardiac function in Atlantic cod (*Gadus morhua*) as a function acclimation temperature and during acute thermal challenge. Society for Experimental Biology Meeting, Glasgow, Scotland, March, 2007.
- **Gamperl, A.K.**; Gollock, M.J.; Johnston, B.D. (2007). Effects of jellyfish (*Periphylla periphylla*) toxin on trout (*O. mykiss*) cardiovascular function. Canadian Society of Zoologists Meeting, Montreal, May 2007.
- Perez-Casanova, J.C.; Dixon, B.; Rise, M.L.; Afonso, L.O.B.; **Gamperl, A.K.** (2007). The Stress and Immune Response of Atlantic Cod Exposed to Chronic Thermal Stress. Canadian Society of Zoologists Meeting, Montreal, PQ, May 2007.
- Costa, I.A.S.F., Corkum, C.; Driedzic, W.R.; **Gamperl, A.K.** (2007). Metabolic Depression in the Cunner (*Tautoglabrus adspersus*): Plasticity and Potential Tradeoffs. Canadian Society of Zoologists Meeting, Montreal, PQ, May 2007.
- Bailey, J.A.; Busby, C.D.; Tosh, J.; Murphy, L.; **Gamperl, A.K.** (2007). The thermal tolerance of Atlantic cod (*Gadus morhua* L.) juveniles held under normoxic and moderately hypoxic conditions. Aquaculture Association of Canada Meeting, Saint John, N.B. May, 2007.

- Tiago, S.; Hori, F.; Johnson, S.C.; **Gamperl, A.K.**; Afonso, L.O.B. (2007). Divergent Cortisol Stress Responsiveness of Atlantic Cod (*Gadus Morhua*). Aquaculture Association of Canada Meeting, Saint John, N.B. May, 2007.

*Research overview and Highlights 2006 – 2007*

- Shaun Killen, PhD candidate, was awarded NSERC PDF and was a finalist for the Howard Alper Postdoctoral Prize (given to the most outstanding postdoctoral candidate in Canada). Shaun was rated as the top-ranked postdoctoral candidate in the Life Sciences & Psychology category during the NSERC scholarships and fellowships Competition.
- Shaun Killen, PhD student and Isabel Costa, MSc student graduate in 2006-2007
- Shaun Killen, PhD student received the Davies Foundation Postdoctoral Fellowship award, Kingston, Ontario worth \$10,000 over one year.

## ***Dr. Annie Mercier***

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 (2006-2007)
- 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*

#### *Conference presentations*

- **Mercier, A.**; Hamel, J.F. (2006). Epibiotic sea anemones on marine gastropods: diversity, dynamics and role of bathyal associations. 11th Int. Deep-Sea Biology Symposium, Solent University, Southampton, UK. August 10-14, 2006
- **Mercier, A.**; Ycaza, R.H.; Hamel, J.F. (2006). Long-term study of gamete release in a broadcast-spawning holothurian: predictable lunar and diel periodicities. 12<sup>th</sup> International Echinoderm Conference, University of New Hampshire, Durham, USA, August 7-11, 2006
- Hamel J.-F.; Becker, P.; Eeckhaut, I.; **Mercier, A.** (2006). Evidence of aberrant oogenesis in a temperate holothurian. 12<sup>th</sup> International Echinoderm Conference, University of New Hampshire, Durham, USA, August 7-11, 2006
- Becker, P.; Ycaza, R.H.; **Mercier, A.**; Hamel, J.F.; Eeckhaut, I. (2006). Parasitic disease in larval cultures of the edible sea cucumber *Isostichopus fuscus*. 12<sup>th</sup> International Echinoderm Conference, University of New Hampshire, Durham, USA, August 7-11, 2006

## *Research Highlights 2006 – 2007*

- **Control of reproduction in marine invertebrates:** Dr. Mercier has received funding from the Natural Sciences and Engineering Research Council of Canada (NSERC), in the form of a Discovery grant (2005) and a Research Tools & Instruments grant (2005), to pursue my research on the control of reproduction of marine invertebrates. While providing new tools for the study of marine chemical ecology, the proposed work strives toward a comprehensive understanding of benthic ecosystems in terms of reproductive strategies and success at the individual and population levels. Knowledge of how benthic animals perceive external stimuli and communicate through chemical signals could eventually help devise aquaculture techniques and more effective ways to protect marine habitats from environmental hazards and disturbances. Additional funds from the Canadian Foundation for Innovation (CFI) and the Industrial Research and Innovation Fund (IRIF) of the Government of Newfoundland & Labrador have allowed her to build a controlled-environment laboratory where her research on the reproductive processes of marine invertebrates is being conducted.
  
- **Deep-sea biology:** Since Dr. Mercier's appointment at Memorial University, she has expanded her study of reproductive biology to deep-sea invertebrates. To that end, she has built collaborative bridges with researchers at Department of Fisheries and Oceans (DFO, St. John's) to collect bathyal invertebrates during groundfish surveys, as well as with experts at the Smithsonian Institute, Ohio State University and Harvey Mudd College for identification of new or poorly known species. Dr. Mercier was also invited to take part in a DFO project on deep-sea corals, led by K. Gilkinson (DFO, St. John's), E. Edinger (Biology/Geography), P. Snelgrove (OSC), and others. The general goal was to provide novel information on the distribution and ecology of cold-water bathyal corals and associated species in the Newfoundland & Labrador region. Within this project, Dr. Mercier took the lead role in the study of reproductive processes, which includes gametogenesis, spawning, fecundity, control/timing of reproduction, development, settlement and early growth. These aspects are tightly linked to her research programme on the control of reproduction and make up the MSc project of Zhao Sun.

While attending the Deep Sea Biology Symposium held in Southampton (UK) in July 2006, Dr. Mercier realized the importance of recent breakthroughs made by her team in the maintenance and reproduction of deep-sea invertebrates. They have successfully kept, reproduced and settled several species. Therefore, she is keen on taking advantage of this unique capacity to pursue studies on live deep-sea organisms.

In July 2007, Dr. Mercier was the principal investigator on a successful NSERC Ship Time grant which allowed her laboratory team to use the Canadian deep-sea submersible ROPOS to pursue our studies of cold-water coral habitats over the SW Grand Banks. Additional funding for this 21-day joint cruise came from DFO International Governance of High Seas Program (IGP, Newfoundland region), and Science Branch and Oceans Branch of DFO Maritimes. The cruise was conducted

jointly with the Bedford Institute of Oceanography (BIO), DFO St. John's, Dalhousie University and OSC/Memorial University. Dr. Mercier and her student successfully collected and brought back dozens of specimens of deep-sea corals which were held alive and studied.

- Commercially important holothurians: Dr. Mercier's expertise in holothurian biology was recently sought by the DFO in Newfoundland & Labrador, who is presently trying to develop a sea cucumber (*Cucumaria frondosa*) fishery with funding through the Fisheries Diversification Program. She is now working jointly with researchers at DFO (St. John's) and the Marine Institute (Memorial University) on the biology and distribution of local populations of *C. frondosa*. Furthermore, I am the principal investigator in a project, which has a total budget of ca. \$400,000. It is a joint venture between MUN, CCFI, DFA, DFO and the local industry (Fogo Island Co-op, harvesters) and serves to finance the MSc project of Justin So in my laboratory. The goal is to gather the biological data necessary to ascertain the sustainability of the stocks and determine how they could best be managed. Apart from assessing the growth, habitat utilization, and predation pressure, this project includes a novel genetic approach to determine the current level of interaction between different populations of *C. frondosa* around Newfoundland and other areas of its distribution range. It involves the collaboration of the Australian Institute of Marine Science where my student has been trained in the study of holothurian population genetics (under the supervision of S. Uthicke). Findings are of ecological significance and will additionally translate into improved fishing/management methods of this emerging resource in eastern Canada. As a direct follow-up, another project proposal is currently being developed to request funds from the International Science and Technology Partnerships Canada (ISTPCanada) through the Canada-China Scientific and Technological Cooperation. This R&D collaboration with a China-based partner aims to establish methods to process Newfoundland sea cucumber suitable for producing nutritional capsule and examine the feasibility of *C. frondosa* aquaculture for the purposes of environment preservation and sustainable development of this emerging fishery.

On the international front, I continue to be involved in numerous projects related to sea cucumber management and conservation. I am a scientific adviser for the FAO Aquaculture Management and Conservation Service and part of an international scientific committee that is authoring and editing a worldwide review of sea cucumber biology, exploitation, management and conservation. My contribution includes a thorough review of commercial sea cucumber species in the northern hemisphere with a special focus on Newfoundland & Labrador. These data were discussed at a workshop in November 2007, and will soon be published by FAO. I am also a collaborator on a project entitled "Sea cucumber hatchery production technology transfer in Pohnpei, the Federated States of Micronesia", which is being developed through the College of Micronesia Land Grant Program.

## **Dr. Chris Parrish**

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
- Environmental Science 6201: Aquatic Lipid Biogeochemistry

### *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.** (2007) Université du Québec à Rimouski, 2007.

### *Research Over-view and Highlights*

- 2006 - 6 refereed publications on blue mussel, scallop and cod aquaculture nutrition.
- 2007 - 3 publications on trophic transfer in aquatic ecosystems; 1 book chapter on aquaculture in a social-ecological context.
- Alexandre Garcia, PhD student graduated in 2006-2007.

## **Dr. Matt Rise**

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.



### *Other Activities (Memorial)*

- 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

### *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*

- **Rise, M.L.** (2007) Genomic approaches for studies of fish responses to pathogens and pollutants. 32nd Eastern Fish Health Workshop, Gettysburg, Pennsylvania, June 2007.
- **Rise, M.L.;** Jones, S.R.M.; von Schalburg, K.R.; Brown, G.D.; Davidson, W.S.; Brown, L.L.; Bowman, S.; Johnson, S.C.; Koop, B.F. (2007) Genomic tools for studying fish transcriptomic responses to pathogens. In symposium, "Physiological insights toward improving fish culture" at the World Aquaculture Society 2007 Meeting, San Antonio, Texas. February 2007.
- **Rise, M.L.;** Douglas, S.E.; Sakhrani, D.; Williams, J.; Ewart, K.V.; Rise, M.; Davidson, W.S.; Koop, B.F.; Devlin, R.H. (2007). DNA microarrays used to study coho salmon global gene expression responses to growth hormone transgenesis. Canadian Regulatory System for Biotechnology (CRSB) Forum: Critical Path Forward, "Looking Back and the Way Forward". January 2007.
- **Rise ML.** (2007) Genomic research on fish immune responses. Seminar for the Immunology Research Group, Faculty of Medicine, Memorial University of Newfoundland. April 2007.
- **Rise ML.** (2007) Genomic research on fish responses to pollutants and pathogens. Departmental Seminar, Department of Biology, Memorial University of Newfoundland. February 2007.
- **Rise ML.** (2007) Genomics and fish health – an array of possibilities. Departmental Seminar, Department of Biochemistry, Memorial University of Newfoundland. January 2007.
- **Rise, M.L.;** Devlin, R.H. (2006). Microarrays applied to comparative studies of fitness traits. EU FP6-funded GENIMPACT Workshop: Monitoring tools for evaluation of genetic impact of aquaculture activities on wild populations, Tenerife, Canary Islands, Spain. Oct. 2006.

##### *Select Conference Presentations*

- **Rise ML,** von Schalburg KR, Cooper GA, Brown GD, Davidson WS, Koop BF. Salmonid EST Databases and DNA Microarrays: Tools for Functional Genomics Research. 23<sup>rd</sup> Meeting of the Aquaculture Association of Canada, Halifax, NS. November 2006
- **Rise ML,** Bowman S, Higgins B, Kozera C, Stone C, Kimball J, Symonds J, and Johnson SC. Genomic research on Atlantic cod. Plant and Animal Genome XV Conference – San Diego, January 2007. *Poster.*

## *Research Overview and Highlights 2006-2007*

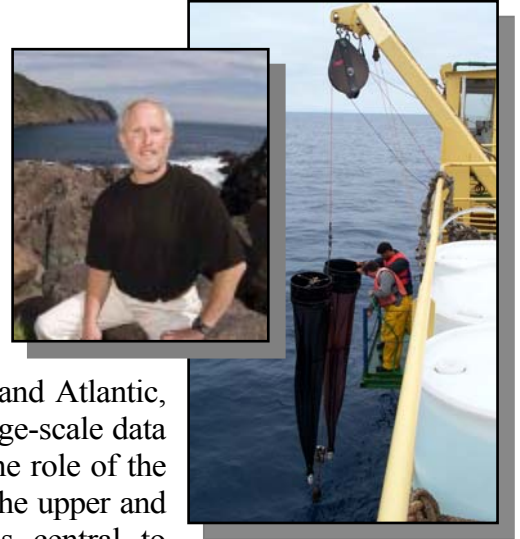
- *Gene expression profiling of GH transgenic coho salmon:* This project, in collaboration with Dr. R. Devlin (Department of Fisheries and Oceans), utilizes microarray hybridizations and quantitative reverse transcription - polymerase chain reaction (QPCR) to study the consequences of growth, growth hormone (GH) transgenesis, and ration level on global gene expression in the tissues of sexually immature coho salmon. The project's first publication, involving the use of three different salmonid DNA microarray platforms to identify hepatic genes responsive to GH transgenesis and/or ration restriction, was published in the *Journal of Molecular Endocrinology* (Rise et al. 2006). A large number of informative genes in this study have functional annotations related to iron homeostasis, mitochondrial function, carbohydrate metabolism, cellular proliferation, and innate immunity. This study was the first to use cDNA microarrays to study the influence of GH transgenesis on liver gene expression in a non - mammalian vertebrate, and the first cross - platform integration of fish microarray data sets. We are currently using microarrays and QPCR to investigate how GH transgenesis influences global gene expression in salmonid muscle tissues. Dr. Devlin and I were invited to present this study at an EU FP6 - funded GENIMPACT workshop, and we have written sections of two GENIMPACT review articles (for submission to *Fish and Fisheries*) on potential uses of microarrays and other methods for assessing the genetic impact of escaped aquaculture individuals on wild fish populations. *Reference: Rise ML, Douglas SE, Sakhrani D, Williams J, Ewart KV, Rise M, Davidson WS, Koop BF, Devlin RH. 2006. Multiple microarray platforms utilized for hepatic gene expression profiling of growth hormone transgenic coho salmon with and without ration restriction. Journal of Molecular Endocrinology. 37, 259 - 282. Accepted Preprint made available 05/06/2006.*

- *Building salmonid and Atlantic cod genomic resources-* As a post-doctoral research fellow with the Genome Canada-funded Genomic Research on Atlantic Salmon Project (GRASP), Dr. Rise worked with various research teams to construct and characterize high-complexity cDNA libraries, build and maintain an expressed sequence tag (EST) database, and design, fabricate, quality test, and use cDNA and oligonucleotide microarrays. Results from this work were published in *Genome Research* (Rise et al. 2004b). This paper was the first to describe a salmonid EST database and DNA microarray, and has been cited 117 times by studies published in journals such as *Nature, Molecular Biology and Evolution, Molecular Ecology, and Environmental Health Perspectives*. The normalized, suppression subtractive hybridization (SSH), and high molecular weight cDNA libraries that he created with GRASP have played a significant role in the characterization of salmonid transcriptomes. GRASP has generated over 350,000 high-quality Atlantic salmon expressed sequences (and smaller EST collections from other salmonid species), and is the largest contributor of the 236,009 ESTs in the current release of The Institute for Genomic Research (TIGR) Atlantic salmon Gene Index. Dr. Rise helped to design the GRASP EST database to facilitate selection of genes for inclusion on GRASP cDNA

microarrays (Rise et al. 2004b; von Schalburg et al. 2005b). GRASP cDNA microarrays have been popular tools for global gene expression profiling, and have been used in several published studies on topics including salmonid growth (Rise et al. 2006), and responses to pathogens (Morrison et al. 2006) and vaccines (reviewed in Rise et al. 2007). Further, heterologous hybridizations have shown that GRASP cDNA microarrays are effective tools for studying global gene expression using labeled targets from a variety of salmonid species including Atlantic salmon, rainbow trout, chinook salmon, and lake whitefish (Rise et al. 2004b; von Schalburg et al. 2005b). Based on his research involving the development and use of salmonid genomic resources, he was invited to contribute a chapter to the Blackwell-published book “Aquaculture Genome Technologies” (Rise et al. 2007).

## ***Dr. Richard Rivkin***

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
- Promotion and Tenure Committee, OSC, 2005-2006
- Search Committee, OSC, 2005-2006

### *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
- Hetzberg 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*

- Levasseur, M.; Merzouk, M.; Scarratt, M. G.; Michaud, S.; Le Clainche, Y.; Wong, C. S.; **RIVKIN, R. B.**(2007).DMS cycling in the NE Pacific versus NW Atlantic: Does Fe matter? Surface Ocean Lower Atmosphere Study (SOLAS) Open Science Meeting, March 2007. Xiamen, China.. INVITED
- **RIVKIN, R. B.** (2007). Microbial response to mesoscale iron fertilization. Case study and global synthesis. Hong Kong University of Science and Technology. March 2007.Hong Kong. INVITED.
- Legendre, L.; **RIVKIN, R. B.** (2007). A new approach to planktonic microbes: the microbial hub. 38<sup>th</sup> CIESM Congress. April 2007. Istanbul, Turkey. INVITED

#### *Conference Presentations*

- Hale, M.; **RIVKIN, R. B.** (2007). Influence of temperature in organic carbon cycling by bacterial in the World Ocean. Global Integration and Analysis-Green Ocean IGBP. Workshop., June 2007. Villefranche-sur-Mer, France.
- Sun, B.; Evans, H.; Way, C.; **RIVKIN, R. B.** (2007). Preliminary assessment of the abundance and community structure of heterotrophic prokaryote in ballast water. CASIN Annual General Meeting. April 2007. Ottawa, ON.
- **RIVKIN, R. B.;** Evans, H.; Hale, M.; Keats, K.; Levasseur, M. (2007). Microbial control on biogas cycling. Surface Ocean Lower Atmosphere Study (SOLAS) Open Science Meeting. March 2007. Xiamen, China.
- Keats, K. F.; Evans, H.; Hale, M. S.; **RIVKIN, R. B.** (2007) Environmental determinants of bacterial community structure in the Northwest Atlantic Ocean: Case study and global comparison. Surface Ocean Lower Atmosphere Study (SOLAS) Open Science Meeting. March 2007. Xiamen, China.

### *Research Overview and Highlights 2006 - 2007*

- 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. Rivkin was selected to receive the award of University Research Professor. The award recognizes scholarly achievements that are of international stature.
- Kimberley Keats has been awarded the Moire A. Wadleigh Graduate Award for Excellence in Environmental Science- Masters of Science in Environmental Science for the 2006-2007 academic year.

## **Dr. Dave Schneider**



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
- Supervisory committee, 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 2006-2007*

- Preparation of 2nd edition of *Quantitative Ecology, Spatial and Temporal Scaling* (1st edition 1994, Academic Press)
- Hope Brock, MS.c. student, and Stephen Benjamins, Ph.D. student graduate in 2006-2007.

## ***Dr. Paul Snelgrove***

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*

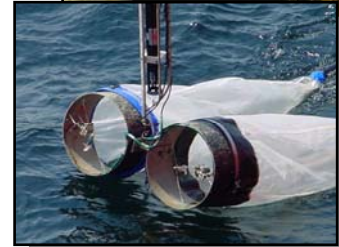
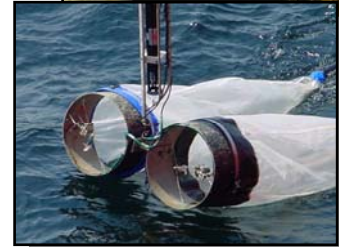
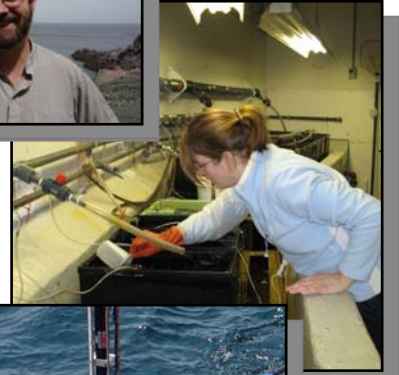
- Co-teaching Biology 2600 (Ecology)
- Co-taught Biology 3712 (Ecology of Open Waters)
- Fisheries Science 6001 (Master of Marine Studies program)

### *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, summer 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
- Chair, Promotion and Tenure Committee – OSC 2004-2005
- 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
- Search Committee, Biology Microbiology Faculty position, MUN 2005-2006
- Search Committee, Biology Invertebrate Biologist position, MUN 2005-2006
- Academic Council Executive, School of Graduate Studies, MUN 2006-present



### *External Activities*

- 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)
- Staff Editorial Board – *Marine Ecology*. (March 2005 – present)
- Editorial Board – *Journal of Experimental Marine Biology and Ecology*, Oct. (2005 – present)
- NSERC Ship Time Allocations Committee, Ottawa 2004-2006 (Chair 2006)
- European Science Foundation – EuroDeep Review Panel, Strasbourg, France June 2006
- 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*

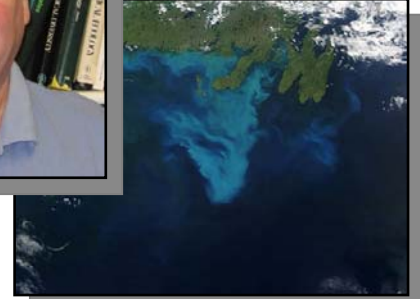
- Carter, K.P.; **Snelgrove, P.V.R.**; Pepin, P (2006). The interaction of climate and overexploitation in the collapse of Newfoundland groundfish. American Society of Limnology and Oceanography (ASLO) Summer Meeting, Victoria, BC, 2006.
- Guan, L.; **Snelgrove, P.V.R.** (2006) Ontogenetic changes in critical swimming speeds of cold–water marine fish larvae and the role of temperature. American Society of Limnology and Oceanography (ASLO) Summer Meeting, Victoria, BC, 2006.

*Research Highlights 2006-2007*

- Guan Lu, M.Sc. student, graduate in 2006-2007
- Karla Short, Canadice St. Germain, Margaret Warren, Steven Cole, Stephen Chung, Kate Gardiner, B.Sc. students graduated in 2006-2007.

## **Dr. Ray Thompson**

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

### *Invited Lectures and Conference Presentations*

#### *Conference Presentations*

- Thompson, R.J., **M.V. Garrido**, O.R. Chaparro, J.M. Navarro & O. Garrido. 2007. Mechanisms of formation and transport of pseudofaeces in the intertidal bivalve *Mulinia edulis*. National Shellfisheries Association, San Antonio, Texas, February 2007.
- **Liu, G.**, D.J. Innes & R.J. Thompson. 2007. The *Mytilus edulis* – *M. trossulus*

hybrid zone in Newfoundland. Canadian Society for Ecology and Evolution, Toronto, Ontario, May 2007.

- **Eloukkal, H., D. Deibel & R.J. Thompson.** 2007. Effects of viscosity on pumping activity in the sea peach, *Halocynthia pyriformis* (Tunicata). Canadian Society of Zoologists, Montreal, May 2007.

- Deibel, D., C.C. Parrish & R.J. Thompson. 2007. Effect of the spring phytoplankton bloom on lipid class and fatty acid content of benthic boundary layer invertebrates at sub-zero water temperatures. American Society for Limnology and Oceanography, Santa Fe, New Mexico, February 2007.

- Deibel, D., H. Eloukkal & R.J. Thompson. 2007. Viscosity and invertebrate behaviour at polar water temperatures. Arctic Frontiers International Meeting, ARCTOS Research Network, Univ. Tromsø, Norway.

### *Research Highlights 2006-2007*

- Response of the deposit feeding protobranch bivalve *Yoldia hyperborea* to an intermittent food supply: This body of work has demonstrated clear physiological and behavioural responses of a deposit-feeding protobranch (*Yoldia hyperborea*) to a seasonal input of sinking organic matter from the decaying spring diatom bloom in a cold ocean coastal environment (240 m depth, Conception Bay, Newfoundland). Several digestive processes and variables were directly correlated with the buildup and decline of the bloom. Furthermore, the magnitude of the digestive response in two consecutive years was positively correlated with the magnitude of the chlorophyll maximum in the photic zone. Dr. Thompson's research group also observed a close coupling between oocyte development and the seasonal pulse of food. Since the temperature is below 0C at all times, the bottom of Conception Bay provides an accessible natural laboratory for studying the effects of a varying food supply on a marine invertebrate without the confounding effects of temperature. It also provides a convenient and cost-effective alternative to polar research for studying benthic organisms which live in permanently cold water. Furthermore, the great majority of studies are undertaken on shallow water species, in which it is impossible to separate the effects of temperature and food in the natural environment. There is a pressing need for more information on the ecophysiology of benthic deposit-feeders, owing to their ecological importance, especially in carbon sequestration and cycling (of potential significance in global climate change), and to redress the severe imbalance between studies of deeper water deposit-feeders and shallow-water suspension-feeders. This work is technically *much* more difficult than studying suspension-feeders, especially epifaunal species. They were able to simulate the sinking spring bloom in controlled laboratory experiments, and reproduced the digestive and reproductive responses we had observed in *Yoldia* in the natural environment.

- 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.

- Jennifer Ryan and Cakiroglu, Ayse, MS.c students, graduated in 2006-2007. *Research Overview and Highlights 2006 - 2007*

## ***Dr. Joe Wroblewski's***

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 recently 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 2007 (January-April 2007):
  - Biology 4750 Fisheries Ecology (32 undergraduate students enrolled)
  - Biology 7551 Fisheries Resource Management (3 graduate students enrolled)
- Teaching during Spring Semester 2007 (May-August 2007):
  - Biology 3714 Estuarine Fish Ecology (8 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, MMS Candidate
- Internal examiner, MMS Candidate
- Comprehensive examination committee member, Ph.D. Candidate
- Steering Committee Member, “Community-University Research for Recovery Alliance (CURRA)”, funded by SSHRC, 2006- present
- Programme Committee member, Masters of Marine Studies Programme, Marine Institute.
- Chair of the Search Committee, Tenure-track faculty position in Marine Aquaculture, Ocean Sciences Centre, Memorial Univ. (April 2006- 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
- Reviewer for the Biological Oceanography Program of the US National Science Foundation. Reviewed the proposal “The role of biocomplexity in the recovery of commercially exploited fish species: Development of predictive statistical models for use in fisheries management” submitted by Dr. Joseph Crivello and Dr. Zhiyi Chi, University of Connecticut. (*delivered 2 November 2006*).

### *Invited Lectures and Conference Presentations*

#### *Conference Presentations*

- **Wroblewski J.;** Bell, T.; Copeland, A.; Edinger, E.; Yu Feng, C.; Saxby, J.; **Schneider, D.** (2007). Research on the Icelandic scallop fishery in Gilbert Bay during August 2006.
- **Wroblewski, J.** (2007). Regional MPA Update and Science Workshop, St. John’s, 19-20 March 2007.

### *Research Overview and Highlights 2006 - 2007*

- Craigdarroch Award for Societal Contribution presented to the Coasts Under Stress MCRI Research Team by Dr. Martin Taylor, V.P. Research, University of Victoria on 25 April 2007.

## ***Emeritus Faculty***

### ***Dr. Derek Burton***

#### *Research Interests*

The neural and hormonal regulation of the changes in pattern texture and colouration of flatfish in response to substrate changes and stressors. The current focus is on the respective roles of  $\alpha$ - and  $\beta$ -adrenoceptors and their subtypes, with particular emphasis on their “transition ranges” in responses to catecholamines. The recognition of different pattern-related “transition ranges” (Burton, 2008) provides a new perspective on the regulatory process involved, particularly emphasized by the simultaneous opposite effects a single concentration of a catecholamine can evoke in different areas of flatfish skin. These changes in the chromatophores represent an important camouflage adaptation, considered by some authors as exceptional among vertebrates in the degree of simulation of flatfish to differences in background pattern.

#### *Teaching*

- Biology 4910, Vertebrate Diversity and Adaptation, taught at the MUN Campus in Harlow, UK

#### *Internal Activities (Memorial)*

- Emeritus Professor 2005-present

#### *External Activities*

- Biographical citation in Canadian Who’s Who, 2007-present.
- Member of the Society for Experimental Biology.
- Member of the Canadian Society of Zoologists.
- External Examiner for a Ph.D. thesis, Department of Zoology, Banaras Hindu University, Varanasi, India. 2006.

### ***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)

#### *Invited Lectures and Conference Presentations*

##### *Conference presentations*

- Moreau D., R. Hobbs, A. Cnaani, I. Fleming, G. Fletcher, E. McLean, and E. Hallerman (2007) Environmental risk assessment parameters for growth hormone transgenic Atlantic salmon, *Salmo salar*. Proceedings Transgenic Animal Research Conference VI. August 12-16, 2007. Granlibakken Conference Center, Tahoe City, California
- Fletcher G.L., N.R. Pettigrew, R.S. Hobbs and P.L. Davies (2006) Fish antifreeze proteins: Their potential value to sea cage culture in cold waters. Aquaculture Canada annual meeting 2006, Halifax Nova Scotia, Nov 19-22. Pp 64.

##### *Research Highlights 2006-2007*

- **Fletcher, G.L.**, C.L. Hew and P.L. Davies. (2007). Microinjection procedures for gene transfer. Canadian Patent # 1,341,553
- 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

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

Metabolic physiology of cunner

***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

***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

**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.

**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.

**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

**Michael Kelly - Biology - M.Sc. (P. Snelgrove)**  
Benthic - pelagic coupling: Food supply and macrofaunal diversity

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

Lobster Larvae and Juvenile Recruitment

***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

## **Ph.D theses**

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

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

***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 wolfish

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

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

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

Glucose in Fish

***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

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

Purification and characterization of antifreeze

***Marieve 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/Atef Mansour - DFO)***

Gastric dilation and air sacculitis syndrome (GDAS) in farmed steelhead trout *Oncorhynchus mykiss*.

***Kimberley Keats - Environmental Science - Ph.D. (R. Rivkin)***

Spatial scales of bacterial biogeography: Relationships to upper - ocean biogeochemical processes

***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

***Louise Copeman - Biology - Ph.D. (P. Snelgrove/C. Parrish)***

Lipid biomarkers in coastal food webs.

***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 mussels *Mytilus* spp.

## **Degreed Students**

**Johanne Lewis - Biology - PhD (W. Driedzic)**

Protein synthesis in hypometabolic fishes

**Jason Treberg - Biology - Ph.D. (W. Driedzic)**

Nitrogen metabolism in fish.

**Chris Lewis- Biology- MSc (I.A. Fleming)**

Cod and hake juvenile habitat use

**Rodney Hobbs - Biology - MSc. (G. Fletcher)**

Purification and characterization of antifreeze

**Shaun Killen - Biology - PhD (K. Gamperl)**

Physiology and metamorphosis.

**Isabel Costa - Biology - MSc (K. Gamperl/W. Driedzic)**

Metabolic Physiology of Cunner

**Alexandre Garcia - Biology - PhD(C. Parrish)**

Marine fish larval nutrition.

**Jennifer Monk - Aquaculture - MSc (V. Puvanandran/L. Halfyard - MI)**

Fine tuning cod larviculture

**Guan Lu - Biology - M.Sc. (P. Snelgrove)**

Larval dispersal in marine fishes

**Hope Brock - CABE - M.Sc. (D. Schneider)**

The Endangered Leatherback Turtle in Newfoundland and Labrador: Northern Habitat Use

**Stephen Benjamins - CABE - Ph.D. (D. Schneider)**

Porpoise bycatch in Newfoundland and Labrador

**Liuming Hu - Environmental Science - M.Sc. (J. Wroblewski)**

A determination of the ecosystem carrying capacity for finfish in Gilbert Bay, Labrador, a Marine Protected Area

**Ayse Cakiroglu - Biology - M.Sc (R. Thompson/A. Aksu/R.Hiscott)**

Mollusc shells in cores from the eastern Aegean and western Black Sea

**Jennifer Ryan - Environmental Science - M.Sc. (R. Thompson)**

Ecophysiology of *Mytilus* at mussel farms

## 7. Research funding inventory

Grants received in the 2006 - 07 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         |
| D. Schneider | \$37,500.00         |
| P. Snelgrove | \$19,000.00         |
| R. Thompson  | <u>\$23,000.00</u>  |
|              | <b>\$387,480.00</b> |

### **NSERC Discovery**

|            |                    |
|------------|--------------------|
| A. Mercier | \$16,500.00        |
| R. Rivkin  | <u>\$53,300.00</u> |
|            | <b>\$69,800.00</b> |

### **NSERC Strategic**

|                           |                     |
|---------------------------|---------------------|
| P. Snelgrove              | \$192,800.00        |
| P. Snelgrove/D. Schneider | <u>\$24,938.00</u>  |
|                           | <b>\$217,738.00</b> |

### **NSERC MFA Grant**

|            |                     |
|------------|---------------------|
| I. Fleming | <b>\$279,000.00</b> |
|------------|---------------------|

### **NSERC CASES**

|           |                    |
|-----------|--------------------|
| D. Deibel | <b>\$34,197.00</b> |
|-----------|--------------------|

### **NSERC STPGP**

|            |                    |
|------------|--------------------|
| I. Fleming | <b>\$30,300.00</b> |
|------------|--------------------|

### **NSERC Ship Time**

|            |                    |
|------------|--------------------|
| A. Mercier | <b>\$93,650.00</b> |
|------------|--------------------|

### **AquaNet**

|            |                     |
|------------|---------------------|
| K. Gamperl | \$14,866.00         |
| K. Gamperl | \$131,250.00        |
| C. Parrish | <u>\$17,125.00</u>  |
|            | <b>\$163,241.00</b> |

## Other Grants

### *Internal Awards*

|               |                   |                    |
|---------------|-------------------|--------------------|
| I. Fleming    | Harris Centre     | \$11,002.00        |
| D. Schneider  | Harris Centre     | \$5,000.00         |
| P. Snelgrove  | Harris Centre     | \$7,500.00         |
| P. Snelgrove  | Harris Centre     | \$3,465.00         |
| J. Wroblewski | MUN Research Pool | <u>\$2,400.00</u>  |
|               |                   | <b>\$29,367.00</b> |

### *External Awards*

|             |                                      |                |
|-------------|--------------------------------------|----------------|
| D. Deibel   | Sloan (U. of Alaska)                 | \$12,000.00    |
| D. Deibel   | DFO                                  | \$18,000.00    |
| W. Driedzic | IRIF                                 | \$126,216.00   |
| W. Driedzic | CIHR                                 | \$41,655.00    |
| W. Driedzic | Genome BC(C-Grasp)                   | \$50,000.00    |
| I. Fleming  | Parks Canada                         | \$25,000.00    |
| I. Fleming  | USDA                                 | \$82,490.00    |
| I. Fleming  | CFI                                  | \$136,717.00   |
| I. Fleming  | IRIF                                 | \$167,370.00   |
| I. Fleming  | DFO                                  | \$9,750.00     |
| I. Fleming  | ACOA/AIF                             | \$811,250.00   |
| I. Fleming  | CRC (M. Rise)                        | \$75,000.00    |
| I. Fleming  | NB Wildlife Trust Fund               | \$12,500.00    |
| I. Fleming  | DFO                                  | \$40,000.00    |
| I. Fleming  | Dept. Envir. & Conser.               | \$3,077.00     |
| K. Gamperl  | Idaho State Univ.                    | \$4,685.00     |
| K. Gamperl  | 7 <sup>th</sup> Intern. Congress BFC | \$161,249.04   |
| K. Gamperl  | Genome Atlantic                      | \$1,681,000.00 |
| K. Gamperl  | Eastern Washington Univ.             | \$6,670.00     |
| K. Gamperl  | CFI (IOF)                            | \$14,941.00    |
| A. Mercier  | CFI                                  | \$95,225.00    |
| A. Mercier  | IRIF                                 | \$89,325.00    |
| A. Mercier  | CFI (IOF)                            | \$2,000.00     |
| A. Mercier  | CCFI/DFA                             | \$52,325.00    |
| A. Mercier  | DFO                                  | \$10,800.00    |
| C. Parrish  | SODIM                                | \$10,000.00    |
| C. Parrish  | DFO                                  | \$9,355.00     |
| C. Parrish  | DFO                                  | \$9,600.00     |
| C. Parrish  | DFO                                  | \$4,667.00     |
| M. Rise     | CFI                                  | \$118,422.00   |
| M. Rise     | IRIF                                 | \$254,964.00   |
| R. Rivkin   | CAISN                                | \$8,750.00     |
| R. Rivkin   | CAISN                                | \$26,250.00    |
| R. Rivkin   | Indian & Northern Affairs            | \$1,500.00     |
| R. Rivkin   | Eur-Oceans/UEM                       | \$5,529.00     |

|                            |                             |                       |
|----------------------------|-----------------------------|-----------------------|
| D. Schneider/P. Snelgrove  | DFO                         | \$33,956.00           |
| D. Schneider/P. Snelgrove  | Dept. Envir. & Conservation | \$2,500.00            |
| P. Snelgrove/ D. Schneider | DFO                         | \$27,482.00           |
| P. Snelgrove               | DFO                         | \$10,800.00           |
| P. Snelgrove               | NEPTUNE                     | \$48,999.00           |
| P. Snelgrove               | NEPTUNE                     | \$49,094.00           |
| J. Wroblewski              | DFO                         | <u>\$4,500.00</u>     |
|                            |                             | <b>\$4,355,614.04</b> |

**Total OSC Research Funding** **\$5,660,387.04**

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

McKenzie, C.; **Deibel, D.** (2006) Newfoundland Port Aquatic Invasive Species Risk - A Baseline Study Department of Fisheries and Oceans (DFO), 50% of \$63,000.

Bourgault, Daniel and **Deibel, D.** (2007) An Acoustic Doppler Velocimeter to Study Zooplankton-turbulence Interactions, NSERC, 50% of \$19,887.

McKenzie, C.; **Deibel, D.** (2007) Aquatic Invasive Species Survey, Department of Fisheries and Oceans (DFO), 50% of \$59,800.

Young, T.L; **Driedzic, W.R.** et al (2007). DNA sequencing for human health and marine science. Canada Foundation for Innovation, Leaders Opportunity Fund, \$280,013/year.

Hindar, K.; **Fleming, I.A.**; et al (2004-2006) Quantifying biological risks of growth-enhanced transgenic salmon. Norwegian Research Council, 4% of \$340,000 (2006) (5 hours/month).

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) and 34% of 73,000 (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) and 25% of \$162,000 (2007) 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) 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)10 hours/month.

Levasseur, L.; **Rivkin, R. B.** (2005-2006).Open Science Meeting, SOLAS, IMBER, Canadian Research Network, Ocean biogeochemistry, Atmospheric chemistry, Atmospheric physics, Ocean-atmosphere exchanges, Climate, Trace gases NSERC, Special Research Opportunities 50% of \$24,500 (10 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).

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

Chapman, R.; **Snelgrove, P.**; et al. (2004-2006). Advancing new frontiers in ocean science by extending ROPOS capabilities, CFI Innovation Fund, CFI 5% of \$318,046 (2006).

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).

Metaxas, A.; **Snelgrove, P.V.R.** (2006). Census of Biodiversity Resources in Canada's Discovery Corridor NSERC, Ship Time Allocations Committee 50% of \$147,280 (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 (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).

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%) (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

## 8. Publications

### Publications appearing in the 2006 - 07 academic year

Afonso, L.O.B.; Osborne, J.; Iwama, G.K.; **Gamperl, A.K.**; Johnson, S. (2007). Lack of glucose and hsp70 responses in haddock (*Melanogrammus aeglefinus*) subjected to handling and heat shock. *J. Fish Biology*. 71, 1–11

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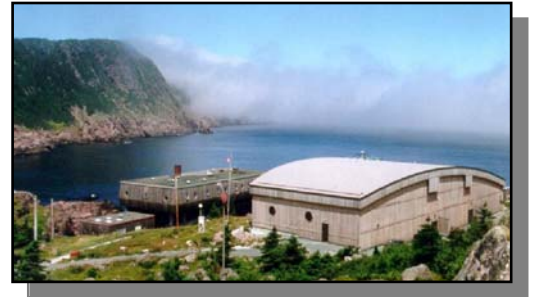
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## 9. Dr. Joe Brown Aquatic Research Building (JBARB)



The 2006 – 2007 year proved to be a very successful year within the Dr. Joe Brown Aquatic Research Facility (JBARB).

The JBARB is composed of a core staff of 14 people at both the OSC and cod research cage site in Poole's Cove. Furthermore, during the last year the facility has had 4 MUCEP positions, 3 work - term students, and one biology student.

During the past year the JBARB has provided research based tours for 400 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.

### **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 continues to support yearly production of juveniles for cage trials. Cage research will occurs 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 rigour 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 16,000 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. Furthermore, the program included a field trip to Petley, Random Island, Newfoundland, where the students spent the day learning about our local marine environment. Students participated in a shoreline walk and visited historic landmarks of the community (i.e. saw mill, boat building operations). The second component of the field trip was aboard the Coastal Connections Ltd. Vessel, MV Coastal Explorer. The vessel traveled around the area of Smith Sound, which has one of Newfoundland and Labrador's healthiest surviving aggregations of Northern Cod. On board, the students learned about this area, participated in scientific studies, and viewed the wonders of our nature - in the sky, on the land, and particularly in the sea. A variety of sampling tests were conducted using plankton tows, bottom grabs, water chemistry and environmental observations.

OSC PEP also participated in Oceans Day on June 8<sup>th</sup>. This international celebration, declared a decade ago at the United Nations Earth Summit in Rio de Janeiro, has grown from a ripple into a tidal wave of awareness about the importance of our oceans. Since then, Fisheries and Oceans Canada in the Newfoundland and Labrador Region has celebrated World Oceans Day by hosting special events and activities that promote ocean health. This past June (June 8<sup>th</sup>, 2007) the Department of Fisheries and Oceans prepared an Oceans Day event at the Fisheries and Marine Institute, Memorial. The OSC put together displays, including a touch tank, careers in science booth and a seal display. The event was successful and involved many local school groups from the Avalon region.

## 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. Seal staff and volunteers also volunteered their time to help with the weekend trip to Petley for the Shad Valley program.

## 12. Field Services Unit

Throughout the academic year 2006-2007 the Field Services Unit had been involved in numerous research projects and provided services to a variety of department, institutions and individuals. As in previous years, Field Services regularly provided collections of fish, invertebrates and algae for teaching purposes for the laboratory 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 educational and research purposes 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 Field Station in Norris Point to collect a variety of specimens for display in their aquarium. Similar collections are also made during the summer months for the Public Education program at the OSC.



Back in 2004 the Field Services Unit had 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 they returned in the summer of 2007 to remove all 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.

Our department also provides services beyond Memorial University and Marine Institute. Once again we collected and shipped specimens for a saltwater aquarium display in the Ontario Science Centre. As in previous years, in the summer of 2007 we collected sea butterflies (*Clione*) for international researchers, shipping to academic institutions in Paris, France and Madrid, Spain.

The Field Services Unit dive truck, which is equipped with a 2500 L tank and oxygen cylinders with diffusers, was used to transport specimens over vast distances. In the fall, of 2006 the team transported juvenile cod, salmon smolt, and steelhead trout from the south coast of the island to Department of Fisheries and Oceans (DFO) White Hills in St. John's for three different researchers. They also transported salmon smolt from a hatchery in Daniel's Harbour on the west coast of the island and juvenile cod from DFO research vessels docked on the South Side of St. John's harbour to DFO White Hills for two

researchers. They have also collected and delivered specimens for the Department of Fisheries and Aquaculture (DFA) Agri-Foods Show in Mount Pearl (Spring 2007).

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 the team surveyed harbours in Botwood, Port aux Basques, Bay of Islands, and Argentia. While surveying these sites the team was able to identify the invasive colonial tunicate, Golden Star, *Botryllus schlosseri*. After these initial findings they were requested by DFA to follow up with surveys in adjacent areas near mussel aquaculture sites, including some ice diving near wharves in the Bay of Islands in the winter of 2007. During the following summer months all sites were revisited. However, fishermen had discovered another invasive species, green crab, *Carcinus maenas* in North Harbour, Placentia Bay. Therefore the team was 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.

Field Services also participated in the Ocean Sciences Public Education program in 2007. Two members of the team participated in the annual Ocean’s Day at the Marine Institute. During this event they displayed their scuba equipment and set-up a touch tank with some native marine species for local school groups.

## 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
- Nisken 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. Erik Heibo<br>Swedish Research Council<br>Visiting Post-Doctoral Fellow   | Collaborating with Dr. Ian Fleming's laboratory<br>March 1 2006 to March 1 ,2007  |
| Dr. Marlies Rise<br>Great Lakes Water Institute, University of Wisconsin  | Collaborating with Dr. Matt Rise on the development and use of genomic resources and animal behaviour assessment tools in studies related to salmonid health<br>July 4, 2006- December 31, 2006 |
| Jim Staples<br>Associate Professor<br>Department of Biology<br>University of Western Ontario                                  | Working with Dr. Gamperl/Courtney Macsween on aspects of mitochondrial function in cunner: ie. what are the mechanisms by which cunner can become hypometabolic                                 |
| Martina Drebenstedt<br>Environment Canada's National Water Research Institute<br>Burlington, Ontario                          | Collaborating with Dr. Chris Parrish and his laboratory on their mass spectrometer<br>23-Jan-07   |
| Dr. Michelle Hale<br>Senior Lecturer<br>School of Earth and Environmental Sciences University of Portsmouth<br>Portsmouth, UK | Collaborating with Dr. Rivkin's Laboratory<br>June 21-29, 2007  |
| Dr. Margaret J. McFall-Ngai<br>Medical Microbiology and Immunology<br>University of Wisconsin                                 | Collaborating with Dr. Matt Rise on squid-vibrio symbiotic relationship<br>July 5th to July 17, 2007  |
| Dr. Andrés Martínez and Andrea Valderrey, Research Assistant<br>University of La Coruña<br>Spain                              | Collaborating with Dr. Ray Thompson on the evolutionary genetics of mussels<br>August 4-21, 2007  |

### **Visiting Students**

|   |  |
|---|--|
| Mr. Jong Soo Oh<br>Student<br>Kangnung National University in Korea                       | Learning about larval and juvenile fish rearing<br>and husbandry<br>JBARB<br>January 22-Feb 28, 2007   |
| Ms. Paulette Penton<br>M.Sc. Candidate<br>Department of Zoology<br>University of Manitoba | The adaptive significance of two spawning<br>strategies in capelin ( <i>Mallotus villosus</i> ) in<br>coastal Newfoundland<br>June 18- Sept 2007 |

## 16. OSC Seminars

### Biology/OSC Seminar Series 2006 – 2007

|  |  |
|--|--|
| Dr. John Sandlos<br>Department of History, Memorial<br>University of Newfoundland  | Bison Management in Northern Canada:<br>Historical Roots and Contemporary Policy<br>Implications in Wood Buffalo National<br>Park<br>27-Oct-06                 |
| Gottfried Pestal<br>SOLV Consulting Ltd., Vancouver  | From wild salmon policy to wild salmon<br>management: Bringing science to<br>stakeholders<br>03-Nov-06   |
| Kim Keats<br>Ph.D. Candidate, OSC, Memorial  | The little things that run the oceans:<br>Delving into the structure and function of<br>marine bacterial communities<br>17-Nov-06                              |
| Dr. Paul Brickle   | Fisheries Biologist Falkland Islands<br>Government Fisheries Department<br>27-Nov-07   |
| John Jacobs<br>Professor Emeritus, MUN Geography   | Between Arctic and Boreal: Investigating<br>the Climate of the central Labrador<br>Highlands<br>10-Nov-06  |
| Dr. Briony Campbell<br>Stirzaker Consulting<br>Crofton, BC   | Control of Reproduction in Finfish<br>Aquaculture<br>01-Feb-07   |
| Dr. Harry Murray,<br>Molecular Microscopy Research Officer,<br>Institute for Marine Bioscience, National<br>Research Council of Canada | Functional Development of the Fish<br>Digestive System<br>The Benefits of a<br>Marriage between Microscopy, Molecular<br>Biology and Biochemistry<br>07-Feb-07 |

|  |  |
|--|--|
| Dr. Nathalie R. Le François<br>Research Professor Université du Québec a<br>Rimouski/MAPAQ     | Progressive R&D in Fish Physiology<br>Applied to Aquaculture: From Species<br>Selection to Commercialization<br>12-Feb-07                                    |
| Dr. Jim Staples<br>Associate Professor<br>Department of Biology                                | Metabolic suppression in hibernation and<br>daily torpor<br>09-Feb-07  |
| Dr. Matt Rise<br>Assistant Professor, Ocean Sciences centre,<br>Memorial University            | Genomics research on fish response to<br>pollutants and pathogens<br>16-Feb-07   |
| Dr. Steven Carr<br>Department of Biology, Memorial<br>University                               | Biotechnology for biodiversity: insights<br>into phylogeographic biology from genomic<br>biology and fish'n' chips with flippers on<br>the side<br>23-Feb-07 |
| Susan Howatt- Council of Canadians<br>Brian O'Neill- Oxfam Canada<br>Julie Graham- KAIROS      | Water for People and Nature: Atlantic<br>Canada and the global fight to protect water<br>02-Mar-07   |
| Jason Simms<br>Department of Fisheries and Oceans  | Grand Banks Integrated Management and<br>Marine Conservation<br>06-Mar-07  |
| Dr. Ratana Chuanpagdee<br>CRC in resources & conservation                                      | Coastal Transects Analysis Model<br>09-Mar-07  |
| Dr. Sylvie Guenette<br>Research Associate, Fisheries Centre,<br>University of British Columbia | Detective work: why have Steller sea lions<br>declined in the Gulf of Alaska<br>20-Mar-07  |
| Dr. Peter Ryan<br>Mississippi State University   | Application of Biophotonics and Thermal<br>Imaging Technologies in Aquatic and<br>Mammalian Species Production Systems<br>16-Mar-07                          |
| Dr. Jan Cann<br>Wadsworth Center/SUNY Albany   | Phylogeography of Neotropical Malaria<br>Vectors<br>23-Mar-07  |

|   |   |
|---|---|
| Dr. Patrick Gagnon<br>Department of Biology, Dalhousie<br>University  | From individual to seascape ecology:<br>pattern and process in the rocky subtidal<br>ecosystem of eastern Canada<br>26-Mar-07           |
| Dr. Sara Good-Avila<br>Acadia University  | Living at the edge of your range isn't so<br>bad: the history of two coastal plains<br>species in Nova Scotia<br>30-Mar-07              |
| Dr. Matt Litvak<br>Director of the Centre for Coastal Studies<br>and Aquaculture<br>University of New Brunswick                     | Complementary approaches to the study of<br>fish ecology and aquaculture<br>09-May-07   |
| Dr. Michelle S. Hale<br>Senior Lecturer<br>School of Earth and Environmental<br>Sciences University of Portsmouth<br>Portsmouth, UK | Control of bacterial dynamics in the<br>Atlantic Ocean: implications for the global<br>carbon cycle in a changing climate.<br>27-Jun-07 |
| Dr. Margaret McFall-Ngai<br>Professor, Symbiosis Cluster, University of<br>Wisconsin  | Exploring beneficial symbioses:<br>Deciphering the host-symbiont dialogue in<br>the squid-vibrio association<br>13-Jul-07               |

**OSC Graduate Student Seminar Series 2006-2007**

|   |  |
|---|--|
| Nate Wilke<br>Ph.D Candidate, OSC, Memorial                     | Maine's endangered Atlantic salmon ( <i>Salmo salar</i> ): Adaptive divergence<br>11-Dec-06  |
| Alexandre Sachside Garcia<br>Ph.D. Candidate, OSC, Memorial     | Effect of differently lipid-enriched live feed on growth, survival, and lipid composition of two larval gadoids: Atlantic cod ( <i>Gadus morhua</i> ) and haddock ( <i>Melanogrammus aeglefinus</i> )<br>01-Dec-06 |
| Mariève Desjardins<br>Ph.D. Candidate, OSC, Memorial University | The molecular basis for difference in AFP levels between two species of wolffish: Gene copy number or gene expression?<br>19-Feb-07  |
| Justin So<br>M.Sc. Candidate, Memorial University               | Science before the fishery – Growth rates, predation, gene flow and substrate related health status of the sea cucumber, <i>Cucumaria frondosa</i> .<br>26-Feb-07  |
| Ashley Callahan<br>M.Sc. Candidate, OSC, Memorial University    | The tunicates are coming! A spatial and genetic look at invasive ascidian tunicates<br>05-Mar-07   |
| Ashlee Lillis<br>M.Sc. Candidate, OSC, Memorial University      | Cribs for Crabs: Habitat Selection at Settlement in Larval Snow Crab.<br>12-Mar-07   |
| Joy Stacey<br>Ph.D. Candidate, OSC, Memorial University         | Heavy metal tunicates: seasonality in the distribution of vanadium among ascidians tissues<br>26-Mar-07  |
| Kim Keats<br>Ph.D. Candidate, OSC, Memorial University          | Biogeography of Marine Bacteria: Does the Environment Regulate Patterns of Diversity and Community Structure?"<br>09-Apr-07  |

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| <p>Juan Perez Casanova<br/>Ph.D. Candidate, OSC, Memorial University</p> | <p>Physiological and Immunological Responses of Atlantic Cod to Thermal Stress<br/>16-Apr-07</p>                     |
| <p>Ryan Stanley<br/>M.Sc. Candidate, OSC, Memorial University</p>        | <p>A biophysical study of connectivity in early life history stages of coastal Newfoundland fishes<br/>23-Apr-07</p> |
| <p>Bei Sun<br/>M.Sc. Candidate, OSC, Memorial University</p>             | <p>Aquatic Prokaryotes Introduced to Canada by Ballast Water<br/>30-Apr-07</p>                                       |

# Appendix

