



Annual Report 2005 - 2006



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1. Director's Report

Another academic year has passed and as I reflect back on it, it is clear that it has been one of continued excellence in research and education at the Ocean Sciences Centre (OSC) of Memorial University of Newfoundland. It is a year that staff, students and faculty of the OSC can reflect on with considerable satisfaction. This report summarizes the activities and numerous accomplishments of their joint efforts.

The Ocean Sciences Centre (OSC)

The OSC (www.osc.mun.ca) is a unique facility on the Canadian academic landscape. By virtue of its location, the OSC provides scientists at Memorial University of Newfoundland (MUN) and other institutions throughout Canada and abroad, access to the unique flora and fauna of the northwest Atlantic Ocean. It is located at Logy Bay, 10 km from the St. John's campus of MUN, and provides facilities for top quality marine science. The Centre is part of the Faculty of Science and has a resident faculty of twelve, three Emeritus Professors and 40 staff, of which 20.5 are University funded (8.5 Infrastructure Services staff handling infrastructure, maintenance, and security; 3.5 Field Services staff serving the MUN-wide community; 4.5 Administrative & Computing staff; and 4 Research Assistants) and 19.5 are externally funded. Its mission is to conduct and promote research and education primarily through the teaching and supervision of graduate students and post-doctoral fellows. Several of the faculty also service undergraduate education through teaching within other MUN departments. The Centre is recognized internationally for its cold-ocean research programmes in oceanography and marine ecology, fisheries and aquaculture, and the underlying physiological, biochemical and behavioural processes of marine organisms.

Activity 09/2005 – 08/2006

This year saw Dr. Matthew Rise join the faculty of the OSC as a Tier II Canada Research Chair in Marine Biotechnology. Matt brings expertise in the development and use of genomic techniques to study the reproduction, development, growth and immune response of aquatic organisms (for details see section 4 – Faculty). We are delighted to have someone of Matt's expertise and enthusiasm join the OSC.

The OSC continues to be highly productive environment for research and education. During the past year 66 graduate students (37 Masters and 29 Doctoral), six postdoctoral fellows, three cross appointees, 11 adjunct appointees, nine groups of visiting scientists, and six visiting graduate students/postdoctoral fellows were involved in research together with our core faculty and staff at the OSC. In addition, numerous high school and undergraduate students trained at the facility.

In the past year, 68 peer reviewed papers were published out of the OSC and another 32 accepted for publication, which are impressive numbers given the faculty compliment (7.4 papers per faculty member). Moreover, many of these papers were published in leading

scientific journals of their fields, including *Science*. The research also attracted the attention of local, national and international media sources (e.g. *The National*, *CBC television and radio*, *NTV Newfoundland*, *New Yorker Magazine*, *Maine Sunday Telegram*, *Aquaculture International*). Success in attaining external funds was important in supporting this level of productivity and scientific quality, which continued to hover around \$2.5 million.

The OSC furthered its international reputation and showcased its capacity by hosting the 7th International Congress on the Biology of Fish this past July. The conference hosted more than 540 delegates from 32 countries. Memorial faculty, students and staff played a large and notable role in the scientific program, with 46 scientific presentations involving personnel from the university. Most impressive was the performance of OSC affiliated graduate students, who gave 23 presentations, three of which received awards for the quality of their science and presentation.

Graduate student education continues to be an integral part of OSC activities. Our 66 graduate students, seven of which graduated this past year, were spread across seven different graduate programmes at MUN. On average, this represents 5.3 graduate students supervised or co-supervised per faculty member, which is well above the University, as well as national average. Our graduate students, together with postdoctoral fellows and research associates, are central to the Centre's research productivity (see Publications). Six students won awards for their research and/or conference presentations this past year. OSC faculty play leading roles in MUN graduate programmes, chairing or serving on the steering committees of three Interdisciplinary Graduate Programs in the Faculty of Science (i.e. Environmental Science, Aquaculture, and Cognitive & Behavioural Ecology) and chairing the Department of Biology Graduate Studies Programme.

OSC faculty actively teach in departments and programmes across MUN, providing 15 regular term courses, one short course and many guest lectures during the academic year. The OSC also has a strong commitment to experiential learning for students, as we hosted 53 high school and undergraduate students through programmes such as Women in Science and Engineering [WISE], Memorial's Undergraduate Career Experience Program [MUCEP], Summer Career Placement [SCP], Student Work Abroad Program [SWAP], Coop and Job Shadow, and Work term, and as student assistants. Moreover, our public education programme, despite its small size, hosted high school students from Shad Valley International again this year. More impressively, it continued to attract over 17,000 visitors to the OSC and our seal compound during June-August 2006 alone.

OSC faculty continued to provide important service to the University, serving on Memorial Institutional Animal Care, MUN Strategic Planning, Faculty of Science Graduate Studies, Faculty of Science Library, MUN Radiation Safety and various departmental Search Committees, as well as serving as Associate Dean of Science (Research). In terms of the broader academic community, OSC faculty played leading roles in large research networks, such as the Genome Canada funded *Atlantic cod genomics and broodstock development*, SSHRC/NSERC funded *Coasts Under Stress*, the *Canadian Arctic Shelf Exchange Study* (CASES), the *Surface Ocean and Lower Atmosphere Study* (SOLAS), *NEPTUNE Canada*

Science Advisory, International North Polynya Program, Canadian Aquatic Invasive Species Network, Institute for Social Ecological Research and the Census of Marine Life. They also sat on the editorial boards of seven scientific journals, and served as president of a learned society and on the advisory boards for several government agencies.

The Aquaculture Research and Development Facility (ARDF) continued to play an integral role in the activities of the OSC and was again very active in research, training, pre-commercial production, and small-scale commercial trials on alternative species for marine aquaculture. Much of the research was supported through the Atlantic Innovation Fund and Aquaculture Collaborative Research Development Program. This year, however, saw the ARDF, as part of a larger consortium, awarded \$18 million over four years to partake in the Genome Atlantic *Atlantic Cod Genomics and Broodstock Development Project*. The ARDF together with researchers from the OSC will play a lead role in the project, the aim of which is to identify and select elite broodstock through the application of selective breeding and genomics. A number of graduate students and High Quality Personnel trained at the facility this past year and over 546 visitors, including researchers, government officials and industry members from over 20 countries, partook in research based tours.

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. 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 Montevecchi- 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. Brian Dixon - University of Waterloo
Dr. Vanya Ewart - National Research Council
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. P. Pepin - Department of Fisheries and Oceans
Dr. Stephen Walsh - Department of Fisheries and Oceans

Professor of Emeritus

Dr. Derek Burton
Dr. Garth Fletcher
Dr. Rasul Khan

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)
Heather Evens - Research Assistant I (Rivkin)
Danny Ings - Research Assistant II (Schneider - March 31, 2006 - 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)
Jeanette Wells - Research Assistant I (Parrish)
Bonita Masters - Science Technician I (Seals/Department)
Christine Vickers - Science Technician III (Department)

Administrative and Computer - Support Staff

Marc Bolli - Research Computer Specialist (started January, 2006)
Maureen James - Intermediate Clerk Steno
Ken Langdon - Computer Support Technician
Danielle Nichols - Research Marketing Manager
Trevor Snow - Research Computer Specialist (finished November, 2005)
Winnie Sparkes - Intermediate Secretary
Delores Wheeler - Administrative Staff Specialist II

Aquaculture Research Development Facility (ARDF)

Danny Boyce - Business Manager
Colleen Crewe - Science Technician I (finished June, 2006)
Francine Godden - Science Technician III
Darrell Green - Science Technician III
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

AquaNet - Administration

Joan Atkinson - Network Manager
Brenda Lye - Administrative Officer
Catherina Murphy - Computer and Administrative Support
Joanne Burry - Education Officer

Pools Cove Cod Grow - out Site

Daniel May - Science Technician I
Sheldon Perham - Science Technician I
Courtney Williams - Science Technician I

Field Services

Renee Boland - Dive Technician
Robert Guest - MUN Safety Diving Officer I
Roberts 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
Terrance Harris - Electronics
Jim Hopkins - Facility Custodian
Wayne Morrissey - Facility Custodian
Damien Whitten - Laboratory Facility Technician II

Facilities Management

Rick Walsh
Ian Churchill

Student Assistants

Scott Caines (Snelgrove)
Stephen Cole (Snelgrove)
Lana Combdon (Seals/Jones Apr. 20–May 27)
Lana Combdon (PEP/Nichols - May 29 - Sept. 4)
Aaron Coward (Schneider)
Charles Feng (Schneider)
Esther Keddie (Schneider)
Laurie Murphy (ARDF/Boyce)
Christopher Negrijn (PEP/Nichols)
Ashley Noseworthy (Seals/Jones)
Sarah Penney (Schneider)
Sabrina Penney (Rivkin)

Terri - Lynn Pinksen (Seals/Jones)
Mitch Randell (ARDF/Boyce)
Corinna Russell (Wroblewski)
Perry Rumbolt (Schneider)
Karla Short (Snelgrove)
Courtney Smith (ARDF/Boyce)
Don Saunders (Schneider)
Stephanie Stack (Deibel)
Joanne Walsh (Schneider)
Krista Walsh (PEP/Nichols)
Margaret Warren (Seals/Jones)
Julia Wheeler (Schneider)

MUCEP

Lindsay Blades (Thompson)
Anuchit Boonlertcharoensuk (Computers/Snow)
Ashley Callahan (Rivkin)
Stephen Chung (Snelgrove)
Colleen Crewe (ARDF/Boyce)
Shelly Dalton (PEP/Nichols)
Ainsley Decker (ARDF/Boyce)
Dominic Foley (Fleming)
Kathleen Gardiner (PEP/ Nichols)
Melanie Groves (Seals/Jones)
Christopher Negrijn (PEP/Nichols)
Ashley Noseworthy (Seals/Jones)
Krista Shea (Seals/Jones)
Karla Short (Snelgrove)
Allison Stagg (Schneider)
Jennifer Swyers (Parrish)
John Walsh (Computers/ Snow and Bolli)
Julia Wheeler (ARDF/Boyce)
Lewis Yang (Wroblewski)

SCP - Students

Erin Stapleton (Thompson)

SWAP

Cheryl Barron (Fletcher)

WISE - Students

Victoria House (Seals/Jones)
Calandra Lawlor (PEP/Nichols)
Hannah Ploskonka (Seals/Jones)

Work - term Students

Laurie Murphy (ARDF/Boyce)
Courtney Smith (ARDF/Boyce)
Elizabeth Dohey (ARDF/Boyce)

Co - op and Work - Term Students

Stephen Halley (Seals/Jones)
Shane Sullivan (Seals/Jones)

Volunteers - Seals

Cynthia Mercer
Nicky Spencer
James Stenson
Katie Stenson
Jennifer Walsh
Margaret Warren
Renee Decker
Peter White
Stephanie Stack
Lana Combdon
Melanie Groves

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. C. Parrish
Dr. P. Snelgrove
Dr. J. Wroblewski

Space Committee:

Dr. K. Gamperl
Ms. D. Nichols

Safety Committee:

Ms. C. Short
Dr. R. Thompson

Search Committee (CRC Biotechnology):

Dr. D. Deibel
Dr. W. Driedzic

Executive Committee:

Dr. I. Fleming
Dr. D. Deibel
Ms. D. Nichols
Mr. J. Devereaux

OSC Tours

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

5. Faculty

Dr. D. Deibel



Research Interests

Dr. Deibel is a zooplankton ecologist and biological oceanographer who focuses on determining the role of mesozooplankton in biogeochemical cycles, particularly on the role of copepods and pelagic tunicates in the cycles of carbon, nitrogen and phosphorus in the arctic. Much of his work in the arctic is as part of international, multi - disciplinary research programs into the affects of global climate change on the Arctic Ocean. He has worked in three arctic polynyas (i.e. the Northeast Water, Northwater and St. Lawrence Island polynyas) and this year will be undertaking a year - long expedition to the Beaufort Sea Shelf. For about 20 years, our 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.

Other Activities (Memorial)

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

External Activities

- National and International Steering Committee, Canadian Arctic Shelf Exchange Study (CASES), 2000 - present
- Theme Leader, Canadian Arctic Shelf Exchange Study (CASES), 2000 - present
- Editorial Advisor, *Marine Ecology Progress Series*, 1995 - present
- Special issue co - editor, *Appendicularians and Global Change*. NATO Advanced Study Workshop, 2002 - present.
- Scientific Steering Group, Arctic Ocean Census of Marine Life, University of Alaska (04 -)

Invited Lectures and Conference Presentations

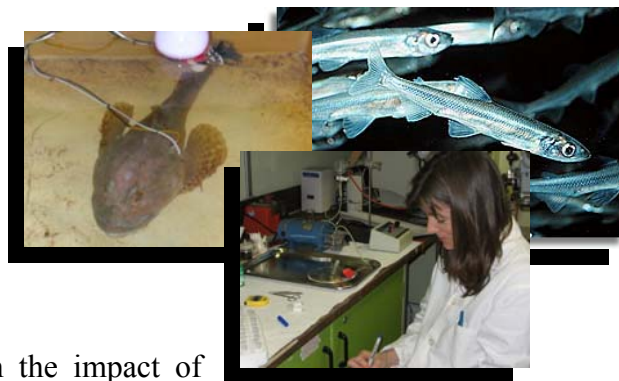
Conference Presentations

- Connelly, T., **D. Deibel and C.C. Parrish.** (2006). Carbon sources for benthic boundary layer zooplankton determined by fatty acid signatures. ASLO/AGU Meeting, Honolulu, February.

Research Overview and Highlights 2005 - 2006

- Finished the first - ever review of the ecology of zooplankton in Arctic and Antarctic polynyas. Collaboration with Dr. Kendra Daly at the University of Southern Florida, which will be published by Elsevier in early 2007.

Dr. W. Driedzic



Research Interests

Dr. Driedzic's research interests are focused on the impact of environmental challenges, especially low oxygen and temperature extremes, on metabolic supply and demand. Current activities include: control of protein synthesis by the mitochondrial genome, cardiac adaptations to anoxia, glycerol as a protective agent against low temperature, and the regulation of metabolism as a function of temperature. Experiments are conducted with a range of animals and tissues and at different levels of organization ranging from isolated proteins to whole animal cardiovascular performance.

Teaching

Biochemistry 3601 - Metabolism (Winter 2006 - 1/3 of course)

Other Activities (Memorial)

- Supervision, graduate students
- Co - supervision, graduate students
- Supervision, research assistant
- Graduate Student Committee
- Promotion and Tenure Committee
- Canadian Research Chair, Marine Bioscience
- Biochemistry Departmental Seminar January 2006
- Chair Search Committee - Canadian Research Chair - Marine Biotechnology
- Co - applicant and member of the University team to present a major CFI proposal entitled North Atlantic Resource for Molecular, Cellular, Integrative and Network Sciences (NARIS)

External Activities

- Member, Science Advisory Council to Department of Fisheries and Oceans
- Conference Co - organizer for the 7th International Congress on the Biology of Fishes, August 2006, St. John's, Newfoundland.
- Granting councils: NSERC, CFI, CRC, National Science Foundation
- 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.

Invited Lectures and Conference Presentations

Conference Presentations

- Costa, I.; **Driedzic, W.R.; Gamperl A.K.** (2006). “Sleepy fish”: metabolic depression in a north Atlantic teleost, *Tautoglabrus adspersus*. 7th International Congress on the Biology of Fish St. John’s, Newfoundland, July 18 - 22, 2006
- Levesque, H.M.; Bondy, J.D.; Short, C.; Ballantyne, J.S.; **Driedzic, W.R.**; Moon, T.W. (2006). Effects of temperature on Atlantic cod morphometrics parameters and tissue metabolites and enzymes. 7th International Congress on the Biology of Fish St. John’s, Newfoundland, July 18 - 22, 2006
- Lewis, J.M.; Costa, I. Val, A.L.; Almeida - Val, V.M.F.; **Gamperl, A.K.; Driedzic, W.R.** (2006). Biochemical and physiological responses to hypoxia in an Amazonian cichlid (*Astronotus ocellatus*). 7th International Congress on the Biology of Fish St. John’s, Newfoundland, July 18 - 22, 2006
- MacCormack, T.J.; **Driedzic, W.R.** (2006). Effect of hypoxia, heart rate and adenosine on in vivo glucose uptake in a hypoglycemic fish, *Myoxocephalus scorpius*. 7th International Congress on the Biology of Fish St. John’s, Newfoundland, July 18 - 22, 2006
- Treberg, J.R.; **Driedzic, W.R.** (2006). The accumulation of TMAO in elasmobranchs revisited: retention vs. synthesis in the winter skate. 7th International Congress on the Biology of Fish St. John’s, Newfoundland, July 18 - 22, 2006

Research Overview and Highlights 2005 - 2006

- Tyson MacCormack, Biology Ph.D Student graduated 2005 - 2006.
- Research trip to Manaus, Amazonas, Brazil in Oct. 2005 along with graduate students Johanne Lewis and Isabel Costa.
- Winner of the best Best Oral Presentation in Advances in Fish Biology Symposia - Jay Treberg (Ph.D. Student/Driedzic). Title: The accumulation of TMAO in elasmobranchs revisited: retention vs. synthesis in the winter skate. 7th International Congress on the Biology of Fish, St. John’s, Newfoundland, July 2006.

Dr. I. A. Fleming



Research Interests

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

Teaching

- Guest lectures: Aquaculture & the Environment (AQUA 6201, AQUA 4111)
- Guest speaker in Graduate Student Forum on *Accessing positions in Academia, Government and Industry*.

Other Activities (Memorial)

- Director, Ocean Sciences Centre, MUN
- Supervision, graduate students
- Supervision, post - doctoral fellow
- Supervision, research assistant
- Graduate student thesis committee
- Executive Committee member, OSC
- Internal thesis examiner, Biology Department and CABE Program
- Participant, Shad Valley Memorial University Summer 2006.

External Activities

- Hosted Research Sabbatical Visit of Professor Jörgen Johnsson, Department of Zoology, Göteborg University, Sweden (2 months)
- Invited Panel Member, Technical Working Group on Escapes, Salmon Aquaculture Dialogue, World Wildlife Fund.
- Aquaculture Collaborative Research and Development Program Regional Committee of the Department of Fisheries and Oceans Canada.
- 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)
- Invited External Reviewer, Department of Fisheries and Oceans Workshop on Conservation Status Report for Atlantic Salmon. Moncton, Canada. (Feb 13 - 17)
- Invited Expert, Workshop on *Environmental Risk Assessment of Genetically Modified Organisms*, World fish Center, Penang, Malaysia. (17 - 21 Oct)

- Canadian representative on the Organisation for Economic Co - operation and Development (OECD) Expert Workshop on the Biology of Atlantic salmon, Trondheim, Norway. (12 - 14 Oct)
- Invited Expert Reviewer, Center for Independent Experts (CIE), Status Review for Anadromous Atlantic Salmon (*Salmo salar*) in the United States.
- Associate Editor, Transactions of the American Fisheries Society.
- Courtesy Faculty, Department of Fisheries and Wildlife, Oregon State University, 104 Nash Hall, Corvallis, Oregon 97331 - 3803, USA. (2004 - Present)
- Scientific Advisor, Section of Applied Ecology, Department of Environmental Science, University of Siena, via Mattioli 4, 53100 Siena, Italy. (2004 - Present)
- Scientific Adviser/Adjunct Professor, Norwegian Institute for Nature Research (NINA), Tungasletta 2, NO - 7485 Trondheim, Norway. (2001 - Present)
- Supervision and Co - supervision, external graduate students

Invited Lectures and Conference Presentations

Invited

- **Fleming, I.A.** (2005) Keynote Speaker. International Workshop on Evaluating Methods for Improving the Quality of Fish Reared for Stocking, Älvkarleby, Sweden. (14 - 16 September 2005).

Conference Presentations

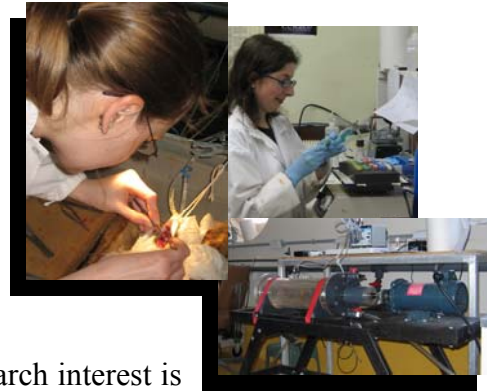
- **Fleming, I.A.** (2006). Sustainability of Newfoundland aquaculture. The Future of Endangered Coastal Communities: Building Capacity for Renewal, Change Islands, Newfoundland, Canada. (August 2006).
- Koseki, Y.; **Fleming, I.A.** (2006). Alternative phenotypes in the variable environment: frequency dynamics in coho salmon (*Oncorhynchus kisutch*). International Congress on the Biology of Fishes, St. John's, Canada. (July 2006).
- Lewis, C.W.; Gregory, R.S.; **Fleming, I.A.**; Brown, J.A. (2006) Comparison of habitat use by juvenile white hake (*Urophycis tenuis*) and greenland cod (*Gadus ogac*) as affected by a predator. International Congress on the Biology of Fishes, St. John's, Canada. (July 2006).
- Neregård, L.; Sundt - Hansen, L.; Hindar, K.; Einum, S.; Johnsson, J.I.; Devlin, R.H.; **Fleming, I.A.**; Björnsson, B.Th. (2006). Selective breeding of Atlantic salmon (*Salmo salar*) affects growth hormone action on growth. International Congress on the Biology of Fishes, St. John's, Canada. (July 2006).

- Sundt - Hansen, L.; Sundström, L.F.; Einum, S.; Hindar, K.; **Fleming, I.A.**; Devlin, R.H.(2006). Hypoxia tolerance; comparing performance of transgenic and wild coho salmon eggs. International Congress on the Biology of Fishes, St. John's, Canada. (July 2006).
- Moreau, D.T.R.; **Gamperl, A.K.**; **Fletcher, G.L.**; **Fleming, I.A.** (2006). Developmental and metabolic rates of growth hormone transgenic Atlantic salmon (*Salmo salar*) during early ontogeny. International Congress on the Biology of Fishes, St. John's, Canada. (July 2006)
- Lewis, C.W.; Gregory, R.S.; **Fleming, I.A.**; Brown, J.A. (2006). Predator - mediated habitat use by juvenile white hake (*Urophycis tenuis*) and Greenland cod (*Gadus ogac*). Canadian Society of Zoologists Annual Meeting, Edmonton, Canada (May 2006).
- **Fleming, I.A.** (2006). Salmon breeding systems and the shape of populations to come. Indian Bay Watershed Research Symposium, Indian Bay, Newfoundland (March 2006).
- Hosack, G.; Dumbauld, B.; **Fleming, I.A.**; Armstrong, D. (2006). Juvenile Chinook salmon *Oncorhynchus tshawytscha* utilization of low - intertidal eelgrass and oyster aquaculture beds. The National Shellfisheries Association Annual Meeting, Monterey, CA (March 2006).
- Hosack, G.; Dumbauld, B.; **Fleming, I.A.**; Armstrong, D. (2006) Juvenile Chinook *Oncorhynchus tshawytscha* utilization of low - intertidal estuarine habitats. Oregon Chapter of American Fisheries Society Annual Meeting, Sun River. (February 2006)
- Hering, D.; Bottom, D.; Jones, K.; **Fleming, I.A.**(2006). Abundance growth, and residence time of sub - yearling Chinook salmon in restored and natural salt marsh channels of the Salmon River estuary, Oregon. Oregon Chapter of American Fisheries Society Annual Meeting, Sun River. February 2006)
- Hindar, K.; **Fleming, I.A.**; McGinnity, P.; Diserud, O. (2005). Genetic and ecological interactions between wild and cultured diadromous fish. ICES/NASCO Symposium on Interactions between aquaculture and wild stocks of Atlantic salmon and other diadromous fish species: Science and management Challenges and Solutions. Bergen, Norway. (October 2005)

Research Overview and Highlights 2005 - 2006

- We found that age at maturity within fish populations is affected by processes operating at different geographical and temporal scales, influencing their evolutionary potential and thus population growth and resilience in the face of natural and human induced environmental change. (postdoctoral fellow Yusuke Koseki)
- Research is showing the degree to which escapes of fish (and potentially other organism) from aquaculture may effect wild populations, and is attempting to identify means of mitigating such effects. (Collaboration with researchers at the Norwegian Institute for Nature Research (NINA) and Marine Institute of Ireland)
- Investigations into the environmental risks of escaped Atlantic salmon transgenic (genetically modified) for growth hormone suggest that they are developmentally, behaviourally and physiologically similar to wild salmon during embryonic and early juvenile stages. Studies are ongoing to: (1) identify the life stage at which the transgenic fish diverge from wild fish and the potential implications; and (2) quantify the potential for interbreeding and thus gene flow between the two. (PhD student Darek Moreau; collaborations with researchers at NINA, University of Göteborg, Fisheries and Oceans Canada [DFO])
- Interactions between juvenile white hake and cod may be influencing recruitment and thus cod recovery. (MSc student Chris Lewis; collaborations with Bob Gregory, DFO).
- Investigations are underway into the successful conservation and re - establishment of endangered salmon populations in Atlantic Canada. (PhD student Nate Wilke; collaborations with Pat O'Reilly, DFO and researchers at the University of Guelph and British Columbia).
- Ongoing research is showing that decisions made by mothers (i.e. maternal effects such breeding time and location, and egg size and quality) can significantly shape the dynamics of fish populations, and can have particularly important ramifications for exploited populations and their management (e.g., harvesting quotas and targets). This work also has important implications for the management of brood fish for aquaculture. (MSc students Michelle Simms and Michelle Bachan; collaborations with Ed Trippel, DFO).
- Research in Labrador is showing that juvenile salmon make extensive use of lakes for rearing, emphasizing the importance of connectivity between fluvial and lacustrine habitats for the sustainability of salmon population. (MSc student Rebecca Poole; collaboration with Dave Reddin, DFO)
- The relevance of body size in a comprehensive understanding of how larval fish grow is currently being investigated through a multi-species investigation, with the aim of developing a predictive model of energy allocation between growth, storage and structural elements. (PhD student Kathryn Morton; collaboration with Pierre Pepin, DFO).
- Co-supervised PhD student, Åslaug Viken, Norwegian University of Science and Technology, graduated 2005-2006.

Dr. K. Gamperl



Research Interests

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

Teaching

- Co - taught Comparative Animal Physiology (BIOL 3401) with Dr. Helene Volkoff in Fall of 2006.
- Taught 3 lectures in Comparative Vertebrate Anatomy (BIOL 3202)
- Short - Course with Dr. Cyr Couturier on Fish Husbandry, Anatomy, Surgery and Anaesthesia as part of the Animal Care Course for Graduate Researchers

Other Activities (Memorial)

- Supervision, graduate students
- Supervision, undergraduate student
- Supervision, postdoctoral fellows
- Memorial University Animal Care Committee
- Space Committee, Ocean Sciences Centre
- Member, OSC Promotion and Tenure Committee
- Member, OSC Construction and Renovation Committee
- Member, Memorial Institutional Animal Care Committee
- Graduate Student Committee member

External Activities

- Symposium Co - organizer for Aquaculture 2007. Title: Physiological Insights Towards Improving Fish Culture. Feb. 2007 (2006 - Present)
- Appointed to the position of Lead Scientist for the Newfoundland (NL) Component of the Genome Atlantic funded project entitled "Atlantic Cod Genomics and Broodstock Development." Funding for MUN - NL approx. 5.5. Million over 4 years. (October 2005)
- Member of the Canadian Society of Zoologists (1987 - present)
- Member, AquaNet Education Committee (2004 - March 2006).
- President, American Fisheries Society, Fish Physiology Section (August/04 - 06)
- Conference Co - organizer for the 7th International Congress on the Biology of Fishes, August 2006, St. John's, Newfoundland. (2004 - August 2006)

- External Reviewer for Grants from the Natural Environment Research Council (UK), NSERC and NSF (2005/2006).
- Manuscript Reviewer for the Journal of Experimental Biology, Comparative Biochemistry and Physiology, Journal of Comparative Physiology B, Physiological Zoology, Journal of Fish Biology, Transactions of the American Fisheries Society. Approx. 10 - 15 manuscripts reviewed per year.
- Invited Participant - Vemco Days. Participated in workshop at Amirix Inc. (Halifax, NS) on marine telemetry: present technology, research, future advancements.

Invited Lectures and Conference Presentations

Invited

- **Gamperl, A.K.** (2006). Dept. of Zoology, University of British Columbia. Title: "Insights into the Physiology of North Atlantic Fishes: Comparative and Environmental Aspects".

Conference presentations

- Moreau, D. T. R.; King, M.J.; **Gamperl, A.K.**; **Fletcher, G.L.**; **Fleming, I.A.** (2006). Development and metabolic rates of growth hormone transgenic salmon (*Salmo salar*) during early ontogeny. 7th International Congress on the Biology of Fish, St. John's, Newfoundland, July 2006.
- Guan, L.; **Snelgrove, P.V.R.**; **Gamperl, A.K.** (2006). Ontogenetic changes in the critical swimming speed of cold - water marine fish larvae and the role of temperature. 7th International Congress on the Biology of Fish, St. John's, Newfoundland, July 2006.
- Hosoya, S.; Johnson, C.S.; **Gamperl, A.K.**; Iwama, G.K.; Hino, A.; Afonso, L.O.B. (2006). The stress response of juvenile (*Melanogrammus aeglefinus*) exposed to long - term stress. 7th International Congress on the Biology of Fish, St. John's, Newfoundland, July 2006.
- Killen, S.S.; Costa, I.; **Brown, J.A.**; **Gamperl, A.K.** (2006). Patterns of metabolic scaling in three species of teleost fish: evidence for ontogenetic changes in aerobic capacity.
- Laing, R.; Hosoya, S.; Johnson, S.C.; **Gamperl, A.K.**; Afonso, L.O.B. (2006). The divergent stress response in Juvenile Atlantic cod (*Gadus morhua*). 7th International Congress on the Biology of Fish, St. John's, Newfoundland, July 2006.
- Mendonça, P.C.; **Gamperl, A.K.** (2006). Nervous and Humoral Control of Cardiac Performance in the Winter Flounder (*P. americanus*). 7th International Congress on the Biology of Fish, St. John's, Newfoundland, July 2006.

- Petersen, L.; Gollock, M.; Currie, S.; **Gamperl, A.K.** (2006). Is the cardiorespiratory system of Atlantic cod (*Gadus morhua*) a limiting factor for survival in extreme environments? 7th International Congress on the Biology of Fish, St. John's, Newfoundland, July 2006.
- Gollock, M.J.; Hunter, K.; Freeman, M.J.; Syme, D.A.; McKinley, R.S.; **Gamperl, A.K.** (2006). Potential methods for measuring activity patterns and energy use in free swimming Atlantic cod (*Gadus morhua*). 7th International Congress on the Biology of Fish, St. John's, Newfoundland, July 2006.
- Pérez - Casanova, J.C.; Afonso, L.O.B.; Currie, S.; Johnson, S.; **Gamperl, A.K.** (2006). The stress and metabolic responses of juvenile Atlantic cod (*Gadus morhua*) to an acute thermal challenge. 7th International Congress on the Biology of Fish, St. John's, Newfoundland, July 2006.
- Syme, D.A.; Gollock, M.; Freeman, M.J.; **Gamperl, A.K.** (2006). Understanding the diversity of mechanical function in fish muscle: where to look next? 7th International Congress on the Biology of Fish, St. John's, Newfoundland, July 2006.
- Costa, I.; Driedzic, W.R.; **Gamperl, A.K.** (2006). "Sleepy fish": Metabolic depression in a North Atlantic teleost, *Tautoglabrus adspersus*. 7th International Congress on the Biology of Fish, St. John's, Newfoundland, July 2006.
- Newby, N.; Mendonça, P.; **Gamperl, A.K.**; Stevens, D. (2006). Pharmacokinetics of morphine in fish: Winter flounder and sea - water acclimated rainbow trout. 7th International Congress on the Biology of Fish, St. John's, Newfoundland, July 2006.
- **Gamperl, A.K.**; Petersen, L.H.; Gollock, M.J.; Rodnick, K.J.; Canada, P.; Currie, S.; **Parrish, C.C.**; Alkanini, T. (2006). Environmental challenges for Atlantic cod (*Gadus morhua*): Physiological limits and ecological implications. American Fisheries Society Annual Meeting, Anchorage, Alaska. Sept. 2005.

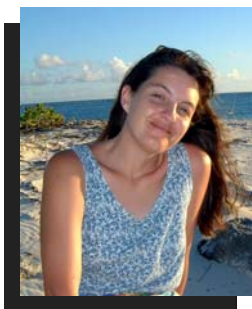
Research overview and Highlights 2005 - 2006

- Winner of the Best Oral Presentation in Physiology of North Atlantic Fish Symposia - Isabel Costa (M.Sc. Student/Gamperl). Title: "Sleepy fish" - Metabolic Depression in North Atlantic Teleost, *Tautoglabrus adspersus*. 7th International Congress on the Biology of Fish, St. John's, Newfoundland, July 2006.
- Winner of the Best Oral Presentation in Physiology of Early Life History Stages of Fish Symposia - Shaun Killen (Ph.D. Student/ Gamperl). Title: Alternate foraging modes in young lumpfish (*Cylopterus lumpus*): balancing food - intake with the energetic costs of foraging. 7th International Congress on the Biology of Fish, St. John's, Newfoundland, July 2006.

Paper: Little left in the tank: metabolic scaling in marine teleosts and its implications for aerobic scope (S.S. Killen, I. Costa, J.A. Brown and A.K. Gamperl accepted in Proceedings of the Royal Society B: Biological Sciences. September 2006.

Dr. A. Mercier

Research Interests



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

Other Activities (Memorial)

- Supervision, graduate students
- Ph.D. Comprehensive Examination Committee, Department of Biology
- Graduate Officer, Ocean Sciences Centre (2005 - 2008)
- Co - author of Faculty of Science Position Paper for the strategic planning of Memorial University of Newfoundland in fall 2005.

External Activities

- Member of an international scientific committee appointed by the Food and Agriculture Organization of the United Nations (FAO), aimed at facilitating regulation and implementation related to CITES and commercially - exploited sea cucumbers on a broad front (2006 to present).
- Supervised a portion of the work carried by Mr. Florent Dordhain and Mr. Vincent Soriano, two students from Université d'Artois (France), who did a training course at DFO, St. John's, Newfoundland.
- Ad hoc referee for different peer - reviewed journals (e.g. Marine Biology, Invertebrate Reproduction & Development, Marine & Freshwater Research, Journal

- of the Marine, Biological Association UK, Marine & Freshwater Behaviour & Physiology, NOAA Fishery Bulletin)
- Project reviewer for grant agencies (NSERC, US Sea Grant and Land Grant, US Department of Agriculture).
 - Editor of the *Trochus Information Bulletin*, dedicated to mollusks. Published by the South Pacific Commission:
<http://www.spc.org.nc/coastfish/News/Trochus/Troc.htm>.
 - Session Editor and invited speaker at a workshop organized by the Food and Agriculture Organization of the United Nations (FAO), entitled "Advances in Sea Cucumber Aquaculture & Management", held in Dalian (China) in October 2003.
 - Member of the International Society of Invertebrate Reproduction & Development and the International Society of Chemical Ecology.
 - Member of PhD supervisory committee of Ms. Benita Chick, Marine Program, Boston University.
 - Member of the "Mentoriel" Web site of the Collège de Sherbrooke since 2000. This site provides a direct link between students and professionals from various fields.
 - On the board of directors of the "Association pour la préservation du lac Magog" in 2002 - 2005. Designed and coordinated grant applications and resulting projects.
 - Writer - photographer: Over the past 15 years, authored and co - authored nearly 400 popular articles on marine and terrestrial wildlife, destinations and environmental issues published in international magazines such as Ocean Realm, Sea Frontiers, Aquaculture Magazine, Aqualife, Freshwater and Marine Aquarium, Scuba World, Photo Life, Explore and Islands Business.

Invited Lectures and Conference Presentations

Invited

- Over 50 conferences for scholars, park rangers, school children and the general public on topics pertaining to aquatic invertebrate and plant biology, photography, wildlife and travels.

Conference presentations

- **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. 12th International Echinoderm Conference, University of New Hampshire, Durham, USA.
- Hamel, J. - F.; Becker, P.; Eeckhaut, I.; **Mercier, A.** (2006). Evidence of aberrant oogenesis in a temperate holothurian. 12th International Echinoderm Conference, University of New Hampshire, Durham, USA.

- 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*. 12th International Echinoderm Conference, University of New Hampshire, Durham, USA.
- **Mercier, A.**; Hamel, J - F. (2006). Epibiotic sea anemones on marine gastropods: diversity, dynamics and role of bathyal associations. 11th International Deep - Sea Biology Symposium, Solent University, Southampton, UK.
- **Mercier, A.** (2005). Sex in the sea: fundamental and applied aspects of marine benthic invertebrate reproduction. Department of Biology/OSC Seminar Series, Memorial University of Newfoundland.

Research Highlights 2005 - 2006

- **Deep - sea biology.** Dr. Mercier has recently extended her program to deep - sea species and habitats. She has built collaborative bridges with DFO (St. John's) to collect bathyal invertebrates during the multi - species surveys and is working with taxonomists (at the Smithsonian Institute and Ohio State University) to identify new or poorly known species. She was also invited to take part in an IGP - funded project on deep - sea corals aiming 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 is supervising the study of gametogenesis, spawning, fecundity, control/timing of reproduction, larval development and growth of corals. These aspects are integrated into the project of an MSc student. Furthermore, 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 lab in the maintenance of deep - sea invertebrates. Several bathyal species have successfully been reproduced and brought to settlement, which is a first according to many peers. Dr. Mercier therefore wishes to build on this unique capacity to pursue studies on deep - sea organisms. She expects to play a lead role in a dedicated deep - sea cruise on the *CCGS Hudson* in June 2007, which will use the Canadian remotely operated vehicle ROPOS to retrieve data and live animals.

- **Commercially important holothurians.** Dr. Mercier's expertise in holothurian biology was recently sought by the Newfoundland government, who is presently trying to develop a sea cucumber (*Cucumaria frondosa*) fishery with funding through the Fisheries Diversification Program. She is the principal investigator in a new project, which is a joint venture between MUN, CCFI, DFA, DFO and the local industry, with a total budget \$397,950 that is funding the work of an MSc student. 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 will include a novel genetic approach to determine the level of connectivity/interaction between different populations of *C. frondosa* around Newfoundland

and other areas of its distribution range. Findings will likely translate into improved fishing/management of this emerging resource in Atlantic Canada.

Dr. C.C. Parrish



Research Interests

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

Teaching

- Environmental Science 6001: Earth and Ocean Systems (1/3)
- Environmental Science 6010: Environmental Seminar
- Environmental Science 6201: Aquatic Lipid Biogeochemistry

Other Activities (Memorial)

- Supervisor, graduate students
- Supervision, research assistant
- Promotion and Tenure Committee - OSC (2005 - 2006)
- Student advisory committees
- Graduate Student committee, Faculty of Science Faculty Council (2005 - present)
- Thesis examiner, graduate students
- Chair, Environmental Science Program
- Steering Committee (East Coast), 2000 - 2005. Major Collaborative Research Initiatives Project 'Coasts Under Stress' - Arm leader
- 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

- "Progress in Atlantic cod aquaculture in North America." Aquaculture Europe, Norway, 2005.

- “Nutrition in hatchery production.” AquaNor Exhibition, Norway, 2005.
- “Lipids in fish biochemistry and physiology and food web relationships.” Lake Whitefish Mortality Workshop, Ann Arbor, Michigan 2005.

Conference Presentations:

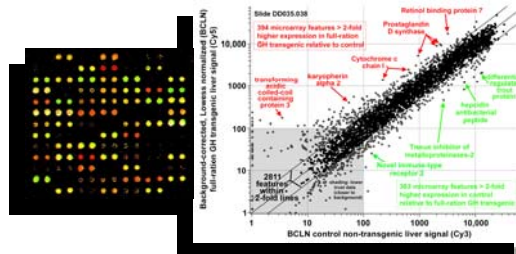
- Garcia, A.S.; **Parrish, C.C.**; **Brown, J.A.** (2005) Effect of different live - food enrichments on the early growth and lipid composition of Atlantic cod (*Gadus morhua*). In: AquaNet V - Fifth AquaNet Scientific Conference, October 18 - 21, 2005, Victoria - British Columbia. AquaNet V - Fifth AquaNet Scientific Conference, 2005. pp. E 16.
- Garcia, A.S.; **Parrish, C.C.**; **Brown, J.A.** (2005). Effect of different live food enrichments on early growth and lipid composition of Atlantic cod larvae (*Gadus morhua*). In: Larvi'05 - Fish and Shellfish Larviculture Symposium, September 5 - 8, 2005, Oostende - Belgium. Larvi'05 - Fish and Shellfish Larviculture Symposium, 2005. pp. 164 - 167.
- Clarke, M.; **Parrish, C.C.**; Penney, R (2006). Lipid profiling as an indicator of viability in cod (*Gadus morhua*) eggs and prefeeding larvae. - 7th International Congress on the Biology of Fish, July 18 - 22, 2006, St. John's, NL.
- Connelly, T.; **Deibel, D, C.C. Parrish.** (2006). Carbon sources for benthic boundary layer zooplankton determined by fatty acid signatures. ASLO/AGU Meeting, Honolulu, February.
- Garcia, A.S., **Parrish, C.C.**; **Brown, J.A.** (2006). Use of enriched rotifers and Artemia during larviculture of Atlantic cod (*Gadus morhua*): Effects on early growth, survival and lipid composition. In: VIIth International Congress on the Biology of Fish, July 18 - 22, 2006, St. John's - Newfoundland.
- Garcia, A.S.; **Parrish, C.C.**; **Brown, J.A.**; Johnson, S.C.; Leadbeater, S. Use of enriched rotifers and Artemia during larviculture of haddock (*Melanogrammus aeglefinus*): Effects on early growth, survival and lipid composition. In: VIIth International Congress on the Biology of Fish, July 18 - 22, 2006, St. John's - Newfoundland.
- Westelmajer, S.K.M.; **Brown, J.A.**, Johnson, S.C.; **Parrish, C.C.** (2006). Acute stress tolerance of Atlantic cod larvae fed differentially enriched live - food. In: VIIth International Congress on the Biology of Fish, July 18 - 22, 2006, St. John's - Newfoundland.
- Westelmajer, S.K.M.; **Brown, J.A.**; Johnson, S.C.; **Parrish, C.C.** (2006). Live - food enrichment products and protocols: their effects on growth, lipid composition and acute stress tolerance in Atlantic cod (*Gadus morhua*) larvae. Paper presented at the Atlantic Universities Aquaculture Conference at the University of Prince Edward Island.
- Wijekoon, M.P.A.; Mansour, A.; **Parrish, C.C.**; Whelan, D.; McKay, D.W. (2006). The effect of decreased temperature in production of gastric dilation and air sacculitis syndrome (GDAS) in farmed steelhead trout (*Oncorhynchus mykiss*). In: VIIth International Congress on the Biology of Fish, July 18 - 22, 2006, St. John's - Newfoundland.

Research Overview and Highlights 2005 - 2006

- Production of Lipids by Algae: We studied algae in bays around Newfoundland. We looked at net plankton, suspended particulate matter, settling particulate matter, and dissolved matter. Our work showed the episodic nature of inputs of high energy material in the water column.
- Transport of Lipids Through the Water Column: Our fjord work indicated that in cold Newfoundland waters, plankton lipids are transferred with little alteration through the water column to benthic and demersal food webs. Fluxes are high compared with values in the literature, and incorporation into the food web seems to be very efficient with little loss through burial in the sediments.
- Fate of Algal Lipids: Newfoundland sediment trap material contained high levels of polyunsaturated fatty acids compared to other North Atlantic locations, while the sediments did not. The fact that few of the nutritionally essential fatty acids remain in the sediment suggests an efficient incorporation into the marine food web, since bottom dwelling organisms in this area had high contents of these long - chain polyunsaturated fatty acids. This work underlines the importance of long - chain PUFA or essential fatty acids in our cold water environment.
- Lipid Metabolism in Finfish: Our main focus was on critical early life stages and on effects of essential fatty acids on growth and survival. We investigated nutrition in Atlantic cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) larvae and identified better live - feed enrichments by improving lipid - to - protein and essential fatty acid ratios. The influence of dietary lipids on the stress response of cod larvae was also investigated. Exposure to stress caused significant differences in larval survival between dietary treatments. Whole body corticosteroid concentrations are now being analysed.
- Lipid Metabolism in Bivalves: Our field work indicated that certain PUFA are critical for growth of blue mussels (*Mytilus edulis*). In the lab we studied sea scallops (*Placopecten magellanicus*) and bay scallops (*Argopecten irradians*) and found that it is not just the amounts of essential fatty acids that are important to growth and survival, but also the relative proportions. Of particular interest is our finding of extensive bioaccumulation of $\omega 6$ docosapentaenoic acid linked to improved growth in scallop species and cod during early ontogeny. This suggests that there is a fourth PUFA that may be essential in marine fauna.
- Marsha Clarke - September 2005 - Awarded Special Scholarship for Students to Pursue Graduate Studies Related to Resource Development.
- Sarah Westelmajer - AquaNet Research Exchange (2006). Internship in the lab of Dr. David Berlinsky at the University of New Hampshire with the purpose of learning and practicing various analytical assay techniques

Dr. M. Rise

Research Interests



Dr. Rise develops and uses genomic resources, including microarrays, in studies related to fish health. DNA microarrays allow a researcher to analyze relative expression levels of thousands of genes simultaneously.

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

Teaching

- Guest lectures: Functional Genomics (Bio Sci 599), Department of Biological Sciences, University of Wisconsin - Milwaukee (UWM) Topic: eukaryotic genomics, global gene expression profiling; School of Education, Department of Curriculum and Instruction, UWM. Topic: Using Genomics in Built Environment Studies
- Mentor for Practicum in Bioinformatics, Course BIIN 290 (1 student). Project title: "Identification and phylogenetic analyses of *Piscirickettsia salmonis* cDNA sequences." Co - mentor for Practicum in Bioinformatics 2, Course BIIN 201 (5 students). Project title: "Using comparative genomics to identify conserved regulatory elements of environmentally responsive genes." Bioinformatics M.Sc. Program, Marquette University and the Medical College of Wisconsin.
- Mentor for Research (Bio Sci 990), Department of Biological Sciences, UWM. Project title: "Effects of malathion exposure on brain gene expression and behavior in rainbow trout."
- Mentor for Independent Study (Bio Sci 699), Department of Biological Sciences, UWM. Project title: "Effects of organophosphate pesticide exposures on gene expression and behavior in juvenile rainbow trout."

Other Activities (Memorial)

- Tier 2 Canada Research Chair, Marine Biotechnology
- Co - supervision, graduate student
- Graduate student committee member

External Activities

- Collaborator: Genome Canada/Genome Atlantic Funded Cod Genome Project
- Conference organizing: Milwaukee SETAC 2007 Program Committee member

- Reviewed grant proposals for the following: NSERC (2006), The Royal Society of New Zealand Marsden Fund (2006), the United States - Israel Binational Agricultural Research and Development Fund (BARD) (2005), the Great Lakes Fishery Commission (2005)
- Reviewer for the following journals: Aquaculture, Comparative Biochemistry and Physiology, Diseases of Aquatic Organisms, Environmental Toxicology and Chemistry, Journal of Great Lakes Research, Journal of Molecular Endocrinology, Marine Biotechnology, Molecular Genetics and Genomics, Physiological Genomics
- Shaw Assistant Scientist, Great Lakes WATER Institute, UWM until June 2006.
- Adjunct Assistant Professor, UWM
- Supervisor, National Science Foundation Funded Research Experience for Undergraduates Program
- Co - supervisor, graduate student (Great Lakes WATER Institute, UWM)
- Graduate student committee member (Department of Biological Sciences, UWM)
- Founding member of the UWM Center for Functional and Environmental Genomics Steering Committee (2004 - present)
- Member of the Metals and Neurotoxicology Core, UWM NIEHS Marine and Freshwater Biomedical Sciences Center
- Appointed member of the UW - M Animal Care and Use Committee (2005 - 2006)
- Member of the Safety Committee at the Great Lakes WATER Institute, UWM
- Member of the Aquatic Vertebrates Committee at the Great Lakes WATER Institute, UWM
- Scientific Affiliations: American Society for Cell Biology, American Fisheries Society, Society of Environmental Toxicology and Chemistry (SETAC)
- Full Member, Society of Toxicology

Invited Lectures and Conference Presentations

Invited

- **Rise ML**, Rise M, Miller SL, and Schmoltdt A. Genomic methods and behaviour testing used to assess impact of organophosphate pesticides on early life stage trout. VIIth International Congress on the Biology of Fish, St. John's, NL. July 18 - 22, 2006.
- **Rise ML**, Douglas SE, Sakhrani D, Williams J, Ewart KV, Rise M, Davidson WS, Koop BF, and Devlin RH. Microarray - based gene expression profiling of GH transgenic coho salmon liver with and without ration restriction. VIIth International Congress on the Biology of Fish, St. John's, NL. July 18 - 22, 2006.
- **Rise ML**, Rise M, Honeyfield DC, Devlin RH, Rexroad CE, Davidson WS, and Koop BF. Genomic resources for studying early life stage salmonid health. VIIth International Congress on the Biology of Fish, St. John's, NL. July 18 - 22, 2006.

- **Rise, ML.** Developing and using DNA microarrays and other genomic resources for studies related to salmonid health. Ozark - Prairie Regional Chapter of Society of Environmental Toxicology and Chemistry (OP - SETAC) 2006 Annual Meeting: Emerging Trends in Ecotoxicology and Short Course: Bioinformatics for Environmental Ecotoxicology, Columbia Environmental Research Center (CERC), U.S. Geological Survey (USGS), Columbia, MO. May 22 - 24 2006.
- **Rise, ML.** Genomic research for development of new molecular diagnostics for infectious and noninfectious fish diseases. Great Lakes Fish Health Committee Annual Meeting, Non - lethal Diagnostics Workshop, Madison, WI. February 2006.
- **Rise ML, Rise M, and Honeyfield DC.** Identifying gene expression signatures of maternal thiamine deficiency in lake trout eggs and larvae. Early Mortality Syndrome Workshop sponsored by Great Lakes Fishery Commission, Ann Arbor, MI. September 2005.
- **Rise, M.L.** “Global gene expression studies of salmonid responses to pathogens and environmental toxicants.” Seminar presentation for members of the Wisconsin - DNR and the Wisconsin Veterinary Diagnostic Lab, Madison, Wisconsin. September 2005.

Select Conference Presentations

- **Rise ML, Rise M, Miller SL, and Schmoldt A.** Effects of chlorpyrifos on juvenile rainbow trout gene expression and behavioral endpoint analyses. Society of Environmental Toxicology and Chemistry (SETAC), North America 26th Annual Meeting, Baltimore, MD. November 2005.
- Rise M, Honeyfield DC, Schmoldt A, Miller SL, and **Rise ML.** Identifying gene expression signatures of maternal thiamine deficiency in lake trout eggs and larvae. Center for Functional and Environmental Genomics Symposium. September 2005. (Poster)

Research Overview and Highlights 2005-2006

- 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.*

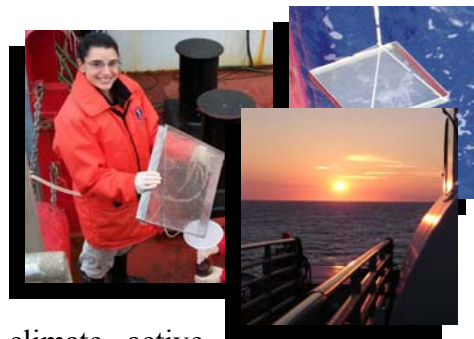
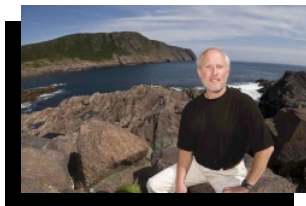
- Studies of Atlantic salmon transcriptomic responses to pathogens: Dr. Rise was a collaborator in a study using 16K GRASP microarrays to identify Atlantic salmon gill genes responsive to the parasite causing amoebic gill disease (Morrison et al. 2006a). This study appeared as the cover article for *Physiological Genomics* vol. 26 (June - August, 2006) and was reviewed in *Aquaculture Health International*, where it was the cover article for the May 2006 issue (Morrison et al. 2006b). These studies have revealed host molecular pathways altered during contact with pathogens, and may lead to the development of novel tools to combat emerging infectious diseases of fish. *References: Morrison RN, Cooper GA, Koop BF, Rise ML, Bridle AR, Adams MB, Nowak BF. 2006a. Transcriptome profiling of the gills of amoebic gill disease (AGD) - affected Atlantic salmon (Salmo salar L.): a role for the tumor suppressor protein p52 in AGD - pathogenesis? Physiological Genomics 26, 15 - 34; Morrison R, Nowak B, Crosbie P, Adams M, Bridle A, and Rise M. 2006b. Insights into amoebic gill disease pathogenesis. Aquaculture Health International 5, 4 - 5.*

- Ongoing functional and environmental genomics research: Dr. Rise has employed genomic methods including DNA microarray hybridization, QPCR, and reciprocal suppression subtractive hybridization (SSH) cDNA library construction and characterization, to study: 1) effects of environmental toxicant exposures on early life stage salmonid and zebrafish gene expression; 2) impact of maternal thiamine deficiency on lake trout egg, embryonic, and larval gene expression (in collaboration with Dr. D. Honeyfield, USGS); 3) cross - species comparisons of tissue - specific global gene expression in lean and siscowet lake trout (in collaboration with Drs. P. Biga and F. Goetz, UWM); 4) effects of estrogen treatment on perch growth rates and brain gene expression (in collaboration with Dr. F. Goetz); and 5) squid light organ gene expression responses to colonization by a bioluminescent bacterial symbiont (in collaboration with Dr. M. McFall - Ngai, UW Madison). These studies are ongoing, with manuscripts in preparation. One of these projects, in collaboration with Dr. M. Carvan (UWM), involves the use of rainbow trout and zebrafish as toxicogenomic models of mercury, dioxin, and organophosphate pesticide (OP) exposures. We are co - principal investigators on a UW Sea Grant, and have begun to co - supervise a new M.Sc. student who uses genomic methods to study the effects of OP exposures on juvenile rainbow trout gene expression.

- Interviewed for study on Ethical Issues Associated with Genomics Projects, for ongoing research at the W. Maurice Young Centre for Applied Ethics, UBC (2006).

Dr. Richard B. Rivkin

Research Interests



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

Teaching

- Biology –7540: Plankton Dynamics

Other Activities (Memorial)

- Supervision, graduate students
- Supervision, research assistant
- Supervision, postdoctoral fellows
- 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

- Member, American Geophysical Union, American Society of Limnology and Oceanography, American Society of Microbiologists, European Geosciences Union, Phycological Society of America
- 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.
- Editorial Advisor, Aquatic Microbial Ecology

- 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)
- Advisory Committee; Canadian Polar Commission.
- Hetzberg Gold Metal Committee member
- GSC 18 Reallocation Committee member
- SCOR/IGBP Global Analysis, Integration and Modeling Task Team

Invited Lectures and Conference Presentations

Invited

- Legendre, L. and **Rivkin, R. B.** (2006). Ecosystems, biogeochemical carbon cycles and ocean climate models: Carbon transformation and partitioning by the “microbial hub”. ASLO/AGU Ocean Sciences Meeting, Honolulu, Hawaii, February 2006
- **Rivkin, R. B.** (2006). Heterotrophic microplankton in marine ecosystem dynamics. Carbon transformation and climate processes. Dynamic Green Ocean Modelling Workshop: Incorporation of Plankton Functional Types in Global Climate Models. Villefranche-sur-Mer, France, April 2006
- Legendre, L. and **Rivkin, R. B.** (2006). Recent concepts in pelagic ecosystem functioning. 38th International Liège Colloquium on Ocean Dynamics. Revisiting the role of zooplankton in pelagic ecosystems. Liège, Belgium. May 2006.

Conference Presentations

- **Rivkin, R. B.;** Hale, M. S.; Li, W. K. W.; Bussey, H. (2006). Microzooplankton response to mesoscale iron enrichment: Case study and global synthesis. ASLO/AGU Ocean Sciences Meeting, Honolulu, Hawaii, February 2006
- Anderson, M. R.; Hale, M. S.; Bussey, H.; Li, W. K. W.; **Rivkin, R. B.** (2006). Spatial and temporal patterns of microzooplankton grazing in the Northwest Atlantic. ASLO/AGU Ocean Sciences Meeting, Honolulu, Hawaii, February 2006
- Hale, M. S.; Bussey, H.; Li, W. K. W.; Fileman, E. S.; Tarran, G. A.; **Rivkin, R. B.** (2006). Microzooplankton grazing activity in contrasting biogeochemical provinces of the temperate, sub-tropical and tropical Atlantic Ocean. ASLO/AGU Ocean Sciences Meeting, Honolulu, Hawaii, February 2006
- Legendre, L.; **Rivkin, R. B.** (2006). Ecosystems and ocean carbon biogeochemistry: transformation and partitioning by the “microbial hub”. European Geosciences Union General Assembly. Vienna, Austria, April, 2006.
- **Rivkin, R. B.;** Hale, M. S.; Anderson, M. R.; Li, W. K. W.; Bussey, H. (2006). Microzooplankton response to mesoscale iron enrichment: Case study and global synthesis. European Geosciences Union General Assembly. Vienna, Austria, April, 2006.

- **Rivkin, R. B.**; Anderson, M. R.; Hale, M.; Evans, H.; Li, W. K. W. (2006). Ocean basin-scale patterns of microzooplankton herbivory and bacterivory. 38th International Liège Colloquium on Ocean Dynamics. Revisiting the role of zooplankton in pelagic ecosystems. Liège, Belgium. May 2006.
- **Rivkin, R. B.**; Hale, M.; Evans, H.; Anderson, M. R.; Keats, K.; Matthews, P.; Li, W. K. W. (2006). Microbial dynamics in the upper ocean: Influence on the cycling of climate active gases 40th Annual Canadian Meteorological and Oceanographic Society Meeting: Weather, Oceans and Climate: Exploring the Connections. Toronto, ON, June 2006.
- Harrison, P.; Levasseur, M.; Boyd, P.; Wong, C. S.; **Rivkin, R. B.**; Pedersen, T. (2006). Mesoscale Fe enrichment produces a large diatom bloom, draws down CO₂, but with limited production of DMS and carbon export in the NE Subarctic Pacific. 40th Annual Canadian Meteorological and Oceanographic Society Meeting: Weather, Oceans and Climate: Exploring the Connections. Toronto, ON, June 2006.
- Keats, K.; Bussey, H.; Hale, M. S.; **Rivkin, R. B.**; Matthews, P.; Li, W. K. W.; Anderson, M. R. (2006). The role of planktonic community respiration in biogenic carbon and climate-active gas cycling in the Northwest Atlantic Ocean. 40th Annual Canadian Meteorological and Oceanographic Society Meeting: Weather, Oceans and Climate: Exploring the Connections. Toronto, ON, June 2006.
- Hale, M.; Anderson, M. R.; Bussey, H.; Li, W. K. W.; **Rivkin, R. B.** (2006). Spatial and temporal patterns of microzooplankton grazing in contrasting biogeochemical provinces of the Atlantic Ocean. 40th Annual Canadian Meteorological and Oceanographic Society Meeting: Weather, Oceans and Climate: Exploring the Connections. Toronto, ON, June 2006.
- Levasseur, M.; Merzouk, A.; Lizotte, M.; Scarratt, M. G.; Michaud, S.; Le Clainche, Y.; Wong, C. S.; **Rivkin, R. B.** (2006). DMS cycling in the NE Pacific versus NW Atlantic: Does Fe matter? 40th Annual Canadian Meteorological and Oceanographic Society Meeting: Weather, Oceans and Climate: Exploring the Connections. Toronto, ON, June 2006.

Research Overview and Highlights 2005 - 2006

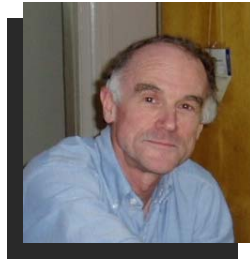
Dr. Rivkin is a principle investigator in the Canadian Aquatic Invasive Species Network (CAISN), a newly - funded Natural Sciences and Engineering Research Council (NSERC) Research Network that is studying the introduction and fate of these aquatic species in both Canadian lakes and marine waters on 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.

- Kimberley Keats, M.Sc. student graduate 2005 - 2006.

- Kimberley Keats, M.Sc. Awarded full funding for 2006 Agouron Institute – University of Hawaii Summer Course in Microbial Oceanography.
- Ryan Murphy- M.Sc. Awarded NSERC PGS-A fellowship Awarded NSERC PGS-A fellowship

Dr. D. Schneider

Research Interests



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

Teaching

- Biology 4605: Quantitative Methods in Biology (Fall semester)
- Biology 7220: Advanced Methods in Quantitative Biology (Fall semester)
- Biology 7932: Applications of the Generalized Linear Model in Biology (Fall semester)
- Guest lectures - Environmental Science 6000 - September 2005
- Developed new course - Biology 7932 : Applications of the Generalized Linear Model in Biology.

Other Activities (Memorial)

- Supervision, graduate students
- Supervision, student assistants
- Supervision, MUCEP students
- Supervision, WISE student
- Supervision, post - doctoral fellows
- Supervision, research assistants
- Supervisory Committee, graduate students
- Associate Dean (Research) Faculty of Science 2003 - 2006
- Thesis examiner, graduate students
- Supervisor, B.Sc. honours student.
- Statistical advice to circa 5 undergraduate and 15 graduate students.

External Activities

- Research Advisory Council. Newfoundland and Labrador Centre for Applied Health Research, St. John's, Canada (review grant applications) 2003 - 2006
- Scientific Review Committee, Institute for Environmental Monitoring and Assessment, Happy Valley Goose Bay, Labrador, Canada. (1998 - present)
- Advisor to U.S. National Park Service on design of long term monitoring in 11 parks in the pacific.
- Canadian Meteorological and Oceanographic Society.
- Sigma Xi Scientific Honorary Society.

- Refereed Journal Reviewer: Circa 5 - 10 reviews, including reviews for Ecology, American Naturalist, and Canadian Journal of Fisheries and Aquatic Sciences
- Co - Director (with R. Ommer), Institute for Social Ecological Research
- Developed and led a TOGA workshop on developing marking schemes in science labs, for Instructional Development Office. 22 November 2005
- Reviewer. Broad audience: BioScience, Philosophical Transactions of the Royal Society of London, Ecology, Ecosystems.
- Reviewer. Subject area journals: Auk; Avian Biology; Biological Oceanography; Biotropica; Canadian Journal of Fisheries and Aquatic Sciences; Canadian Journal of Zoology (in French and English); Canadian Wildlife Service Monograph Series; Condor; Continental Shelf Research; Estuarine, Coast and Shelf Science; Fisheries Oceanography; Landscape Ecology; Limnology and Oceanography; Marine Biology; Marine Ecology - - Progress Series; Miscellanea Zoologica (in Spanish) North American Journal of Fisheries Management; Ornithological Monographs Polar Biology; Polar Research, Transactions American Fisheries Society; Waterbirds.
- Reviewer. Grant Proposals: Canada Natural Sciences and Engineering Research Council; Israel Council for Scientific Research; New Zealand Foundation for Research and Technology (1/yr); Norway Natural Resources Institute (NINA), Norwegian Research Council (5/year); UK Natural Environment Research Council; USA National Science Foundation (ca 2/yr); USA National Undersea Research Center (NOAA); USA Hudson River Foundation; USA Sea Grant (Alaska)

Invited Lectures and Conference Presentations

Invited

- Invited presenter at career development workshop organized by graduate students at OSC, 20 April 2006

Conference Presentations

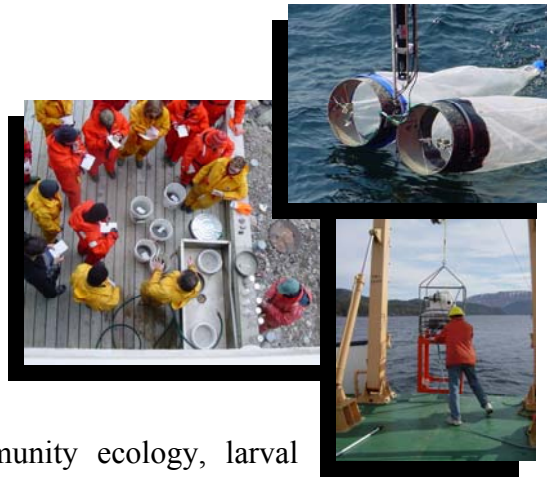
- Mayor, S.J.; Schaefer, J.A.; **Schneider, D.C.**; Mahoney, S.P. (2006). The spatial structure of caribou habitat selection. Poster presentation, Canadian Society for Ecology and Evolution Inaugural Meeting. Montreal, April 3 - 4, 2006.
- Mayor, S.J.; Schaefer, J.A.; **Schneider, D.C.**; Mahoney, S.P. (2006). How Caribou see the world: Scale structure, and habitat selection. Oral presentation, Aldrich Interdisciplinary Conference. St. John's, March 4 - 5, 2006.

Research Overview and Highlights 2005 - 2006

- Preparation of 2nd edition of Quantitative Ecology, Spatial and Temporal Scaling (1st edition 1994, Academic Press)
- Interview for CBC, St. John's, on Terra Nova Oil Spill.

- Interview for CBC on sea jelly swarms in summer of 2006
- Allison Stagg, B.Sc. Honours student graduate 2006.
- Erin Alcock , M.Sc. student graduated 2005 - 2006
- Megan Whitehead, M.Sc. student (Schneider/Brown) graduated 2005 - 2006
- Rapid growth and maturation of program of community based science in Leading Ticks, in preparation for expected designation as Marine Protected Area under Canada's Ocean Act.

Dr. P. Snelgrove



Research Interests

Dr. Snelgrove's interests include marine community ecology, larval ecology of invertebrates and fish, ecology of benthic invertebrates; 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 Reviewer - *Marine Ecology Progress Series* (1998-2005)
- 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)

- Consultant, White Rose Environmental Impact Assessment and Advisory Group , Jacques Whitford Inc. St. John's, (2003-2005)
- 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

Invited

- Invited Workshop participant – Downeast Fisheries Initiative, Winter Harbor ME, October 2005.
- Invited Participant – Census of Marine Life Steering Committee Meeting, Hawaii, Feb. 2006
- Board of Directors, CSSF (Canadian Scientific Submersible Facility) Annual General Meeting
- Invited Participant – CORONA (Coordinated Research on the North Atlantic) workshop, Tavira, Portugal. May 2006
- Organizer and Chair – Census of Marine Life Framework Committee meeting, Narragansett, RI. May 2006
- 2006 Oceanography Department, Dalhousie University
- Sigma Xi Public Lecture, Avalon Chapter, St. John's, NL
- 2006 Biology Department, MUN
- 2006 Canadian Protected Areas and Wildlife Society – St. John's, NL
- 2006 Congress of the Italian Zoological Union (UZI) Invited Plenary Lecture, Naples Italy

Conference Presentations

- Congress of the Italian Zoological Union (UZI) Invited Plenary Lecture, Naples Italy, 2006

Research Highlights 2005-2006

- Jared Crawford, Master of Marine Studies graduated 2005-2006.
- Stephen Cole, Honours student graduates 2005-2006
- Stephen Chung, Honours student graduated 2005-2006
- Kate Gardiner, Honours student graduated 2005-2006

Research Cruises

- July 2005. CGS TULLY. S. Leys and V. Tunnicliffe, Chief Scientists. Fraser Ridge, BC. ROPOS ROV work sampling shallow-water sponge reefs and sedimentary fauna.
- February 2006. CGS TULLY. V. Tunnicliffe, Chief Scientist. Saanich Inlet, BC. ROPOS ROV work sampling sponge reefs and sedimentary fauna.
- May, 2006. C.C.G.S. SHAMOOK. R. Gregory, Chief Scientists. Trinity Bay, NL. Tucker trawl sampling of ichthyoplankton.
- July 2006, CGS Hudson. P. Lawton Chief Scientist, Scotian Slope, NS. ROPOS ROV work sampling sedimentary fauna and deep-sea coral environments.
- July 2006, CGS TULLY. V. Tunnicliffe, Chief Scientist. Saanich Inlet, BC. ROPOS ROV work sampling sedimentary fauna as part of the VENUS Observatory project.
- August 2006. CGS TULLY. K. Juniper, Chief Scientist. BC Slope. ROPOS ROV work sampling deep-sea sedimentary, coral and seep fauna, mapping habitats and preparing for NEPTUNE instrument deployment.

Dr. R. Thompson



Research Interests



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

Other Activities (Memorial)

- Supervision, graduate students
- Supervision, students assistants
- Graduate Students Committee, Biology Department
- Director Safety Committee, OSC
- NSERC UFA Search Committee, OSC 2004
- Faculty of Science Library Committee

External Activities

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

Invited Lectures and Conference Presentations

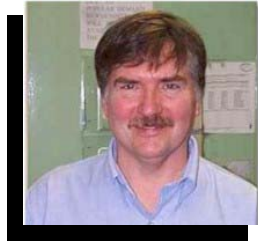
Conference Presentations

- **Thompson, R.J.;** Innes, D.J.; Lowen, J.B.; Miranda, B.A. (2006). Genetic and ecological interactions in a mussel hybrid zone. National Shellfisheries Association, Annual Meeting, Monterey, California, March 2006.

Research Overview and Highlights 2005 - 2006

Stead and Thompson 2006 (J. Exp. Mar. Biol. Ecol. 332: 37 - 48). Simulate the sinking spring bloom in controlled laboratory experiments, and demonstrated a behavioural feeding response of *Yoldia* to an input of organic matter. This provides a laboratory system in which researchers are able to study responses in this deposit - feeder.

Dr. J. Wroblewski



Research Interests

Dr. Wroblewski's research interests include fisheries oceanography, global ocean ecosystem dynamics, and physical - biological oceanographic modeling. For the past decade Dr. Wroblewski and his students have been studying the Atlantic cod population living in Gilbert Bay, Labrador, which was designated 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 2006:

- Biology 4750: Fisheries Ecology (25 undergraduate students enrolled)
- Biology 7551: Fisheries Resource Management (4 graduate students enrolled)

Teaching during Spring Semester 2006:

- Biology 3714: Estuarine Fish Ecology (20 undergraduate students enrolled)

A field course at the Bonne Bay Marine Station, co - taught with Dr. David Methven of the Biology Department, UNB, St. John

Other Activities (Memorial)

- Supervision, graduate students
- Supervision, honours students
- Supervision, MUCEP students
- Supervisory committee, graduate students
- Promotion and Tenure Committee, OSC
- Chair, Search Committee, faculty position in Marine Aquaculture, OSC
- Internal Examiner, Ph.D. Examination Board, Dept. Physics and Physical Oceanography
- Delegate of the Dean of Graduate Studies, Ph.D. Comprehensive Examination Committee, Dept. Earth Sciences
- Delegate of the Dean of Graduate Studies, Ph.D. Comprehensive Examination Committee, Dept. Biochemistry
- Chair, Ph.D. Examination Board, Dept. Psychology
- Chair, B.Sc. Honours Thesis Defence, Dept. Biology
- Facilitator, Graduate Research Integrity Programme (GRIP), for new graduate students in the Masters of Marine Studies (Fisheries Resource Management) program, School of Graduate Studies
- Program Committee member and Admission Committee member, Masters of Marine Studies (Fisheries Resource Management), School of Graduate Studies

- Selection Committee member, National Scholarship in Ocean Studies

External Activities

- Steering Committee member, Gilbert Bay as a Marine Protected Area governed under the Oceans Act, Government of Canada
- Labrador Research Advisory Committee member
- East Coast Steering Committee member, “Coasts Under Stress” Research Project funded by NSERC and SSHRC
- Editorial Board member, Journal of the Marine Biological Association of the United Kingdom
- Book reviewer: Journal of the Canadian Nautical Research Society
- Reviewer of grant proposals: National Science Foundation (US)
- Judge: Eastern Newfoundland Regional Science Fair, St. John’s

Invited Lectures and Conference Presentations

Invited

- Invited panelist during the workshop “The Future of Endangered Coastal Communities”, A.R. Scammell Academy, Change Islands, NL, August 2006.

Conference Presentations

- Kendall, V.; **Wroblewski, J.** (2005). Do the boundaries of the proposed Gilbert Bay MPA provide adequate protection to the critical life history stages of its threatened fish species? Oceans Management Research Network 2005 National Conference, Ottawa.
- **Wroblewski, J.** (2006) Presentation on stewardship by coastal communities of inshore cod stocks and recommendations on aquaculture policy in Newfoundland and Labrador. “Coasts Under Stress” Policy Workshop in cooperation with the Leslie Harris Centre of Regional Policy and Development, Memorial University, St. John’s.

Research and Overview Highlights 2005 - 2006

- The past decade of field work by Dr. Wroblewski’s laboratory and other MUN researchers resulted in legal designation of Gilbert Bay, Labrador as a Marine Protected Area on 11 October 2005 under the Oceans Act, Government of Canada (DFO News Release NR - HQ - 05 - 85E).
- A Certificate of Recognition for an outstanding contribution to the Steering Committee for the Gilbert Bay Marine Protected Area was presented to Dr. Joe Wroblewski by the Regional Director General, NL Region, Fisheries and Oceans Canada.

- The research by Dr. Joe Wroblewski and his students on inshore cod stocks was mentioned in a newspaper article which appeared in the Maine Sunday Telegram on 25 September 2005.
- The research by Dr. Joe Wroblewski's laboratory was mentioned in an article in the magazine Science 310: 1110 - 1111.
- The research by Dr. Joe Wroblewski on homing behaviour of cod was mentioned in an article in The New Yorker magazine, 31 July 2006.
- Valerie Kendall, Masters Environmental Science, and Joanne Stares, B.Sc. Biology Honours, graduated 2005 - 2006.

Emeritus Faculty

Dr. D. Burton

Research Interests

Currently investigating the neural and hormonal regulation of the complex chromatotropic processes in flatfish.

Teaching

- Teaching: Biology 4910, Vertebrate Diversity and Adaptation. Taught at the MUN campus in Harlow, UK.

Internal Activities

- Formally appointed as *Professor Emeritus* at the Fall Convocation 2005.
- Examiner for a Ph.D. comprehensive examination.

External Activities

- Formal invitation for inclusion in *Canadian Who's Who*.
- Appointed as external examiner for a Ph.D. thesis.
- Member of the Society for Experimental Biology.
- Member of the Canadian Society of Zoologists

Research Overview and Highlights 2005 - 2006.

- Much of the year was used to obtain *in vitro* experimental data on the range of melanophore α - and β - adrenoceptor relative transition values at which the α - subtype regulation overrides the β - subtype in different areas of the cryptic patterning of winter flounder, *Pseudopleuronectes americanus*. This information expands our understanding of the physiological basis for the complex chromatic behaviour of flatfish.

Dr. G. Fletcher

Research Interests

Antifreeze proteins and cold adaptation in fish. A number of marine fish produce antifreeze proteins to protect themselves from freezing in a sub - zero, ice - laden marine environment. The research we are carrying out focuses on these antifreeze proteins and their physiological regulation mechanisms of action, diversity, evolution and potential economic value in the field of biotechnology.

Other Activities (Memorial)

- Supervision, SWAP student
- Supervision, honours students
- Supervision, graduate students
- Supervisory committee, graduate students
- Professor Emeritus, OSC (2004 - present)
- Selection Board, Genesis Centre, MUN
- Cross - appointed to Department of Biology
- NSERC Advisory Committee on University Industry Grants 2004 - present.

External Activities

- Chief Scientific Officer, Aqua Bounty Canada, January 2005 - September 2005.
- Advisory Board, North Atlantic Biopharma, Inc. St John's NL (2002 - 2005).
- Board of Directors. Aqua Bounty Canada, Inc. (2000 - Present)
- President/CEO & Chair Board of Directors, A/F Protein Canada 2000, Inc.(2000 - 2005)
- Advisory Board, Bio - East (Newfoundland Biotech., Working Group). (1998 - 2005)
- Co - Founder, Member, Board of Directors & Vice - President R&DA/F Protein, Inc. Boston USA (1992 - 2005).
- NSERC Advisory Committee on University Industry grants (2004 - Present).
- CCAC, Biotechnology sub - committee. (1999 - Present)
- Master of Ceremonies for the Graduation of North Atlantic Biopharma from the Genesis Centre. March 1, 2006
- Co - organizer of Transgenic fish session at International Congress of Fish Biology July 2006, St John's NL Canada.

Invited Lectures and Conference Presentations

Invited

- Fletcher, G. (2006). Transgenic salmon. From lab to slab. Marine Institute, Memorial University. (February 2006)

Conference Presentations

- Lesveque H. M.; Shears, M.A.; **Fletcher, G.L.**; Moon, T.W. (2006) Myogenesis and muscle metabolism in Atlantic salmon (*Salmo salar*) made transgenic for growth hormone. International Congress of Fish Biology July, 2006. St John's Newfoundland pp 146.
- Young H.M.; **Fletcher, G.L.** (2006). The potential use of antifreeze proteins during cryopreservation of fish embryos. Atlantic Universities Aquaculture Conference (AUAC), March 2006, Charlottetown, PEI.

- Moreau D.T.R.; King, M.J.; **Gamperl, A.K.; Fletcher, G.L.; Fleming, I.A.** (2006). Developmental and metabolic rates of growth hormone transgenic Atlantic salmon (*Salmo salar*) during early ontology. Int. Congress of Fish Biology July, 2006. St John's Newfoundland pp 165
- Young, H.M.; **Fletcher, G.L.** (2006). Expression of antifreeze protein genes in the embryos of winter flounder (*Pseudopleuronectes americanus*). International Congress of Fish Biology July, 2006. St John's Newfoundland pp 239
- Hobbs, R.S.; Kirby, T.; Fletcher, G.L. (2006). Tissue specific expression of growth hormone transgenes in Atlantic salmon (*Salmo salar*). International Congress of Fish Biology July, 2006. St John's Newfoundland pp 123

Research Overview and Highlights 2005 - 2006

- Heather Young (Honours Student/Fletcher). Winner of the Corey Feed Mills/NSERC Award for the 2nd Best Undergraduate Presentation at the Atlantic Universities Aquaculture Conference (AUAC), University of Prince Edward Island, March 3 - 5, 2006, Charlottetown, PEI
- Marieve Desjardins (Ph.D. Candidate) - Winner of the Best Poster Presentation at the VIIth International Congress on the Biology of Fish last July: Plasma antifreeze levels respond to photoperiod through liver hypertrophy in Atlantic wolfish.

Dr. R. Khan

Research Interests

Dr. Khan's research continues to focus on the long term effects of pollutants and parasitic diseases on the health of fish. A ciliate protozoan caused extensive mortality in cultured Atlantic cod and has been an on - going problem in cod culture. Another dealt with a microsporean parasite that metastasised into several organs of winter flounder exposed to paper mill effluent. Two others dealt with the effects of drill mud and an oil dispersant on winter flounder. These studies revealed the deleterious effects of these stressors on fish.

Internal Activities

- Emeritus Professor, OSC

External Activities

- President, World Federation of Parasitologists (www.parasitologists.org)
- Ad hoc reviewer: J. Parasitology; Fisheries Research; Folia parasitologia; Bulletin of Environmental Contamination and Toxicology; Archives of Environmental Contamination and Toxicology; Chemosphere; Sarsia

Invited Lectures and Conference Presentations

Invited

- Environmental changes affecting parasites of Atlantic cod off Labrador, Canada. XVII Congress of the Federation of Latin American Parasitologists, Mar del Plata, Argentina, November 24 - 28/05.
- Influence of environmental change on the parasites of Atlantic cod on the continental shelf off Newfoundland and Labrador. XI International Congress of Parasitology, Glasgow, Scotland, U.K., August 6 - 11/06.

Research Overview and Highlights 2005 - 2006

- Studies were conducted to determine the influence of climatic changes on the parasites of Atlantic cod as bioindicators in five geographical on the continental shelf of Newfoundland and Labrador. Samples were obtained from the Department of Fisheries and Oceans in St. John's and removal was performed by C.V. Chandra who is employed as a research assistant. About four hundred fish were examined in the last year and the parasites were stained and identified. Preliminary results on parasitic levels, when compared to those of 1980, suggest that climatic changes affected cod only off the coast of Labrador but not fish sampled from the Grand or St. Pierre Banks.
- A second project involved the impact of bilge - water crude oil deliberately spilled by ships on the parasites sea birds off the south coast of Newfoundland. About 36 birds were examined for parasites and the data accrued is being statistically compared with that of a non - contaminated group.
- A third study involved parasites of caribou that are believed to be transmitted to people in Labrador. Samples of organs and meat were examined for parasites and preliminary results confirm that there are foci of infection, primarily Echinococcus and Cryptosporidium.

6. Graduate Students

M.Sc. Theses

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

Ecology of ascidian tunicates

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

Chris Lewis - Biology - M.Sc. (I.A. Fleming/R. Gregory - DFO)

Spatial Segregation of Habitat by Juvenile White Hake (*Urophycis Tenuis*) and Juvenile Greenland Cod (*Gadus ogac*) in the Presence and Absence of a Predator

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

The Effects of Intraspecific and Interspecific Competition on the Growth of Juvenile Fish (*Gadus morhua*, *Gadus ogac*, and *Urophycis*)

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

Isabel Costa - Biology - M.Sc. (K.Gamperl/W. Driedzic)

Metabolic Physiology of Cunner

Darell Green - Aquaculture - M.Sc. (K. Gamperl)

Simulated Transportation of Atlantic Cod Effects of physical stress and water quality

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)

Larval cod nutrition

Sarah Westelmajer - Biology - M.Sc. (C. Parrish)

Nutrition of larval cod

Jennifer Monk - Aquaculture - M.Sc. (V. Puvanandran/L. Halfyard - MI)

Fine tuning cod larviculture

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.

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

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

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

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

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

Larval dispersal in marine fishes

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 gadids

Ryan Stanley - Biology - M.Sc. (P. Snelgrove)
Connectivity of egg and larval early life history stages of fish populations within Trinity Bay

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

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

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

Johanne Lewis - Biology - Ph.D. (W. Driedzic)

Protein synthesis in hypometabolic fishes

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

The physiology of metal accumulation by ascidians

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

Nitrogen metabolism in fish.

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

Physiological processes of juvenile growth in spotted wolffish

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

How do larval fish develop?

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

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

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

Purification and characterization of antifreeze

Shaun Killen - Biology - Ph.D. (K. Gamperl)

Physiology and metamorphosis.

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.

Alexandre Garcia - Biology - Ph.D. (C. Parrish)

Marine fish larval nutrition.

Manjursir Wijekoon - Biology - Ph.D. (C. Parrish/Atef Mansour - DFO)

Gastric dilation and air sacculitis syndrom (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

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

Porpoise bycatch in Newfoundland and Labrador

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.

Degreed Students

Tyson MacCormack - Biology - Ph.D. (2006) (W. Driedzic)

Purinergic and ionic regulation of cardiac function in fish.

Tara Hooper - Chemistry - M.Sc. (2005) (C. Parrish)

Development of new extraction and analysis procedures for marine lipid classes

Kimberley Keats - Environmental Science - M.Sc. (2006) (R. Rivkin)

Microbial Dynamics in the Western North America

Megan Whitehead - Biology - M.Sc. (2005) (J.A. Brown/ D.Schneider)

Multiple predator effects on juvenile Atlantic Cod

Erin Alcock - Biology - M.Sc. (2005) (D. Schneider)

Reconstruction of food web during period of heavy fishing

Jared Crawford - Masters of Marine Studies (P. Snelgrove)

The Use of Artificial Wetlands and Greenhouses to Filter Land - Based Aquaculture Wastewater

Valeria Kendell - Environmental Science - M.Sc. (2006) (J. Wroblewski)

Population dynamics and life history sensitivities of Atlantic cod (*Gadus morhua*) in Gilbert Bay, Labrador

7. Research funding inventory

Grants received in the 2005 - 06 fiscal year

NSERC Operating Grants

J. A. Brown	\$22,000.00
D. Deibel	\$41,000.00
W. Driedzic	\$57,180.00
I. Fleming	\$32,000.00
G. Fletcher	\$60,000.00
K. Gamperl	\$41,890.00
A. Mercier	\$16,500.00
C. Parrish	\$36,000.00
P. Pepin	\$17,800.00
R. Rivkin	\$53,300.00
D. Schneider	\$37,500.00
P. Snelgrove	\$19,000.00
R. Thompson	<u>\$23,000.00</u>
	<u>\$457,170.00</u>

NSERC Equipment Grant

K. Gamperl	\$38,609.00
A. Mercier	<u>\$44,742.00</u>
	<u>\$83,351.00</u>

NSERC CASES

D. Deibel	<u>\$36,456.00</u>
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NSERC MFA Grant

C. Parrish	<u>\$230,000.00</u>
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NSERC/Dalhousie

R. Rivkin	<u>\$113,957.00</u>
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NSERC STPGP

I. Fleming	<u>\$55,626.00</u>
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NSERC (Special Gen. Res. Grant)

R. Rivkin	<u>\$8,800.00</u>
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NSERC Strategic

P. Snelgrove

\$195,380.00**AquaNet**

J. A. Brown/C. Parrish

\$56,500.00

J. A. Brown

\$75,000.00

K. Gamperl

\$52,425.00

\$183,925.00**Other Grants***Internal Awards*

D. Schneider

Dean of Science

\$10,000.00

\$10,000.00*External Awards*

D. Deibel

Sigma Xi Scientific Res. Soc. Inc.

\$687.83

W. Driedzic

CRC

\$13,000.00

I. A. Fleming

ACOA/AIF

\$811,250.00

I.A. Fleming

Parks Canada

\$25,000.00

I.A. Fleming

USDA

\$50,628.00

I.A. Fleming

Harris Centre

\$3,668.00

I.A. Fleming

DFO

\$4,000.00

G. Fletcher

Genesis Group

\$51,989.00

K. Gamperl

CCFI

\$20,243.00

K. Gamperl

CCFI

\$7,000.00

K. Gamperl

Genome Atlantic

\$69,000.00

C. Parrish

SODIM

\$10,000.00

C. Parrish

DFO

\$6,060.00

C. Parrish

DFO

\$8,000.00

C. Parrish

DFO

\$6,625.00

D. Schneider

Harris Centre

\$5,000.00

D. Schneider

DFO

\$7,495.00

P. Snelgrove

Harris Centre

\$6,065.00

P. Snelgrove

DFO

\$4,000.00

P. Snelgrove

Alfred P. Sloan Foundation

\$48,969.00

P. Snelgrove

Harris Centre

\$7,500.00

J. Wroblewski

DFO

\$9,464.00

J. Wroblewski

DFO

\$9,750.00**\$1,185,393.83****Total OSC Research Funding****\$ 2,560,058.83**

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

Biotechnology Risk Assessment Grants Program, US Department of Agriculture. (\$494,000). Principal Investigators - E.M. Hallerman, **I.A. Fleming, J.A. Brown, G.L. Fletcher**, E. McLean. Title - Environmental risk assessment parameters for growth hormone transgenic Atlantic salmon, *Salmo salar*. (2005 - 08).

Parks Canada Ecological Integrity Innovation and Leadership Funds. (subcontract \$75,000). Principal Investigators –D. Cote (overall project leader) - **I.A. Fleming**, B. Adams (subcontract). Title - Building the road to proactive and scientifically sound management of fish populations in Canada’s National Parks. (2005 - 2008)

Norwegian Research Council. (\$1,200,00) Principal Investigators - K. Hindar, S. Einum, B.Th. Bjornsson, J.I. Johnsson; Associates - J. Tufto, **I.A. Fleming** and R.H. Devlin. Title - Quantifying biological risks of growth - enhanced transgenic salmon. (2003 - 06).

Norwegian Research Council. (\$133,000). Principal Investigators - T. Forseth, O. Ugedal, P. Fiske, B.M. Larsen, S. Einum, P. Eklöv and **I.A. Fleming**. Title - Evolutionary and cascading ecological effects of translocation of native species into new ecosystems. (2003 - 06)

Société de développement de l’industrie maricole Inc., Québec “Nutrition des jeunes stades de développement des especes commerciales de mollusques bivalves”. Principal Investigators - V.M. Bricelj , **C.C. Parrish** \$30,000 04 - 05, Parrish share: \$5,000 *p.a.*

DFO International Governance Program (3 - year). The ecology of deep - sea corals of Newfoundland and Labrador waters: biogeography, life history, biogeochemistry, and role as critical habitat. CAD \$47,500 / \$144,500 / \$36,500. Investigators: K. Gilkinson, D. Hamoutene, G. Veinott, E. Edinger, **P. Snelgrove**, R. Haedrich, R. Jamieson. I was invited to become involved in the project in fall 2005 to lead the life history section; I received funds for equipment and to support the work of an M.Sc. student (ca. \$20,000).

Real time ocean observatory at Bonne Bay Marine Research Centre. Principle Investigator: B. deYoung, **D. Deibel** L. Zedel, **C. Parrish**, R. Hooper, and **P. Snelgrove**. Canadian Foundation for Innovation. 2002 - 2005. (\$1,800,000).

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

The Shaw Foundation (**\$175,298**) Principal Investigator - **Rise, M.L.** “Creating and applying genomics tools to address fish health and conservation issues.” Shaw Scientist Start - up (2003 - 2006), Great Lakes WATER Institute, University of Wisconsin - Milwaukee.

UWM Centre for Water Security (**\$27,919**) Principal Investigators - **Rise, M.L.**, Carvan, M.J. and Strickler, J.R. “Effects of organophosphate pesticide exposures on juvenile rainbow trout and zebrafish gene expression, correlated with behavioral endpoint analyses.”

Pilot Project Program (2004 - 2005), Great Lakes WATER Institute, University of Wisconsin - Milwaukee.

UWM Centre for Water Security (**\$38,740**) Principal Investigators - Goetz, F.W. (and 4 others including **Rise, M.L.**). “A modular bioinformatics computer cluster for computationally intensive genome analyses.” Pilot Project Program (2004 - 2005), Great Lakes WATER Institute, University of Wisconsin - Milwaukee.

UWM NIEHS Marine & Freshwater Biomedical Sciences Centre (**\$16,752**) Principal Investigator - **Rise, M.L.** “Toxicogenomics: effects of subthreshold organophosphate pesticide exposures on rainbow trout gene expression and behavior.” Pilot Project Program (2004 - 2005), Great Lakes WATER Institute, University of Wisconsin - Milwaukee.

University of Wisconsin Sea Grant College Program (**\$280,655**) Principal Investigators - **Rise, M.L.** and Carvan, M.J. “Parallel Toxicogenomic resources for zebrafish and rainbow trout: identifying conserved and molecular biomarkers of toxicant exposure.” Biotechnology Theme (2006 - 2008), Great Lakes WATER Institute, University of Wisconsin - Milwaukee.

8. Publications

Publications appearing in the 2005 - 06 academic year

Alkanani, T.; **Parrish, C.C.**; Rodnick, R.J.; **Gamperl, A.K.** (2005). Lipid Class and nonesterified fatty acid profiles in plasma of North Atlantic cod (*Gadus morhua*). *Can. J. of Fish. Aquat. Sci.* **52**: 2509–2518.

Carvan, M.J.; **Rise, M.L.**; Klaper, R.D. (2005). Genomic Technologies in Biomonitoring. In *Water Encyclopedia*, Vol. 5, Water Quality and Resource development (ed. J.H. Lehr, J. Keeley, and J. Lehr), John Wiley and Sons, New York.

Chaparro, O.R.; Navarette, L.R.; **Thompson, R.J.** (2006). The physiology of the larva of the Chilean oyster *Ostrea chilensis* and the utilisation of biochemical energy reserves during development: an extreme case of the brooding habit. *J. Sea Res.* **55**: 292 - 300

Deibel, D.; Daly, K.L. (2006). Zooplankton processes in Arctic and Antarctic polynyas. in, *Arctic and Antarctic Polynyas*, Walker O. Smith and D.G. Barber (eds.) B.V. Elsevier. 44 pp.

Deitch, E.J., **Fletcher, G.L.**, Petersen, L.H., Costa, I., Shears, M.A., **Driedzic, W.R.**, **Gamperl, A.K.** (2006). Cardiorespiratory modifications, and limitations, in post - smolt growth hormone transgenic atlantic salmon (*Salmo salar*). *J. Exp. Biol.* (7): 1310 - 1325

Desjardins, M.; Le Francois, N.R. ; **Fletcher, G.L.** ; Blier, P.U.(2006). Seasonal modulation of plasma antifreeze protein levels in Atlantic (*Anarhichas lupus*) and spotted (*A. minor*) wolffish. *J. Exp. Mar. Biol. Ecol.* **335**:142 - 150.

Dolan, A.H.; Taylor, S.M.; Neis, B.; Ommer, R.E.; Eyles, J.; **Schneider, D.C.**; Montevecchi, W.A. (2005). Restructuring and health in Canadian coastal communities. *EcoHealth* **2**: 1–14.

Driedzic, W.R.; Clow, K.A.; Short, C.E.; Ewart, K.V. (2006). Glycerol production in rainbow smelt (*Osmerus mordax*) may be triggered by low temperature alone and is associated with the activation of glycerol - 3 - phosphate dehydrogenase and glycerol - 3 - phosphatase. *J. Exp. Biol.* **209**: 1016 - 1023.

Evans, R.P.; **Fletcher, G.L.** (2005). Type 1 AFPs Expressed in Skin Tissues of Atlantic (*Liparis atlanticus*) and Dusky (*L. gibbus*) Snailfish are identical to their circulating plasma proteins. *FEBS Journal*, **272**:5327 - 5336.

Evseenko, S.A.; Laurel, B.; **Brown, J.A.**; Malikova, D. Yu. (2006). On *Gadus* Taxonomy: Ontogenetic Evidence. *Journal of Ichthyology*, **46**:326 - 333.

Fletcher, G.L. (2006). The Science and Business of Transgenic Salmon: Promises and Problems. In "Assessment of Environmental and Indirect Human Health Effects of Genetically modified Aquatic Organisms" (ed. R. H. Devlin) *Can. Tech. Rept, Fish, Aquat, Sciences*. PP 62 - 75.

Gollock, M.J.; Petersen, L.H.; Currie, S.; **Gamperl, A.K.** (2006). Cardiac function and blood oxygen carrying capacity only limit cod (*Gadus morhua*) oxygen consumption at high temperatures. *J. Exp. Biol.* 209: 2961 - 2970

Fletcher, G.L. (2006). The Science and Business of Transgenic Salmon: Promises and Problems. In "Assessment of Environmental and Indirect Human Health Effects of Genetically modified Aquatic Organisms" (ed. R. H. Devlin) *Can. Tech. Rept, Fish, Aquat, Sciences*. PP 62 - 75.

Hale, M. S.; **Rivkin, R.B.** (2006). Comment on - Nature of phosphorous limitation in the ultraoligotrophic Eastern Mediterranean. *Science*. 312: 1748c.

Hall, J.R.; Richards, R.C.; MacCormack, T.J.; Ewart, K.V.; **Driedzic, W.R.** (2005). Cloning of GLUT3 cDNA from Atlantic cod (*Gadus morhua*) and expression of GLUT1 and GLUT3 in response to hypoxia. *Biochimica et Biophysica Acta* 1730: 245 - 252.

Hamel, J. - F.; **Mercier, A.** (2006). Factors regulating the breeding and foraging activity of a tropical opisthobranch. *Hydrobiologia*, 571: 225 - 236.

Hamel, J. - F.; **Mercier, A.** (2006). Note on the spawning and development of the common spider conch *Lambis lambis*. *SPC Trochus Information Bulletin* 12: 19 - 21.

Hamel, J. - F.; **Mercier, A.** (2006). Observations on the biology of the common egg shell *Ovula ovum* in Majuro, Marshall Islands. *SPC Trochus Information Bulletin* 12: 22 - 26.

Henning, J.A., Gresswell, R.E. and **Fleming, I.A.** 2006. Floodplain emergent wetlands as a rearing habitat for juvenile salmonids. *North American Journal of Fisheries Management* 26: 367 - 376.

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9. Aquaculture Research and Development Facility (ARDF)



The 2005 - 2006 year proved to be a very successful year within the Aquaculture Research Development Facility (ARDF). Additions within the ARDF have included an additional 44 family rearing tanks (500 Litres each), 6 paired mating tanks (5000 L each) with external egg collectors, a new fish physiology laboratory on the second floor that has (10 - 300L tanks, 1 3000L tank, 2 raceways and 3 chillers) and a new fish health and water quality laboratory situated in the OSC.



The ARDF is composed of a core staff of 18 people at both the OSC and cod research cage site in Poole's Cove. Furthermore, during the last year the facility has had 1 IRAP NRC funded position, 4 MUCEP positions, 3 work - term students, and one biology student.

During the past year the ARDF has provided research based tours for 546 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:

Aquaculture Collaborative Research Development Program (ACRDP)

Cod Broodstock Development in Newfoundland: Collaboration between the Department of Fisheries and Oceans (DFO) and its industry partner Northern Cod Ventures through the Government of Canada's Aquaculture Collaborative Research and Development Program (ACRDP) has led to great advances in cod broodstock technology and understanding. Extensive research over the past five years has generated a year - round productive broodstock supplying high quality eggs to industry and other partners.

AIF Funded Research

(a) Larviculture Research

1. Jennifer Monk (M.Sc. candidate) - Joe Brown and V. Puvanendran
 - i) The effect of light intensity on growth, survival and foraging behaviour
 - ii) The effect of tank bottom colour on growth, survival and foraging behaviour of larval cod.

2. Ms. Colleen Crewe (B.Sc. (Hons.) candidate) - Joe Brown and V. Puvanendran

Title: Causes of deformity in Atlantic cod (*Gadus morhua*) under culture conditions. I. Effects of egg density during incubation.

3. ARDF Research Group

After the modifications made in the live feed production since the live feed workshop in November 2004, we had a better survival during Winter 2005 production using a modified INVE protocol. Thus, ARDF research group carried out an experiment in collaboration with INVE to test the larval rearing protocol proposed by INVE.

(a) INVE and ARDF larval rearing protocols

Although it was not major, some differences exist between ARDF and INVE larval rearing protocol, mainly in green water, live feed enrichments, feeding time, flow rates and water oxygen levels.

Four 3000L tanks were used for this experiment and INVE larval rearing protocol was used. During green water period, two tanks received *t - isochrysis* sp. (t - iso tanks hereafter) and other two tanks received *Nanocloropsis* sp. (nano tanks hereafter) for greening the water. Except for this difference, all other rearing conditions were same. Larvae were sampled weekly for length measurements and at 35, 40, 45, 50 and 56 dph for biochemical analysis. Experiment continued until first grading (58 dph). Larval survival was estimated by sub - sampling just before grading. After the first grading juveniles from all four tanks were combined and graded into three size class. These juveniles will be kept separately and the deformity levels will be monitored.

Results from the experiment showed a significant improvement in growth and survival compared to 2004. Currently we are conducting one experiment (continuation of an AquaNet student project) comparing the growth, survival, stress resistance and deformity levels of cod larvae reared with differently enriched rotifer and *Artemia*. Based on the results from this experiment and INVE experiments, appropriate changes were made to our larval rearing protocol.

(b) Live - Feed Enrichment Formulation and Larval Performance.

The Effect of Different Commercial Live - Feed Enrichment Diets on the Stress Response
Sarah K.M. Westelmajer. (MSc Candidate) - Dr. Chris Parrish and Dr. J.A. Brown.

The nutritional components of larval live - feed 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 - feed enrichment products currently available differ greatly in their nutritional compositions and HUFA ratios.

The primary objective of this study is 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 is also being investigated. Pre and post acute handling stress tissue samples will be analysed for cortisol content at various stages of development starting at hatch and continuing through metamorphosis and weaning. The results will indicate when the hypothalamus - pituitary - interrenal axis in larval cod is fully developed and able to respond to external stressors.

Current status: First part of the experiments is completed, however, analysis of the samples has not been completed. A second part of the experiment, studying the ontogeny of cortisol production in cod will be carried out in 2006.

(c) Larval Stocking Density

No experiments were carried out yet. However, we will carryout this experiment in summer 2006.

(d) Weaning

No experiments carried out this year. We are planning to carry out two experiments next year.

1. Comparison of different weaning diets on weaning success.
2. Effect of co - feeding on weaning success

(e) Grading

Grading has been carried out on the cage site with a salmonoid vertical bar grader, but results were variable. Modifications to this grader will be carried out in 2006 and tried on the larger 1.5 kg fish this summer. To date, all fish have been manually graded by a hand held grader with is very labor intensive and stressful to the fish.

(b) Juvenile Studies

Activity 1: Cage Stocking Density Studies.

No experiment has been carried out in 2005 and we do not expect to have a stocking density trial due to the numbers of fish required for this experiment. The AIF Research Committee feels that a feed delivery trial with a Storvik Feeding System and a Photoperiod Study with continuous light has more industrial significance at this time.

Activity 2: Feeding Frequency Study

No experiment has been carried out in 2005, but the Storvik feeding System will be installed in 2006 to begin this experiment, now that we have purchased a 12,000 watt Diesel Generator for the site.

Activity 3: Juvenile Health Studies

1. Prevalence and intensity of parasites from juvenile Atlantic cod (*Gadus morhua*) over a two - year production cycle from hatchery and sea cage environments. Sean Hickey (MSc student) - Duane Barker and Joe Brown

Cultivated Atlantic cod were monitored for the prevalence (%) and mean abundance of external and internal parasites from the hatchery phase to the sea cage grow - out phase. Continuous monitoring of each year class of cod are being conducted to identify: (i.) trends in parasite epidemiology and (ii.) effect on overall fish health. It is hoped that we will be able to identify key times during the production cycle that cod are at high risk to parasite infection. Of the 50,000+ juvenile cod produced during 2004, 360 fish (232 from the ARDF experimental hatchery, 128 from the AIF experimental sea cage) were screened and assessed for parasite levels. For each fish, the identified parasite(s) found were given a standard score from 0 - 4 (0=none, 1=light, 2=moderate, 3=heavy & 4=severe).

Parasite sampling of cultured Atlantic cod continued in June 2005 at the ARDF. Juvenile cod were surveyed for external and internal parasites following the same screening protocols used on the 2004 population of cultured cod. Sampling of fish from the McGrath's cove site was delayed from December 2004 until March 2005 as winter conditions was not suitable for sampling. In collaboration with Dr. Daryl Whelan (DFA), we shared the samples for bacteriology, virology, histology and parasite screening to minimize the number of fish taken while maximizing the amount of data able to be collected of interest. This has continued since March 30, 2005 to the present day where sampling is performed monthly and fish examined at the DFA lab in St. Alban's, Bay d'Espoir, NL. This was carried out on the cod (2004 year class) at the cage site for an additional 12 months while the latest batch of juvenile cod from the ARDF (2005 year class) were being screened on a bi - weekly basis for external and internal parasites. These fish were monitored for 12 months as well, from the ARDF to the sea cage site. As water temperatures rise in at the sea cage site and in the ARDF, close observations were made to monitor parasite loads, species and life cycles to distinguish trends, if any. Fish and farmer would benefit from any early detection of a possible invasion and could aid in preventing a parasite from becoming a severe pathogen.

Results from the juvenile cod from the hatchery at the ARDF indicate that parasite presence (i.e. *Trichodina*) in the ARDF were not high enough to create a negative impact on fish health having a maximum value of 0.1 from June to August. This number is much less than the low measurement of 1. Levels of *Costia*, or *Ichthyobodo* were not sufficient enough to register within the scoring scheme.

Results from the sea cage from September 2004 - May 2005 have indicated a mean score of 1 or less with a prevalence of <1% for *Trichodina*. Endoparasites have been absent during both phases of production, thus far. Farmed cod have not yet experienced extreme problems with parasites in Newfoundland; however, this may change as production levels are increased for commercialization.

Sampling resumed at McGraths Cove in Oct of this year and continues until Dec. Results also produce findings that demonstrate parasites were not concentrated in large enough numbers to deteriorate animal health. The parasite *Cryptocotyle lingua*, a Digenea responsible for 'black - spot disease', was found amongst the population, however levels were not large enough to create a health problem. This parasite is eliminated in the ARDF hatchery due to the use of filters and screening of the incoming seawater. To date no parasites appear to be problematic for hatchery and sea - cage operations as monitoring at McGraths Cove continues for both the 2004 & 2005 fish. Project findings up to June 2005 were presented as a poster at the Aquaculture Association of Canada annual conference in St. John's, NL.

2. Immunostimulants and Fish Growth/Disease Resistance.

Crispin Jenkins (M.Sc. student) - Duane Barker

This part of the AquaNet project is being conducted by Dr. Duane Barker and Crispin Jenkins (M.Sc. student) at the quarantine facility of the Marine Institute.

In our third (Apr. 2004 - Sept.2004) and fourth (Nov. 2004 - Mar. 2005) immunostimulant trials we examined the effect of varying dosage, the timing of immunostimulant application, and the size of hatchery - reared cod (*AIF - contributed*) receiving treatment. Once again, we demonstrated an increase in lymphocyte density and mitigation of *Loma* infections among the immunostimulant - fed groups. However, three new interesting trends have emerged: a threshold level, a size related response and an expiry time for the products. We have demonstrated that the cod can actually received an 'overdose' of oral immunostimulants resulting in suppressed growth and increased mortality. In addition, smaller cod (< 10g) show more elevated lymphocyte and neutrophil densities than larger cod (> 25g). In addition, our fourth trial demonstrated a lack of efficacy (no increase in lymphocyte density and lack of infection mitigation) followed feeding of a previously proven efficacious but aged (> 2 years) product (see Figure below). These observations will have implications for the timing of immunostimulant feeding during the production cycle of cod with respect to fish size and age of product.

Thus far, we have tested 4 different commercial products and one (Beta - Bec™ @ 4mg/g) has continuously demonstrated repeated efficacy and was also tested by co - investigators Gamperl, Dixon and Johnson in a stress - response experiment to measure blood and humoral responses of immunostimulant - fed cod.

We have recently received 900+ hatchery - reared cod (*AIF contribution*) to use in a temperature stress and infection challenge model. In this trial, cod will be held concurrently at 2 temperatures (5° and 10 °C), exposed to *Loma* and given immunostimulants (Beta - Bec™ @ 4mg/g) as a treatment, rather than prevention as in our previous trials. The prime objective is to assess the suitability of a proven effective oral immunostimulant as a treatment to mitigate stress induced by temperature and parasite infection. It is also hoped that a cage - site trial to evaluate growth response of immunostimulant - fed cod can be conducted in the summer of 2005. The results of trials 1 - 3 were reported by Crispin Jenkins in two oral presentations (AAC 2004, APICS - AUUBC 2005) and were submitted for publication in the Bulletin of the Aquaculture Association of Canada (11 - 12 - 04). In addition, Dr. Barker has presented a summary of the trials and biology of *Loma* in departmental seminars at various universities (Atlantic Veterinary College - UPEI, Malaspina University - College) and will be presenting at the upcoming AAC 2005. On a related note, Crispin Jenkins has finished his M.Sc. research and is planning to submit his thesis in Winter 2006.

3. Stress and Immunological Status of Cod and Haddock at Different Temperatures.

This part of the AquaNet project is being conducted by Drs. Kurt Gamperl, Atef Mansour (DFO), Brian Dixon (University of Waterloo) and Stewart Johnson (IMB - NRC, Halifax).

Afonso/Iwama/Johnson carried out a long - term stress (15 sec net stress everyday for 30 days) study with juvenile haddock. They obtained data weekly for the following parameters: 1) free and bound plasma cortisol at rest, 2) plasma glucose, 3) liver hsp70 and 4) growth parameters. An ultrafiltration method for the analysis of bound and unbound cortisol was developed by Sho Hosoya. Exposure to daily handling for 4 weeks had a significant suppressive effect on growth; i.e. the body weight increase in the control and stressed groups was 32% and 18%, respectively. There was a significant increase in total plasma cortisol levels in the stressed group during the second week of the experiment. Interestingly, the percentage of free cortisol was already significantly elevated during the first week of the experiment. Control and stressed group had 15% and 48% of free cortisol during the first week, and 30% and 60% of free cortisol during the second week. Plasma glucose and hsp70 levels did not change throughout the experimental period in both groups. We are presently examining the expression of IL1 - beta, MH class 1, elongation factor 1 alpha and Mx protein in these samples to determine if there is any evidence of immunosuppression in these fish by RT - PCR.

Molecular Probe Development.

We have now developed probes for MHC class I, beta - 2 microglobulin, Immunoglobulin heavy chain, immunoglobulin light chain, Interleukin 1, ribosomal protein S11 and elongation factor 1 alpha from both cod and haddock. The only two other genes we were looking for MHC class II alpha and beta continue to elude us, but given the lack of specific antibody responses in the gadids, it may not be present. Our problem may also be that they are sufficiently different from other known fish MH genes that the approach we have been using - designing degenerate primer - will not detect them. Therefore we have sent cod and haddock libraries to Stewart Johnson, who is sequencing clones from them at random in the hope we pick up MH class II or other immune system genes. So far, although we have not yet identified MH class II, this resulted in the identification of several more immune system genes, including a novel CC chemokine and a chemokine receptor.

We tested our salmonid beta - 2 microglobulin polyclonal antiserum on cod and haddock, but it didn't cross react. We have initiated production of a recombinant protein for beta - 2 microglobulin that should produce a polyclonal antibody, we are also starting to make recombinant protein for Interleukin 1. The serum collected after the first boosts in the rabbits injected with beta - 2 - microglobulin has shown strong reactivity to the recombinant protein. We will be collecting the final serum in July and will then use it to assess beta - 2 - microglobulin expression in the samples we have collected to date.

We are currently putting the finishing touches on the haddock MHC papers and are starting to write up the haddock immunoglobulin paper. IL - 1 has been reported this year for cod, so we can no longer publish the cloning of this gene, but we can use it in functional analysis. The two papers described here will be submitted by August.

We performed an oxygen - burst assay on cod at both 10 °C and 15 °C before immunostimulant administration, and two weeks after a two week treatment with the immunostimulant (Beta - Bec™ @ 4mg/g). This assay measures reactive oxygen species produced by blood neutrophils in response to a simulated pathogenic challenge. It is a measure of innate immunity. Prior to immunostimulant treatment the fish held at 10 °C had a significantly higher oxygen burst response than those at 15 °C, perhaps a reflection of the higher stress levels found in the 15 °C fish - stress suppresses immune responses. After the immunostimulant treatment, however, the 15 °C fish had a significantly higher oxygen burst response. This was probably, however, a sampling effect. Although fish at 15 °C experienced much higher mortality rates than those at 10 °C, the survivors from these tanks were much bigger than the 10 °C fish ; ie. we may have artificially selected the healthiest most robust/fast growing fish. Tissue samples from all the fish sampled on both dates have been shipped to Waterloo and we have initiated an analysis of the expression of the genes we have cloned above. Interestingly, these results show that there is significant variability in thermal tolerance amongst the cod population we are currently using, and thus, that the proposed breeding program (Genome Atlantic application) could have significant benefits in this area.

4. Clinical Field Trial for Vaccines and Transfer Time Assessments for Atlantic Cod (*Gadus morhua*).

Dr. Nicole O'Brien (M.Sc. Candidate and Veterinary resident) - Dr. Larry Hammel, Dr. Daryl Whelan, Dr. Joe Brown.

The overall objective of this clinical trial is to provide the industry with evidence to critically evaluate the potential for adverse effects of adjuvants contained in different vaccines as well as the timing of sea transfer. This will be accomplished by using double-blind, randomized clinical trials under field conditions and evaluating the outcomes at the individual fish level. The outcomes of interest here are growth, survival and carcass characteristics for individual fish.

15,000 Atlantic Cod (*Gadus morhua*) ranging in size from 0.5 to 2 grams will be entered into the study. They will be physically separated by tanks into dip and no dip vaccine groups. Lethal sampling, culling and expected mortalities will result in 9000 fish as a final study population entered into the IP vaccine trial and transfer groups.

Under general anesthetic, a PIT tag will be implanted into the abdominal cavity of all study fish once they reach an appropriate size (10 - 15 g). Intra - peritoneal vaccine (oil - based adjuvant, water - based, or saline/no vaccine) groups and transfer groups will be formally randomized using the PIT tags to identify individuals. Prior to transfer, 20 fish from each treatment group will be lethally sampled to determine IP adhesions and will be scaled according to the Speilberg score.

At regular intervals, at the sea cage site, all fish will be sampled with weights, lengths, and disease condition information obtained. Serum samples (for possible antibody determination by ELISA), brain, eye samples and IP adhesion scores will be sampled from 30 fish. 30 fish from the treatment groups of interest will be obtained during the following sample periods: study initiation, pre - transfer, 30 - 60 days post - transfer, and at harvest. All mortalities will be monitored (record PIT tag number and weight/length) from time of PIT tag implant until termination of study.

Comparison of incidence rates will be done by treatment / vaccine group allowing quantification of the preventable fraction for each treatment. Analyses will also include relative risk of various individual fish factors (such as initial weight or maturity status) predictive of final outcome assessments (such as survival, early sexual maturation, and weight gain).

Progress to date:

Pilot Study on PIT tagging Cod: To date, PIT tags have been successfully implanted into 40 Atlantic Cod approximately 80 grams in weight. This pilot study was conducted over a four week time interval to provide experience in PIT tagging procedures in cod and to evaluate the potential for other adverse reactions to tag placement. These fish were monitored daily for mortalities and weekly samples were obtained for weights, lengths, sex, intraperitoneal (IP) adhesion scores and tissue samples for histology. These fish did not show any gross evidence of IP adhesions associated with the PIT tag implant and no PIT tags were lost. Proper placement of the PIT tag was determined through this pilot project.

Clinical Trial of Implanting Microchips in Juvenile Cod: A second pilot study was performed on six hundred 12 - 18 gram Atlantic Cod. PIT tags were placed in 200 fish, incisions were made in 200 fish and 200 fish (control) were handled the same as the other two populations but with no PIT tag inserted or incision made. This study was blinded to the investigator and the OSC staff. In addition, the individual placing the incision in the cod was not aware if these fish were having a PIT tag placed or not. These fish were maintained in three separate tanks for approximately 6 weeks and mortalities were monitored during this time period. The mortalities were dated and weights/lengths, sex and IP adhesions were recorded. In addition, tissues were obtained for histology at 3 weeks and at the termination of the study. The histology results are still pending from AVC and will likely be available in March of 2006. Based on preliminary results there does not appear to be any difference in survivability between these populations.

Clinical Trial of Cod Vaccinations & Transfer Seasons: The larger study populations of approximately 12,000 Atlantic Cod weighing 6 - 8 grams were randomly assigned to vaccine or control groups. Both the investigator and the OSC staff were blinded as to which tanks received the vaccine and which did not. The vaccination groups were vaccinated using a dip vaccine (Vibrogen 2) and the control groups were handled the same way but with no vaccine given. These populations were maintained in 6 separate tanks therefore the study was done in triplicate. The mortalities were monitored over a 6 week period. Due to a chronic high mortality in these populations and positive nodavirus diagnosis based on RT - PCR and cell culture these populations were culled. This decision was made for the best interest of the hatchery and new fish being brought into the facility. This study will be re - initiated once new fish populations and new funding sources are identified.

Future work

Apply to AIF Management Board for more fish to start the study again in the spring of 2006.

Obtain results from histology from the PIT tag studies.

Activity 4 Juvenile Growth and Energetics.

1. Feeding Behaviour and Digestive Physiology of Atlantic Cod and Haddock. Juan Casanova (Ph.D. student) - Kurt Gamperl and Joe Brown.

Mr. Casanova has now completed all his growth/metabolic experiments with the exception of the 2°C cod growth/gut evacuation trial, and the feeding behaviour studies are now underway. Below is an overview of the main findings.

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 h g^{-1} food); and 3) 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 a 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 illustrated 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.

2. Metabolic Scope, Routine Metabolism and Activity of Cod and Haddock in Sea Cages at 0, 4 and 10 °C. Matt Gollock (Post - Doctoral Fellow) - Kurt Gamperl.

There has been little progress in this area of research in the past few months due to the lack of availability of large fish, and cage - sites where work can be conducted. 1) We have been waiting for 9 months for fish to conduct lab - based studies; 2) with the exception of fish at Bay Bull's there are no large sea - caged cod in Newfoundland, and Heritage salmon is currently preparing to terminate its cod and haddock programs in New Brunswick. We are

expecting to receive some large cod from the Bay Bulls site in the next week for lab - based studies, and will begin experiments shortly after they arrive.

3. Regulation of Glucose Utilization in Atlantic Cod. MacCormack, Tyson J (Ph.D. candidate), Jennifer Hall, Bill Driedzic.

It is well recognized that Atlantic cod do not utilize carbohydrates (glucose and larger molecules made from glucose and its derivatives) very well as a nutritional source. The overall objective of our work is to understand the limiting factors to the use of carbohydrates and thereafter design ways to enhance utilization. This area of biochemistry is poorly understood in fish but very well studied in mammals where the rate limiting step in the use of carbohydrate is the transport of glucose across cell membranes. Glucose does not move freely across membranes but is dependent upon a family of proteins known as the glucose transporters or GLUTs to facilitate the movement of glucose from blood into glucose utilizing cells, primarily muscle, heart, and brain. The main GLUTs, identified as 1,2,3, and 4, have different tissue distributions and respond to dietary and other signals in different ways. We believe that through an understanding of the GLUT proteins and glucose transport, progress can be made towards improving the use of dietary carbohydrate in Atlantic cod and secondarily reduce the utilization of fat while reserving protein energy for growth.

(c) Other Activities

Use of continuous light to mitigate the early maturation of 1⁺ old Atlantic cod in sea cages.
Anne Kellett (M.Sc. student) - Dr. Joe Brown, Dr. Atef Mansur, Dr. V. Puvanendran.

A significant obstacle to commercial scale cod production is early maturation of the fish (Dahle et al. 1999). Farmed Atlantic cod (*Gadus morhua*) usually spawn for the first time around 2 years of age (Karlsen et al. 1995). Early maturation causes the fish to use energy stores to develop their gonads instead of muscle. This increases the length of culture time and the cost of production (Hansen et al. 2001).

Norberg et al. (2004) cite photoperiod as an environmental cue that has been shown to play an important role in the onset of reproduction. The technique of continuous light has successfully changed photoperiod to control spawning time in broodstock (Norberg et al. 2004). This strategy has been expanded to delay maturation in cultured fish. Periods of continuous light have successfully prevented early maturation of cod in indoor tanks (Hansen et al. 2001).

Translating this knowledge to culture in sea cages has presented some complications. The level of light needed and the diel rhythms created by natural photoperiod are not well

understood. This study will investigate continuous light as a strategy to prevent early maturation of cod raised in sea cages.

Training to Personnel

Cod Training and On the Job Work Experience

We have had trained numerous High Quality Personnel during 2005 - 06 in areas of larval, transport and grow - out. There have been 3 full time graduate students and 10 others participating within this project. We have had 6 work term related students participate on this project as well.

There have been a variety of visitors to our facility and at our cage site, from laypeople to veterinarians and researchers.

Mr. Rodney Healey, Live Feed Specialist, participated in an Industrial Live Feed Workshop in Gent, Belgium during September 2005.

Training of HQP will continue until December 31, 2006.

Cod Genomics Project



Atlantic Cod Genomics and Broodstock Development Project (CGP)

Dr. Jane Symonds, Huntsman Marine Science Centre

Dr. Sharen Bowman, The Atlantic Genome Centre

Project Duration: 4 years

Project Budget: \$18M

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. Aquaculture is one of the fastest growing sectors of the agricultural economy. Despite this growth, aquaculture often relies on wild populations for broodstock, which is the situation with Atlantic cod farmed in Canada. The CGP, in partnership with the aquaculture industry, is identifying and selecting elite broodstock through the application of selective breeding and genomics. Fish breeding programs have already been developed in Newfoundland and Labrador and New Brunswick which are identifying individuals among cod families that show good resistance to disease and stressors such as changes in water temperature. In parallel, thousands of cod genes have already been sequenced at The Atlantic Genome Centre. Differences within individual genes have also been identified, preparing us to develop a set of molecular markers and to associate these markers with fish that perform well or badly under aquaculture conditions.

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.

Presentations at Scientific Conferences:

Boyce, D.L. (2005) Aquaculture Activities at the Ocean Sciences Centre. Presented at New Wes Valley Rural Revitalization Workshop for Harris Centre, November.

Boyce, D.L. (2005) Cod Activities at the Ocean Sciences Centre. Presented at AquaNor, Norway.

Boyce, D.L. (2005) Cod Activities at the Ocean Sciences Centre. Presented at Sterling University, Scotland.

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 1st to Labour Day weekend (September 4th, 2006). This past summer the program successfully welcomed 17,571 visitors, which included individuals, groups (i.e. school children, daycare kids, summer camps and bus tours), and organized educational programs (i.e. Shad Valley).

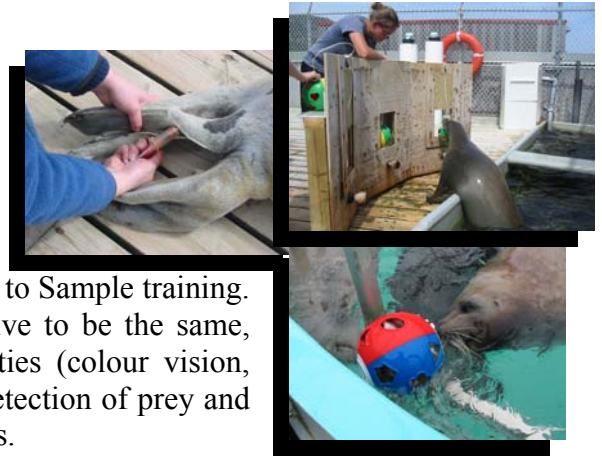


The OSC PEP has been directly involved in marine science programs offered to high - school students within Canada. Since 2003, the OSC has played an important role in Shad Valley Memorial, which host 50 of the brightest and most enterprising senior high school students from across the country. As part 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 8th. 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 year's Oceans Day theme was "*Watersheds...your link to Canada's oceans...explore the connection!*" 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. In addition, the OSC PEP participated in the St. John's Water Festival that was hosted by the Fluvarium.

Although the current public education program successfully attracts visitors to the OSC, we hope to provide a new and expanded public education program in the near future through the Memorial University Ocean Sciences Research Aquarium. With support from Memorial University, government agencies and private industry, the establishment of a permanent interpretive program within the Ocean Sciences Centre will showcase marine biological and aquaculture research being conducted at Memorial University. In doing so, the uniqueness of our cold, ocean environment and its flora and fauna will be evident.

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 2006, the Field Services Unit (FSU) of the Ocean Sciences Centre has again provided numerous services to many people. As in previous years, the FSU regularly provided collections of fish, invertebrates and algae for teaching purposes for the laboratory component of Introductory Botany, Biology for Students of Earth Sciences, Invertebrate, Cell Biology and Animal Physiology courses and for continuing research of faculty and graduate students of the OSC. In addition, the FSU has collected specimens for teaching purposes and researchers at the Marine Institute, and has made regular deliveries of seawater for their aquaculture facility. During summer months we collected small marine plants and animals for the touch tank for both the OSC for the Public Education Program and for the Bonne Bay Marine Station in Norris Point.

Back in 2004 we 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 within the electronics of the system our services were required this past summer for retrieval and replacement of the system components including the fibre-optic cable itself. Once the components were reinstalled the oceanographic station became operational.

Previously, the FSU 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. Over the last year some of these screens needed to be reattached along with a bottom plate that was not properly secured during some maintenance work that had been carried out on the tank when it was drained. We have also assisted in some experimental research in the flume tank by setting up and dismantling portions of an engineering project studying stress on underwater cables and pipes. In addition, this past spring we worked with the Marine Institute on a project in Cape Freels. We conducted some underwater surveys in the area to assess the local population of soft-shelled clam for a potential future commercial fishery.

Using our large dive truck, which is equipped with a 2500 L tank and oxygen cylinders with diffusers, we are able to transport specimens vast distances. This year we have transported juvenile salmon from Aquabounty's hatchery in PEI to their experimental site here at the OSC, we have also transported juvenile cod from New Brunswick to the Aquaculture Research and Development Facility (ARDF) for the Cod Genomic project.

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. We have also collected some juvenile shorthorn sculpins and shipped them live to a researcher in BC. We have collected and transported some adult Atlantic salmon to the Marine Institute for a researcher at Dalhousie University for reproductive studies. We have also become a member of the international research network

CORONA. This year we have collected specimens of two indigenous chiton species and shipped them to a researcher in the Department of Biological Science, California State University. We expect future requests for various organisms from other countries in the coming year. Previously we had collected several representative Newfoundland fish species that were sent to British Columbia where an artist there turned these fish into painted resin cast replicas. These are now on display in recently opened Provincial Museum section of The Rooms here in St. John's. We have since sent several more samples of local fish species to be made into replicas for a museum in the UK. This year we were even asked to assist on the set of the new Mary Walsh film. Two members of our team stood as safety standby in dive gear in our zodiac for several actors and members of the film crew who were filming scenes near a local pond. We were also asked to act as stand-ins for one scene for actors to have something to focus on while being filmed. One team member was later also filmed for an instructional video for Primary Care for Medical students in the Health Sciences Department.

We have participated in several public education events this past year. Two members of our team participated in the annual Ocean's Day at the Marine Institute. One team member later participated in the St. John's Annual Water Festival. During these events we displayed our scuba equipment and a touch tank with some local marine species and described each to local school children. Furthermore, one member of our team also volunteered for the 7th International Congress on the Biology of Fish held in St. John's, NL, July 2006.

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

13. AquaNet



AquaNet is Canada's Network of Centres of Excellence in aquaculture. It is a unique collaboration of universities, industry, government and non-government organizations. The Network is hosted by Memorial University of Newfoundland, and supported by an annual grant of \$3.6 million from the Government of Canada, along with substantial contributions from its industrial and institutional partners. Its Administration Centre is located at the Ocean Sciences Centre.

AquaNet is well positioned to address diverse production, environmental, social and economic research needs from coast to coast with its two core facilities at Memorial University of Newfoundland's Ocean Sciences Centre and The University of British Columbia's Centre for Aquaculture and the Environment, along with affiliate universities and research laboratories across Canada.

MISSION

To foster a sustainable aquaculture sector in Canada through high quality research and education.

- Increasing the recruitment and retention of highly qualified personnel,
- Establishing effective networking and partnerships,
- Effectively transferring findings to the aquaculture sector, and
- Helping to build a consultative environment where Canadians are informed about aquaculture.

PRINCIPLES

Activities of AquaNet reflect a commitment to the following underlying principles of sustainable, socially acceptable aquaculture:

- Evidence-based management of risk,
- Promotion of innovation, and
- Respect for traditional and local knowledge.

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 m³ 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 re-design 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. Carlos Bertrán Dean of Science Universidad Austral de Chile Independencia 641 Valdivia · Chile	Collaborating on research with Dr. Ray Thompson and discussing international development funding opportunities and curriculum development. October 6th - 27th, 2005
Dr. Oscar Chaparro Director of the Institute of Marine Biology Universidad Austral de Chile Independencia 641 Valdivia · Chile	Collaborating on research with Dr. Ray Thompson and discussing international development funding opportunities and curriculum development. October 6th - 27th, 2005
Dr. Pål Arne Bjørn Research Scientist Norwegian Institute of Fisheries and Aquaculture Research Tromsø, Norway	Meetings and collaborations with Dr. Fleming November 7 - 11, 2005
Dr. Arne Arnesen Director of Research Norwegian Institute of Fisheries and Aquaculture Research Tromsø, Norway	Meetings and collaborations with Dr. Fleming November 7 - 11, 2005
Børge Damsgård Senior Scientist Norwegian Institute of Fisheries and Aquaculture Research Tromsø, Norway	Meetings and collaborations with Dr. Fleming November 7 - 11, 2005
Bengt Finstad Senior Research Scientist Norwegian Institute for Nature Research Trondheim, Norway	Meetings and collaborations with Dr. Fleming November 7 - 11, 2005
Ingebrigt Uglem Research Scientist Norwegian Institute for Nature Research Trondheim, Norway	Meetings and collaborations with Dr. Fleming November 7 - 11, 2005
Sigurd Einum Research Scientist Norwegian Institute for Nature Research Trondheim, Norway	Meetings and collaborations with DR. Fleming February 27 - March 4, 2006

Dr. Gunilla Rosenqvist Research Scientists Norwegian University of Science and Technology Trondheim, Norway	Meetings and collaborations with Dr. Fleming March 17 - 21, 2006
Dr. Marlies Rise Affiliate Great Lakes WATER Institute, University of Wisconsin - Milwaukee	Genomics and Fish Health Dr. Matthew L. Rise July 1, 2006 to December 31, 2006
Dr. Jean - François Hamel Research Scientist Society for the Exploration and Valuing of the Environment (SEVE) Quebec	Working on the mechanisms of the marine invertebrate reproduction Dr. Annie Mercier May 9, 2005 to December 31, 2006
Jorgen Johnsson Professor Department of Zoology Gothenburg University Sweden	Collaboration ongoing research projects - risk assessment of GH - transgenic fish and writing and planning new research projects. July 16 - August 31, 2006
Dr. Don Stevens Professor Emeritus Integrative Biology University of Guelph Guelph, Ontario	Aspects related to the use of analgesics in fish, and the extent to which fish feel pain. Dr. Gamperl July 23 - August 2, 2006

Visiting Post - Doctoral Fellowships

Anders Finstad Post-Doctoral Fellow Norwegian Institute for Nature Research Trondheim, Norway	Meetings and collaborations with Dr. Fleming February 27 - March 4, 2006
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Visiting Students

Ian Bradbury Ph.D. Candidate Dalhousie University Halifax, NS	Laboratory and field research Dr. Snelgrove September 2003 - January 2006
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<p>Nicole O'Brien, Ph.D. Atlantic Veterinary Collage University of PEI, Charlottetown Veterinary Resident</p>	<p>Alternative marine species health for Newfoundland and Labrador ARDF December 2004 - 2006</p>
<p>Mr. Glenn Lurman Ph.D. Candidate Marine Animal Physiology Alfred-Wegener-Institute for Polar and Marine Research Bremerhaven Germany</p>	<p>Collaborating on experiments related to the effects of temperature acclimation and acute thermal challenges on cod cardiac functions. Dr. Gamperl April 23 - June 3, 2006</p>
<p>Nathalie Newby M.Sc. Candidate Integrative Biology University of Guelph Guelph, Ontario</p>	<p>Aspects related to the use of analgesics in fish, and the extent to which fish feel pain. Dr. Gamperl July 23 - August 2, 2006</p>
<p>Mr. Guillaume Werstink M.Sc. Canadiate University of Montpellier 11 (CREUFOP France</p>	<p>Collaborating and/or receiving training with staff in the Aquaculture Research and Development Facility (ARDF) May 2006 - Sept 2006</p>

15. OSC Seminars

Biology/OSC Seminar Series 2005 - 2006

Ms. Amy Kehoe Biology Department Memorial University	Isolation and characterization of three feeding-related neuropeptides, Neuropeptide Y (NPY), Cocaine and amphetamine regulated transcript (CART) and orexin, in Atlantic cod (<i>Gadus morhua</i>) September 16, 2005
Dr. Dr. Hugh Whitney, Director Animal Health Division, NL Provincial Government	Important diseases of wild and domestic animals in NL (including rabies, Lyme disease, West Nile virus, French heartworm, caribou brain worm) September 23, 2005
Dr. Jeff Hutchings, CRC Chair in Biodiversity, Biology Department, Dalhousie University	Alternative reproductive strategies: implications for the conservation biology of Atlantic salmon September 30, 2005
Dr. Eva Enders Postdoctoral Fellow Department of Fisheries and Oceans	Effects of turbulence on behaviour and swimming energetics of Atlantic salmon parr. October 7, 2005
Dr. Annie Mercier Assistant Professor Ocean Sciences Centre Memorial University	Sex in the sea: fundamental and applied aspects of marine benthic invertebrate reproduction. October 14, 2005
Dr. Erica Crespi Vassar College New York	Feast or Famine: Linking resource availability and metamorphic timing in amphibians. October 21, 2005
Dr. Don Deibel Associate Director Ocean Sciences Centre Memorial University	Carbon flow through the lower food web of Conception Bay: Vertical flux, climate change and global comparisons October 28, 2005
Shaun Killen Ph.D. Candidate Ocean Sciences Centre Memorial University	You can't always get what you want: the energetic cost of foraging tradeoffs in marine larval fish November 4, 2005

Dr. Garry Stenson Department of Fisheries and Oceans NWAFC	Harp seals in the Northwest Atlantic: Impact of the current seal hunt pressure on population size. November 18, 2005
Dr. Tom Rand Saint Mary's University	Pathophysiology of building associated fungal spores and mycotoxin exposure in animal lungs. November 25, 2005
Dr. Robin Waples Northwest Fisheries Science Center Seattle	Seed banks, salmon, and sleeping genes December 2, 2005
Dr. Daniel Sandweiss University of Southern Maine	The Archaeology of El Niño in Ancient Peru. January 20, 2006
Dr. Keith Lewis Biology Department Memorial University	Nest predation by introduced red squirrels in boreal forests: Why introduced species are bad for birds in Newfoundland. January 27, 2006
Dr. Dounia Hamoutene Fisheries and Oceans Canada Northwest Atlantic Fisheries Branch	Effects of water contaminated with petroleum hydrocarbons on mussel hemocytes: DNA damage (and cell cytoskeleton). February 10, 2006
Dr. K.N.I. Bell Biology Department Memorial University	Conservation, cod, and COSEWIC - the fundamental flaw and how to fix it: Academia's role. February 17, 2006
Carolyn Parsons Department of Biology, Memorial University	The role of diversity in agricultural systems: a pest management perspective. February 24, 2006
Dr. Sigurd Einum Research Scientist Norwegian Institute for Nature Research	Salmon in space - Ontogenetic changes in space use may drive patterns of density dependence. March 3, 2006
Dr. Paul Snelgrove CRC in Biology and Cold Ocean Systems Ocean Sciences Centre and Biology Dept Memorial University	Larval Dispersal and Marine Protected Areas: Complex Solutions for Complex Problems March 10, 2006
Jason R. Treberg Ph.D. Candidate OSC and Biology Department	Insights into urea and water balance in aquatic animals and what, if anything, can be inferred about the (re)invasion of vertebrates into marine habitats? March 17, 2006

<p>Dr. Patrick Nantel Parks Canada Ottawa</p>	<p>Monitoring and modelling populations of rare plants: a case study at Mingan Archipelago National Park Reserve. March 24, 2006</p>
<p>Dr. Blair Adams Post-Doc Ocean Sciences Centre</p>	<p>A lot of fish and a little data! Generalized life history models as a tool for sustainable fisheries management. March 31, 2006</p>
<p>Dr. Isabelle Schmelzer, Newfoundland and Labrador's Inland Fish and Wildlife Division</p>	<p>Conservation Status and Recovery Potential of the Eastern Wolverine in Labrador: Insights Gained from an Extensive Aerial Survey. April 7, 2006</p>

Appendix

