



March 2-4, 2012
Sackville, New Brunswick

Mount
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Science Atlantic's 22nd Student Aquaculture & Fisheries Conference





Happy 50th Anniversary Science Atlantic!

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The Science Atlantic Aquaculture and Fisheries Committee gratefully acknowledges donations made by the following sponsors



The **Canadian Centre for Fisheries Innovation** is a non-profit organization owned by Memorial University of Newfoundland and funded by the Government of Newfoundland and Labrador with additional support from the Maritime Provinces' Governments. CCFI provides the tools of scientific research and technology to the fishing industry.



The **Bluenose Coastal Action Foundation** was incorporated in 1993 as a non-profit charitable organization that addresses environmental concerns in Lunenburg County. Its goal is to promote the restoration, enhancement and conservation of our ecosystem through research, education and action.



Clearwater is a wild seafood company dedicated to sustainable seafood excellence, with a large fleet of vessels and several processing plants throughout Eastern Canada.



The **Lobster Council of Canada** mandate is to enhance the value of the Canadian lobster sector in a sustainable fashion by addressing the issues of importance to the industry.



The **Natural Sciences and Engineering Research Council of Canada** supports university students in their advanced studies, promotes and supports discovery research, and fosters innovation by encouraging Canadian companies to participate and invest in postsecondary research projects.

Getting around campus



11 Campus Tours

2nd Floor
Wallace McCain Student Centre
(506) 364-2257
campusvisit@mta.ca

Contact Info

Admissions Team
Mount Allison University
62 York St.
Sackville, NB E4L 1E2

(506) 364-2269
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mta.ca/apply

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- | | | | |
|---|----------------------------------|-----------------------|-----------------------------|
| 1 Convocation Hall | 11 Wallace McCain Student Centre | 12 Thornton House | 24 Centennial Hall |
| 2 Athletic Centre | International Centre | 13 Edwards House | 25 Bennett Building |
| 3 Ralph Pickard Bell Library | Wellness Centre | 14 Hunton House | 26 Windsor Theatre |
| 4 Crabtree Building | Meighen Centre | 15 Bennett House | 27 Hart Hall |
| 5 Marjorie Young Bell Conservatory of Music | Fitness Centre | 16 Bigelow House | 28 Campbell Hall |
| Brunton Auditorium | CHMA Campus Radio | 17 Gemini Observatory | 29 Windsor Hall |
| 6 Avar-Dixon Building | Campus Pub | 18 Carriage House | 30 Jennings Dining Hall |
| Ron Joyce Centre for Business Studies | Gracie's Café | 19 Bermuda House | Academy Gardens |
| 7 Flemington Building | SAC Office | 20 Cuthbertson House | 31 Harper Hall |
| 8 Barclay Chemistry Building | Argosy Student Newspaper | 21 Pavillion Bousquet | 32 Downtown Sackville |
| 9 Owens Art Gallery | University Bookstore | 22 Dunn Building | 33 Sackville Waterfowl Park |
| 10 Gairdner Fine Arts Building | Admissions & Registrar's Office | Wu Centre | 34 Swan Pond |
| | Student Affairs | 23 Chapel | 35 Anchorage House |
| | Tweedie Hall | | |

Best parking: **P**

Friday registration/reception/poster displays: **11**

Saturday/Sunday talks: **22**

Meals: **30**

Science Atlantic Aquaculture & Fisheries Student Conference schedule

Friday, Mar 2

- 17:00–20:00 Joint Registration (outside Tweedie Hall, Wallace McCain Student Centre)
- 17:00–19:00 Poster Setup (Tweedie Hall)
- 18:30–20:00 Mixer with cash bar (Tweedie Hall)
- 19:00–21:00 Science Atlantic Committee Meetings (McCain Student Centre rooms 124, 125, 130)

Saturday, Mar 3

- 8:00–9:00 Registration/Poster Setup (Tweedie Hall)
- 9:00–9:15 Joint Welcoming remarks (Dunn 113)
- Berkeley Fleming VP, Academic & Research, Mount Allison University
Robert Hooper, Chair of Science Atlantic Biology Committee
Jim Duston, Chair of Science Atlantic Aquaculture & Fisheries Committee
Van Lantz, Chair of Science Atlantic Environment Committee

Aquaculture & Fisheries session 1 (Dunn 106)

- 9:30–9:45 Zhiyu Chen: Nova Scotia Agricultural College
Digestibility of enzyme treated pre-pressed solvent extracted camelina meals by rainbow trout (*Oncorhynchus mykiss*)
- 9:45–10:00 Kim Novak: Nova Scotia Agricultural College
Catching American lobsters (*Homarus americanus*): Does the trap type make a difference?
- 10:00–10:15 David Keith: Dalhousie University
The Functional Response of Fisheries
- 10:15–10:30 Gouqiang Wang: Nova Scotia Agricultural College
Digestibility of nutrients including phosphorus and growth performance of rainbow trout (*Oncorhynchus mykiss*) fed diets based on plant proteins with or without dietary phytase
- 10:30–11:00 Joint Break & Poster viewing (Tweedie Hall)

Aquaculture & Fisheries session 2 (Dunn 106)

- 11:00–11:15 Zhuhui Ye: Nova Scotia Agricultural College
Abundance and body size of young-of-the-year (YOY) Shubenacadie striped bass (*Morone saxatilis*) in relation to their age and environmental conditions
- 11:15–11:30 Yingqiang Zhang: Nova Scotia Agricultural College
Effect of photoperiod on salinity tolerance of rainbow trout (*O. mykiss*) and Atlantic salmon (*S. salar*)
- 11:30–11:45 Kyle Matheson: Memorial University of Newfoundland
Temperature mediates non-competitive and competitive foraging in indigenous rock (*Cancer irroratus*) and recently introduced green (*Carcinus maenas*) crabs
- 11:45–12:00 Lauren Ellis: University of New Brunswick, Fredericton
The effect of dissolved oxygen concentration on critical thermal maximum in triploid brook charr, *Salvelinus fontinalis*
- 12:00–12:15 Devon Johnstone: Dalhousie University
Assessing the usefulness of single sample estimators of effective population size for wild and farmed populations of atlantic salmon (*Salmo salar*)
- 12:15–12:30 Njal Rollinson: Dalhousie University
Big Forestry, Big Fish, and the Evolution of Maternal Investment in Atlantic Salmon
- 12:30–13:30 Lunch (Jennings Hall)
- 13:45–14:45 Keynote speaker – Dr. Ian Mauro, Mount Allison University (Dunn 113)
The Science of Storytelling: A Digital Dispatch on Biotechnology and Climate Change

Aquaculture & Fisheries session 3 (Dunn 106)

- 14:45–15:00 Jessica Ellis: Dalhousie University
Current trends in hagfish fisheries in Atlantic Canada and worldwide
- 15:00–15:15 Jamie Fraser: Nova Scotia Agricultural College
Digestibility of *Camelina sativa* seed and its by-products by Atlantic cod (*Gadus morhua*) and rainbow trout (*Oncorhynchus mykiss*)
- 15:15–15:30 Jeremy Corbin: Bedford Institute of Oceanography
Identifying inter/intra-species variability in sharkskin morphology for application in shark conservation

15:30-15:45 Christina Bullerwell: Nova Scotia Agricultural College
Performance of Rainbow trout (*Oncorhynchus mykiss*) fed graded levels of prepress solvent extracted *Camelina sativa* meal

15:45–16:15 Joint Break (Tweedie Hall)

Aquaculture & Fisheries session 4 (Dunn 106)

16:15 –16:30 Vicky Yaroshewski: Dalhousie University
Genetic Effects of Pearl Culture Practices and Fine Scale Recruitment of the Black-Lipped Pearl Oyster (*Pinctada margaritifera*) in French Polynesia

16:30 –16:45 Rebecca Parker: Dalhousie University
Is it possible to reconstruct the original donor oyster genetic profile by microsatellite genotyping of recipient grafted oysters muscle and pearl sac tissue?

16:45 –17:00 Maxime Boudreau: Université de Moncton
Preparation and investigation of experimental feeds for *Homarus americanus* larvae

17:00 –17:15 Larina Carroll: Memorial University of Newfoundland
Functional genomic studies of Atlantic salmon (*Salmo salar*) development, and larval responses to chronic incremental hyperthermia

17:15 –17:30 Nancy Roney: Dalhousie University
Old fish, new fish: The effects of stock structure on recruitment in *Gadus morhua* and *Clupea harengus*

19:00–21:00 Banquet with cash bar (Jennings Hall)

Sunday

9:00–9:30 Poster session presenters required (Tweedie Hall)

Aquaculture & Fisheries session 5 (Dunn 106)

9:30–9:45 Jonathan Cottreau: Acadia University
Habitat use by american eel, *Anguilla rostrata*, in relation to environment and vegetation growth in Oakland Lake

9:45–10:00 Rachel Porter: Cape Breton University

The meroplankton community of Sydney Harbour: spatial and temporal patterns in an industrial marine ecosystem in Sydney, Nova Scotia, Canada

- 10:00–10:15 Andy Muise: Acadia University
American eel, *Anguilla rostrata*, habitat use within a Nova Scotia watershed
- 10:15–10:30 Gina Stewart: Nova Scotia Agricultural College
Shubenacadie River striped bass egg and larvae spatio-temporal density and distribution
- 11:00 – 11:30 Joint Break (Tweedie Hall)
- 11:30 – 12:30 Keynote speaker – Dr. Paul Snelgrove, Memorial University (Dunn 113)
Marine Biodiversity in the 21st Century; Making Ocean Life Count
- 12:30 –13:30 Lunch and awards (Jennings Hall)

Abstracts : Oral presentations

Preparation and investigation of experimental feeds for *Homarus americanus* larvae

Maxime Boudreau

(Graduate student, Université de Moncton)

The lobster industry is responsible for one of the most important aquatic exports in Canada. The preservation of American lobster populations are therefore of great priority for the well-being of our marine ecosystem as well as our economy. Homarus Inc. has undertaken, a few years ago, the production and seeding of stage IV American lobster larvae in an effort to raise the lobster population within Maritimes commercial fishing zones. The techniques already in place yield good results, but are still costly in terms of feed and human resources. These feeds are based on commercial products made from *Artemia* (brine shrimp) and are often poorly adapted for American lobster larvae. There is therefore a growing need to develop a dry feed specifically designed for American lobster larvae. This project consists of developing, producing, and testing experimental feeds that meet all the lobsters' nutritional requirements. The feeds must also stimulate food intake in the lobster larvae. Biochemical profiles (proteins, lipid composition) will be used to evaluate the quality of the larvae fed experimental feeds. We will use the biochemical profiles of wild lobster larvae as our base of comparison. This presentation will offer an introduction to lobster aquaculture as well as recent advances in the field of feed development, followed by some preliminary results.

Préparation et investigation de moulées expérimentales pour larves de *Homarus americanus*

L'industrie du homard représente l'une des exportations canadiennes les plus importantes. Le maintien des populations de homard américain doit donc être une grande priorité pour le Canada, tant du point de vue économique qu'environnemental. Homarus Inc. a débuté, il y a quelques années, la production et l'ensemencement de larves de homard de stade IV dans le but d'augmenter les populations de homard sur les sites de pêche commerciale dans les Maritimes. Les techniques d'élevage développées jusqu'à présent produisent de bons résultats, mais elles sont encore coûteuses en termes de ressources humaines et techniques. La nourriture utilisée présentement est basée entre autres, sur des produits à base d'artémies, souvent mal adaptés aux larves de homard américain. Le développement d'une nourriture sèche adaptée aux larves de homard devient une priorité. Ce projet consiste donc à concevoir, fabriquer et tester des moulées nutritionnellement complètes pouvant stimuler la prise alimentaire chez les larves de homard. Des profils biochimiques (protéines et composition lipidique) seront utilisés afin d'évaluer la qualité des larves produites avec les moulées expérimentales, en utilisant comme référence des larves de homard sauvage. Cette présentation offrira une introduction aux domaines de l'aquaculture du homard ainsi que des avancées récentes en développement de moulées, et sera suivi de résultats préliminaires.

Performance of Rainbow trout (*Oncorhynchus mykiss*) fed graded levels of prepress solvent extracted *Camelina sativa* meal

C. Bullerwell, Dr. D. M. Anderson & J. Fraser

(Graduate student, Nova Scotia Agricultural College)

The growing aquaculture industry requires dietary alternatives to fish meal. Plant protein sources such as Camelina meal (CM) may be a promising alternative. A feeding trial with 600 Rainbow trout (initially $2.36 \pm 0.18\text{g}$) was conducted using five, randomly assigned, isocaloric and isonitrogenous diets including 0, 5, 10, 15 or 20% CM. Twenty tanks (40L) supplied with flow-through freshwater (2L/min.) at 14.5°C contained 30 fish which were fed to satiation three times a day and weighed every 28 days. Feed consumption (FC) and feed conversion ratio (FCR) were calculated for 0-28, 29-56, 57-84 and 85-112 day periods. Mean weights (MW) of fish fed 15 and 20 % CM (6.08g and 5.78g) were smaller ($P \leq 0.05$) at day 28 than fish fed 0 and 5% CM (8.75g and 8.53g). On days 56 and 112, MW of fish fed 0 and 5% CM (27.86g and 28.03g; 131.43g and 140.85g) were higher ($P \leq 0.05$) than fish fed 10, 15 and 20% CM (25.28g, 21.35g and 18.63g; 111.50g, 113.38g and 106.89g). MW of fish fed 0, 5 and 10% CM (76.34g, 74.30g and 66.55g) were greater ($P \leq 0.05$) than fish fed 15 and 20% CM (57.83g and 50.98g) at day 84. FC of all diets was similar during 0-28 and 29-56 days. During 57-84 and 85-112 days, FC was similar ($P \leq 0.05$) for 0, 5 and 10% CM and decreased with higher levels of CM. FCR was similar ($P \leq 0.05$) for all diets and periods.

Functional genomic studies of Atlantic salmon (*Salmo salar*) development, and larval responses to chronic incremental hyperthermia

Larina A. Carroll, Charles Y. Feng & Dr. Matthew L. Rise

(Undergraduate student, Memorial University of Newfoundland)

Functional genomics techniques were used to study gene expression in a single Atlantic salmon cohort (eggs from one female, milt from 2 males) during normal embryonic and early larval development, and in larvae exposed to chronic incremental hyperthermia (water temperature increased by 1°C every 24 hours, from $7.4\text{--}21.4^{\circ}\text{C}$). Expressed sequence tags (ESTs) representing four paralogous Atlantic salmon small heat shock proteins (sHSPs), each encoding a complete open reading frame (ORF) including a conserved α -crystallin domain, were identified in the cGRASP EST database and assembled into contiguous sequences (contigs). 32K cGRASP microarrays were used to identify transcripts that were reproducibly higher expressed in hatch stage embryos compared to eye-up embryos. Four paralogous γ -crystallin-domain-encoding contigs (containing two partial and two complete ORFs) were assembled based on ESTs retrieved from the cGRASP EST database. Parologue-specific QPCR assays were developed to study mRNA expression of the four sHSP and four γ -crystallin genes at developmental stages surrounding the hatch event. 32K cGRASP microarrays were used to identify transcripts that were reproducibly dysregulated in larvae exposed to chronic incremental hyperthermia relative to time-matched larvae maintained at 7.4°C . The impact of increasing ambient temperature on larval gene expression was further studied using QPCR for four sHSP paralogues and four microarray-identified genes (trypsin-1, chymotrypsin b, ferritin, and ubiquitin). This research could lead to: a) the identification of molecular biomarkers to study

adaptability of early life stage salmon under normal and potentially stressful conditions (e.g. changing hydrology due to accelerated climate change); b) the selection of superior broodstock; and c) development of optimized rearing techniques to reduce industrial mortalities.

**Digestibility of enzyme treated pre-pressed solvent extracted camelina meals by rainbow trout
(*Oncorhynchus mykiss*)**

Zhiyu Chen & Dr. D.M. Anderson

(Undergraduate student, Nova Scotia Agriculture College)

Pre-pressed solvent extracted camelina meal (PSCM) is a by-product from the oilseed (*Camelina sativa*) derived from extrusion and oil extraction. PSCM contains anti-nutritional compounds (phytate, glucosinolates, mucilage and high fiber level) that may limit its use in fish diets unless they can be effectively degraded with dietary enzymes. To evaluate enzyme treatment of PSCM on the apparent digestibility (AD) and digestible nutrients by rainbow trout (402g av. wt), four test ingredients were created by incubating PSCM with either Bio-phytase[®] (PSCM+PHY), Superzyme-OM[®] (a multi-carbohydrases) (PSCM+SUP), mixed Bio-phytase[®] and Superzyme-OM[®] (PSCM+MIX) and water (PSCM+H₂O) at 35-40°C for 24 hours. A basal diet was formulated then five experimental diets were created by adding a test ingredient to the basal diet at an inclusion rate of 30%. Using 3 tanks per treatment, a digestibility trial was run for 4 weeks in freshwater at 11°C. Fecal matter was collected by sedimentation method and the apparent digestibility of dry matter (DM), crude protein (CP), gross energy (GE) and crude fat (CF) determined by the Cr₂O₃ (at 1%) indicator method. data were analyzed by ANOVA in the mixed model program of SAS with treatment means differentiated using LS means ($P \leq 0.05$). The apparent digestibility of the test ingredients were not different ($P > 0.05$). The digestible protein and fat in PSCM+MIX ($38.9 \pm 1.43\%$ and $6.4 \pm 0.23\%$) respectively were 4% and 3% higher than all other treatments ($P \leq 0.05$). If the PSCM is used in commercial fish diets, the enzyme mix of Bio-phytase[®] and Superzyme-OM[®] would be effective to further increase PSCM's digestible nutrients.

Identifying inter/intra-species variability in sharkskin morphology for application in shark conservation

Jeremy Corbin

(Undergraduate student, Bedford Institute of Oceanography)

Interspecific differences in sharkskin morphology have been acknowledged, but little has been done to quantify these differences. The intent of this study was to describe and quantify both intraspecific and interspecific differences in dermal denticle morphology of five shark species from the Northwest Atlantic, and thereby test their potential as a method of species identification. Skin samples were collected from the dorsal fins, pectoral fins, lower lobe of the caudal fin and from the bodies of five individuals of each of the following species: shortfin mako (*Isurus oxyrinchus*), porbeagle (*Lamna nasus*), blue shark (*Prionace glauca*), black dogfish (*Centroscyllium fabricii*) and spiny dogfish (*Squalus acanthias*). Skin samples were photographed at high magnification using a scanning electron microscope (SEM) and eight structural variables in dermal denticle morphology were measured (denticle length, width, density, number of longitudinal ridges, presence of parallel ridges, number of posterior marginal teeth, presence of a honeycomb surface structure and the presence of a single vertical spike). A two-way analysis of variance (ANOVA) and an analysis of covariance (ANCOVA) - with fork length as the covariate - were used to test for significant differences in denticle morphology among shark species and between locations on the body. Fishermen involved in illegal shark finning often rely on an inability to identify shark species after having been dressed for market, which limits the ability to enforce anti-finning measures. Species-specific differences in denticle morphology may prove useful in identifying the source of shark fins in the market, and thus reduce the supply of illegally finned species.

Habitat use by american eel, *Anguilla rostrata*, in relation to environment and vegetation growth in Oakland Lake

Jonathan Cottreau & Dr. Trevor Avery

(Undergraduate student, Acadia University)

Little is known about habitat use by American Eels, *Anguilla rostrata*, and this poses issues when looking at ways to protect these culturally, commercially, and ecologically important animals. This study identifies aquatic habitat types used most frequently by eels in Oakland Lake, a protected watershed, particularly as vegetation changes throughout the growing season. Habitat characteristics included vegetation type (taxa), vegetation abundance, substrate composition, dissolved oxygen levels, pH, temperature, and depth. These characteristics were compared to unique captures of eels generated through a mark-recapture survey that was conducted throughout Oakland Lake over a three-year period. The frequency of use of each habitat type will be statistically analyzed using classification and regression trees, regressions, and visualizations to identify primary habitat characteristics throughout the course of the summer months. This baseline habitat characterization will help to identify habitat use by eels and build a habitat portfolio for comparisons with other areas where eels are found such as impounded waterways.

Current trends in hagfish fisheries in Atlantic Canada and worldwide

Jessica E. Ellis

(Undergraduate student, Dalhousie University)

Over the past 60 years, invertebrate fisheries have expanded in terms of landings, target species, and the number of countries fishing and are now prominent around the world. Hagfish (family Myxiniidae) have been fished commercially in Asia since the 1980s where their skin is used as leather and their meat for human or animal consumption. Since then, the animals have been increasingly exploited on a global scale with so far limited management or monitoring. In this study, national and global trends were analyzed using landings and effort data compiled from published literature, government reports and assessments. Exploitation patterns have been driven by the Asian market where, after local hagfish stocks have been depleted, companies aimed to fish in other regions. Thus, fisheries have expanded on the East and West coasts of North America and in New Zealand. Our analyses have revealed that hagfish fisheries have exhibited spatial expansion and serial exploitation patterns around the world, as seen in sea urchin and sea cucumber fisheries. In Atlantic Canada, the hagfish fishery has strongly expanded over the past 20 years with a 24-fold increase in both annual landings and fishing effort and a 10-fold increase in the number of NAFO units fished. Overall, our study increases our understanding of the abundance, distribution and exploitation of this ecologically important but little managed species.

The effect of dissolved oxygen concentration on critical thermal maximum in triploid brook charr, *Salvelinus fontinalis*

Lauren Ellis, Dr. Tillmann J. Benfey & Charles F.D. Sacobie

(Undergraduate student, University of New Brunswick, Fredericton)

Induced triploidy is the most effective method of producing sterile salmonid fishes for aquaculture. However, triploid brook charr (*Salvelinus fontinalis*) have reduced tolerance to elevated temperatures and a lower thermal optimum when compared to their diploid counterparts. Thermal tolerance in fish is commonly assessed using a critical thermal maximum (CTM) test, where the non-lethal experimental endpoint (loss of equilibrium) provides an estimate of the upper lethal limit. To determine whether reduced temperature tolerance is a direct effect of temperature or an indirect effect of low dissolved oxygen, diploids and triploids were tested in CTM trials under varying oxygen concentrations: 1) a "standard" CTM, 2) maintaining oxygen at 9-10mg/L, 3) supersaturating the water with oxygen and 4) using nitrogen to drive out oxygen. In all cases temperature was increased at 3°C/hr. A fifth trial was conducted to determine the critical oxygen concentration of both ploidies without changing the temperature. Based on preliminary results, treatment 4 showed the largest ploidy effect, so a more in-depth study was done on this treatment. Blood samples were taken during this trial and over an 18-hour recovery period for the determination of glucose, plasma ions and plasma osmolality. The results of statistical analysis as well as blood glucose and ion concentrations will be presented.

Digestibility of *Camelina sativa* seed and its by-products by Atlantic cod (*Gadus morhua*) and rainbow trout (*Oncorhynchus mykiss*)

Jamie Fraser & Dr. D.M. Anderson

(Graduate student, Nova Scotia Agricultural College)

Camelina sativa, an oilseed, and its by-products have potential in fish diets. Ground full-fat seed (FFS), pre-pressed meal (PP), oil (O), and PP solvent extracted meal (PPSE) were tested. In addition, for the rainbow trout trial, toasted PPSE (TSE) was produced. Digestibilities were determined for Atlantic cod (AC) and rainbow trout (RT). A practical ingredient basal diet with chromic oxide (AC, 1% of basal diet; RT, 1% of total diet) was formulated for each species; 30% of each meal ingredient or 20% O was added to the basal diets. AC (69.5 g/fish \pm 0.8) were placed on trial in an 18-tank flow-through saltwater (7.0°C \pm 0.04) system; RT (153 g/fish \pm 1.4) were placed on trial in the same system with fresh water (10.0°C \pm 0.03). Feces were collected (AC, 15 days; RT, 11 days) via sedimentation. Each diet was assigned randomly to 3 tanks. Digestibilities were calculated using the indicator method. Digestible dry matter (DDM), digestible energy (DE) and digestible crude protein (DP) were calculated for the ingredients. All parameters were subjected to a proc mixed model of SAS ($p \leq 0.05$). DE was highest in O for both AC (4922 kcal/kg \pm 490) and RT (8152 kcal/kg \pm 351). DP was highest in PPSE (20.5% \pm 0.3) for AC. DP for RT was equally high in the PPSE (34.3% \pm 0.5), PP (33.7% \pm 1.1), and TSE (31.6% \pm 4.8). Due to species differences, digestible nutrients need to be determined for each species for future ration formulations.

The meroplankton community of Sydney Harbour: spatial and temporal patterns in an industrial marine ecosystem in Sydney, Nova Scotia, Canada

Bruce G. Hatcher & Rachelle A. Porter

(Undergraduate student, Cape Breton University)

The recent dredging of the Sydney Harbour gives cause for concern about potential impacts on marine biodiversity and fishery production. This small, industrial estuarine ecosystem sustains nine annual commercial fisheries. All depend on recruitment from larval stages that comprise the meroplankton community. Preliminary sampling of zooplankton was undertaken opportunistically at nine sites in three locations of the Harbour from July to November 2009 (n = 21). Identification of characteristic larval species (e.g. *Homarus americanus*) could be made to Genus level. Over all samples, Copepods were the most abundant taxa, followed by the larvae of gastropods and fish. Copepods, and Stage-1 larvae of lobster and crab larvae were significantly more abundant in the South Arm of the Harbour (a fishery reserve) than in North Arm and Outer Harbour sites. The abundances of later stages of lobster and crab larvae, as well as those of fish and gastropods, did not differ significantly among sites. Densities of Copepods and lobster peaked in September of 2009, while crab and fish larvae peaked in August that year. With the dredging set to start in October of 2011, plankton sampling was undertaken bi-weekly from July to December. Results to date from the November to December samples show similar abundances of Copepods as in 2009, but no larvae of lobster, crab or eel. Ongoing work will complete the analyses of summer and autumn data from 2011, and incorporate samples collected with a 202µm mesh net at other sites and depths in the Harbour.

Assessing the usefulness of single sample estimators of effective population size for wild and farmed populations of atlantic salmon (*Salmo salar*)

Devon Johnstone & Dr. D.E. Ruzzante
(Graduate student, Dalhousie University)

The effective population size (N_e) is a key parameter describing the genetic integrity and evolutionary potential of a population; however the most common (temporal) method of estimating it empirically requires sampling periods well in excess of generation time. Recent developments have produced methods that can estimate the effective number of breeders (N_b) from a single sampling event and are therefore desirable for practical use. We examined the genetic variability (13 microsatellite loci) in $N = 869$ smolt (out migrating) and post-spawning kelt samples from a small, isolated population of Atlantic salmon (*Salmo salar*) in Newfoundland, collected from 1985 to 2011 (median $N = 38$ per year of sample) for a total of 21 annual collections. Estimates of the effective number of breeders were obtained for cohorts using a variety of single sample methods and were compared to the effective size estimated using the temporal method. Our results emphasize the need for significant sampling efforts and provide further evidence for the importance of precocious parr in maintaining genetic diversity.

The Functional Response of Fisheries

David M. Keith & Dr. J.A. Hutchings
(Graduate student, Dalhousie University)

Sustainable harvesting is a primary goal of fisheries management. As part of this mandate managers should reduce mortality/harvest rates at low abundance. Ideally the reduction in fishing pressure would be applied equally across all age classes within the population. If fishing mortality remains high, even at low abundance, population recovery will be impaired, and the risk of inducing irreversible changes in population dynamics may increase. We have developed a unique database of fishery data for over 130 fishery stocks which includes long term estimates of the relative fishing mortality and abundance for each age class within a stock. Utilizing this database we show that the functional response of numerous stocks is destabilizing with the relative fishing mortality peaking at low abundance. This increase in fishing pressure at low abundance is in direct conflict with the goals of fisheries management and may help to explain population collapses and their subsequent lack of recovery. Additionally, in a number of stocks there are significant differences in the functional response between old and young age classes, with younger age classes experiencing a considerable increase in relative fishing mortality as abundance declines. This is often due to a substantial reduction in the abundance of older age classes during the early stages of a fishery, and the subsequent intensification of fishing on the younger age classes. To date the consequences of variation in the age specific functional response within a population has not been well studied from a population dynamic or evolutionary perspective.

Temperature mediates non-competitive and competitive foraging in indigenous rock (*Cancer irroratus*) and recently introduced green (*Carcinus maenas*) crabs

Kyle Matheson, Patrick Gagnon & Cynthia McKenzie
(Graduate student, Memorial University of Newfoundland)

The recent (2007) discovery of green crab, *Carcinus maenas*, in predominantly cold water ecosystems of Newfoundland and Labrador (NL, Canada) raised concerns about its ability to interfere with foraging in indigenous rock crab, *Cancer irroratus*. We used microcosm experiments to determine effects of low water temperature representative of southern NL (4°C and 12°C), crab body size (small, medium, and large), and chela loss on non-competitive and competitive foraging for the blue mussel, *Mytilus edulis*, in rock and green crabs from NL. In the absence of competition, rock and green crabs held singly captured threefold more mussels at 12°C than 4°C. Mussel capture rate and size selection (six size classes; 10 to 40 mm in shell length) were similar between large rock and green crabs, though small green crab clearly preferred small (<20 mm) over large mussels. In competitive foraging for one mussel, green crab was first to grasp the mussel in >90% of trials regardless of temperature, whereas large intact rock crab held the mussel as frequently as green crab in cold water only. The recent introduction of green crab to NL may negatively affect foraging in rock crab, particularly in competitive interactions with smaller rock crab in warm water. The marked preference by small green crab for small mussels also suggests that green crab may alter mussel populations in NL. In this presentation, we also address preliminary research examining non-competitive foraging in both crab species for the sea scallop, *Placopecten magellanicus*.

American eel, *Anguilla rostrata*, habitat use within a Nova Scotia watershed

Andy Muise & Dr. Trevor Avery
(Undergraduate student, Acadia University)

American eel, *Anguilla rostrata*, have been identified as a species of special concern by COSEWIC after experiencing drastic population reductions in the Great Lakes and upper St. Lawrence regions of Canada. The purpose of this study was to examine habitat use by eels in a small watershed to gain insight regarding the health of eel populations within the Atlantic region and to characterize eel movement patterns. East River, located in East River, Nova Scotia, was chosen as the study site for its range of representative habitat conditions. Three eel pots were set in the East River, one in a small tributary (Barry's Brook), and three in Labrador Lake, the headwater to Barry's Brook. Traps were relocated every 2-3 weeks to examine various habitat conditions within these sites and to randomize sampling both spatially and temporally. Selected eel were tagged with Passive Integrated Transponder (PIT) tags to monitor movement and catch activity. A total of 295 eel were captured between 10 June and 26 August 2011 during 25 days of fishing with 93 recaptures from 65 tagged individuals. Eel catch-per-unit-effort was highest within the East River, and similar, but lower in Barry's Brook and Labrador Lake. Eels captured in Labrador Lake were significantly longer and heavier than those in the brook or lake. Recapture data suggested that eels do not move between different habitat types if even minor barriers exist. The longest movement was 258 m within East River between an unobstructed stretch. Capture activity suggested that eel are influenced by both lunar cycles and precipitation.

Catching American lobsters (*Homarus americanus*): Does the trap type make a difference?

Kim Novak

(Undergraduate student, Nova Scotia Agricultural College)

Commercial lobster fishing is important to Atlantic Canada. In 2010, \$390 million of lobsters were landed, but depressed prices are forcing fishermen to cut costs. The primary objective was to determine if there was a catch difference between wooden lobster traps and metal mesh traps. The secondary objective was to assess stock health within Northumberland Strait (Fishing area 26A) in May-June 2011 by quantifying body-size distribution, sex ratio, berried female, claw condition. Two lines of wooden and two lines of wire traps, each line consisting of six traps, were set in pairs in the same location in 6.4 – 12.5 m water depth (4.4-12.2 °C). In total, the wooden traps caught 105 lobsters and the wire traps caught 118 lobsters. The number of lobsters caught was independent of trap type ($P < 0.05$). However, when only legal or marketable lobsters are considered, there is a significant difference ($P < 0.05$) with the use of wooden traps over the wire traps. The wooden traps captured fewer undersized lobster (11% of total catch) compared to the wire (26%). Male: female ratio was 1:2, independent of trap type. Sexually mature 'berried' females made up 24% of total catch, indicating the stock is in good health. This information can help fishermen in determining where to invest their money, and it can also assist science in monitoring and accessing the lobster stock in the area.

Is it possible to reconstruct the original donor oyster genetic profile by microsatellite genotyping of recipient grafted oysters muscle and pearl sac tissue?

Rebecca Parker

(Undergraduate student, Dalhousie University)

Pearls are created artificially by a grafting process that removes a small section of secretory mantle from a donor oyster and places it with a small bead nucleus into the gonad of a recipient oyster. The mantle tissue from the donor oyster then surrounds the nucleus forming a pearl sac that coats the nucleus with nacre and eventually creates a cultured pearl. It is not well understood how the two genetically distinct tissues of the donor and recipient oysters interact to form the pearl though there seems to be a strong association with the phenotype of the donor for many traits. An experiment was conducted to look for differences in pearl size and formation success rates between different families of donor oysters. The study was compromised however when many of the receiving oysters fell from their culture lines resulting in a loss of pedigree information. A conclusion about the heritability aspect of pearl phenotypes cannot be drawn without knowledge of the donor and this study has been halted since this time. It is assumed that the pearl sac tissue within the recipient grafted oysters consists at least partly of donor genetic material due to its origin as donor oyster mantle tissue. For this reason the genotyping of the recipient oyster pearl sac and muscle tissues is expected to reveal two distinct genetic profiles, that of the recipient oyster in the muscle tissue and that of the recipient and the donor oyster in the pearl sac. This information together with the genetic profile of all the donor oysters used in the original experiment should allow for the assignment of most recipient oysters to their respective donors or donor families. Eventually, the reconstruction of

this pedigree should give some insight into whether there are differences in pearl traits between the different donor families.

Muscle tissue samples from the donor oysters were genotyped at various microsatellite loci. Not all the cultured recipient oysters fell from their culturing lines and these individuals were used as a control for the experiment as there was already intact donor information available for them. Approximately 130 control recipients were genotyped at two loci known to successfully distinguish individuals of this species, Pmarg2di and Pmarg45, and compared with the profiles of their known donors. In many cases a signal from the donor oyster could not be seen in the gels, likely due to the minute quantity of this tissue in the sample compared with that of the recipient oyster. However most samples that seemed to reveal a potential donor correctly matched the reconstructed donor profile with the known profile. These results indicate that this technique may be successful in reconstructing the original pedigree. The recipient oysters with unknown donors will next be profiled at these loci.

Big Forestry, Big Fish, and the Evolution of Maternal Investment in Atlantic Salmon

Njal Rollinson & Jeffrey A. Hutchings

(Graduate student, Dalhousie University)

Forestry practices in the vicinity of salmon rivers sometimes results in increased stream-bed sedimentation. While the effects of sedimentation on salmon embryos and alevins are understood, effects of sedimentation on salmon fry are not. In the present study, we marked and released 9,000 unfed salmon fry into each of 9 rivers near the Inner Bay of Fundy. Across sites ($n = 9$ streams), we find that larger fry survive better in streams with smaller gravels in the streambed. Within streams, salmon fry ($n = 1,200$ recaptures) that established territories in areas with relatively small gravels were smaller at the end of the study. Given that gravel size is a positively correlated with the availability and quality of territories for fry, our results suggest that competition for territories is relatively intense when fewer territories are available, and that intense competition favours larger fry. Our results suggest that forestry practices near salmon streams will result in greater competition among fry for the fewer available territories, such that forestry practices may ultimately be influencing the evolution of maternal investment strategies in salmon. However, ours is a predictive study, as it did not directly investigate the effect of forestry on salmon fry.

Old fish, new fish: The effects of stock structure on recruitment in *Gadus morhua* and *Clupea harengus*

Nancy Roney

(Undergraduate student, Dalhousie University)

Current fisheries management is based on the maximum sustainable yield of the spawning stock biomass, and aims to maximize harvest while ensuring sufficient recruits to replace the stock. These management schemes assume that all spawning stock biomasses will consistently produce the same levels of recruitment, however research shows that older females in certain species may have a higher reproductive potential than their younger counterparts. In this study, the relationship between the age structure of a spawning stock biomass and corresponding recruitment levels was examined on a broad scale and at the species level for *Gadus morhua* and *Clupea harengus*. A linear analysis was run, $\text{Rec/SSB} \sim \text{Skew}$, using skew as a function of the age structure of a stock in a given year, and the number of recruits per spawning stock biomass as a level of recruitment. The only significant correlation for the relationship between skew and recruitment levels was seen in *G. morhua*. The relationship, however weak, showed as the age structure shifted towards younger age classes, there were significantly lower levels of recruits per spawning stock biomass. Evidence of age specific reproductive potential in some species will be important in future fisheries management decisions, as there will be an increased need to not only consider the level of spawning stock biomass, but also its age structure.

Shubenacadie River striped bass egg and larvae spatio-temporal density and distribution

Gina M. Stewart & Dr. Jim Duston

(Graduate student, Nova Scotia Agricultural College)

The tidal portion of the Shubenacadie and Stewiacke Rivers is a nursery habitat for early life stages striped bass. Understanding the early life stage distribution and retention mechanisms will aid in recruitment predictions and conservation efforts. Plankton net tows were conducted in 2010-2011 temporally 4 km downstream of the confluence between the Shubenacadie and Stewiacke rivers, and spatially extending the full range of the estuary and into Cobequid Bay. In May and June of both years there were several large spawning events resulting in daily mean egg density $>1000 \text{ eggs/m}^3$ water filtered. Cohorts of eggs were carried back and forth with the tide at least three times on the ebb and a further three times on the flood tide. Daily average density of first feeding larvae peaked at 200 larvae/m^3 in 2010 and 800 larvae/m^3 in 2011, 5 fold lower than egg density. Larvae density decreased dramatically in mid-June 2011 associated with large freshets and large tides. Advection of both eggs and larvae from the estuary into Cobequid Bay was established. The upstream transport on the flood tide of early life stage striped bass extended 9 km up the Stewiacke River and 41 km up the Shubenacadie River. The spatio-temporal distribution of passive early life stage striped bass was influenced by the timing and location of spawning, tide, fresh water runoff, and settlement. The high abundance of eggs indicates the adult population is healthy, but survival of early life stages is low and affected by fluctuations in temperature and freshwater run-off.

Digestibility of nutrients including phosphorus and growth performance of rainbow trout (*Oncorhynchus mykiss*) fed diets based on plant proteins with or without dietary phytase

Guoqiang Wang & Dr. D.M Anderson

(Undergraduate student, Nova Scotia Agricultural College)

This study evaluated the effect of adding microbial phytase to plant or animal protein-based diets for rainbow trout (*Oncorhynchus mykiss*). Four diet treatments were formulated: fish meal based diets supplemented with (PDE) and without phytase (0.025%) (PDNE) and plant based diets with (FME) and without phytase (0.025%) (FMNE). Apparent digestibility coefficients (ADC) were determined for dry matter, gross energy, protein, ash, P, and fat, using the fecal stripping method. These four diets were fed to triplicate tanks of rainbow trout (700g) for 9 weeks. Feed consumption, growth rate were monitored at 3-week intervals. Both experiments were completely randomized with diet as the main effect. ANOVA was conducted using the mixed model of SAS with repeated measures when time was a factor. Feeding the fish meal based diets had higher level of ADC for nutrients. The ADC for dry matter and protein were 75.8% and 87.3% with FMNE diet, compared to the PDNE diet, 71.3% and 85.8% respectively. The ADC for dry matter and protein were 69.3% and 83.1% with FME diet and 68.1%, 83.3% for PME diet, respectively. Feeding PDE and PDNE diets improved rainbow trout growth performance. Feed consumption and growth rate were not much higher when fed FME and PDE, compared to FMNE and PDNE meals. Microbial phytase did not effectively increase the ADC and bioavailability for some nutrients. Adding phytase did not have an effect on fish growth performance. PDE and PDNE diets improved the growth performance of rainbow trout compared to FME and FMNE diets.

Genetic Effects of Pearl Culture Practices and Fine Scale Recruitment of the Black-Lipped Pearl Oyster (*Pinctada margaritifera*) in French Polynesia

Vicky L. Yaroshewski

(Graduate student, Dalhousie University)

French Polynesia relies solely on the collection of wild *Pinctada margaritifera* spat for pearl oyster culture. This was developed to help protect the wild populations from overexploitation. However, it is now believed that large-scale transfer of wild spat in this region is primarily responsible for the genetic homogeneity observed across a broad geographic range for this species. Furthermore, there is fear that massive spat collection could lead to loss of genetic diversity in both farmed and wild stocks. With microsatellite DNA markers I examined: 1) if genetic diversity of farmed oysters was lower compared to adjacent wild populations; and 2) how many wild parents may have contributed to cohorts of recruits on collector lines. Indeed, female fecundity is so high that juveniles may originate from a limited number of parents. This could have future detrimental consequences. In four atoll populations, no evidence of genetic erosion within farmed populations was detected. Significant genetic structure was observed between young adults collected at three sites within the Takapoto Lagoon, despite the absence of genetic heterogeneity at a geographic scale of more than 1000 kilometres. Furthermore, strong genetic differences among groups of new recruits were detected, but there was no evidence that a limited parental pool produced the recruits. Therefore, present culture practices do not appear to have potentially serious impacts on the genetic diversity

of wild resources. Similarities and differences with other types of mussel and oyster culture in Nova Scotia will be presented.

Abundance and body size of young-of-the-year (YOY) Shubenacadie striped bass (*Morone saxatilis*) in relation to their age and environmental conditions

Zhuhui Ye, G. Stewart & Dr. J. Duston

(Undergraduate student, Nova Scotia Agricultural College)

The Shubenacadie River estuary is the principal nursery habitat for Bay of Fundy striped bass. Recruitment success varies greatly from year to year, but the mechanism has not been described. We related the timing of spawning and egg abundance in May-June to the subsequent environmental conditions and abundance of juveniles in July-August. Juvenile age, and hence their 'birth date' was determined by counting otolith daily growth rings. The method was validated using larvae of known age. In 2011, three big spawning events occurred May 23, May 29 and June 10. Later, otoliths were extracted from eighty-six YOY caught between July 11 and August 12. Among these juveniles, an estimated 27% were from the May 23 spawning, 33% from May 29 and only 16% from the June 10 spawning. The relatively low abundance of juveniles derived from the June 10 spawning was associated with cold weather and heavy rain from June 14 to 18 which caused water temperature to drop from 15 to 10 °C, which likely caused mass mortality of the early yolk-sac stage larvae. Moreover, end of summer body size, around 40mm total length, was about 50% lower than the previous year, due to relatively cool wet summer. The results support the hypothesis that rainfall and temperature are the main factors affecting year-class strength of Shubenacadie striped bass.

Effect of photoperiod on salinity tolerance of rainbow trout (*O. mykiss*) and Atlantic salmon (*S. salar*)

Yingqiang Zhang

(Undergraduate student, Nova Scotia Agricultural College)

Seasonal grow-out of rainbow trout in seawater is an important part of finfish aquaculture in Nova Scotia. Because rainbow trout do not fully smolt like Atlantic salmon, mortality in seawater is an issue following transfer to sea-cages. To investigate whether photoperiod manipulation can reduce post-transfer mortality juvenile rainbow trout (27g) and pre-smolt Atlantic salmon (19g) were raised for 18 weeks under either a natural daylength (LDN) or a long photoperiod (LD18:6) preceded by LD8:16 for 6 weeks. Over 12 weeks, the ability of both species to osmoregulate in seawater, as judged by 24h, 40ppt salinity challenge test, improved significantly due to both long photoperiod ($p=0.0239$) and time ($p<0.0001$), associated an increase in body size. Plasma osmolality in rainbow trout (LD=18:6) decreased from 480 to 385 Mosmol/kg and the mortality decreased from 42 to 0% within long photoperiod regime. By comparison, plasma osmolality in Atlantic salmon (LD=18:6) dropped from 494 to 378 Mosmol/kg and the mortality reduced from 83.3% to 8.33%. Survivors had a significant larger body size than mortalities' in two species ($p<0.05$). Body size had a strong negative correlation with plasma osmolality in rainbow trout ($r = -0.87$, $p = 0.000$).