MEETING OF THE FACULTY COUNCIL OF THE FACULTY OF SCIENCE

A regular meeting of the Faculty Council of the Faculty of Science will be held on Wednesday, February 18, 2015, at 1 p.m. in C-2045.

AGENDA

1. Regrets

2. Adoption of the Minutes of January 21, 2015

3. Business Arising from the October Minutes:
   a. Department of Ocean Sciences, updates to new Minor Program in Oceanography, paper 3.a (28 pages).

4. Correspondence: None

5. Reports of Standing Committees:
   A. Undergraduate Studies Committees: None
   B. Graduate Studies Committee:
      a. Grenfell Campus, new program proposal, Agricultural, Forest and Environmental Science (MSc AFES), paper 5.B.a (74 pages).
   C. Nominating Committee: None
   D. Library Committee: None

6. Reports of Delegates from Other Councils

7. Report of the Dean

8. Question Period

9. Adjournment

Mark Abrahams
Dean of Science
FACULTY OF SCIENCE
FACULTY COUNCIL OF SCIENCE
MINUTES OF MEETING OF JANUARY 21, 2015

A meeting of the Faculty Council of the Faculty of Science was held on Wednesday, January 21, 2015, at 1:00 p.m. in room C-2045.

FSC 2311 Present

Biochemistry
Booth, V. Mulligan, M.

Biology
Innes, D.

Chemistry
Merschrod, E. Pickup, P.

Computer Science
Banzhaf, W. Gillard, P. Kolokolova, A. Lu, S.W.

Earth Sciences
Hanchar, J.

Mathematics & Statistics
Loredo-Osti, J.C. Mantyka, S. Pike, D. Sullivan, S.

Physics & Physical Oceanography
Curnoe, S. Morrow, M. Plumer, M.

Psychology
Martin, G.

Dean of Science Office
Rideout, J. Surprenant, A. Zedel, L.

School of Music
Cook, N.

FSC 2312 Regrets: Rob Nolan
Katie Doyle
Donna Stapleton
FSC 2313 Adoption of Minutes

FSC 2314 Business Arising: None

FSC 2315 Correspondence:
  a. Notification received that Paul Snelgrove will replace Ian Fleming as the Department of Ocean Sciences’ representative on the Faculty of Science Graduate Studies Committee effective January 2015.
  b. Notification received that Rob Nolan will replace Joan Burry as the Registrar’s representative for the Faculty of Science Faculty Council effective January 2015.

FSC 2316 Reports of Standing Committees:
A. Undergraduate Studies Committee:
   Report presented by Shannon Sullivan, Chair, Undergraduate Studies Committee. It is noted that Rob Nolan is the new Registrar’s Office representative to Faculty Council, replacing Joan Burry. Council would like to recognize the many years of outstanding work and service provided by Joan to our Faculty Council.
   a. Moved: Faculty of Science, calendar change, deletion of Science 5998, Exchange Programs in Science (Sullivan/Morrow). Carried.
   b. Moved: Response to Senate Committee on Undergraduate Studies, Changes to General Academic Regulations 6.6 EVALUATION and 6.7 EXAMINATIONS (Sullivan/Morrow). Carried. The undergraduate studies committee will continue to monitor future discussion and decisions regarding these regulations. It is requested that any regulations deemed to no longer serve the purpose for which they were intended should be brought to the attention of the committee. The issue can then be addressed to hopefully, avoid the situation where faculty feel compelled to follow a course of action that contravenes regulations. The Associate Dean (Undergraduate & Administration) also noted that department members are encouraged to adhere to calendar regulations. If situations arise where regulations aren’t followed and students appeal grades, the students will win the appeal resulting in appropriate adjustments to the grades.

B. Graduate Studies Committee:
   Report presented by J.C. Loredo-Osti, Chair, Graduate Studies Committee
b. Moved: Department of Computer Science, calendar changes (Loredo-Osti/Banzhaf). Carried.

C. Nominating Committee: None

D. Library Committee: None

FSC 2317 Reports of Delegates from Other Councils: None

FSC 2318 Report of the Dean
Presented by Aimée Surprenant, Associate Dean (Undergraduate & Administration).

The Dean apologizes for missing Science Council and wishes to thank Dr. Surprenant for chairing the meeting. He is attending an NSERC meeting in Vancouver today and will be back on campus Friday, the same day as the enrolment-planning workshop. As a reminder, that planning retreat will be held at the Gazebo of Clovelly Golf course from 8:30 am to 4:30 pm.

Work on the Core Sciences Facility is continuing on schedule with the next round of consultations on site scheduled for next week. The plan is to complete the 60% Design and Development phase that will allow more precision on the cost estimates as well as provide sufficient detail to begin the tendering process for construction. This milestone keeps the project on track to begin the first phase of construction that is scheduled for this Spring. While the decline in oil prices is a concern, this is a long-term project that is both an investment in the university and the province. The government is expecting the project to proceed as planned.

The Canada First Excellence Research Fund grant application is being developed and work is proceeding toward the first deadline of February 2 for submission of the Notice of Intent. The full proposal will be submitted by the March 2 deadline.

Proposals for the classroom teaching/infrastructure development fund (CTID) are due to the Dean of Science office by February 5. The three major purposes of the funding are: replacement of aging teaching equipment (classroom and laboratory); modernization/upgrading of existing classroom space or other learning spaces; promotion of innovative use of technology to enhance the teaching/learning experience and/or to allow for more efficient program delivery. The call for proposals indicates that joint proposals would be viewed favorably.

Applications for the Chairs in Teaching and Learning program are due to the Dean of Science Office February 15, 2015. If you have any questions, please contact Dr. Surprenant.

The Dean's office has only received one nomination for the Toronto Alumni Scholarship and the Colbourne Family Scholarship. The Scholarships and Awards
office needs the nominations by January 30. Please consider nominating a student for these very lucrative scholarships.

RDC Ocean Industries Student Research award proposals are due to RDC for graduate students on February 16 and for undergraduates on May 14.

ACEnet award applications for both undergraduate and graduate students are due to the Dean of Science office on February 16.

**FSC 2319**  
**Question Period**  
The point was made that plans for the new Core Sciences building were only received yesterday with comments due by Monday for the 60% sign-off phase. This tight deadline does not provide departments enough time to meet for discussion.

Information was requested as to what the requirements are for the Toronto Alumni and the Colbourne Family Scholarships. The scholarships will be awarded based on academic marks and community involvement.

**FSC 2320**  
**Adjournment**  
The meeting adjourned at 1:14 p.m.
Hi Shannon:

We have made all of the changes to our two minors that were requested by SCUgS and I have attached the revised proposals. I trust all will be in good order for the Senate.

Best regards

Garth

Hi Garth and Aimée,

At its meeting today, the Senate Committee on Undergraduate Studies considered the proposals by the Department of Ocean Sciences for new Minors in Oceanography and in Sustainable Aquaculture and Fisheries Ecology.

Before these proposals can be forwarded to Senate, SCUgS has requested the following changes, which involve both the Department of Ocean Sciences and the Dean's Office:

* The Dean's signature is missing on both proposals. This is essential before the proposals can be considered by Senate. I expect it will probably be sufficient to provide a signed version of the proposal as it currently exists (i.e. without the changes I'm about to list below) but the Dean's Office may wish to contact Jennifer Porter, the Deputy Registrar, to ensure that this would be sufficient.

* In the proposal for the Minor in Oceanography, the "Resource Implications" section indicates that there are instructional costs for the Departments of Chemistry, Earth Sciences, and Physics &
Physical Oceanography, but there is no documentation to indicate that those units have consented to these costs. Indeed, the feedback from Michelle Miskell appears to raise this as a potential concern.

* It is not clear how the Calendar regulations introduced in both proposals will appear within the Ocean Sciences section of the Calendar. Appropriate section/subsection numbers should be introduced in the proposal (presumably, these would be Regulations 9.9.1 and 9.9.2).

* Finally -- and this is one I've just noticed myself in composing this e-mail -- the existing paragraph in the Ocean Sciences section of the Calendar which reads:

"The Department aims to offer both undergraduate and graduate programs in Ocean Sciences. Immediate plans are underway to offer two undergraduate Minors in Oceans and in Aquaculture. It is expected that the first course offerings will be available in 2013-2014."

will now be redundant and should be deleted. This ought to be included as a secondary Calendar change on one of the forms.

To ensure that the proposals are not delayed from consideration by Senate at its February meeting, I'd encourage you to address these comments no later than Tuesday, January 20th. The revised versions can be submitted as Word (or WordPerfect) and PDF files directly to the Recording Secretary of SCUgS, Linda Noseworthy <lnosewor@mun.ca>.

Finally, I should mention that the proposed changes to the prequisites for Ocean Sciences 3002 and Ocean Sciences 4000 were also considered at today's SCUgS meeting, and I'm happy to report that these proposals passed without amendment.

Cheers,
Shannon

--

Dr. Shannon Patrick Sullivan
Dept. of Mathematics & Statistics
Senior Faculty Advisor, Faculty of Science Memorial University of Newfoundland St. John's · NL · Canada shannon@mun.ca · www.ucms.mun.ca/~shannon
Proposal for a New Program

Minor in Oceanography

Resource Implications: Instructional Costs

There are resource implications for the Departments of Chemistry, Earth Sciences and Physics and Physical Oceanography which are offering new courses cross-listed for this minor. However for Ocean Sciences the proposed program does not require any new instructional costs beyond those associated with the practical component of OCSC 4000: Scientific Diving Methods. The five core courses for the minor: OCSC 1000 Exploration of the World Ocean, OCSC 2000 Introductory Biological Oceanography, OCSC 2100/CHEM 2610 Introductory Chemical Oceanography, OCSC 2200/EASC 2919 Introductory Geological Oceanography and OCSC 2300/PHYS 2300 Introductory Physical Oceanography have all been approved at least up to level of the Council of the Faculty of Science on or before 19 March 2014.

Library Holdings and/or Other Resources Required

The library can support this program with existing resources.

The costs associated with new program/courses can be met from within the existing budget allocation.

Signature of Unit Head (if appropriate): ____________________________________________

Date: _______________________________________________________________________

Signature of Dean/Associate Vice-President (Academic)/Vice-President: ________________

Date: _______________________________________________________________________

EXECUTIVE SUMMARY

Oceanography is the scientific exploration and study of the ocean and its phenomena. It is an interdisciplinary science incorporating the basic principles of biology, chemistry, geology and physics. The minor curriculum is designed to complement the strong disciplinary training of MUN basic science majors by providing a broad interdisciplinary perspective in each of oceanography’s four subdisciplines:

- Biological Oceanography examines the processes governing distributions, abundances, and production of life in the ocean.
- Chemical Oceanography examines sources, distribution, and transformations of elements and compounds in the ocean.
- Geological Oceanography examines formation, transport, and deposition of marine sediments, ocean basin formation, processes governing shoreline formation, and the origin, structure, and history of the oceanic crust and upper mantle.
- Physical Oceanography examines the properties of seawater, ocean circulation, tides and shoreline processes as well as ocean coupling with the atmosphere, geosphere and ice and its implications for climate change.

DEMAND FOR PROGRAM

This minor will support MUN’s goal of becoming Canada’s oceans university. It will allow MUN basic science majors to discover more about the world around them and the systems that regulate it and to contribute to the future use and care of the world ocean.

BENEFITS TO STUDENTS

This minor will help our graduates gain employment in ocean related university research departments, government departments and agencies, non-governmental organizations, industries concerned with inshore and offshore work and marine instrumentation, private consulting companies, and navies.
CONSULTATIONS

The original version of this document was circulated on 29 April 2014. The e-mail sent to other academic units seeking consultation as well as those received back from units consulted are appended at the end of this document.

PROGRAM TITLE: Minor in Oceanography

COURSE ADDITIONS

The five core courses for the minor: OCSC 1000 Exploration of the World Ocean, OCSC 2000 Introductory Biological Oceanography, OCSC 2100/CHEM 2610 Introductory Chemical Oceanography, OCSC 2200/EASC 2919 Introductory Geological Oceanography and OCSC 2300/PHYS 2300 Introductory Physical Oceanography have all been approved at least up to level of the Council of the Faculty of Science on or before 19 March 2014.

CALENDAR ENTRY

9.9.1 Minor in Oceanography

Students who take a minor in Oceanography will complete 24 credit hours as follows:

1. Ocean Sciences 1000, 2100, 2200, 2300.

2. Ocean Sciences 2000 or Biology 3710

3. Earth Sciences 1000

4. The remaining credit hours should be selected from Biology 3014, 3709, 3711, 3712, 3714, 3715, 4122, 4601, 4710, 4750, 4810, Chemistry 2100, 3110, 4151, 4156, Earth Sciences 4302, Geography 3120, 3510, 4190, 4300, Environmental Science 3072, 3210, 3211, 4230, Ocean Sciences 2001, 3000, 3002, 3620, 4000, 4122, 4601, and Physics and Physical Oceanography 3300, 3340, 4300, 4340.

Course prerequisites stipulated in the course descriptions shall apply to a minor in Oceanography.
SECONDARY CALENDAR CHANGE

9.9 Ocean Sciences

www.mun.ca/osc/

The Department of Ocean Sciences is a newly formed Department within the Faculty of Science. The faculty within this Department are the former faculty of the Ocean Sciences Centre, a research unit and facility that was first opened in 1967.

The Department’s mandate as an interdisciplinary unit is to focus on increasing our understanding of biological and chemical processes within the oceans, and with those associated with aquaculture.

The Department aims to offers both undergraduate and graduate programs in Ocean Sciences. Immediate plans are underway to offer two undergraduate Minors in Oceans and in Aquaculture. It is expected that the first course offerings will be available in 2013–2014.

Ocean Sciences course descriptions are found at the end of the Faculty of Science section under Course Descriptions, Ocean Sciences.
SUMMARY PAGE FOR SENATE
Approval Form

Program Title

Minor in Oceanography

Summary of Changes
This proposal organizes a series of new Ocean Sciences courses which have been approved at least up to level of the Council of the Faculty of Science into a minor. This interdisciplinary program is to be administered by the Department of Ocean Sciences in cooperation with the Departments of Chemistry, Earth Sciences and Physics and Physical Oceanography. It is intended primarily for any student in the Faculty of Science but would be open to students in other faculties.

Consultations Sought on 29 April 2014 From

<table>
<thead>
<tr>
<th>Marine Institute</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grenfell campus</td>
<td>Yes</td>
</tr>
<tr>
<td>Department of Biochemistry</td>
<td>No</td>
</tr>
<tr>
<td>Department of Biology</td>
<td>Yes</td>
</tr>
<tr>
<td>Department of Chemistry</td>
<td>Yes</td>
</tr>
<tr>
<td>Department of Computer Sciences</td>
<td>No</td>
</tr>
<tr>
<td>Department of Earth Sciences</td>
<td>Yes</td>
</tr>
<tr>
<td>Department of Economics</td>
<td>No</td>
</tr>
<tr>
<td>Department of Geography</td>
<td>Yes</td>
</tr>
<tr>
<td>Department of Mathematics and Statistics</td>
<td>Yes</td>
</tr>
<tr>
<td>Department of Physics and Physical Oceanography</td>
<td>Yes</td>
</tr>
<tr>
<td>Department of Psychology</td>
<td>No</td>
</tr>
<tr>
<td>Faculty of Arts</td>
<td>No</td>
</tr>
<tr>
<td>Faculty of Education</td>
<td>Yes</td>
</tr>
<tr>
<td>Faculty of Engineering and Applied Science</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Library Report Received
Yes

Approved by Dean, Associate Vice-President (Academic) or Vice-President
Yes/No

Name
FOR OFFICE USE ONLY

APPROVAL GRANTED BY SENATE COMMITTEE ON UNDERGRADUATE STUDIES

Chair:

Secretary:

Date:
Appendix 1: Courses for the Minor

There are five core courses for the minor:

**OCSC 1000 Exploration of the World Ocean.**

Exploration of the World Ocean is an introductory course covering the major ocean sciences (biology, chemistry, geology, physics) at a level sufficient for science majors but accessible to non-science majors. It explores phenomena occurring from the shoreline to the abyss and from equatorial to polar regions. It also examines principles of marine ecology as well as how the marine environment affects humans and vice versa. The course is offered in a blended format that combines face-to-face lectures and online interactive activities in the form of virtual oceanographic expeditions.

**OCSC 2000 Introductory Biological Oceanography.**

This course provides a general understanding of the biological processes that occur in coastal and oceanic environments. It introduces students to the major groups of bacteria, phytoplankton, invertebrates and fish, emphasizing the biotic and abiotic factors controlling primary production and marine biomass. It shows how the physical, chemical, and geological environments interact with biology to define processes and patterns affecting nutrients and life in marine ecosystems.

PR: OCSC1000

**OCSC 2100/CHEM 2610 Introductory Chemical Oceanography.**

This course will provide an introduction to the fundamental chemical properties of seawater and the processes governing the concentrations of elements and compounds in the oceans. It is an introduction to the sources, distribution, and transformations of chemical constituents of the ocean, and their relation to biological, chemical, geological, and physical processes. Topics include: controls on average concentration of chemicals in the ocean; vertical and horizontal distributions of ocean constituents; air-sea interactions; production, export, and remineralization of organic matter; the ocean carbon cycle; human-induced changes; stable isotopes; and trace elements.

CR: CHEM 2610

PR: CHEM 1011 OR CHEM 1051 which may be taken concurrently OR CHEM 1001

**OCSC 2200/EASC 2919: Introductory Geological Oceanography.**

The formation and evolution of oceans are discussed, including plate tectonics, mid-ocean ridges (birth place of oceans), subduction zones (where oceans are consumed), sedimentary environments such as estuaries, deltas, beaches and barrier islands, continental shelves, slopes and deep abyssal plains and special topics, including anoxic events, evolution of tides, atmosphere-ocean interactions, formation of banded iron formations, snowball Earth, black and white smokers, and how Earth modulates its climate through atmosphere, hydrosphere, biosphere and lithosphere interactions.

PR: EASC1000

**OCSC 2300/PHYS 2300: Introductory Physical Oceanography.**
Introductory Physical Oceanography will provide an introduction to the physical ocean. Ocean characteristics studied will include: the properties of seawater, key features of ocean circulation, wind-forcing in the ocean, tides and shoreline processes as well as ocean coupling with the atmosphere, geosphere and cryosphere (ice) and new approaches to ocean sampling and numerical modelling. The course will take an integrated earth systems approach to the study of upwelling zones, open ocean ecosystems and climate change.

CR: ENVS 2371

PR: Any two first-year courses in Physics.

There are six elective courses from the Department of Ocean Sciences:

OCSC 2001: Introduction to Sustainable Fisheries and Aquaculture
This course introduces students to the breadth of aquaculture and fisheries science and the variety of animal species cultured and harvested. Basic aspects of aquaculture and fisheries and the links between the two are covered, including production systems, capture fisheries, environmental interactions, and the physiology, ecology and reproduction of finfish and shellfish in the context of their culture and harvest.

PR: OCSC1000 or BIOL 1002 Principles of Biology

OCSC 3000: Aquaculture Principles and Practices
This course will emphasize the techniques and methods used to culture finfish and shellfish, with a primary focus on Canadian aquaculture species. Basic aspects of aquaculture will be covered, including the design and maintenance of production systems, culture techniques, and the nutrition, health, physiology and reproduction of finfish and shellfish. The laboratory portion of this course will provide students with practical experience in the maintenance of land-based aquaculture production systems and in the husbandry/culture of aquatic organisms.

PR: OCSC 2001, or OCSC 1000 and BIOL 1002.

OCSC 3002: Aquaculture and Fisheries Biotechnology
Aquaculture and Fisheries Biotechnology is an introduction to biotechnology and genetics as they are applied to aquaculture and fisheries. Topics covered include genetic variation; genetic structure of fish and shellfish populations; the genetic basis of aquaculture traits; finfish and shellfish genomic research; marker-assisted selection in aquaculture; manipulation of ploidy; genetic engineering in aquaculture; and techniques used to study the responses of aquatic animals to external stressors such as hypoxia, temperature stress, acidification, and pathogens.

PR: Biology 2250, 2060

OCSC 4000: Scientific Diving Methods
Scientific Diving Methods is an in-depth study and application of methods routinely employed for data collection in underwater scientific research. Aspects covered include habitat mapping; installation and use of instrumentation; still and video camera techniques; planning and execution of surveys and experiments in major subtidal habitats; as well as data analysis and interpretation. Participants are
trained in accordance with Memorial University of Newfoundland’s Guide for Diving Safety and the Canadian Association for Underwater Science (CAUS) standards to meet the criteria for Scientific Diver I rating. This course is normally offered at the Bonne Bay Marine Station in a special 2-week session at the beginning or end of the spring semester depending on station’s availability.

PR: BIOL 2122, BIOL 2600, STAT 2550 (or approval by instructor), nationally recognized advanced level SCUBA certification with diver rescue and accident management techniques.

OCSC 4122: Advanced Studies in Marine Animal Diversity (same as BIOL 4122)

Advanced Studies in Marine Animal Diversity provides an in-depth examination of cellular, physiological, behavioural and ecological adaptations in marine animals. Lectures will be combined with discussions of relevant papers from the primary literature on topics of current interest which may relate morphology, ecology, evolution, natural history, species interactions and practical applications. Students will also gain hands-on experience by designing and conducting research projects involving live or preserved animals.

PR: BIOL 2122, 2600 and 2900

OCSC 4601: Functional Biology of Fish (same as BIOL 4601)

Functional Biology of Fish is an introduction to anatomical physiological and cellular processes in the life cycle of fishes.

PR: Biology 2060, 2210, and 3401

Choices from Biology:
3014 Biology and Ecology of Boreal and Arctic Seaweeds
3709 Field Course in Marine Principles and Techniques
3711 Principles of Marine Biology
3712 Benthic Biology
3714 Estuarine Fish Ecology Field Course
3715 Ecology and Evolution of Fishes
4122 Advanced Topics in Marine Invertebrates (same as OCSC 4122)
4601 Functional Biology of Fish (same as OCSC 4601)
4710 Experimental Marine Ecology of Newfoundland Waters
4750 Fisheries Ecology
4810 Field Course in Marine Biology

Choices from other departments:
CHEM 2100 Analytical Chemistry I
CHEM 3110 Analytical Chemistry II
CHEM 4151 Analytical Separations and Organic Mass Spectrometry
CHEM 4156 Analytical Method Development and Sampling

EASC 4302 Advanced Marine Geology (This course covers geology and geophysics as well as more general oceanography and has only a 1st year EASC course as a specific prerequisite: EASC 1001 or 1002 and completion of any 15 credit hours in core courses at the 3000 and/or 4000 levels in Biology, Biochemistry, Chemistry, Earth Sciences, Physics, or Geography).

ENVS 3072 Comparative Marine Environments
ENVS 3210 Environmental Analytical Chemistry I
ENVS 3211 Environmental Analytical Chemistry II
ENVS 4230 Aquatic Chemistry

GEOG 3120 Climatology is an introduction to climatology and has considerable material that is relevant to oceanography (prerequisites: GEOG 2102 and MATH 1000).

GEOG 3510 Geography of the Seas (An introductory course in marine science and management. It has two 2nd year GEOG prerequisites or “permission of instructor”).

GEOG 4190 Coastal Geomorphology (An advanced course in geomorphology of coastal regions in all climate zones. It has one 3rd year GEOG prerequisite or “permission of instructor”).

GEOG 4300 World Fisheries: Current Discourse and Future Directions (A seminar course on the key concepts, principles, and challenges in fisheries resources worldwide. The prerequisites are two 3rd year GEOG courses or permission of Head of Department).

PHYS 3300 Intermediate Physical Oceanography (PHYS 2053 and MATH 2000 are prerequisites)

PHYS 3340 Principles of Environmental Physics
PHYS 4300 Advanced Physical Oceanography
PHYS 4340 Modelling in Environmental Physics

Scheduling and prerequisites

The minor needs to be established in a manner that facilitates access to students in the three partner departments delivering the majors as well those in other science departments. One way is to deliver 2nd year introductory oceanography courses in the winter semester with co-requisite 1st year partner department science courses, so that these 2nd year courses are available in the first year.

The following courses are required to major in Biochemistry, Biology, Chemistry, Earth Sciences, Physics and Psychology (Behavioural Neuroscience):
Mathematics 1000, two first year Chemistry courses and two first year Physics courses.

Thus requiring oceanography students to take four 1st year Chemistry and Physics courses will not increase the course load outside of the major or minor for Biochemistry, Biology, Chemistry, Earth Sciences Physics and Psychology (Behavioural Neuroscience) majors. For some students scheduling may be difficult, so putting a 2nd first year course as a co-requisite may help.

For Biochemistry, Biology, Chemistry, Physics and Psychology (Behavioural Neuroscience) majors there will be an extra Earth Sciences course required: EASC 1000 (Earth Systems). This will count towards the minor.

In this way we are adding a maximum of only one cognate course beyond the requirement for a disciplinary major in science and the interdisciplinary Oceanography minor. It adds a maximum of one course for Biochemistry, Biology, Chemistry and Physics and Psychology (Behavioural Neuroscience) majors. There is no additional cognate course load for Earth Sciences majors.

Course requirements for the minor for each of the partner departments:
Chemistry, Earth Sciences, and Physics and Physical Oceanography

OCSC 1000 Exploration of the World Ocean.
EASC 1000 Earth Systems.
OCSC 2000 Introductory Biological Oceanography. PR: OCSC1000
OCSC 2100/CHEM 2610 Introductory Chemical Oceanography. CO: CHEM1051
OCSC 2200/EASC 2919 Introductory Geological Oceanography. PR: EASC1000
Two 2nd – 4th year electives.
Appendix 2: Consultations

January Responses from Partner Departments

From: Peter Pickup [mailto:chemhead@mun.ca]
Sent: January-19-15 10:49 AM
To: Fletcher, Garth
Subject: RE: Oceanography minor

Garth,

This is to confirm that the department of Chemistry has the resources to offer the course CHEM 2610 on a regular basis.

Peter

From: John Hanchar [mailto:jhanchar@MUN.CA]
Sent: Friday, January 16, 2015 4:25 PM
To: Fletcher, Garth
Cc: Peter Pickup, Chemistry; Brad de Young; Parrish, Chris
Subject: Re: Oceanography minor

Dear Garth,

This is to confirm that the department of Earth Sciences has the resources to offer the course EASC 2919 on a regular, annual, basis.

Regards,

John

John M. Hanchar, PhD, PGeo
Professor and Head
Department of Earth Sciences
Memorial University of Newfoundland
Alexander Murray Building / ER-4083A
300 Prince Philip Drive
St. John's, NL A1B 3X5
Canada

Tel: 709-864-6785
Fax: 709-864-4851

From: Brad deYoung [mailto:bdeyoung@mun.ca]
Sent: Friday, January 16, 2015 1:55 PM
To: Fletcher, Garth
Cc: John Hanchar; Peter Pickup; Parrish, Chris
Subject: Re: Oceanography minor

Garth
This is to confirm that the department of Physics and Physical Oceanography has agreed that we have the resources to offer the course Physics 2300 on a regular, annual, basis.

Brad

Brad deYoung
Professor and Head
Memorial University
St. John's NL
709-864-8738
bdeyoung@mun.ca

From: Fletcher, Garth [mailto:fletcher@mun.ca]
Sent: January-16-15 1:52 PM
To: 'John Hanchar, Earth Sciences'; 'Peter Pickup, Chemistry'; 'Brad de Young'
Cc: Parrish, Chris
Subject: Oceanography minor

Hi John; Peter and Brad: Our proposal for a minor in Oceanography was reviewed by SCUGS and results of the review were conveyed to us by Shannon Sullivan. I have copied one of the comments of concern as follows:

* In the proposal for the Minor in Oceanography, the "Resource Implications" section indicates that there are instructional costs for the Departments of Chemistry, Earth Sciences, and Physics & Physical Oceanography, but there is no documentation to indicate that those units have consented to these costs.

Could you please let me know if there are resource implications for your department and if so could you provide me with details.

Best regards

Garth

Garth L. Fletcher
Head and Professor Emeritus
Department of Ocean Sciences
Ocean Sciences Centre
0 Marine Lab Road
St John's NL
Canada
A1C 5S7

Tel: 709-864-3276
Fax: 709-864-3220

Comments from Biology
From: Karen Morris [mailto:morrisk@mun.ca]
Sent: June-06-14 3:05 PM
To: Fletcher, Garth
Cc: Marino, Paul
Subject: Proposal for a New Program- Minor in Oceanography

Hi Garth,

The Proposal for a New Program Minor in Oceanography was reviewed at a departmental meeting May 22, 2014.

1. It was noted that, for reasons unknown, Biology has been excluded from the list of cooperating department of this interdisciplinary program. We certainly did work on this proposed program for a number of months.

2. In terms of overall content we would like to suggest that (page2) under Calendar entry #4 Biology 4810 (Field Course in Marine Biology) be added to the list of Biology courses; this was an oversight on our part when our suggestion was sent regarding this minor.

3. On Page 3 under OCSC 2000 Introductory Biological Oceanography a credit restriction needs be added under the PR 1000: ‘CR BIOL 3710’
   a. In making the above calendar change it also needs to be added to BIOL 3710 Biological Oceanography: CR OCSC 2000

4. On page 4 under OCSC 3002, PR it may be a good idea to add CHEM 2440 as it is required as a prerequisite or co-requisite for Biology 2250.

5. On page 5 under 4122 the course title is incorrect it should read:
   a. ‘Advanced Studies in Marine Animal Diversity (same as OCSC 4122)’

6. A slight change to:
   a. 4601 Functional Biology of Fish (same as OCSC 4601)

7. As noted under the calendar description addition of:
   a. ‘4810 Field Course in Marine Biology’

If you have any questions please let me know.
Thanks
Karen
Karen Morris  
Undergraduate Officer  
Dept. of Biology  
Memorial University of Newfoundland  
St. John’s, NL A1B 3X9  
709-864-8021  

Responses to Biology  

From: Fletcher, Garth  
Sent: Monday, July 28, 2014 3:04 PM  
To: Karen Morris  
Cc: Parrish, Chris  
Subject: RE: Proposal for a New Program- Minor in Oceanography

Thanks Karen: We have now received and collated comments from most of the units we consulted. As to Biology's comments,  

(1) Partner departments are those offering new courses cross-listed for this minor. We requested that Biology modify one of your courses for this minor. However this offer was declined.  

(2) 4810 (Field Course in Marine Biology) has been added to the list of Biology courses.  

(3) An excellent alternative to putting a credit restriction would be to allow oceanography students to take BIOL 3710 as an advanced course. In any case we will let you file the paper work.  

(4) This is true but we are investigating simplifying our prerequisites to maximize availability to science students.  

(5) - (7) Done.  

Best regards  
Garth

Comments from Geography  

From: Charles Mather [mailto:cmath@mun.ca]  
Sent: Monday, May 26, 2014 12:52 PM  
To: Roche, Marsha  
Subject: Minor in Oceanography

Dear Marsha
Faculty involved in ocean related research and teaching in our Department have looked at the proposal for a Minor in Oceanography and are happy to support it. We have added three additional courses that we teach on a regular basis in Geography that are relevant to this proposal. I have attached the relevant document - the new additions are highlighted in yellow.

Best wishes
Charles Mather, Head

Response to Geography

-----Original Message-----
From: Fletcher, Garth
Sent: Monday, July 28, 2014 3:09 PM
To: cmather@mun.ca
Cc: Parrish, Chris
Subject: RE: Minor in Oceanography

Thanks Charles: We have now received and collated comments from most of the units we consulted. We now include all the GEOG courses suggested and have also included GEOG 4300: World Fisheries: Current Discourse and Future Directions as an alternative to BIOL 4750: Fisheries Ecology in our other proposed minor in Sustainable Aquaculture and Fisheries Ecology. We look forward to further programming collaboration with Geography.

Best regards

Garth

Comments from Engineering

From: Engineering Consultations [mailto:engrconsult@MUN.CA]
Sent: May-22-14 9:32 AM
To: Fletcher, Garth
Cc: Fisher, Andrew; Edmunds, Jayde; Glyn George
Subject: Re: Proposed Minor in Sustainable Aquaculture and Fisheries Ecology

Thank you for the opportunity to comment on the proposed Calendar changes for the introduction of
1) a Minor in Oceanography and
2) a Minor in Sustainable Aquaculture and Fisheries Ecology

At its regular meeting of 2014 May 21 the Committee on Undergraduate Studies for the Faculty of Engineering and Applied Science found no impact on our programs from either of these two sets of proposed Calendar changes.

I wish you well in the development of these two minors.

Dr. Glyn George, Chair
Committee on Undergraduate Studies
Faculty of Engineering and Applied Science Memorial University of Newfoundland
http://www.engr.mun.ca/~ggeorge
Comments from the Queen Elizabeth II Library

19 May 2014

To: Garth Fletcher Department of Ocean Sciences

From: Erin Alcock, Science Research Liaison Librarian

Subject: Minor in Oceanography

I have reviewed the proposal for the minor in Oceanography, and have determined that the Memorial University Library system has more than sufficient resources to support this program.

The summary of library holdings below indicates numerous monograph titles in the four subdisciplines of oceanography. The resources will be held both in the Queen Elizabeth II Library and the C.R. Barrett Library. Additionally, there is more than sufficient coverage from article indexes. Any additional resources required could be purchased under allocations for biology, physics and physical oceanography, the Marine Institute Library and other appropriate funds. The major journals in this area are well covered.

Library Holdings Summary

Table One: General Programme Subject Themes

<table>
<thead>
<tr>
<th>Course Topic</th>
<th>LCSH</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oceanography</td>
<td>3049</td>
<td>5425</td>
</tr>
<tr>
<td>AND Biol$</td>
<td>275</td>
<td>324</td>
</tr>
<tr>
<td>AND Chem$</td>
<td>241</td>
<td>412</td>
</tr>
<tr>
<td>AND Geol$</td>
<td>2</td>
<td>515</td>
</tr>
<tr>
<td>AND Phys$</td>
<td>228</td>
<td>752</td>
</tr>
</tbody>
</table>

*as of date of memo

Table Two: Selected Article Indexes and Databases

<table>
<thead>
<tr>
<th>Article Indexes and Databases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied Science and Technology Index</td>
</tr>
<tr>
<td>ASFA: Aquatic Science and Fisheries Abstracts</td>
</tr>
<tr>
<td>Scopus</td>
</tr>
<tr>
<td>Web of Science</td>
</tr>
</tbody>
</table>

Comments from the Marine Institute
From: Fletcher, Garth  
Sent: May-16-14 1:09 PM  
To: 'MIUG Consultations'  
Subject: RE: Proposed Minor in Oceanography

Thank you Derek. I'm hoping we can all work together on this so that your and our programs are harmonious.

Best regards

Garth

From: Dawn King [mailto:Dawn.King@mi.mun.ca] On Behalf Of MIUG Consultations  
Sent: May-16-14 1:06 PM  
To: Fletcher, Garth  
Cc: Derek Howse  
Subject: RE: Proposed Minor in Oceanography

Garth,
Thank you for the opportunity of reviewing the Proposed Minor in Oceanography. We have identified some areas of overlap with our own programs but these areas are not significant enough to cause any concern or conflicts between programs.

We are happy to support this proposal as presented.

Sincerely,

Derek Howse

Derek Howse  
Chair, Undergraduate Studies Committee  
Marine Institute, Memorial University  
TEL: 709-778-0586  
FAX: 709-778-0394  
Derek.Howse@mi.mun.ca

Comments from Chemistry

-----Original Message-----
From: Peter Pickup [mailto:chemhead@mun.ca]  
Sent: May-13-14 10:22 AM  
To: Alisaraie, Laleh; 'Bob Davis'; 'Bob Helleur'; 'Chris Flinn'; 'Chris Kozak'; 'Chris Rowely'; 'Christina Bottaro'; cora.young@mun.ca; 'Dave Thompson'; 'Erica Merschrod'; 'Fran Kerton'; 'Graham Bodwell'; 'Karen Hattenhauer'; 'Kristin Poduska'; 'Paris Georghiou'; 'Paul Mezey'; 'Peter Warburton'; 'Ray Poirier'; 'Rosalind Collins'; 'Sunil Pansare'; 'Travis Fridgen'; 'Yuming Zhao'  
Cc: Fletcher, Garth
Subject: FW: Oceanography minor proposal

Dear Colleagues,

Please review the attached documents and let me know if you have any comments, and whether you support this program or not. Since this is not our program, I don't think that we need to discuss it at a department meeting, but we can if you wish. Depending on your responses by 26 May, I will either inform the Department of Ocean Sciences of our support (with further modifications if required), or bring this to a department meeting.

Thanks,

Peter

Comments from CUGS: collected via email 13 May 2014

The chemical oceanography course number is Chem 2610 not Chem 2600.

Brandon Furlong (UG student rep): Gave enthusiastic support for the program.

John MacInnes (GS student rep): Gave strong support for students taking Chem 4156 as part of the minor. He suggested that some of the oceanography courses could be offered in the spring semester to alleviate scheduling problems.

Travis Fridgen pointed out errors in the required first year courses for Biochemistry, Chemistry and Physics. He also pointed out that more work needs to be done on scheduling.

Ideally, a student wanting to do a Chemistry major and an Oceanography minor should start their first year with

<table>
<thead>
<tr>
<th>Fall</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem 1050</td>
<td>Chem 1051</td>
</tr>
<tr>
<td>Math 1000</td>
<td>Math 1001</td>
</tr>
<tr>
<td>Physics 1050</td>
<td>Physics 1051</td>
</tr>
<tr>
<td>English 1080</td>
<td>English 1110 or equivalent</td>
</tr>
<tr>
<td>EASC 1000</td>
<td>OCSC 1000</td>
</tr>
</tbody>
</table>

Chris Flinn has edited the proposal to reflect needed changes. He suggested that at least some oceanography courses need to be offered in several semesters to accommodate scheduling.

Karen Hattenhauer also wondered about majors in various departments being able to schedule their major and minor courses easily in 4 years.
The following prerequisites are common to majors in Biochemistry, Biology, Chemistry, Earth Sciences, and Physics and Psychology.

Mathematics 1000 and 1001 Chemistry 1010 1050 and 1011 1051 (or equivalent) and or Physics 1020 1050 and 1021 1051 (or equivalent). Biochemistry majors can take Physics 1020 and Physics 1021.

The following prerequisites are common to majors in Biochemistry, Biology, Chemistry, Earth Sciences, Physics and Psychology.

Mathematics 1000 and Chemistry 1010 and 1011 (or equivalent) or Physics 1020 and 1021 (or equivalent).

However, in order to graduate with a major in Biology, Chemistry, Earth Sciences and Physics all 5 or 6 of the above specified math, chemistry and physics courses are required courses. Thus requiring oceanography students to take all four 1st year Chemistry and Physics courses will not increase the course load outside of the major or minor for Biology, Chemistry, Earth Sciences and Physics majors. For some students scheduling may be difficult, so putting a 2nd first year course as a co-requisite may help.

For Biology, Chemistry and Physics majors there will be an extra Earth Sciences course required for the minor: EASC 1000 (Earth Systems). This will count towards the minor.

**Response to Chemistry**

-----Original Message-----
From: Fletcher, Garth
Sent: Monday, July 28, 2014 3:31 PM
To: Peter Pickup
Cc: Parrish, Chris
Subject: RE: Oceanography minor proposal

Thanks Peter. We have now received and collated comments from most of the units we consulted. Many thanks for the extensive editorial suggestions which have led us to greatly simplify the language under Scheduling and Prerequisites.

Best regards
Garth

**Comments from Earth Sciences**

From: Michelle Miskell [mailto:mmiskell@mun.ca]
Sent: May-12-14 9:44 PM
To: Fletcher, Garth
Cc: jhanchar@mun.ca; 'George Jenner'; 'Dr Alison Leitch'; 'Robbie Hicks'; 'Penny Morrill'; 'Luke Beranek'
Subject: RE: Proposed Minor in Oceanography - comments from Earth Sciences

Sorry Garth, I just discovered one more:

On page 5, under the heading “Course requirements for the minor in each…”, under the heading “Earth Sciences”, it states 3 electives. As EASC 1000 will count toward their minor in Oceanography, Earth Sciences students will only have two electives.
Thanks!
Michelle

Ms. Michelle Miskell
Manager of Academic Programs
Department of Earth Sciences
Memorial University of Newfoundland
St. John's, NL  A1B 3X5
(709) 864-4464
mmiskell@mun.ca
www.mun.ca/earthsciences

From: Michelle Miskell [mailto:mmiskell@mun.ca]
Sent: May-12-14 9:41 PM
To: 'fletcher@mun.ca'
Cc: 'jianchar@mun.ca'; 'George Jenner'; 'Dr Alison Leitch'; 'Robbie Hicks'; 'Penny Morrill'; 'Luke Beranek'
Subject: Proposed Minor in Oceanography - comments from Earth Sciences

Hello Garth,

We discussed the proposal from the Department of Ocean Sciences for a minor in Oceanography at our recent Undergrad Matters Committee in Earth Sciences. Generally we thought the proposal was fine, and the program itself looks great. We do have one concern to share, and a couple of minor comments. Please see below.

Good luck with it! Give me a call if you wish to discuss this (4464).
Michelle

(1) On page 1, under the heading “Resource Implications”, it states that the proposed program does not require any new instructional costs beyond the new scientific diving course. We feel this is an inaccurate statement. OCSC is seeking instructors from other units to teach OCSC minor courses. In Earth Sciences, this means that one of our faculty members is unavailable to teach one course in the EASC program each year so that OCSC teaching requirements are met. This is a cost to us in that it is reducing our available teaching resources, at a time when we are already stretched to, or past, our limit. Furthermore, should the situation arise sometime that we are unable to provide an instructor, OCSC would be potentially faced with having to hire a sessional to teach the course. I imagine that these issues apply to the other units as well.

(2) On page 4, under the last heading on the page “Choices from other departments”, EASC 4302 is listed as a choice. The statement in parentheses that follows, while accurate, could be misleading. (In fact it tripped me up the first time I read it and I know this program inside out.) It states that this course has only a 1st year EASC course as a specific prerequisite. Again, while this is true, the word “specific” is kind of lost in there. Another sentence here about the 15 credit hours required in core sciences at the 3000 and/or 4000 levels in any of Biol, Biochem, Chem, Earth Sciences, Physics or Geography would offer clarification and help the reader understand that this is an easily accessible course to most science students.
(3) On page 5, under the heading “Scheduling and prerequisites”

a. First sentence – why is the Dept of Biology set apart in this sentence? Not a big deal, just confusing.

b. Second sentence – it appears that it states that 2nd year introductory oceanography courses could/should be delivered in the winter semester so that 1st year prerequisites can be taken as co-requisites, enabling 2000 level OCSC courses to be taken in the student's first year. We thought it would be worthwhile pointing out that while have no issue with offering OSCS 2200 in the winter semester (and plan to do so), the prerequisite EASC 1000 is just that, a prerequisite, not a corequisite. It will be up to the course instructor to agree to admit students to OCSC 2200 if the prerequisite has not been met. And truthfully, it is doubtful that the instructor would.

c. Furthermore, it may be very difficult for many science students to take 2000-level OCSC courses in their first year as their programs are already chock-a-block full with the major program requirements. EASC students for example would not be able to take any OCSC courses in their first year at all, due to the program requirements.

Ms. Michelle Miskell  
Manager of Academic Programs  
Department of Earth Sciences  
Memorial University of Newfoundland  
St. John's, NL A1B 3X5  
(709) 864-4464  
miskell@mun.ca  
www.mun.ca/earthsciences  

Responses to Earth Sciences  
From: Fletcher, Garth  
Sent: Monday, July 28, 2014 3:36 PM  
To: Michelle Miskell  
Cc: Parrish, Chris  
Subject: RE: Proposed Minor in Oceanography - comments from Earth Sciences

Hi Michelle:
We have now received and collated comments from most of the units we consulted. As to Earth Sciences concerns and comments,

(1) EASC 2919/OCSC 2200 is an Earth Sci course, but your point is well taken and this is a concern shared by Chemistry. We now specify the implications for each of the partner departments as well as for Ocean Sciences: “There are resource implications for the Departments of Chemistry, Earth Sciences and Physics and Physical Oceanography which are offering new courses cross-listed for this minor. However for Ocean Sciences . . .”

(2) We’ve put in the exact phraseology from the current calendar.

(3) a. Partner departments are those offering new courses cross-listed for this minor. We requested that Biology modify one of their courses for this minor – they declined.

b. Yes, this is focusing on Physics and Chemistry where two first year courses are required. EASC 1000 Earth Systems is the only prerequisite and is offered in the fall so there is no issue here.

c. This is true for Earth Sciences; however, not all departments require as many first year courses as does Earth Sciences.
Best regards

Garth

Comments from Physics & Physical Oceanography

-----Original Message-----
From: Brad deYoung [mailto:bdeyoung@mun.ca]
Sent: May-02-14 9:20 AM
To: Fletcher, Garth
Cc: Mike Morrow; Rick Goulding
Subject: Minor in Oceanography

Garth

Our undergraduate studies committee looked at the minor and are happy with the integrated structure with one challenge, one that I already mentioned - the requirement for EASC 1000. We are very doubtful that our students will take that and will only really note the need to do so late in their programs and will therefore be very unlikely to take it. That is why that course was not in our list when we all had separate regulations.

We would like to suggest that a phrase be added

Students majoring in Physics will take Physics 3300 in place of EASC 1000.

If that can be added then we fully support the program and are on board.

Let me know how this seems.

thanks

Brad

Brad deYoung
Professor and Head
Memorial University
St. John's NL
709-864-8738
bdeyoung@mun.ca

Responses to Physics & Physical Oceanography

From: Fletcher, Garth
Sent: Monday, July 28, 2014 3:40 PM
To: Brad deYoung
Cc: Parrish, Chris
Subject: RE: Minor in Oceanography

Thanks Brad.
We have now received and collated comments from most of the units we consulted. As to Earth Sciences 1000, it is actually a prerequisite to OCSC 2200/EASC 2919: Introductory Geological Oceanography. It seems unlikely they would accept PHYS 3300 as an alternative to EASC 1000 as we received the following from them in response to our original proposal:
“We thought it would be worthwhile pointing out that while we have no issue with offering OSCS 2200 in the winter semester (and plan to do so), the prerequisite EASC 1000 is just that, a prerequisite, not a corequisite. It will be up to the course instructor to agree to admit students to OCSC 2200 if the prerequisite has not been met. And truthfully, it is doubtful that the instructor would.”

Best regards
Garth

**Comments from Grenfell**
*From:* Gunther, Georg [mailto:ggunther@grenfell.mun.ca]
*Sent:* May-05-14 1:32 PM
*To:* Fletcher, Garth
*Subject:* FW: Proposed Minor in Oceanography

Dear Dr. Fletcher

Please see the email below from Dr. Don-Roger Parkinson, Program Chair of the Environmental Science Program Unit at Grenfell Campus.

All the best

Georg Gunther,
Head, Division of Science

*From:* Parkinson, Don-Roger
*Sent:* April-30-14 9:59 AM
*To:* Gunther, Georg
*Subject:* RE: Proposed Minor in Oceanography

HI,

The proposal seems to be an apt one and should enable Earth Science to entice an few students.

Comments on Proposed Minor in Oceanography:

1) I am not aware of Chem 2600. Is this a new course not listed in the MUN 2013-2014 calendar or do they mean the old Chem 3600 (inactive Marine Chemistry)?
2) Choices from Biology should also include (from Grenfell): ENVS 2371 (Oceanography), ENVS 3072 (Comparative Marine Environments)
3) Choices from other depts section should also include (from Grenfell): ENVS 3210 (Environmental Analytical Chemistry I), ENVS 3211
(Environmental Analytical Chemistry II) and perhaps ENVS 4230
(Aquatic Chemistry)

Regards,

Don-Roger
Chair of ENVS

Response to Grenfell
From: Fletcher, Garth
Sent: Monday, July 28, 2014 3:42 PM
To: Gunther, Georg
Cc: Parrish, Chris
Subject: RE: Proposed Minor in Oceanography

Thanks Georg.
We have now received and collated comments from most of the units we consulted. We now include all the ENVS courses suggested and look forward to further programming collaboration with Grenfell.
Best regards
Garth

Math & Stats
From: Math Consult [mailto:mathconsult@mun.ca]
Sent: April-30-14 12:09 PM
To: Fletcher, Garth
Subject: Re: Proposed Minor in Oceanography

The Department of Mathematics and Statistics has no objection to this proposal.

H. Johnson

Engineering: Proposed Minor in Oceanography
From: Engineering Consultations [mailto:engrconsult@mun.ca]
Sent: April-30-14 11:43 AM
To: Fletcher, Garth
Cc: Fisher, Andrew; Edmunds, Jayde; Glyn George
Subject: Re: Proposed Minor in Oceanography

Thank you for the invitation to comment on Calendar proposals for two minors in Ocean Sciences (SAFE and Oceanography).

Neither the associate dean (Andy Fisher) nor I can see any impact on our programs from these minors. However, I shall add them to the agenda of the next regular meeting of our Committee on Undergraduate Studies on May 18.

--
Dr. Glyn George, Chair
Committee on Undergraduate Studies
Education
From: Gerald Galway [mailto:ggalway@mun.ca]
Sent: April-29-14 7:32 PM
To: Fletcher, Garth
Subject: Re: Proposed Minor in Oceanography

Dear Garth
We have reviewed the proposal for a minor in Oceanography and from the perspective of the Faculty of Education there are no concerns with the proposal. Congratulations and good luck with the new option.
Gerald

Gerald Galway
Associate Dean

Sent from my iPad

On Apr 29, 2014, at 4:49 PM, "Fletcher, Garth" <fletcher@mun.ca> wrote:

Colleagues: I have attached the Department of Ocean Sciences proposal for a Minor in Oceanography for you to review prior its submission to the Faculty of Science Undergraduate Studies Committee. Please send me your thoughts on this proposal as soon as you are able.
Best regards
Garth

Garth L. Fletcher
Head and Professor Emeritus
Department of Ocean Sciences
Ocean Sciences Centre
0 Marine Lab Road
St John's NL
Canada
AiC 557

Tel: 709-864-3276
Fax: 709-864-3220
Hi Shannon: We have made all of the changes to our two minors that were requested by SCUgS and I have attached the revised proposals. I trust all will be in good order for the Senate.

Best regards

Garth

Hi Garth and Aimée,

At its meeting today, the Senate Committee on Undergraduate Studies considered the proposals by the Department of Ocean Sciences for new Minors in Oceanography and in Sustainable Aquaculture and Fisheries Ecology.

Before these proposals can be forwarded to Senate, SCUgS has requested the following changes, which involve both the Department of Ocean Sciences and the Dean's Office:

* The Dean's signature is missing on both proposals. This is essential before the proposals can be considered by Senate. I expect it will probably be sufficient to provide a signed version of the proposal as it currently exists (i.e. without the changes I'm about to list below) but the Dean's Office may wish to contact Jennifer Porter, the Deputy Registrar, to ensure that this would be sufficient.

* In the proposal for the Minor in Oceanography, the "Resource Implications" section indicates that there are instructional costs for the Departments of Chemistry, Earth Sciences, and Physics &
Physical Oceanography, but there is no documentation to indicate that those units have consented to these costs. Indeed, the feedback from Michelle Miskell appears to raise this as a potential concern.

* It is not clear how the Calendar regulations introduced in both proposals will appear within the Ocean Sciences section of the Calendar. Appropriate section/subsection numbers should be introduced in the proposal (presumably, these would be Regulations 9.9.1 and 9.9.2).

* Finally -- and this is one I've just noticed myself in composing this e-mail -- the existing paragraph in the Ocean Sciences section of the Calendar which reads:

"The Department aims to offer both undergraduate and graduate programs in Ocean Sciences. Immediate plans are underway to offer two undergraduate Minors in Oceans and in Aquaculture. It is expected that the first course offerings will be available in 2013-2014."

will now be redundant and should be deleted. This ought to be included as a secondary Calendar change on one of the forms.

To ensure that the proposals are not delayed from consideration by Senate at its February meeting, I'd encourage you to address these comments no later than Tuesday, January 20th. The revised versions can be submitted as Word (or WordPerfect) and PDF files directly to the Recording Secretary of SCUgS, Linda Noseworthy <lnosewor@mun.ca>.

Finally, I should mention that the proposed changes to the prequisites for Ocean Sciences 3002 and Ocean Sciences 4000 were also considered at today's SCUgS meeting, and I'm happy to report that these proposals passed without amendment.

Cheers,
Shannon

--
Dr. Shannon Patrick Sullivan
Dept. of Mathematics & Statistics
Senior Faculty Advisor, Faculty of Science Memorial University of Newfoundland St. John's · NL · Canada shannon@mun.ca · www.uces.mun.ca/~shannon
Proposal for a New Program

Minor in Sustainable Aquaculture and Fisheries Ecology

Resource Implications: Instructional Costs

The proposed program does not require any new instructional costs beyond those associated with the laboratory component of OCSC 3000: Aquaculture Principles and Practices. The five core courses for the minor: OCSC 1000 Exploration of the World Ocean, OCSC 2001 Introduction to Sustainable Fisheries and Aquaculture, OCSC 3000 Aquaculture Principles and Practices, OCSC 3002 Aquaculture and Fisheries Biotechnology, and BIOL 4750 Fisheries Ecology have all been approved at least up to level of the Council of the Faculty of Science on or before 19 March 2014.

Library Holdings and/or Other Resources Required

The library can support this program with existing resources.

The costs associated with new program/courses can be met from within the existing budget allocation.

Signature of Unit Head (if appropriate): ____________________________

Date: ______________________________________

Signature of Dean/Associate Vice-President (Academic)/Vice-President:

Date: ______________________________________
EXECUTIVE SUMMARY

Fisheries and aquaculture play a key role in providing food and livelihoods worldwide. The science surrounding these linked activities has become an ever more challenging and varied field of study as their management has become increasingly diverse. Fisheries science, for example, now aims to incorporate a much broader understanding of not only the fished species, but also the effects of fisheries on ecosystems and the economic and social implications of the activity. Aquaculture, which continues to be the fastest growing food sector, has also evolved in terms of technological innovation and adaptation to meet changing requirements. There is much scope to improve the management of fisheries and aquaculture and the way we utilize the marine environment. This minor in Sustainable Aquaculture and Fisheries Ecology (SAFE) will expose students to aquaculture and fisheries management practices and help prepare them for a career as a developer, technologist, or researcher. This is an interdisciplinary minor program to be administered by the Department of Ocean Sciences in consultation with the Marine Institute. It is intended primarily for any student in the Faculty of Science but would be open to students in other faculties.

DEMAND FOR PROGRAM

Capture fisheries and aquaculture production are important contributors to the world’s food supply. Capture fisheries require management to avoid decline, while aquaculture must be effectively managed to increase production. Aquaculture production is expanding faster than agriculture or fisheries production and it has been identified as an important social and economic priority for the federal and provincial governments. There is a large demand for leaders, managers, researchers and highly skilled workers in the aquaculture sector across Canada and around the world. As we domesticate aquatic animals in the process of transiting from hunting to farming, aquaculture is increasingly interacting with fisheries at both a biological and socio-economic level. For example, about a third of the landings from fisheries are used for the production of fishmeal and fish oil which provide essential feed ingredients for many aquaculture species. This program aims to provide a broad understanding of not only the fished or farmed species, but also the effects of fisheries and aquaculture on ecosystems.
BENEFITS TO STUDENTS

This minor will provide the student with the biological underpinnings to understand the interactions between aquaculture and fisheries and their importance in terms of food security, environmental sustainability and resource use efficiency. Students will also learn the theory and applications of biotechnology in aquaculture and fisheries research and they will acquire hands-on experience with fish husbandry. With this minor, students will be well positioned to participate in the fishing and rapidly expanding aquaculture industries in Newfoundland and Labrador and beyond and to enter graduate programs in these fields.

CONSULTATIONS

The e-mail sent to other academic units seeking consultation as well as those received back from units consulted are appended at the end of this document.

PROGRAM TITLE: Minor in Sustainable Aquaculture and Fisheries Ecology

COURSE ADDITIONS

The five core courses for the minor: OCSC 1000 Exploration of the World Ocean, OCSC 2001 Introduction to Sustainable Fisheries and Aquaculture, OCSC 3000 Aquaculture Principles and Practices, OCSC 3002 Aquaculture and Fisheries Biotechnology, and BIOL 4750 Fisheries Ecology (or GEOG 4300: World Fisheries: Current Discourse and Future Directions) have all been approved at least up to level of the Council of the Faculty of Science on or before 19 March 2014.
CALENDAR ENTRY

9.9.2 Minor in Sustainable Aquaculture and Fisheries Ecology

Students who take a minor in Sustainable Aquaculture and Fisheries Ecology will complete 24 credit hours as follows:

1. Ocean Sciences 1000, 2001, 3000, 3002
2. Biology 4750 or Geography 4300
3. One of Ocean Sciences 2000, 3620, 4000, 4122, 4601
4. One of Biology 2122, 3401, 3640, 3715, 4251, 4605
5. One of Biochemistry 3107, 3402, 4002, 4101, 4104, 4105, 4200, 4201.

Course prerequisites stipulated in the course descriptions shall apply to a minor in Sustainable Aquaculture and Fisheries Ecology.

SECONDARY CALENDAR CHANGE

9.9 Ocean Sciences

www.mun.ca/osc/

The Department of Ocean Sciences is a newly formed Department within the Faculty of Science. The faculty within this Department are the former faculty of the Ocean Sciences Centre, a research unit and facility that was first opened in 1967.

The Department’s mandate as an interdisciplinary unit is to focus on increasing our understanding of biological and chemical processes within the oceans, and with those associated with aquaculture.

The Department aims to offer both undergraduate and graduate programs in Ocean Sciences. Immediate plans are underway to offer two undergraduate Minors in Oceans and in Aquaculture. It is expected that the first course offerings will be available in 2013-2014.

Ocean Sciences course descriptions are found at the end of the Faculty of Science section under Course Descriptions, Ocean Sciences.
SUMMARY PAGE FOR SENATE

Approval Form

Program Title

**Minor in Sustainable Aquaculture and Fisheries Ecology**

Summary of Changes

This proposal organizes a series of new Ocean Sciences courses which have been approved at least up to level of the Council of the Faculty of Science into a minor. This interdisciplinary minor program is intended primarily for any student in the Faculty of Science but would be open to students in other faculties.

<table>
<thead>
<tr>
<th>Consultations Sought on 23 April 2014 From</th>
<th>Comments Received</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine Institute</td>
<td>Yes</td>
</tr>
<tr>
<td>Grenfell campus</td>
<td>No</td>
</tr>
<tr>
<td>Department of Biochemistry</td>
<td>Yes</td>
</tr>
<tr>
<td>Department of Biology</td>
<td>Yes</td>
</tr>
<tr>
<td>Department of Chemistry</td>
<td>No</td>
</tr>
<tr>
<td>Department of Computer Sciences</td>
<td>No</td>
</tr>
<tr>
<td>Department of Earth Sciences</td>
<td>No</td>
</tr>
<tr>
<td>Department of Economics</td>
<td>No</td>
</tr>
<tr>
<td>Department of Geography</td>
<td>No</td>
</tr>
<tr>
<td>Department of Mathematics and Statistics</td>
<td>Yes</td>
</tr>
<tr>
<td>Department of Physics and Physical Oceanography</td>
<td>No</td>
</tr>
<tr>
<td>Department of Psychology</td>
<td>No</td>
</tr>
<tr>
<td>Faculty of Arts</td>
<td>No</td>
</tr>
<tr>
<td>Faculty of Education</td>
<td>Yes</td>
</tr>
<tr>
<td>Faculty of Engineering and Applied Science</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Library Report Received: Yes

Approved by Dean, Associate Vice-President (Academic) or Vice-President: Yes/No

Name
FOR OFFICE USE ONLY

APPROVAL GRANTED BY SENATE COMMITTEE ON UNDERGRADUATE STUDIES

Chair:

Secretary:

Date:
Appendix 1: Courses for the Minor

There are five compulsory courses

OCSC 1000: Exploration of the World Ocean

Exploration of the World Ocean is an introductory course covering the major ocean sciences (biology, chemistry, geology, physics) at a level sufficient for science majors but accessible to non-science majors. It explores phenomena occurring from the shoreline to the abyss and from equatorial to polar regions. It also examines principles of marine ecology as well as how the marine environment affects humans and vice versa. The course is offered in a blended format that combines face-to-face lectures and online interactive activities in the form of virtual oceanographic expeditions.

OCSC 2001 Introduction to Sustainable Fisheries and Aquaculture

This course introduces students to the breadth of aquaculture and fisheries science and the variety of animal species cultured and harvested. Basic aspects of aquaculture and fisheries and the links between the two are covered, including production systems, capture fisheries, environmental interactions, and the physiology, ecology and reproduction of finfish and shellfish in the context of their culture and harvest.

PR: OCSC 1000 or BIOL 1002 Principles of Biology

OCSC 3000: Aquaculture Principles and Practices

This course will emphasize the techniques and methods used to culture finfish and shellfish, with a primary focus on Canadian aquaculture species. Basic aspects of aquaculture will be covered, including the design and maintenance of production systems, culture techniques, and the nutrition, health, physiology and reproduction of finfish and shellfish. The laboratory portion of this course will provide students with practical experience in the maintenance of land-based aquaculture production systems and in the husbandry/culture of aquatic organisms.

PR: OCSC 2001, or OCSC 1000 and BIOL 1002.

OCSC 3002: Aquaculture and Fisheries Biotechnology

Aquaculture and Fisheries Biotechnology is an introduction to biotechnology and genetics as they are applied to aquaculture and fisheries. Topics covered include genetic variation; genetic structure of fish and shellfish populations; the genetic basis of aquaculture traits; finfish and shellfish genomic research; marker-assisted selection in aquaculture; manipulation of ploidy; genetic engineering in aquaculture; and techniques used to study the responses of aquatic animals to external stressors such as hypoxia, temperature stress, acidification, and pathogens.

PR: Biology 2250, 2060 [we will request to have this changed to Biology 2250 or Biochemistry 2100]
BIOL 4750: Fisheries Ecology (taught by Ocean Sciences Faculty)

Fisheries Ecology is the application of ecological principles to the problem of managing exploited fish populations. Laboratory exercises will be based on a simulation approach to fisheries problems using computer and animal models.

PR: BIOL 2600 [the request to have this changed to BIOL 2600 or OCSC1000 and OCSC 2001 has been denied by Biology so we are supplying an alternative below]

Alternatively -

GEOG 4300: World Fisheries: Current Discourse and Future Directions

World Fisheries is a seminar course on the key concepts, principles and challenges in fisheries resources worldwide. Topics of discussion include the state of world fisheries, analysis of various management approaches and tools, and future scenarios for world fisheries.

PR: 6 credit hours in Geography at the 3000-level or permission of Head of Department. It is strongly recommended that GEOG 3222 and 3226 be completed before registration in 4000-level courses.

There are four elective courses from Ocean Sciences

OCSC 2000 Introductory Biological Oceanography

Introductory Biological Oceanography provides a general understanding of the biological processes that occur in coastal and oceanic environments. It introduces students to the major groups of bacteria, phytoplankton, invertebrates and fish, emphasizing the biotic and abiotic factors controlling primary production and marine biomass. It shows how the physical, chemical, and geological environments interact with biology to define processes and patterns affecting nutrients and life in marine ecosystems.

PR: OCSC1000

OCSC 4122: Advanced Studies in Marine Animal Diversity (same as BIOL 4122)

Advanced Studies in Marine Animal Diversity provides an in-depth examination of cellular, physiological, behavioural and ecological adaptations in marine animals. Lectures will be combined with discussions of relevant papers from the primary literature on topics of current interest which may relate morphology, ecology, evolution, natural history, species interactions and practical applications. Students will also gain hands-on experience by designing and conducting research projects involving live or preserved animals.

PR: Biology 2122, 2600 and 2900

OCSC 4601: Functional Biology of Fish (same as BIOL 4601)

Functional Biology of Fish is an introduction to anatomical physiological and cellular processes in the life cycle of fishes.
OCSC 4000: Scientific Diving Methods

Scientific Diving Methods is an in-depth study and application of methods routinely employed for data collection in underwater scientific research. Aspects covered include habitat mapping; installation and use of instrumentation; still and video camera techniques; planning and execution of surveys and experiments in major subtidal habitats; as well as data analysis and interpretation. Participants are trained in accordance with Memorial University of Newfoundland’s Guide for Diving Safety and the Canadian Association for Underwater Science (CAUS) standards to meet the criteria for Scientific Diver I rating. This course is normally offered at the Bonne Bay Marine Station in a special 2-week session at the beginning or end of the spring semester depending on station’s availability.

PR: Biology 2122, Biology 2600, STAT 2550 (or approval by instructor), nationally recognized advanced level SCUBA certification with diver rescue and accident management techniques.

**Choices from Biology**

2122 Biology of Invertebrates
PR: BIOL 1001 and 1002

3401 Comparative Animal Physiology
PR: BIOL 2060 and 2210 and Biochemistry 3106

3640 Environmental Physiology of Animals
PR: BIOL 2060 and 2210; Biochemistry 3106

3715 Ecology and Evolution of Fishes
PR: BIOL 2600 and 2900

4251 Genomics
PR: BIOL 2060, 2250

4605 Quantitative Methods
PR: Statistics 2550

3715 Ecology and Evolution of Fishes
PR: BIOL 2600 and 2900

Note: All Biochemistry Majors need to take Biochemistry 3106 as well as Biology 1001 and 1002
Choices from Biochemistry

3107 Nucleic Acid Biochemistry and Molecular Biology
PR: BIOC 2101; and BIOC 2100 or Biology 2250

3402 Food Chemistry
PR: BIOC 2005; BIOC 2101; Chemistry 2440 or Chemistry 2401

4002 Biochemical Regulation
PR: BIOC 2100 or Biology 2250; BIOC 3106

4101 Proteins
PR: BIOC 3105

4104 Eukaryotic Gene Regulation and Developmental Biology
PR: BIOC 3107 or 3108

4105 Immunology
PR: BIOC 2101, and either BIOC 311B or Medicine 310B

4200 Bioenergetics and Biological Oxidation
PR: BIOC 3106

4201 Membranes - Structure and Function
PR: BIOC 3105

Note: All Biology Majors need to take Biology 2250 as well as Biochemistry 2101 and 3106.
Appendix 2: Consultations

Comments from Biology

From: Karen Morris [mailto:morrisk@mun.ca]
Sent: June-19-14 9:35 AM
To: Fletcher, Garth
Cc: Marinaro, Paul
Subject: New Program Proposal . Minor in Sustainable Aquaculture and Fisheries Ecology

Hi Garth,

The Proposal for a New Program Minor in Oceanography was reviewed at a departmental meeting May 22, 2014.

It was felt by many that the proposal should be broken down into two separate minors; one in Sustainable Aquaculture and the other in Fisheries Ecology, as they are conceptually somewhat different.

If there was a separation then it may also be easier to see a rational for the choice of courses from Biology as listed under “calendar entry” # 3 and suggest other courses that are offered by Biology that may be a better fit than the ones suggested. It may also lead to additional course suggestions such as Biology 3715( Ecology and Evolution of Fishes) and others related to Fisheries Ecology.

Another concern that was raised relates to the Biology courses required and suggested (some of which are cross-listed with OCSC) and the prerequisites required.

Since all Biology courses require at a minimum Biology 1001 and 1002 this needs to be reiterated as well as an advisory to check the prerequisites for all Biology course that are suggested and/or required. This includes Biology 4750 (a course that has been offered by Biology for more than 20 years). The prerequisites for this course are Biology 2600 (Biology 1001 & 1002 are prerequisites for Biology 2600). There will be no change in this prerequisite requirement. Indeed, all upper level ecology courses in Biology have Biology 2600 (General Ecology) as their prerequisite and there is no logical reason as to why this course should be different. Moreover, the two upper level Ocean Sciences courses in the general area of ecology (OCSC 4122 and OCSC 4000) both have BIOL 2600 listed as their prerequisite thus, students in the program will be taking BIOL 2600 anyway as well as its associated prerequisites of BIOL 1001 and BIOL 1002.

If you have any questions please let me know.

Thanks

Karen

Karen Morris
Undergraduate Officer
Dept. of Biology
Memorial University of Newfoundland
St. John’s, NL A1B 3X9
709-864-8021
**Responses to Biology**

From: Fletcher, Garth  
Sent: Monday, July 28, 2014 2:51 PM  
To: Karen Morris  
Cc: Parrish, Chris  

Hi Karen:

We have now received and collated comments from about half the units we consulted. The suggestion about splitting the minor is reasonable, but for the moment we prefer to keep the two fields together as they are linked at several levels. We will nonetheless include Biology 3715 as you suggest. As to the prerequisite issue, it is unfortunate that once again Biology will not consider revising the prerequisites in order to make the course accessible to students other than biology students. Again this is a course taught by Ocean Sciences faculty and again we discussed it with the instructor first. As a consequence we have added an alternative to Fisheries Ecology for the moment. In addition, on the advice of a long time instructor in the Biology department we will be increasing prerequisite flexibility in OCSC courses.

Best regards

Garth

---

**Comments from Engineering**

From: Engineering Consultations [mailto:engrconsult@MUN.CA]  
Sent: May-22-14 9:32 AM  
To: Fletcher, Garth  
Cc: Fisher, Andrew; Edmunds, Jayde; Glyn George  
Subject: Re: Proposed Minor in Sustainable Aquaculture and Fisheries Ecology

Thank you for the opportunity to comment on the proposed Calendar changes for the introduction of  
1) a Minor in Oceanography and  
2) a Minor in Sustainable Aquaculture and Fisheries Ecology

At its regular meeting of 2014 May 21 the Committee on Undergraduate Studies for the Faculty of Engineering and Applied Science found no impact on our programs from either of these two sets of proposed Calendar changes.

I wish you well in the development of these two minors.

Dr. Glyn George, Chair  
Committee on Undergraduate Studies  
Faculty of Engineering and Applied Science Memorial University of Newfoundland  
http://www.engr.mun.ca/~ggeorge

---

**Comments from the Queen Elizabeth II Library**
19 May 2014

To: Garth Fletcher  Department of Ocean Sciences

From: Erin Alcock, Science Research Liaison Librarian

Subject: Minor in Sustainable Aquaculture and Fisheries Ecology

I have reviewed the proposal for the minor in Sustainable Aquaculture and Fisheries Ecology, and have determined that the Memorial University Library system has ample resources to support this program.

The summary of library holdings below indicates monograph titles in this subject areas, held both in the Queen Elizabeth II Library and the C.R. Barrett Library, as well as, more than sufficient coverage from article indexes. Any additional resources required could be purchased under allocations for biology, physics and physical oceanography, the Marine Institute Library and other appropriate funds. The major journals in this area are well covered.

Library Holdings Summary

Table One: General Programme Subject Themes

<table>
<thead>
<tr>
<th>Course Topic</th>
<th>LCSH</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquaculture</td>
<td>1486</td>
<td>2843</td>
</tr>
<tr>
<td>AND Manag$</td>
<td>121</td>
<td>592</td>
</tr>
<tr>
<td>AND Fisher$</td>
<td>297</td>
<td>1513</td>
</tr>
<tr>
<td>AND “Food security”</td>
<td>2</td>
<td>41</td>
</tr>
<tr>
<td>AND Environment$</td>
<td>97</td>
<td>510</td>
</tr>
<tr>
<td>AND “Resource use”</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>AND Biotechnol$</td>
<td>15</td>
<td>32</td>
</tr>
<tr>
<td>“Fish husbandry”</td>
<td></td>
<td>Cross ref to “Fish Culture” 265</td>
</tr>
</tbody>
</table>

*as of date of memo

Table Two: Selected Article Indexes and Databases

<table>
<thead>
<tr>
<th>Article Indexes and Databases</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASFA: Aquatic Science and Fisheries Abstracts</td>
</tr>
<tr>
<td>Biological Abstracts</td>
</tr>
</tbody>
</table>
Comments from the Marine Institute
From: Dawn King [mailto:Dawn.King@mi.mun.ca] On Behalf Of MIUG Consultations
Sent: May-15-14 12:12 PM
To: Fletcher, Garth
Cc: Derek Howse
Subject: RE: Proposed Minor in Sustainable Aquaculture and Fisheries Ecology

Dr. Fletcher,

Thank you for the opportunity to review the proposed Minor in Sustainable Aquaculture and Fisheries Ecology. We believe the proposed curriculum will provide a good foundation for an actual Minor program in science, as we see it.

One of the Rationales given is to provide insight that may pique the interest of students to continue into fisheries or aquaculture graduate programs, and we feel this is a strong point of this particular proposed Minor program.

The Executive Summary and Rationale portions were written somewhat in an awkward fashion, and contained some inaccuracies/inconsistencies, so we have provided recommendations therein using track changes, for consideration by the OSC. We feel these edits will much improve the program proposal to Senate, and so we are happy to support it.

You will find in the attached our suggested edits to the document, including some formatting changes for consistency.

We wish you every success with this program.

Derek Howse

Derek Howse
Chair, Undergraduate Studies Committee
Marine Institute, Memorial University
TEL: 709-778-0586
FAX: 709-778-0394
Derek.Howse@mi.mun.ca<mailto:Derek.Howse@mi.mun.ca>

Fisheries and aquaculture play a key role in providing food and livelihoods worldwide. The science surrounding these linked activities has become an ever more challenging and varied field of study as their management has become increasingly diverse. Fisheries and aquaculture science, for example, now aims to incorporate a much broader understanding of not only the fished or farmed species, but also the effects of fisheries and aquaculture on ecosystems and the economic and social implications of these activities. There is opportunity to improve the management of fisheries and aquaculture and the way we utilize the marine environment. This
minor in Sustainable Aquaculture and Fisheries Ecology will help expose students to many important aspects of aquaculture or fisheries management and may spur interest in a career as a developer, technologist, or researcher.

Capture fisheries and aquaculture production are important contributors to the world’s food supply. Capture fisheries require management to avoid decline, while aquaculture must be effectively managed to increase production. Aquaculture production is expanding faster than agriculture or fisheries production and has been identified as an important social and economic priority for the federal and provincial governments of Canada, and indeed the United Nations. There is a large demand for leaders, managers, and researchers in the aquaculture sector across Canada and around the world. As it expands, aquaculture is increasingly interacting with fisheries at both a biological and socio-economic level. This minor will provide the student with the biological underpinnings to understand the interactions between aquaculture and fisheries and their importance in terms of food security, environmental sustainability and resource use efficiency. Students will also learn the theory and applications of biotechnology in aquaculture and fisheries research and they will acquire hands-on experience with fish husbandry. With this minor, students will be well positioned to either participate in the aquaculture and fishing industries in Newfoundland and Labrador and beyond or to search out graduate study opportunities in these exciting and innovative fields.

**Responses to the Marine Institute**

**From:** Fletcher, Garth  
**Sent:** Monday, July 28, 2014 3:00 PM  
**To:** MIUG Consultations  
**Cc:** Parrish, Chris  
**Subject:** RE: Proposed Minor in Sustainable Aquaculture and Fisheries Ecology

Thanks for your comments Derek: We have now received and collated the comments from about half the units we consulted. We are grateful for the extensive editing by the Marine Institute. We have carefully considered all the suggestions in the Executive Summary and Rationale and have incorporated many of them.

Best regards

Garth

**Comments from Biochemistry**

-----Original Message-----

**From:** Biochemistry Head  
**Sent:** May-05-14 3:03 PM  
**To:** Fletcher, Garth  
**Subject:** RE: Proposed Minor in Sustainable Aquaculture and Fisheries Ecology

Garth,
With the understanding that entry into the biochemistry courses in your list would necessitate completion of 1-3 other biochemistry courses, we would be OK with this proposed program. The numbers will not likely cause us any problem.

Phil

Philip J. Davis
Professor and Head
Department of Biochemistry
Memorial University

**Responses to Biochemistry**

-----Original Message-----
From: Fletcher, Garth
Sent: May-05-14 3:18 PM
To: Biochemistry Head
Subject: RE: Proposed Minor in Sustainable Aquaculture and Fisheries Ecology

Thanks Phil. I'm assuming you mean Biochem's prerequisites. Yes of course.

Best regards
Garth

**Education**

From: Galway, Gerald J.
Sent: April-24-14 11:35 AM
To: Fletcher, Garth
Subject: Re: Proposed Minor in Sustainable Aquaculture and Fisheries Ecology

Dear Garth

We have reviewed your note and there are no obvious implications for the Faculty of Education related to the proposal for a Minor in Sustainable Aquaculture and Fisheries Ecology. Best wishes for a successful implementation.

In reading the proposal it occurs to me that our science and social studies education students would benefit from some exposure to this study area. Perhaps we could arrange a seminar on Aquaculture and visit to the Ocean Sciences Centre at some point.

Best regards,
Gerald

--
Dr. Gerald Galway
Associate Dean (Undergraduate Programs)
Associate Professor
Faculty of Education
Math and Stats
From: Math Consult [mailto:mathconsult@mun.ca]
Sent: April-23-14 4:03 PM
To: Fletcher, Garth
Subject: Re: Proposed Minor in Sustainable Aquaculture and Fisheries Ecology

Hello Dr. Fletcher:

The Department of Mathematics and Statistics has no objection to this proposal.

Harold Johnson, Undergraduate Officer in Mathematics
Department of Mathematics and Statistics

On 4/23/2014 1:43 PM, Fletcher, Garth wrote:
Colleagues: I have attached the Department of Ocean Sciences proposal for a Minor in Sustainable Aquaculture and Fisheries Ecology for you to review prior its submission to the Faculty of Science Undergraduate Studies Committee. Please send me your thoughts on this proposal as soon as you are able.
Best regards
Garth

Garth L. Fletcher
Head and Professor Emeritus
Department of Ocean Sciences
Ocean Sciences Centre
0 Marine Lab Road
St John’s NL
Canada
AIC 557

Tel: 709-864-3276
Fax: 709-864-3220
December 22, 2014

Dr. Len Zedel  
Associate Dean (Research & Graduate)  
Faculty of Science  
Memorial University of Newfoundland  
St. John’s, NL

Dear Dr. Zedel,

It is with pleasure that I am forwarding to you a copy of the proposed MSc in Agricultural, Forest and Environmental Science (MSc AFES) program being developed for the Grenfell Campus as a part of our Boreal Ecosystem Research Initiative (BERI).

The proposal has been developed with the assistance of the Divisions of Science and Social Science at Grenfell Campus, and the support of the Department of Natural Resources, Government of NL, the Canadian Forest Service, and Agrifoods-Agriculture Canada.

It is our hope that this program will be well regarded by the university community and external stakeholders as Grenfell Campus pursues increasing research capacity and graduate programming.

It would be very much appreciated if you could circulate this proposal to your faculty for feedback, and we would like to hear whether the Faculty of Science at Memorial University’s St. John’s Campus would be willing to support this program proposal as it progresses through the academic approval process. We would like to receive feedback as quickly as possible to assist in bringing this forward to Senate in January.

Thank you for considering this request, and if you have questions or would like to discuss this further, please feel free to contact me at your convenience.

Regards,

[Signature]

Robert Gallant, PhD  
Associate Professor  
Head, Division of Science

Attachment
New Graduate Program Proposal
Memorial University of Newfoundland

Master of Science in Agricultural, Forest and Environmental Science (MSc AFES)

Division of Science, Grenfell Campus
Dr. Robert Gallant, Head of Division
Email: rgallant@grenfell.mun.ca

Division of Social Science, Grenfell Campus
Dr. Sandra Wright, Head of Division
Email: swright@grenfell.mun.ca

Boreal Ecosystem Research Initiative, Grenfell Campus
Dr. Antony Card, AVP (Research), Grenfell Campus
Email: acard@grenfell.mun.ca

Date: December 22, 2014

Anticipated start of new program: Fall 2015
# Table of Contents

1. Executive summary .................................................................................................................. 4  
2. Program description ................................................................................................................ 5  
3. Statement of justification ......................................................................................................... 6  
   3.1 Benefits to the Grenfell Campus and Memorial University ............................................... 7  
   3.2 Benefits to the Province of Newfoundland and Labrador .................................................. 8  
   3.3 Benefits to the Greater Academic Community, Including Potential Students............... 9  
4. Market analysis ........................................................................................................................ 11  
   The Canadian Job Market .......................................................................................................... 11  
   Table 4.1 Job creation in Canada since 2009 ............................................................................ 11  
   Table 4.2 Provincial job creation in Canada since 2009 ......................................................... 12  
   Table 4.3 Post-secondary enrolment in Canada (1992-2011) .................................................. 12  
   Table 4.4 Skill requirements for emerging markets in Canada (1990-2012) ......................... 13  
   The Environmental Employment Market ................................................................................ 13  
   Table 4.5 Environmental professionals working in Canada (1993-2013) - Source: Eco-Canada (2013) .................................................................................................................................................. 14  
   Table 4.6 Environmental employees by sub-sector in Canada (2013) - Source: Eco-Canada (2013) .................................................................................................................................................. 15  
5. Demand for environmental employees .................................................................................. 15  
6. Summary of employment opportunities ............................................................................... 15  
7. Analysis of competing graduate programs ......................................................................... 16  
   Table 4.7 Selected Scan of Relevant Graduate Programs ....................................................... 17  
8. Projected enrolment ............................................................................................................... 20  
   Table 5.1 MSc AFES Projected 5-year enrolment* (including continuing students) ............ 20  
9. Resource implications ............................................................................................................ 20  
   6.1 Faculty complement and workload .................................................................................... 20  
      Faculty expertise .................................................................................................................. 20  
      Laboratory and technical personnel .................................................................................... 21  
      Additional / potential research faculty .............................................................................. 21  
      Support services for faculty and graduate students ......................................................... 21  
6.2 Space, facilities, and student support ............................................................................... 21  
6.3 Financial support ................................................................................................................. 22
Graduate Student Funding .................................................. 22

7. Budget ........................................................................ 22
   Table 7.1 Graduate student enrolment and projected revenue .......... 23
   Table 7.2 Program budget (Years 1-5) .................................. 24

Appendix A. Library holdings evaluation ................................. 25
   Introduction .................................................................. 25
   Monographs .................................................................. 25
   Journal Literature .......................................................... 25
   Facilities ....................................................................... 25
   Library Hours .................................................................. 26

Appendix B. Calendar regulations ........................................... 27
   1.0 Regulations Governing the Degree of Master of Science in Agricultural, Forest and Environmental Science ........................................... 27
   1.1 Qualifications for Admission ......................................... 27
   1.2 Program of Study and Research ..................................... 27
   1.3 Program Requirements ................................................ 27
   1.4 List of Optional Courses .............................................. 28
   1.5 Evaluation .................................................................. 28
   1.6 Study Options ............................................................ 28

Appendix C. Course Calendar Descriptions ............................... 29

Appendix D. Consultations .................................................... 34

Appendix E. Consultation Plan ............................................... 40

Appendix F. Potential Faculty and Academic CVs ...................... 41

Appendix G. Letters of Support ............................................. 64
1. Executive summary

Grenfell Campus is proposing to offer an inter-disciplinary graduate degree program: Master of Science in Agricultural, Forest and Environmental Science (MSc AFES), with study concentrations matched to the skills and expertise of faculty members and research collaborators.

With a long-standing reputation in the field of environmental studies and environmental sciences, Grenfell Campus has offered a variety of programs and degrees in the environmental field since 1995. Today, Grenfell Campus offers four bachelor-level environmental degree programs and a Master of Arts in Environmental Policy. The development of an additional Master program in the environmental field is recognition of both the maturity and capacity of Grenfell Campus’ academic growth.

The development of this new graduate program at Grenfell Campus has been spearheaded in part by the Grenfell Campus Strategic Plan, which includes increasing student enrolment at the graduate level. A fundamental part of the campus strategic plan has centered around the development of environmental programs and research at Grenfell as a basis to help increase enrolment, stimulate the regional economy, and develop a niche research area that would set Grenfell Campus apart from other small campuses. Existing partnerships with provincial and federal agencies provided context for the development of applicable and relevant research programs to meet key research objectives of local, provincial and national agencies, and the needs expressed by the environmental industry. Primary research areas include forest science, agricultural / agrifood science, and more broadly-based environmental science.

Since the initiation of program planning for the Master of Science in Agricultural, Forest and Environmental Science, Grenfell Campus has completed major steps toward the development of research and graduate programming: 1) construction of a $4M boreal ecosystem research facility, 2) hiring of 5 research professors for the research initiative, 3) the purchase and installation of over $5M in major research equipment, and 4) the hiring of 2 laboratory technicians to support the equipment and research requirements in the laboratories. The investment in facilities, equipment and human resources has prepared Grenfell Campus to conduct world-class research in agricultural, forest and environmental science.

Consultations within Memorial University to date, and with external agencies and industry have resulted in unanimously positive support for the initiative at the local, provincial and national level. The ability of the laboratories to not only support graduate research but to also provide industrial support for the testing and analysis of environmental materials and processes will result in the reduction of analysis costs and time to corporate partners.

The MSc AFES program is intended to be "thesis only" format for the initial five-year period. This will allow time for the Campus to determine the success of the program in attracting suitable candidates and to determine their success in the academic or corporate sector. Non-thesis options may be considered after the initial five-year period where demand from industry would permit candidates to work with industry on specific projects that would provide suitable background and experience to supplement program course requirements.

Enrolment for the MSc AFES program would initially begin with five (5) students and an estimated enrolment cap of thirteen (13) students annually.

Although capital investments in the building and equipment have been made, heavy laboratory and field experience requirements for the degree require the addition of special fees to cover these resource requirements. Total fees (tuition and special fees) are proposed to be $5000/year for Canadian students, and $10,000/year for international students. See the Budget in Section 7 for details.

With the proposed fees, resources required for successful implementation and maintenance of the programs are available within Memorial University, and Grenfell Campus more particularly.
2. Program description

2.1 Degree: Master of Science in Agricultural, Forest and Environmental Science

2.2 Short Name: MSc AFES

2.3 Academic Unit: Division of Science, Grenfell Campus, Memorial University

2.4 Administrative Unit: Division of Science, Grenfell Campus, Memorial University

2.5 Study areas: Agricultural Science, Forest Science and Environmental Science

2.6 Intended learning outcomes: The Master of Science in Agricultural, Forest and Environmental Science (MSc AFES) program will provide graduate students with advanced knowledge and skills in theoretical and technical advances in environmental science, specifically related to sustainability in forestry, agriculture and climate change.

2.7 Overview: A recent Grenfell Campus environmental initiative, the Boreal Ecosystem Research Initiative (BERI), was created in July 2013 with the signing of the Collaborative Research Agreement (CRA) between Memorial University – Grenfell Campus, the Canadian Forest Service (CFS) of Natural Resources Canada, and more recently, the Forest and Agrifoods Division of the Government of Newfoundland and Labrador. The recommended courses for the program can currently accommodate graduate students with an interest in forest science, and the expectation is that the Canadian Forest Service will contribute to the MSc AFES as their resources permit.

The proposed MSc AFES has been initiated to expand into areas that are not evident in the existing MSc in Environmental Science at the St. John’s Campus. The MSc AFES is driven by need (provincial agricultural and forest research), the program utilizes the newly developed labs and hired expertise, and takes advantage of Grenfell Campus’ connection with federal forest science expertise on campus. BERI has been conceived and developed as an “environmental, natural science-based research institute” where multi-disciplinary researchers coordinate expertise in the forestry, agricultural and environmental science sector of academia and industry. BERI will provide the operating framework whereby Grenfell Campus and partnered researchers from organizations and industry leaders in the boreal ecosystem research sector can develop leading-edge research knowledge, projects and products. BERI will complement the existing social science-oriented Environmental Policy Institute (EPI), which facilitates debate, research and capacity building on critical environmental policy challenges relevant to Newfoundland and Labrador.

Integrated with the new Boreal Ecosystem Research Facility, this natural science-based graduate program will enhance the academic environment of Grenfell Campus, and provide opportunities for graduate students and experts in boreal science to develop new knowledge and applications to solve environmental problems. Grenfell Campus is proposing to offer a Master of Science in Agricultural, Forest and Environmental Science (MSc AFES) with study concentrations matched to the skills and expertise of faculty members.
3. Statement of justification

The development of graduate programs at Grenfell Campus has been spearheaded, in part by the Grenfell Campus Strategic Plan\(^1\), which includes increasing student enrolment at the graduate level.

"Strengthen our identity as an excellent small university with distinctive academic and research programs.

Goal 2: Introduce new undergraduate and graduate programs and expand opportunities for other learning experiences.

Goal 3: Promote Grenfell Campus’ research activities and programs and implement changes to ensure a productive research environment."

**Grenfell Campus Strategic Plan 2014**

In the development of a campus strategic plan, a great deal of consideration and discussion has centered around the development of environmental programs and research at Grenfell as a basis to help increase enrolment, stimulate the regional economy, and develop a niche research area that would set Grenfell Campus apart from other small campuses. The concept of creating an environmental cluster around our existing post-secondary institutions and resource base originated with academic and community leaders who saw an opportunity to grow the knowledge economy in the Western Region of the province. While much has changed since the original concept was first proposed, Grenfell Campus is now in a position to present a clear, focused and achievable approach to developing enhanced environmental programs and research, in particular at the graduate level.

Through existing partnerships with the Canadian Forest Service (Natural Resources Canada), and the addition of new partnerships with the provincial Forest and Agrifoods Agency (Department of Natural Resources), and Agriculture-Agrifoods Canada (Government of Canada), Grenfell Campus has reinforced its relationship with these agencies in the development of applicable and relevant research programs. With the signing of an MOU between these partners in 2013, a research program is being developed using current expertise from all parties to meet key research objectives. Primary research areas include forestry, agriculture/afrifoods, and climate change. Additional opportunities for research and environmental services (i.e. municipal water testing / environmental assessments / mining research) applicable to regional, provincial or national environmental problems and solutions will emerge from existing research faculty, new research faculty hiring, industry partners, and graduate students.

In a study conducted for the Office of the President, Memorial University of Newfoundland, Goss and Harvey (2012) noted:

"as the [Grenfell] Campus moves to a culture of intensive research, means will have to be found to provide faculty with sufficient time to carry out research activity including the teaching and supervision of graduate students…. It would therefore be desirable to have a mechanism whereby the appointed faculty to this area plus other faculty who would like to have some input into the area could function together as a unit. **We support the development of a graduate-level academic/research unit, perhaps an “institute”, based at the Grenfell Campus. This unit could contain as full time members the newly appointed and any seconded faculty and have as associate or part time members any faculty or outside researchers who can make a**

\(^1\) Grenfell Strategic Plan 2014 is available at: http://www.swgc.ca/administration/Pages/strategic-plan.aspx
contribution to its goals. The unit would then be responsible for appointments, assignment of duties and career development decisions as well as strategic planning for the area". (pp. 8-9)

Based on the advice of Goss and Harvey (2012), the signing of the 2013 MOU between Grenfell Campus and its partners was the initiation of program planning for the Master of Science in Agricultural, Forest and Environmental Science (MSc AFES). Since that period, Grenfell Campus has completed major steps toward the development of research and graduate programing in environmental science: 1) construction of a $4M boreal ecosystem research facility, 2) hiring of 5 research professors, 3) the purchase and installation of over $5M in major research equipment, and 4) hiring of 2 laboratory technicians to support the equipment and research requirements in the laboratories. The significant investment in facilities, equipment and human resources has prepared Grenfell Campus to conduct world-class research in agricultural, forest and environmental science.

3.1 Benefits to the Grenfell Campus and Memorial University

Grenfell Campus and Memorial University are growing, and along with the increase in the student base, programs that meet current and anticipated demand need to be rationalized, developed, and initiated. Grenfell Campus has graduated students in environmental science since 1998, and many of these graduates have moved into greater leadership and research-based positions. Many of these positions, and others which are on the market today, require a science-based Masters degree.

The environmental research demands in this country and globally, are expanding as the world faces greater environmental challenges and demands. Climate change, food security, and the production of resource based products all have immediate challenges which the MSc AFES will serve to provide expertise to meet these challenges. The need for increased student enrolment at Grenfell Campus combined with the demand for specialized programs in environmental science is an opportunity knocking. With the addition of highly qualified personnel in the hiring of five research professors and two laboratory coordinators, Grenfell Campus is in a position to lead academic programming across Canada and North America in agricultural, forestry and climate change research.

The proposed MSc AFES graduate program will support Memorial University’s strategic plan².

i. Serve students by:
   - Accessing and potentially providing financial support to graduate students collaborating on BERI research projects
   - Giving access to a unique Master degree that is valuable both on the Canadian and on the international labour market
   - Providing innovative, cutting edge ecological science experiences to graduate students that will assist them in transitioning to employment
   - Facilitating student research by suggesting research priorities and key resources and by providing research support for graduate students
   - Supporting the development of the future graduate programs at Grenfell Campus and within the Memorial University system

ii. Contribute to Memorial University’s research agenda by:
   - Securing external funding for research formulation and dissemination
   - Helping to build Grenfell Campus’ research profile by:
     o Creating and maintaining cross-disciplinary collaboration
     o Disseminating research findings within the university system
     o Collaborating with and sharing research findings with communities and industry in the province

² The 2014-17 Strategic Plan for Memorial University is available at www.mun.ca/ciap/Planning/plans_and_annual.php
 Supporting new research and new researchers
 Helping secure funding for graduate researchers

• Filling a significant gap in environmental analysis needs in the province, particularly soil, plant, water and air analysis
• Building on Memorial University’s existing strengths in diverse environmental fields in the social sciences, humanities and sciences and honing these strengths toward environmental analysis and development

iii. Contribute toward institutional responsibility by:

• Supporting research and providing leadership on campus by linking with and supporting the President’s Advisory Committee on Sustainability (PACS) at Grenfell Campus and the Advisory Committee on Sustainability (ACS) and the Earth and Human Systems Sustainability Initiative (EHSSI) in St. John’s.

The proposed MSc AFES graduate degree program will benefit Grenfell’s students (goals 1 and 4 of the Grenfell Campus Strategic Plan\(^3\)) by helping to connect graduate students to meaningful research experiences. The graduate program will strive to hire students to provide hands-on experience with research work that combines skills in the sciences.

By contributing to and focusing on Grenfell’s current environmental programs, the MSc AFES graduate degree program will further strengthen Grenfell Campus’ appeal as a “destination of choice” (goal 5) for environmental research and studies. The presence of an environmental science master degree program at Grenfell Campus demonstrates it as a place where research is engaged with real-world problems, and this is greatly appealing to students.

Finally, as the MSc AFES graduate degree program develops within the Boreal Ecosystem Research Initiative, it will increasingly create connections to other universities and researchers (goal 6), as required by specific projects, conferences, retreats and summer schools.

3.2 Benefits to the Province of Newfoundland and Labrador

The MSc AFES graduate degree program is designed to provide a pool of talented and well-trained researchers. With the province of Newfoundland and Labrador’s expanding development in mining, oil and gas, and renewable energy, as well as the increased need for food production and secondary wood fibre production, many graduates will potentially work with environmental and natural resource-based companies and organizations in the province. Many graduate students in the program will likely choose local and national companies in which to conduct their research, further increasing their chances of obtaining employment in the province after graduation. Companies such as NALCOR, Anaconda Mining, AMEC, Vale Minerals, and an increasing number of members of the Newfoundland and Labrador Environmental Industry Association (NEIA) are growing, and with their growth comes the demand to increase their environmental programs and services.

The MSc AFES graduate degree program will address the needs of the province specifically by: 1) collecting data and studying environmental issues impacting Newfoundland and Labrador; 2) collaborating with government, local communities and other institutions to respond to provincial needs for environmental research; 3) collaborating with the Labrador Institute and Aboriginal communities to support environmental research relevant to Aboriginal communities, and 4) supporting the attraction and retention of out-of-province and international student researchers at both the undergraduate and graduate levels.

\(^3\) Grenfell Strategic Plan 2014 is available at: http://www.swgc.ca/administration/Pages/strategic-plan.aspx
3.3 Benefits to the Greater Academic Community, Including Potential Students

The Master of Science in Agricultural, Forest and Environmental Science program will meet the needs of students seeking a research-based graduate degree program in the environmental field in Newfoundland and Labrador. It is anticipated that student demand would come initially from graduates of undergraduate science programs at Memorial University, but as the program becomes known, it will attract students from North America and global markets. Matched with the existing Master of Arts in Environmental Policy (MAEP) at the Grenfell Campus, the MSc AFES graduate degree program will provide students with the option of pursuing a social science or natural science graduate degree in the environmental field. In the process of developing the graduate program, letters of support for the graduate program and the supporting research in agriculture, forestry and climate change were received from the following individuals and agencies:

- Mr. Frank Ricketts, Chair, Newfoundland Environmental Industries Association
- Dr. Brian Hearn, Acting Director, Canadian Forest Service, Corner Brook
- Dr. Christiane Delauriers, Director General, Agriculture-Agrifoods Canada
- Mr. James Evans, CEO, Forestry and Agrifoods Agency, Government of NL
- Dr. Richard Donald, Associate Dean, Faculty of Agriculture, Dalhousie University
- Dr. Susan Ziegler, Canada Research Chair in Environmental Science, Memorial University of Newfoundland
- Mr. Eugene Legge, President, NL Federation of Agriculture

To quote relevant comments from these letters of support:

*Newfoundland and Labrador Environmental Industry Association*

*NEIA is a not-for-profit association of businesses that promotes the growth and development of the environmental sector in Newfoundland and Labrador. We represent firms operating in areas as diverse as waste management, sustainable resource development, green building and green transportation. The growth of this sector depends on qualified professionals. Several firms within the sector have identified “access to skilled human resources” as a barrier to growth. A recent report published by GLOBE Advisors and Earth & Environmental, “An Analysis of the Economic Development Opportunities Associated with the Green Economy in Newfoundland and Labrador”, states that the environmental sector employs over 10,300 Newfoundlanders and Labradorians in over 1,100 private and public organizations. The report, even in its conservative estimates, predicts significant growth for the sector. The availability of qualified labour is a crucial factor in this growth. The current Grenfell [BERI] initiative helps address these workforce challenges within the environmental sector in a number of ways. The facilities will ensure the high quality of environmentally related education by complementing classroom teaching efforts and exposing students to the state of the art technology used within the sector. In addition, new facilities will assist Memorial in recruiting highly qualified faculty, laboratory technicians, graduate students, and postdoctoral fellows in environmental research. The presence of these skilled individuals not only contributes to an enhanced classroom experience, but also serves to establish Grenfell*

---

4 The full version of the letters of support can be found in Appendix F.
Campus and the Corner Brook region as a centre of excellence for environmental research. These measures, we hold, will further enhance the supply of qualified labour available to work in this growing sector.

Mr. Frank Ricketts, Chair
Newfoundland Environmental Industries Association

Faculty of Agriculture, Dalhousie University

.... universities in Atlantic Canada should be more deliberate about working together to support agriculture through closer research and academic planning and coordination of resources. Following in that vein, the Faculty of Agriculture at Dalhousie University is eager to lend support to your initiatives at Grenfell Campus toward the development of agriculture-focused research and graduate programs.

Dr. Richard Donald, Associate Dean
Faculty of Agriculture, Dalhousie University

Agriculture-Agrifood Canada

I am pleased to express Agriculture and Agri-Food Canada's (AAFC) support for Memorial University's initiative in creating a graduate program with a focus on agricultural research at its Grenfell Campus. The new faculty and labs will also form the basis of future collaboration between our two organizations and contribute to industry and provincial government objectives of increasing the overall economic output of Newfoundland and Labrador's agricultural sector.

Dr. Christiane Delauriers, Director General
Agriculture-Agrifoods Canada

Dr. Sue Ziegler

I am writing to express my strong support for the proposed Environmental Research Facility and graduate programs. This facility will provide an important platform for the development of a knowledge-based industry linked to the natural resources sector. The research supported through this facility will enable the province and Canada to gain the knowledge required to adapt and establish forward thinking policy relevant to those resources including forestry and agriculture. We are all keenly aware of our changing climate, which is the primary driver of ecosystem processes including forest and agricultural systems.

Dr. Susan Ziegler, Canada Research Chair in Environmental Science
Memorial University of Newfoundland

Canadian Forest Service, Natural Resources Canada

As you know, the CFS office in Corner Brook has had a strong working relationship with Grenfell Campus, its students, faculty, and administration over the last 15+ years. This is demonstrated by the fact that many CFS staff members serve as Adjunct Professors at Grenfell Campus and co-supervise graduate students. Further, Grenfell and CFS are actively working together, in collaboration with the Provincial Department of Natural Resources - Forest Service, in the development of a Collaborative Research Agreement for enhanced forest research capacity which will pave the way for the creation of the Boreal Ecosystem Research Institute (BERI). BERI will augment the forest sector research capacity by means of increased research infrastructure, the hiring of additional forest sector research positions, and increased graduate programming in Environmental Science and Environmental Policy - initiatives critical to the success of BERI.

Dr. Brian Hearn, Acting Director
Canadian Forest Service, Corner Brook
4. Market analysis

The Canadian Job Market

According to the Jobs Report: State of the Canadian Labour Market (2014), Canada's labour market has outperformed those of other Group of Seven (G-7) economies since 2006 with close to 1.6 million net new jobs created across the country. Despite the weak global economic environment, the Canadian economy has expanded at a faster pace than other G-7 economies and the labour market has been resilient, with over 1 million net new jobs created since the recovery began in July 2009 (See Table 4.1). This represents the strongest labour market performance among all G-7 economies. Moreover, high-wage, high-skilled, full-time and private-sector employment has been the main source of job creation over the recovery.

![Image of bar chart showing job creation in Canada over the recovery has largely been in high-wage, full-time, private-sector employment]

Table 4.1 Job creation in Canada since 2009

Also evident is the fact that Newfoundland and Labrador has experienced higher than average job creation across Canada, with over 11 percent employment gains since 2009 (Table 4.2).
Table 4.2 Provincial job creation in Canada since 2009

Canada also fares well compared to other countries with regard to post-secondary educational attainment. Overall, Canada enjoys a fairly mobile population that responds well to economic opportunities and regional differences in labour market conditions. Table 4.3 demonstrates the increasing demand for education at all levels, and shows that there are over 1.75 millions graduate students in Canada (2011) and increasing yearly.

Table 4.3 Post-secondary enrolment in Canada (1992-2011)

Fuelling innovative growth in the shift to a knowledge-based economy in the Canadian job market requires a highly skilled workforce. In this respect, workers with science, technology, engineering and mathematics (STEM) degrees play an important role as they are at the leading edge of technological
progress. Canada’s college system produces a substantial number of graduates in STEM fields. In particular, Canada graduates relatively more students than the OECD average and the United States in the Environmental Science, physical sciences, and mathematics and statistics. Table 4.4 demonstrates that a university degree is becoming the skill requirement for successful employment in emerging labour markets, and graduate degree completion undoubtedly significantly increases the opportunity for employment.

Table 4.4 Skill requirements for emerging markets in Canada (1990-2012)

Occupations related to natural and applied sciences have had persistently high job vacancy rates over the recovery, suggesting unfilled labour demand in this occupation group.

Alberta, Saskatchewan, and Newfoundland and Labrador have seen the largest increase in job vacancy rates since 2009, largely reflecting high labour demand in certain occupations in these regions, particularly skilled trades and science-based occupations.

The Environmental Employment Market

ECO (Environmental Careers Organization) Canada develops programs that help individuals build meaningful environmental careers, provides employers with resources to find and keep the best employees, and informs educators and governments of employment trends to ensure the ongoing prosperity of the Canadian environmental sector.

Since 1992, ECO Canada has established itself as the national, industry-initiated and led organization for environmental human resources issues. ECO Canada’s extensive labour market intelligence provides insight on the opportunities, challenges and solutions for building a world-leading environmental workforce. ECO Canada offers environmental career resources for professionals and employers.

Eco-Canada’s publication "Labour Market Research - Profile of Canadian Environmental Employment, 2013" summarizes the labour market statistics for environmental professional in Canada. It’s most recent report shows tremendous promise for job creation and emerging professions in environmental industries:

“As social awareness of the environment’s importance continues to grow, so does the impact that
environmental work has on the Canadian economy. This growth produces many important benefits, including the creation of new jobs, the reduction of economic costs, and the development of innovative business opportunities."

Labour Market Research - Profile of Canadian Environmental Employment, Eco Canada, 2013

According to their recent study (2013), over 730,000 environmental professionals are employed in Canada (Table 4.5), and spend at least 50% of their work time performing environmental activities. This represents just over 4% of the total Canadian labour force. Since 2010, the number of environmental professionals has grown by about 7%. Based on a general comparison of trends over the years, there is a continual increase in the demand for environmental skills. This growth has consistently outpaced that of the overall Canadian workforce.

![Graph showing the number of environmental professionals working in Canada from 1993 to 2013.]

Table 4.5 Environmental professionals working in Canada (1993-2013)- Source: Eco-Canada (2013)

The study highlights the fact that more than 10% of all employed workers in Canada use environmental skills, underscoring the diversity and importance of environmental competencies in a wide range of industries. The following industries have the highest proportion of environmental employees: Administrative and Support, Waste Management and Remediation Services (25.1%), Professional, Scientific, and Technical Services (22.4%), Wholesale Trade and Retail Trade (13.9%), Other Services (13.8%), and Manufacturing (13.7%). With 22.4 percent of environmental workers employed in the "professional, scientific and technical services" category, this amounts to over 163,000 professional (>50% of their work) workers employed in Canada in 2013.

However, the total number of environmental employees (Table 4.6) in Canada is over 1.7 million as many employees do other non-environmental work as a part of their job. The table also clearly shows the lack of environmental scientists specializing in agriculture and forestry.
Environmental Employees by Environmental Sub-Sector

Table 4.6 Environmental employees by sub-sector in Canada (2013) - Source: Eco-Canada (2013)

Demand for environmental employees
Eco-Canada also estimates that the demand for workers with environmental skills will increase over the near future. Their study found that most employers (74.5%) intend to hire new environmental employees over the next two years, both for newly created roles and replacement positions following staff departures and retirements. In addition to growth among current environmental employers, the number of environmental employees may also expand as regulatory requirements continue to evolve and a greater number of Canadian establishments adopt environmental practices.

New job openings will include technical roles, such as Forestry and Mining Workers, and Environmental Technicians, as well as specialist roles that require advanced education, such as Environmental Engineers, Marine Biologists, and Geoscientists. If recent trends hold, employers will need to hire recent graduates and transitioning workers from other industries to fill these positions. A notable proportion (13.1%) of job opportunities will be for past employees who have changed positions within the same establishment or changed employers.

Retirements will create many job openings in the near future. Nearly one-fifth (19.0%) of the environmental workforce is expected to retire over the next 10 years, creating openings for primarily intermediate- and senior-level roles. Employers will need to rely on existing junior- and intermediate-level employees to fill some of these senior roles. Transitioning workers from other sectors and industries may also help meet this increased demand for experienced practitioners.

Employers have had some difficulty filling a wide variety of different environmental occupations, including both technical occupations and specialist roles that require advanced education. Some employers found it especially difficult to fill positions for Environmental Engineers, Environmental Technicians or Technologists, Forestry or Mining Workers, and Remediation Specialists.

Summary of employment opportunities
Based on the Government of Canada's job analysis and Eco-Canada's career opportunities, it is evident that the environmental industries are growing in Canada, and globally. This resulted in increased
graduate studies opportunities for students around the world. As an emerging provider of environmental graduate degree programs, Grenfell Campus has the opportunity to compete nationally and internationally for graduate students, faculty and staff. The proposal for the MSc in Agricultural, Forest and Environmental Science at Grenfell Campus will set forth tremendous opportunities for Canadian and international students in this growing field of study.

Analysis of competing graduate programs
As a component of the proposal for the MSc in Agricultural, Forest and Environmental Science at Grenfell Campus, a scan was undertaken (Table 4.7) to determine the competitive "marketplace" for graduate programs relevant in the broad field of the environment and environmental sustainability in particular, including disciplines in agriculture, forestry and Environmental Science. The scan is focused on graduate programs that are geographically close to Grenfell Campus – Memorial University, or that may compete in the graduate studies marketplace for students in the agricultural, forest science, environmental and life science fields. It is primarily comprised of interdisciplinary and applied programs focused on the environment that could feasibly produce graduates capable of working at the interface of environmental science, environmental studies and the social sciences, and the humanities. Programs with a pure, non-applied science focus, and arts programs lacking a clear link to BERI's strategic research priorities, have been excluded.
<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>Threat</th>
<th>Institution(s)</th>
<th>Discipline(s)</th>
<th>Location</th>
<th>UR</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSc. in Agriculture</td>
<td>Masters</td>
<td>High</td>
<td>Dalhousie University</td>
<td>Agriculture</td>
<td>Truro, NS, Canada</td>
<td>Pr</td>
</tr>
<tr>
<td>Master of Environmental Studies (MES)</td>
<td>Masters</td>
<td>High</td>
<td>Dalhousie University</td>
<td>Environmental Studies and Sciences</td>
<td>Halifax, NS, Canada</td>
<td>Ho</td>
</tr>
<tr>
<td>Master's in Forestry and Environmental Management (MScF, MF, MScFE, MFE, MEM)</td>
<td>Masters</td>
<td>Low</td>
<td>University of New Brunswick</td>
<td>Other</td>
<td>Fredericton, NB, Canada</td>
<td>Ho</td>
</tr>
<tr>
<td>M.Env. in Environmental Assessment</td>
<td>Masters</td>
<td>Low</td>
<td>Concordia University</td>
<td>Environmental Studies and Sciences</td>
<td>Montreal, QC, Canada</td>
<td>Ho</td>
</tr>
<tr>
<td>MA, MSc, MBA, MEd, MEng, MFC, MI, MScF, MScPI in Environmental Studies (collaborative program with student's &quot;home&quot; department)</td>
<td>Masters</td>
<td>Medium</td>
<td>University of Toronto</td>
<td>Environmental Studies and Science</td>
<td>Toronto, ON, Canada</td>
<td>Ho</td>
</tr>
<tr>
<td>Master of Science in Sustainability Management (MScSM) (management or science stream)</td>
<td>Masters</td>
<td>Low</td>
<td>University of Toronto</td>
<td>Sustainability Studies and Science</td>
<td>Toronto, ON, Canada</td>
<td>Ho</td>
</tr>
<tr>
<td>MA or MSc in Environmental Sustainability (Collaborative)</td>
<td>Masters</td>
<td>Low</td>
<td>University of Ottawa</td>
<td>Sustainability Studies and Science</td>
<td>Ottawa, ON, Canada</td>
<td>Ho</td>
</tr>
<tr>
<td>Master of Environmental Studies (MES)</td>
<td>Masters</td>
<td>Medium-High</td>
<td>Queen's University</td>
<td>Environmental Studies and Sciences</td>
<td>Kingston, ON, Canada</td>
<td>Ho</td>
</tr>
<tr>
<td>Masters in Environment and Sustainability (MES)</td>
<td>Masters</td>
<td>Low</td>
<td>University of Western Ontario</td>
<td>Environmental Studies and Sciences</td>
<td>London, ON, Canada</td>
<td>Ho</td>
</tr>
<tr>
<td>Program</td>
<td>Degree</td>
<td>Level</td>
<td>University</td>
<td>Discipline</td>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>----------</td>
<td>---------------------</td>
<td>---------------------------------</td>
<td>------------------</td>
<td>---------------------------------</td>
<td></td>
</tr>
<tr>
<td>M.Sc. in Food, Agriculture &amp; Resource Economics</td>
<td>Masters</td>
<td>Medium Primarily Social Science Policy-based</td>
<td>University of Guelph</td>
<td>Agriculture</td>
<td>Guelph, ON, Canada</td>
<td></td>
</tr>
<tr>
<td>Master of Environment and Sustainability (MES)</td>
<td>Masters</td>
<td>High Full-range AG-ES Master programs</td>
<td>University of Saskatchewan</td>
<td>Environmental Studies and Sciences</td>
<td>Saskatoon, SK, Canada</td>
<td></td>
</tr>
<tr>
<td>MA or MSc in Agricultural Studies</td>
<td>Masters</td>
<td>Medium-High Flexible MSc in AG</td>
<td>University of Lethbridge</td>
<td>Agriculture</td>
<td>Lethbridge, AB, Canada</td>
<td></td>
</tr>
<tr>
<td>MSc or MEng or MAg or MBA/MSc in Agricultural, Food &amp; Nutritional Science</td>
<td>Masters</td>
<td>High Full-range AG-ES Master programs</td>
<td>University of Alberta</td>
<td>Agriculture</td>
<td>Edmonton, AB, Canada</td>
<td></td>
</tr>
<tr>
<td>Master of Forestry (MF), MSc or Master of Applied Science (MASc), Soil Science, Master of Sustainable Forest Management (MSFM)</td>
<td>Masters</td>
<td>High Full-range Soil-Forest AG-ES Master programs</td>
<td>University of British Columbia</td>
<td>Other</td>
<td>Vancouver, BC, Canada</td>
<td></td>
</tr>
<tr>
<td>M.S. in Ecology and Environmental Sciences</td>
<td>Masters</td>
<td>Medium Basic MS program</td>
<td>University of Maine</td>
<td>Environmental Studies and Sciences</td>
<td>Orono, ME, USA</td>
<td></td>
</tr>
<tr>
<td>M.S. in Sustainable Agriculture</td>
<td>Masters</td>
<td>High Full-range AG Master programs</td>
<td>Iowa State University</td>
<td>Agriculture</td>
<td>Ames, IA, USA</td>
<td></td>
</tr>
<tr>
<td>M.S. in Agroecology</td>
<td>Masters</td>
<td>High Full-range AG Master programs</td>
<td>University of Wisconsin-Madison</td>
<td>Agriculture</td>
<td>Madison, WI, USA</td>
<td></td>
</tr>
<tr>
<td>M.S. in Agriculture, Food and Environment</td>
<td>Masters</td>
<td>High Full-range AG-ES Master programs</td>
<td>Tufts University</td>
<td>Agriculture</td>
<td>Medford, MA, USA</td>
<td></td>
</tr>
</tbody>
</table>
Sources


Various academic institution websites

NOTES:

Based on the scan of relevant Master of Science programs in Agricultural Science, Forest Science, and Environmental competitors for graduate students are in the major agricultural and environmental science universities in Canada and The in Canada these include Dalhousie University (Faculty of Agriculture and Faculty of Science), the University of Saskatchewan, Alberta and the University of British Columbia, with secondary competition from Ontario universities Queens University and Guelph. Each of these universities has significant capacity in a range of overlapping research areas in agriculture, forest science, and sustainability disciplines. The scope of the proposed program is sufficiently diverse to attract graduate students from a wide background in natural and social sciences to study in a small university environment with world class faculty and resources (laboratory and technical equipment, and resources), Grenfell Campus is in a unique position to create a research identity second to none in North America.
5. Projected enrolment

Although difficult to predict over a five-year period, projected enrolment is estimated to increase over the period, due in part to the increased exposure of the programs, and the strength of the faculty members in attracting graduate students in their specialization. The MSc AFES program steady-state enrolment is estimated to cap at approximately thirty (30) students in all aspects of the program (specialization, part-time, full-time, and returning students), and the balance of Canadian versus international students is expected to achieve a 2/3 – 1/3 ratio respectively after five years. Over a longer term, judging by the history of Grenfell’s Master of Arts in Environmental Policy (MAEP), international enrolment may exceed Canadian enrolment. International student enrolment may also rise above expected numbers due to the increased demand for environmental scientists in the global labour market. To achieve this level of enrolment, MSc AFES annual student intake would initially begin with five (5) students and cap at thirteen (13). Table 5.1 below demonstrates the anticipated annual intake and continuing enrolments.

Table 5.1 MSc AFES Projected 5-year enrolment* (including continuing students)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>New FT enrolment</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>35</td>
</tr>
<tr>
<td>New PT enrolment</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Annual New Enrolment</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>13</td>
<td>45</td>
</tr>
<tr>
<td>Returning FT enrolment</td>
<td>0</td>
<td>5</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>Returning PT enrolment</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Canadian enrolment</td>
<td>4</td>
<td>9</td>
<td>12</td>
<td>15</td>
<td>18</td>
<td>58</td>
</tr>
<tr>
<td>International enrolment</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>10</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>12</td>
<td>17</td>
<td>22</td>
<td>28</td>
<td>84</td>
</tr>
</tbody>
</table>

*Enrolment as of Fall semester of each year.

6. Resource Implications

6.1 Faculty complement and workload

Faculty expertise

Grenfell Campus currently has 15 faculty members and 17 staff specializing in environmental programs associated with the Division of Science. Another 17 faculty members deliver degree programs in the Division of Social Science, including Environmental Studies and Sustainable Resource Management, and faculty members from the St. John’s Campus of Memorial University may be involved with the delivery of the graduate program at Grenfell Campus. The list of potential expertise for the program, including CV’s, can be found in Appendix F.

Grenfell Campus has recently hired five (5) research professors for the Boreal Ecosystems Research Initiative. Individuals hired for these positions have strong research backgrounds in areas of soil analysis, water quality analysis and herbaceous plants. New faculty and staff will work with existing campus expertise to develop and oversee the implementation of graduate programs in environmental science, and will participate in the teaching and the supervision of graduate students in their respective fields. The
areas of faculty expertise associated with this environmental research agenda include Agronomy, Biology, Physics, Chemistry, Earth Science, Engineering, Soil Science, Plant / Crop Science, Natural Resource Economics and Hydrology.

**Laboratory and technical personnel**

Operating an environmental research laboratory for the purposes of soil, water quality and plant chemical analysis will require the assistance of fully trained, accredited and qualified personnel. Two (2) highly qualified laboratory coordinators / technicians were recently hired, and they will assist in the set-up and maintenance of the equipment, conducting tests, developing methods and analyses, as well as training graduate students in the use of the advanced research equipment.

**Additional / potential research faculty**

Western Newfoundland is becoming a hub for environmental research, and there are many people within the region to conduct research facilitated by BERI. Beyond faculty at Grenfell College, there are also environmental researchers within Natural Resources Canada (NRCan), Agriculture-Agrifood Canada (AAFC), Parks Canada (PC), provincial Departments of Natural Resources (DNR) and Environment and Conservation (DEC), and local non-governmental organizations. Many of these researchers are already working in environmental scientific research and many more are interested in developing this capacity within Grenfell and in the greater community. Furthermore, as the MSc AFES graduate program develops at Grenfell Campus, there will also be a local pool of graduate students specifically trained in this field. In addition, BERI will network with researchers currently working on relevant topics across the province and in other provinces. The institute will draw on faculty from St. John’s campus, the Labrador Institute, the partner agencies (CFS / NL Forestry & Agrifoods / Agriculture-Agrifood Canada) and other universities (Dalhousie’s Faculty of Agriculture) and institutes to support BERI through sabbatical replacements, post-doctoral appointments, and/or by serving as adjuncts on specific projects. Work is ongoing to continue expanding the list of collaborators who will participate and assist with BERI. The list of currently identified experts for the MSc AFES program can be found in Appendix F.

**Support services for faculty and graduate students**

The Master of Science in Agricultural, Forest and Environmental Science program will require the services of administrative support, including a Director for BERI, a graduate officer, and an administrative assistant. These services have been included in the budgetary requirements for the program (see Table 7.2).

### 6.2 Space, facilities, and student support

Grenfell Campus has recently completed the development of a 500 m² (5382 ft²) boreal ecosystems research facility, containing 3 separate laboratory spaces in which to conduct environmental research for the MSc AFES graduate programs. The facility houses a full complement of research space, equipment, and administrative workspaces to accommodate the proposed graduate programs.

i. **Physical Plant - Extension of the Forest Centre building:** Construction of the environmental research laboratories was completed in Fall 2013, attached to the current Forest Centre on the Grenfell Campus. This new facility has been designed to meet the needs of the environmental sciences research faculty, associate researchers and graduate students, including research space, workstations, high-speed internet access, and data transfer and storage.

ii. **Equipment:** A suite of research grade equipment with the capacity to analyze soils, water and plants valued at over $5M has been established at Grenfell Campus. As the development of the research
agenda expands over time, it is proposed that additional equipment will be added to the lab with the support of external research funding grants and that all such equipment will become part of the general pool of equipment available to all faculty and adjunct researchers at Grenfell Campus.

iii. Classroom Space: Classroom space is sufficient on the Grenfell Campus to accommodate class sizes up to 60 students. Due to the nature of the environmental graduate program being proposed, it is anticipated that classrooms suitable for up to 15 graduate students will be required, and that there is sufficient access to classrooms and meeting spaces for the proposed program.

iv. Graduate Study Space: Grenfell Campus has been expanding its building capacity and support for graduate research. Currently approximately 27 graduate students are enrolled in the MAEP program, and as students become enrolled in the MSc AFES program, graduate study space will be added.

6.3 Financial support

Graduate Student Funding

Eligible students will receive baseline fellowship funding through the School of Graduate Studies of approximately $6,800 per year (student must meet minimum academic requirements). MSc AFES students will also be eligible to receive support from the Research Office, Grenfell Campus for up to $3,150, and Graduate Assistantship support up to $3,553 annually, for a total potential graduate student funding of $13,553 annually. Scholarships and bursaries may also be available to graduate students as they progress through their program. The graduate student support funding is included in the program budget. Faculty members will also have access to competitive research grants through Tri-Council and commercialization activities and research contracts that will benefit graduate student funding opportunities.

7. Budget

Although capital investments in the building and equipment have been made, heavy laboratory and field experience requirements for the degree necessitate the addition of special fees to cover the costs to operate the research laboratories and field units. Based on the anticipated costs of operating the MSc AFES graduate program, total fees (tuition and special fees) are proposed to be $5000/year for Canadian students, and $10,000/year for international students. Additional revenue is projected for the operation of the laboratories from faculty research grants, partner and industry opportunities for research projects, environmental sampling, testing and analysis. The projected enrolment for the program is noted below (Table 7.1).
Table 7.1 Graduate student enrolment and projected revenue

### Student Enrolment & Fees

#### MSc AFES Enrolment

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>New FT enrolment</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>35</td>
</tr>
<tr>
<td>New PT enrolment</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Annual New Enrolment</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>13</td>
<td>45</td>
</tr>
<tr>
<td>Returning FT enrolment</td>
<td>0</td>
<td>5</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>Returning PT enrolment</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Canadian enrolment</td>
<td>4</td>
<td>9</td>
<td>12</td>
<td>15</td>
<td>18</td>
<td>58</td>
</tr>
<tr>
<td>International enrolment</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>10</td>
<td>28</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5</strong></td>
<td><strong>12</strong></td>
<td><strong>17</strong></td>
<td><strong>22</strong></td>
<td><strong>28</strong></td>
<td><strong>84</strong></td>
</tr>
</tbody>
</table>

* Program Tuition (CDN) - $2199/year  
  ** Program Tuition (INT) - $2859/year  
  ** Special Fees (CDN) - $6600 (total)  
  ** Special Fees (INT) - $14300 (total)

| **Annual Totals** | **$ 30,005.00** | **$ 75,018.00** | **$ 110,033.00** | **$ 145,048.00** | **$ 190,072.00** | **$ 550,176.00** |

* Program tuition fees are collected over 6 program semesters (2 years)
** The full amount of special fees are collected at initial registration for the program

Based on the anticipated enrolment projections and costs associated with the MSc AFES program, it is anticipated that the programs will become self-supporting after the initial three-year period (see Table 7.2). With possible increases in enrolment or revenue from research grants or commercial applications of the laboratory services, this revenue balance may increase favourably.
Table 7.2 Program budget (Years 1-5)

<table>
<thead>
<tr>
<th>Proposed Budget (Years 1-5)</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenue (Projected)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSc Program fees (based on enrollment projections)</td>
<td>$30,005.00</td>
<td>$75,018.00</td>
<td>$110,033.00</td>
<td>$145,048.00</td>
<td>$190,072.00</td>
</tr>
<tr>
<td>PhD Program fees (based on enrollment projections)</td>
<td>$24,280.00</td>
<td>$72,840.00</td>
<td>$113,188.00</td>
<td>$161,728.00</td>
<td>$194,240.00</td>
</tr>
<tr>
<td>AES funding (Research Office)</td>
<td>$831,435.00</td>
<td>$831,435.00</td>
<td>$831,435.00</td>
<td>$831,435.00</td>
<td>$831,435.00</td>
</tr>
<tr>
<td>Internal revenue (research grants)</td>
<td>$150,000.00</td>
<td>$165,000.00</td>
<td>$181,500.00</td>
<td>$199,650.00</td>
<td>$219,615.00</td>
</tr>
<tr>
<td>External revenue (contractual lab work)</td>
<td>$150,000.00</td>
<td>$165,000.00</td>
<td>$181,500.00</td>
<td>$199,650.00</td>
<td>$219,615.00</td>
</tr>
<tr>
<td><strong>Total Revenue</strong></td>
<td>$1,185,728.00</td>
<td>$1,309,293.00</td>
<td>$1,417,636.00</td>
<td>$1,537,511.00</td>
<td>$1,654,377.00</td>
</tr>
<tr>
<td><strong>Expenditures (Projected)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instructional costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular faculty (2% increase annually)</td>
<td>$660,000.00</td>
<td>$673,200.00</td>
<td>$686,664.00</td>
<td>$700,397.28</td>
<td>$714,405.23</td>
</tr>
<tr>
<td>Term appointments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LUMUN appointments (2-6 courses annually)</td>
<td>$10,000.00</td>
<td>$16,000.00</td>
<td>$20,000.00</td>
<td>$25,000.00</td>
<td>$30,000.00</td>
</tr>
<tr>
<td>Graduate Assistantships</td>
<td>$46,900.00</td>
<td>$53,600.00</td>
<td>$60,300.00</td>
<td>$73,700.00</td>
<td>$80,400.00</td>
</tr>
<tr>
<td><strong>Total instructional costs</strong></td>
<td>$716,900.00</td>
<td>$741,800.00</td>
<td>$766,564.00</td>
<td>$799,097.28</td>
<td>$824,805.23</td>
</tr>
<tr>
<td>Administrative costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salary costs (2% increase)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lab coordinators</td>
<td>$148,800.00</td>
<td>$151,776.00</td>
<td>$154,811.52</td>
<td>$157,907.75</td>
<td>$161,085.01</td>
</tr>
<tr>
<td>Administrative support</td>
<td>$16,035.00</td>
<td>$18,385.70</td>
<td>$16,682.81</td>
<td>$17,016.47</td>
<td>$17,356.80</td>
</tr>
<tr>
<td>Course remissions</td>
<td>$4,800.00</td>
<td>$4,800.00</td>
<td>$4,800.03</td>
<td>$4,800.00</td>
<td>$4,800.00</td>
</tr>
<tr>
<td>Director stipend</td>
<td>$1,800.00</td>
<td>$1,800.00</td>
<td>$1,800.00</td>
<td>$1,800.00</td>
<td>$1,800.00</td>
</tr>
<tr>
<td>Thesis Supervision</td>
<td>$21,600.00</td>
<td>$21,200.00</td>
<td>$20,000.00</td>
<td>$20,000.00</td>
<td>$20,000.00</td>
</tr>
<tr>
<td><strong>Operating costs</strong></td>
<td>$300,000.00</td>
<td>$300,000.00</td>
<td>$300,000.00</td>
<td>$300,000.00</td>
<td>$300,000.00</td>
</tr>
<tr>
<td>Materials and supplies (labs)</td>
<td>$5,000.00</td>
<td>$5,000.00</td>
<td>$5,000.00</td>
<td>$5,000.00</td>
<td>$5,000.00</td>
</tr>
<tr>
<td>Reference materials</td>
<td>$10,000.00</td>
<td>$10,000.00</td>
<td>$10,000.00</td>
<td>$10,000.00</td>
<td>$10,000.00</td>
</tr>
<tr>
<td>Computers and software</td>
<td>$5,000.00</td>
<td>$5,000.00</td>
<td>$5,000.00</td>
<td>$5,000.00</td>
<td>$5,000.00</td>
</tr>
<tr>
<td>Travel (field sampling and collection)</td>
<td>$113,163.50</td>
<td>$113,163.50</td>
<td>$113,163.50</td>
<td>$113,163.50</td>
<td>$113,163.50</td>
</tr>
<tr>
<td><strong>Other operating costs (overhead)</strong></td>
<td>$138,098.50</td>
<td>$137,695.20</td>
<td>$140,221.83</td>
<td>$1,454,358.00</td>
<td>$1,493,191.43</td>
</tr>
<tr>
<td><strong>Total expenditures</strong></td>
<td>$1,338,098.50</td>
<td>$1,375,695.20</td>
<td>$1,409,221.83</td>
<td>$1,454,358.00</td>
<td>$1,493,191.43</td>
</tr>
<tr>
<td><strong>Net Income/expenditures</strong></td>
<td>$(152,378.50)</td>
<td>$(68,602.20)</td>
<td>$(8,414.17)</td>
<td>$(83,126.00)</td>
<td>$(167,785.57)</td>
</tr>
</tbody>
</table>
Appendix A. Library holdings evaluation

Introduction
An assessment of the Ferriss Hodgett Library collection was conducted to determine its ability to support the proposed Master of Science in Agricultural, Forest and Environmental Science (MSc AFES). While the program will benefit from the existing print and electronic collections at both the Ferriss Hodgett Library and the Queen Elizabeth II Library, additional funds will be required to further develop and provide ongoing support for these programs on the Grenfell Campus. These funds will come from the existing library materials budget. As well, funds will be required to refurbish existing library space to meet the unique needs of this student group.

Monographs
Erin Alcock, Science Research Liaison Librarian at QEI, was consulted on the course list associated with this program and has confirmed that the library system has strong print and electronic book collections in crop production and nutrition, climate change and global food security, sustainable agriculture, soil functions, plant biochemistry and physiology, organic farming, functional food and lipid metabolism. She did note that there are fewer more limited sources for soil as bioreactor and metagenomics for environmental science.

Kathryn Rose, History and Economics Liaison Librarian at QEII, was also consulted on the course list and has confirmed that the library has strong print and electronic book collections in the areas of production economics and commodity marketing, ecological economics, natural resource economics, environmental economics, and applied economic methods.

CNS is a special research collection of books, government documents, periodicals, newspapers, theses, microforms, and historic maps reserved for the study of all aspects of Newfoundland and Labrador. The Centre holds the largest collection of published Newfoundlandia in the province. It is a non-circulating collection but due to our distance, the Grenfell Library has an agreement with CNS that allows material to be sent here for use by our researchers in our library.

As a branch of Memorial University libraries, the Grenfell Library is able to provide faculty and students with prompt access via Intercampus Loan, to the extensive research collections especially of the Queen Elizabeth II Library, including the Centre for Newfoundland Studies.

The Library also provides a collection on demand service. If a book is requested for loan, but it is a recent publication and relatively inexpensive, the library will purchase the title instead of borrowing the book. The process is more effective as it can be cost saving to the Library, but more importantly, gets the material to the student or faculty faster. The Library also provides a rush order service for faculty. Material that is needed immediately for a course or a research project can be obtained for that individual by the library within a few days.

Journal Literature
The library system has an extensive collection of online journals in all subjects areas included in the proposed programs. Access to the journal literature is available via the following databases: AgEcon Search, Agricola, Agricultural & Environmental Biotechnology Abstracts, Agris, Biological Abstracts, EconLit, Scopus, and Web of Science. Full database descriptions can be found at: www.library.mun.ca/eindex/index.php

Select potential faculty were consulted concerning database access to the journal literature and all required databases are included in current library subscriptions.

Facilities
Over the past few years the Library has created diverse study spaces, designed primarily to suit the needs of the undergraduate students. Currently, there is one small room in the library specifically for graduate students. This room has already exceeded its capacity, so should additional graduate programming be added to the Campus, more library space directed to the needs of this student
population group will need to be developed prior to program commencement.

Library Hours
One of our primary services is providing access to our facility and ensuring we have qualified staff on the ground to answer user queries at all times. Since 2008 we have reworked the library staff schedules to ensure that a trained library assistant is working with the students during evening and weekend shifts. We have also extended library hours since 2008. The library is now open Monday to Thursday from 8:00am to midnight throughout the regular semester. Friday hours have been extended to 6pm, Saturday hours are now 10am to 8pm (previously 11am to 5pm) and Sunday hours are now 12pm to 10pm (previously 2pm to 10pm).

Louise McGillis
Associate University Librarian, Grenfell Campus, MUN

Ferriss Hodgett Library

November 12, 2014
Appendix B. Calendar regulations

1.0 Regulations Governing the Degree of Master of Science in Agricultural, Forest and Environmental Science
Associate Professor and Division Head (Grenfell Campus)

R. Gallant

1.1 Qualifications for Admission

To be considered for admission, applicants shall normally hold a Bachelor's (Honours) degree in Science, Forestry, Agriculture, Engineering, Geography, or Environmental Science with at least second class standing, or equivalent, from an institution recognized by the Senate or shall have qualifications and/or experience in environmental science acceptable to the Dean of Graduate Studies and the Grenfell Campus BERI graduate committee. The Grenfell Campus BERI graduate committee makes recommendations on admission to the Dean of Graduate Studies for this program.

The Degree is offered to full-time and part-time students in three areas of concentration: (1) Agricultural Science; (2) Forest Science; (3) Environmental Science.

Admission is limited and competitive, and will follow the general qualifications for admission to Masters Programs at Memorial University of Newfoundland as set out under General Regulations, Qualifications for Admission. All applicants found academically acceptable to the MSc AFES program are required to have a faculty supervisor before final acceptance can be offered.

As well, if a student is accepted for admission and is required to demonstrate English proficiency by submission of a minimum score in TOEFL, IELTS, or another acceptable language test, that applicant is required to take the English Placement Test (EPT) upon arrival. Details on this requirement can be found in the University Calendar (General Regulation 3.1.7).

1.2 Program of Study and Research

1. The program of study for the MSc AFES degree shall consist of the successful completion of a program of courses and a thesis embodying original research.
2. Every candidate shall successfully complete at least 12 credit hours as per program requirements (see 1.3 below). One undergraduate course at the 4th year level may, if necessary, be taken, with the approval of the Supervisor and the course instructor.
3. Every candidate shall submit a thesis (see General Regulation Theses and Reports) on an approved subject in which systematic research has been conducted under the direction of the Supervisor recommended by the academic unit concerned and approved by the Dean.
4. In addition to courses and thesis research, graduate students are expected to participate in Grenfell Campus graduate student seminars.

1.3 Program Requirements

Students admitted to the program must complete a research thesis under the supervision of a faculty member, and a minimum of four (4) courses (12 credit hours) as determined by the thesis supervisor.

All students must complete the following three courses:

ENVS 6000 – Environmental Science and Technology
BERI 6000 – Advanced Quantitative Research Methods OR BERI 6001 - Sampling and Analysis
BERI 6002 – Research Focus Group Seminar and Communication Skills (as per the guidance of the thesis supervisor)

Plus one graduate course related to the student’s research speciality from the list below.

1.4 List of Optional Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BERI XXXX: Advanced Groundwater Management</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Analytical Ecology</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Applied Bioinformatics and Metagenomics for Environmental Sciences</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Applied Economic Methods Laboratory</td>
<td>1.5</td>
</tr>
<tr>
<td>BERI XXXX: Applied Hydrology</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Chemical Separations</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Climate Change and Global Food Security</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Climate Change and Sustainable Development</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Controlled Environment Crop Production</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Crop Management</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Ecological Economics</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Environmental Economics and Policy</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Environmental Soil Physics</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Functional Food Analysis</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Lipid Metabolism and Environmental Stress Physiology</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Management of Crop Nutrition</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Modeling Chemical Speciation in Environmental Matrices</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Natural Resource Economics</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Organic Farming for Sustainable Agriculture</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Plant Biochemistry</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Plant Physiology</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Production Economics and Commodity Marketing</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Soil and Groundwater Remediation</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Soil and Water Conservation</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Soil Functions: Soil as a Bioreactor</td>
<td>3</td>
</tr>
<tr>
<td>BERI XXXX: Solid Waste Management</td>
<td>3</td>
</tr>
</tbody>
</table>

1.5 Evaluation

1. In order to continue in the School of Graduate Studies and in order to qualify for a Master’s Degree, a candidate shall obtain an A or B grade in each program course. (See General Regulation Evaluation, Evaluation of Graduate Students).

2. When it has been determined, on the basis of consultation with the candidate, the instructors in graduate courses, and the thesis Supervisor, that a candidate’s work has fallen below a satisfactory level, the Supervisor or the Head of the appropriate academic unit may recommend to the Dean that such a candidate be required to withdraw from the program.

1.6 Study Options

Students are able to study in a full-time or part-time capacity.
Appendix C. Course Calendar Descriptions

BERI XXXX: Advanced Groundwater Management: 3 credits

This course intends to provide students the background and opportunity in understanding and solving real field problems related to groundwater rather than derivation of theory. The main idea is to expose students to understand groundwater as a resource in agriculture, forestry and environment of which development and management is essential for the sustainability of the ecosystem. Topics will include groundwater flow, aquifers, resource evaluation, field methods, and sustainable management. Case studies will provide students in depth understanding of issues with respect to groundwater development and management and developing sustainable solutions.

BERI 6000: Advanced Quantitative Research Methods: 3 credits

This course will introduce students to the basic concepts of experimental design and data analysis in Environmental Sciences. The course will focus on statistical analysis of quantitative data, using the R programming environment. Specific topics will include data exploration and plotting, basic statistical tests, linear regression, statistical model selection, non-parametric tests and mixed effects models.

BERI XXXX: Analytical Ecology: 3 credits

Assessment of environmental impacts on higher-level ecological systems requires a critical analysis of scientific reports, along with the ability to evaluate ecological terminology and concepts and associated statistical methodologies. Students in this course will critically read and analyse recent scientific literature in Environmental Science, with selected topics at the community, ecosystem and landscape level, and examine related univariate and multivariate statistical procedures.

BERI XXXX: Applied Bioinformatics and Metagenomics for Environmental Sciences: 3 credits

Tremendous advances in the collection of genetic information via cheaper and rapid sequencing techniques allows users to produce huge amounts of genetic information. To deal with this informational deluge a number of data analysis techniques, generally covered by the term "bioinformatics" also became available. The course aims at making sense of such large datasets though the use of several bioinformatics packages that allow for sequence visualization, alignment, and assembly, and phylogenetic and taxonomic analysis. Applications for microbial ecology will be specifically targeted. Open source software such as QIIME and mothur, and the integrative Geneious package will be employed.

BERI XXXX: Applied Economic Methods Laboratory: 1.5 credits

This laboratory class provides students with the opportunity to conduct an economic or financial analysis of an environmental sciences problem. Examples might include a cost-benefit analysis, an enterprise budget, or a sensitivity analysis. It is highly recommended that students enroll in the laboratory currently with or immediately following the completion of the applicable course in environmental sciences.

BERI XXXX: Applied Hydrology: 3 credits

This course will provide students an understanding of the interpretation techniques used in the computation of water flows from hydrological processes in agriculture, forestry and environmental perspectives. The course covers all physical processes in the hydrological cycles and their influence on the eco-systems. Effect of snow, fog and land use changes on hydrological processes and water yield will be discussed. In depth understanding of hydrological processes, measurements and interpretation in spatial and temporal scales that are affected by land use changes under managed and natural ecosystems will be highlighted.

---

5 A complete list of course descriptions will be available in the final draft of the proposal.
BERI XXXX: Chemical Separations: 3 credits

Material to be covered will be drawn from the topics outlined below:

Separation in engineering and analytical processes; Unit processes (Distillation, Extraction, Membrane Separation, Intermolecular Interactions); Sample preparation techniques: LLE, SPE, SPME, SFE; Membrane separations; Chromatographic techniques; Gas (GLC), liquid (LLC, LSC, GPC, IEC, Affinity), supercritical fluid; Physiochemical application of chromatography; Electrophoresis techniques (Gel, Capillary, Moving boundary, Zone, Isoelectrophoresis); Capillary separations; Detection methods, GC-MS, LC-MS, CE-MS; Multidimensional separations.

BERI XXXX: Climate Change and Global Food Security: 3 credits

This course examines the challenges and implications of climate change on agriculture and crop productivity; Focus will be on impact, adaptation and mitigation strategies of climate change, effects on food security an overview, climate models and their projections of future changes, Connections between Climate Change, Drought and Agricultural Production; Global climate changes and agricultural production, Direct effects of rising atmospheric CO2 and Ozone on crop yield, Food security and adaptation strategies to mitigate climate change, Economy-wide impacts of climate change on agriculture- a case study for adaptation strategies of sub-Sahara - Africa.

BERI XXXX: Climate Change and Sustainable Development: 3 credits

This seminar course examines the interface between human-driven global climate change, and the demands and challenges of developing sustainable human societies. Class discussions cover topics such as how the potential impacts of climate change affect sustainable development efforts, as well as the need to develop sustainable energy sources that do not further degrade the global climate system. The course also includes an overview of current literature in the fields of climate science and environmental sustainability.

BERI XXXX: Controlled Environment Crop Production: 3 credits

This course will introduce students to the technical aspects of greenhouse design, environmental control, interaction between plants and microenvironment, lighting, hydroponics crop production, plant nutrient requirements, plant nutrient delivery systems, plant productivity, post-harvest handling and storage of crops.

BERI XXXX: Crop Management: 3 credits

The course aims at giving an exposure to students about the occurrence of different stresses under field conditions, and how these can be tackled for successful crop production. Topics may include: Introduction of abiotic stresses; Classification of abiotic stresses; Morphological and physiological effects of moisture, heat, cold, pollutants, chemicals and salt stresses; Physiological, molecular and genetic basis of stresses; Plant resistance mechanisms at the whole plant, organ, cellular and molecular levels; Candidate genes for stress tolerance induction; Mitigation of stress tolerance though physiological enhancements; Agro- management practices for successful crop husbandry under different types of stresses.

BERI XXXX: Ecological Economics: 3 credits

This course reflects the theoretical distinction between ecological economics and classical approaches. The course familiarizes students with the scientific study of ecosystem services, non-market valuation methods, and payment for ecosystem service programs. Successful examples of provincial, national, and international payment for ecosystem service programs are provided.
BERI XXXX: Environmental Economics and Policy: 3 credits

This course familiarizes students with policy tools that can be used to assess the efficient and equitable management of scarce environmental goods. The interface between property rights, law, and economics is also discussed. Topics include air and water quality, public lands, land-use transitions, water use, waste management, and global climate change.

BERI XXXX: Environmental Soil Physics: 3 credits

This course will cover topics which may include flow of water in saturated and unsaturated soils, movement of solutes, movement and exchange of gases in the soil, soil temperature and heat flow, soil compaction, entry and redistribution of water in soil, groundwater drainage and pollution, uptake of soil moisture by plants, water and energy balance in the field, and water-use efficiency. Spatial variability and applications of soil physics to soil and groundwater remediation also will be discussed.

BERI XXXX: Lipid Metabolism and Environmental Stress Physiology: 3 credits

This course will introduce students to the diverse roles of lipids in organism survival. Areas covered will include lipid nomenclature, biochemistry and metabolism, role of lipids in human health and nutrition, disease diagnosis/prevention/treatment, pollution, environmental stress response/survival, organism identity, food spoilage, energy metabolism, and cell membrane architecture. Techniques for lipid analysis such as mass spectrometry, photometrics, and chemical ion imaging will also be covered.

BERI XXXX: Functional Food Analysis: 3 credits

This course will introduce students to the concept of functional foods. Areas covered will include nomenclature for functional foods, nutraceuticals, natural health products and food based bioactives; identify and describe functional foods and associated health benefits, health policies relating to functional foods, functional lipids and roles in health and disease, production of foods with functional capacity; extraction, identification and analysis of bioactives in functional foods.

BERI XXXX: Management of Crop Nutrition: 3 credits

This course focuses on the management and physiological aspects of macro and micronutrients in crops. Topics may include: Introduction and scope of crop nutrition; principles of mineral nutrition in crops, Nutrients and their classification, Biological membranes, Mechanisms of nutrients absorption, Nutrient translocation, Micronutrients, absorption, translocation and metabolism, Novel sustainable nutrient management approaches for optimum crop productivity with minimum impact on environment.

BERI XXXX: Modeling Chemical Speciation in Environmental Matrices: 3 credits

This is a course aimed at exposing students to the use of applied speciation models. The course aims to achieve understanding of environmental processes through hands-on modeling of chemical phenomena in aqueous environments, including soil water. Particular attention is given to reactions involved in environmental pollution and management of wastes. Modeling of chemical environmental processes through use of the PHREEQC model. Sections may include: Flow and Transport of chemical species; Minerals and water – chemical speciation modeling; Carbonates and carbon dioxide in water and soils (dissolved carbonate equilibria); Surface interactions; Redox processes; Weathering processes, Complexation to humic acids; Pollution by organic chemicals.

BERI XXXX: Natural Resource Economics: 3 credits
This course applies microeconomic theory to the management and economic modeling of renewable and non-renewable resources. Examples include forestry, agriculture, fisheries, mineral and energy extraction, and alternative energy.

**BERI XXXX: Organic Farming for Sustainable Agriculture: 3 credits**

This course will cover the topics which may include overview of organic agriculture, opportunities and challenges, Principles of organic farming, soil fertility and crop agronomy in organic agriculture, crop protection in organic agriculture, organic plant breeding and seed production; ecological and ethical aspects, organic standards and certification, environmental impacts of organic farming, food quality, Nutrient cycling, Rotation design for organic system with examples, special topics will be included like biodynamic agriculture today, Regulatory and management issues, contradictions of principles in organic farming.

**BERI XXXX: Plant Biochemistry: 3 credits**

This course will introduce students to concepts in plant biochemistry and cover areas such as plant metabolism, plant-specific biochemical pathways, processes, and their regulation. Storage carbohydrates, cell wall biosynthesis, lipid metabolism, nitrogen fixation and assimilation, and photosynthesis; biochemical ecology of secondary plant metabolites such as lipids, isoprenoids, phenolics and alkaloids will also be covered.

**BERI XXXX: Plant Physiology: 3 credits**

This will introduce students to concepts in plant cell biology, physiology and biochemistry. Specifically areas such as plant nutrient metabolism, photosynthesis, respiration, water relations, plant response to environmental stress, plant-pathogen interaction, plant hormones, signal transduction, and plant biotechnology will be covered.

**BERI XXXX: Production Economics and Commodity Marketing: 3 credits**

This course incorporates classic microeconomic production models and regional commodity examples to illustrate the firm and operator decision-making process to produce and sell agricultural and forest products. Specific topics include production and cost analysis, decision-making under risk and uncertainty, price forecasting, and commodity marketing.

**BERI 6002: Research Focus Group Seminar and Communication Skills**

This seminar provides an opportunity to extend, deepen, and apply the conceptual and methodological frameworks presented in the core and elective courses, through a combination of classroom discussions and attendance in research seminars. Students are taught research and presentation skills and are guided through the process of preparing their thesis research proposals. Presentation of the student's proposed research to thesis committee members is a requirement for successful completion of this course.

**BERI 6001: Sampling and Analysis: 3 credits**

Sampling of environmental matrices is the first step for any experimental and monitoring effort. Inaccurate sampling protocols can easily introduce errors that cannot be easily corrected at analysis stages. The course will introduce students to:

1. Project planning: Relevant and valid data: data quality objectives; The sample and the error; total error and its sources; Regulatory overview and action levels; Quality control and quality assurance; Planning documents; Cost estimates; Strategies for sampling and project coordination
2. Sampling: Sampling process overview; Chain of custody; Soil Sampling; Water Sampling; Air sampling; Surface sampling techniques; Field measurements; Records

3. Analysis of Environmental Contaminants (What, where and how to analyze your samples): Commercial analytical laboratories; Analytical techniques; QA/QC in the lab; Understanding and interpreting lab results

**BERI XXXX: Soil and Groundwater Remediation: 3 credits**

This course will cover topics which may include an overview of principles of flow and contaminant transport in porous media and site characterization, soil and groundwater remediation technologies such as pump-and-treat method, air sparging, electrokinetic remediation, bioremediation, phytoremediation, reactive wells and barrier technology. Remediation technology development – past experience and future directions will be discussed. Topics such as constructed wetlands and vegetative filters for effluent treatment, and assessing the impact of remediation will be covered.

**BERI XXXX: Soil and Water Conservation: 3 credits**

In this course, land degradation issues and management practices of land and water resources disturbed by human activities are reviewed. In depth understanding of soil erosion process, causes of erosion and prediction of erosion will be provided. It intends to provide a holistic understanding of soil and water conservation in the perspective of watershed management. Emphasis is placed on technical, agronomic and biological approaches to soil and water conservation, conservation methods and the design of terraces, waterways and water control structures. Special emphasis will be given to Boreal and Agricultural Eco-systems, case studies will be varied from temperate to tropical climate systems.

**BERI XXXX: Soil Functions; Soil as a Bioreactor: 3 credits**

Microbes carry out most soil functions. The regime of water, gaseous and heat flows will control microbial activity. Management activities that affect these regimes will affect microbial activities and thus nutrient and contaminant kinetics in soil. The course aims to offer an integrated approach to numerical modeling of the chemical, physical and biological processes relevant for nutrient availability and contaminant risk and transport through soils. The course is aimed at a wide range of students interested in soil sciences, water quality, bioengineering systems, and agricultural sciences.

**BERI XXXX: Solid Waste Management: 3 credits**

This course will cover topics which may include categories of wastes and waste management, characterization, components, chemical and physical properties of municipal solid waste, collection and recycling of solid wastes, solid waste processing including material recovery. Disposal methods such as composting, incineration, and sanitary landfill including potential for soil and groundwater contamination will be covered. Handling of electronics waste also will be discussed.

**ENVS 6000: Environmental Science and Technology: 3 credits**

This course is the common denominator, first course for the interdisciplinary Graduate Program in Environmental Science and as such needs to lay some groundwork for subsequent coursework in this program. This course, however, is primarily designed to introduce the breadth or scope, approaches, and interdisciplinary nature of the field of environmental science. Further, this course will serve to introduce students in the program to the breadth of their colleagues in the program as well as some of the faculty members participating in this program across campus as well as other research professionals in the region (e.g. industry, federal and provincial departments).
Appendix D. Consultations

During the development of the Boreal Ecosystems Research Initiative, an in-depth consultation process proceeded regarding the initiative, as well as the need for graduate programming at Grenfell Campus. Consultations were held widely within Grenfell Campus and across the Province. The initial phase of consultations, completed in 2011, surveyed representatives from both the federal and provincial levels of government, non-governmental institutions and universities across Canada regarding the suitability of a Boreal Ecosystem Research Institute and its complementary graduate program at Grenfell Campus. A list of these consultation meetings is included below. This phase of consultations demonstrated a very positive response for the establishment of BERI and graduate programs at Grenfell Campus, in particular the development of forestry, agriculture and climate change research initiatives.

The second phase of consultations focused on the Grenfell Campus and MUN community, and took place from Sept 2012-May 2013. A list of these meetings is also included below. This phase was designed to consult with interested faculty and staff on the details of the BERI proposal, graduate programs, and to identify individuals interested in the project. Strong support for the development of a research institute and graduate programs was heard across all divisions within the university.

Phase three of consultations regarding the proposed MSc AFES program occurred during the Fall 2014 semester. These consultations were held within the Grenfell Campus and Memorial University communities, with representatives from both the federal and provincial levels of government, non-governmental institutions and Atlantic Canadian universities, and the environmental industries in the Atlantic region. The purpose of the consultations was to provide a draft outline of the Master of Science in Agricultural, Forest and Environmental Science graduate program, and to seek advice and recommendations from the internal and external stakeholders regarding the focus and design of the program.

Consultations with Federal Government, Provincial Government, NGO and Academic Institutions

Participants

Conducted by:
Michael J. Goss and Bryan Harvey – September 2011
Greg Wood – Sept 2012 – May 2013
Greg Wood – May 2014 – October 2014

<table>
<thead>
<tr>
<th>Name</th>
<th>Department / Division / Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crystal Anderson-Baggs</td>
<td>Provincial Agrifoods Division</td>
</tr>
<tr>
<td>Bill Dawson</td>
<td>Provincial Forestry Division</td>
</tr>
<tr>
<td>Mark Tierney</td>
<td>ACOA</td>
</tr>
<tr>
<td>Katie Temple</td>
<td>Environmental Policy Institute, Grenfell</td>
</tr>
<tr>
<td>Susanne Dawe</td>
<td>Prov. Human Resources Labour and Employment</td>
</tr>
<tr>
<td>Jocelyn Noseworthy</td>
<td>Prov. Human Resources Labour and Employment</td>
</tr>
<tr>
<td>Chris Freake</td>
<td>Employment preparation</td>
</tr>
</tbody>
</table>
Gordon Hancock  
Humber Economic Development Board

Dmitry Sveshnikov  
Environmental Science/Biology, Grenfell

Mark Lamswood  
Red Ochre Economic Development Board

Susan Pottle  
Environmental Policy Institute, Grenfell

Louis MacDonald  
College of the North Atlantic, Stephenville

Danny Brock  
Provincial Agrifoods Division

Carolyn Wheeler  
Western Environment Centre

Colin Walsh  
Provincial Agrifoods Division

Craig Blanchard  
Provincial Agrifoods Division

Dave Jennings  
Provincial Agrifoods Division - Production

Sabrina Ellsworth  
Provincial Environment and Conservation, IBES

Rick Carey  
Provincial Agrifoods Division - Soils and Lands

Jianghua Wu  
Sustainable Resource Management, Grenfell

Wade Bowers  
Environmental Science and EPI, Grenfell

Chan Wiseman  
Young Farmers and College of the North Atlantic

Leah Madore  
Provincial Agrifoods Division - Pest Management

Blaine Hussey  
Provincial Agrifoods Division – Cranberries, etc.

Stewart Reid  
Provincial Innovation Trade and Rural Development

Mano Krishnapillai  
Environmental Science, Grenfell Campus

Ivan Emke  
Former VP Research- Research Office, Grenfell

Brent Howell  
Dean, Tourism and Natural Resources, College of the North Atlantic

Keith Deering  
ADM, Provincial Agrifoods Division

Ed O’Rielly  
Director of Strategic Resource Development, Forestry and Agrifoods Division

Dean Strickland  
Manager, Research Office, Grenfell

Gerry Sullivan  
Agriculture Awareness and Agri-Tourism Coordinator, NL Federation of Agriculture

Christa Wright  
Agriculture in the Classroom Coordinator, NL Federation of Agriculture

Mary Bluechaardt  
Vice President, Grenfell Campus, MUN
Christine Campbell
Head, Science Division, Grenfell

Gabriela Sabau
Chair, Environmental Studies, Grenfell

Bryan Harvey
Consultant - Univ. of Saskatchewan

Michael Goss
Consultant - University of Guelph

Gary Kachanoski
President, Memorial University

Charles Pender
Director, Grenfell Secretariat

Angela Carter
Faculty, Environmental Policy Institute, Grenfell

Geoff Rayner-Cenham
Faculty, Environmental Science, Grenfell

Robert Scott
Faculty, Sustainable Resource Management, Grenfell

Chen Lui
Faculty, Environmental Science, Grenfell

Tamara Murphy
Financial Officer, Provincial Agrifoods Division

Darryl Houlihan
Policy Analyst, Provincial Agrifoods Division

Karen Kennedy
Alternative Feeds Specialist, Agrifoods Division

Krisia Bradley
Manager, Agricultural Services, Agrifoods Division

Paul Lomond
Owner, Lomond Farms, Steady Brook, NL

Melvin Rideout
Owner, Rideout's Farm and Dairy, Cormack, NL

Kevin Clarke
Marine Institute, MUN

Heather Manual
Marine Institute, MUN

Fereidoon Shahidi
Dept. of Biochemistry, MUN

Tom Chapman
Dept. of Biology, MUN

Paul Marino
Department Chair, Dept. of Biology, MUN

Norm Catto
Dept. of Geography, MUN

Hugh Whitney
Chief Veterinarian, Dept. of Natural Resources

Richard Carey
Agrifoods Division - Soils Lab

Peggy Dixon
AAFC - Agriculture - Agrifoods Canada, St. John's, NL

Gary Bishop
AAFC - Agriculture - Agrifoods Canada, St. John's, NL

Allan Kwabiah
AAFC - Agriculture - Agrifoods Canada, St. John's, NL
<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samir Debnath</td>
<td>AAFC - Agriculture - Agrifoods Canada, St. John's, NL</td>
</tr>
<tr>
<td>Gerry Wicks</td>
<td>Lester's Farm, Mount Pearl, NL</td>
</tr>
<tr>
<td>Rebecca Schiff</td>
<td>Labrador Institute, Happy Valley-Goose Bay, Labrador</td>
</tr>
<tr>
<td>Ron Sparkes</td>
<td>Labrador Institute, Happy Valley-Goose Bay, Labrador</td>
</tr>
<tr>
<td>Frank Pye</td>
<td>Grand River Farm, Mud Lake Road, Labrador</td>
</tr>
<tr>
<td>Joyce Pye</td>
<td>Grand River Farm, Mud Lake Road, Labrador</td>
</tr>
<tr>
<td>Scott Neilsen</td>
<td>Labrador Institute, Northwest River, Labrador</td>
</tr>
<tr>
<td>Jennifer Butler Wight</td>
<td>Labrador Institute, Happy Valley-Goose Bay, Labrador</td>
</tr>
<tr>
<td>Robert Miller</td>
<td>Soil and Crops Lab, Colorado State University</td>
</tr>
<tr>
<td>Julian Dust</td>
<td>Faculty, Environmental Science, Grenfell</td>
</tr>
<tr>
<td>Sudhir Abhyankar</td>
<td>Faculty, Environmental Science, Grenfell</td>
</tr>
<tr>
<td>Don Roger Parkinson</td>
<td>Faculty, Environmental Science, Grenfell</td>
</tr>
<tr>
<td>Len Moores</td>
<td>CEO, Forestry and Agrifoods Division, DNR (Retired)</td>
</tr>
<tr>
<td>Hon. Tom Marshall</td>
<td>Minister of Finance, Gov't of NL</td>
</tr>
<tr>
<td>Holly Pike</td>
<td>Former Principal, Grenfell Campus, MUN</td>
</tr>
<tr>
<td>Mike Dolter</td>
<td>Chief Administrative Officer, City of Corner Brook</td>
</tr>
<tr>
<td>Danny Williams</td>
<td>Former Premier, Gov't NL (Retired)</td>
</tr>
<tr>
<td>Glenn Payne</td>
<td>Research Coordinator - GRF, College of North Atlantic</td>
</tr>
<tr>
<td>Bill Lams</td>
<td>Former Vice-Principal, Grenfell Campus, MUN</td>
</tr>
<tr>
<td>John Davis</td>
<td>Regional Director, Innovation, Business and Rural Development</td>
</tr>
<tr>
<td>Mario Levesque</td>
<td>Faculty, Environmental Policy Institute, Grenfell</td>
</tr>
<tr>
<td>Pierre Rouleau</td>
<td>Faculty, Environmental Science, Grenfell</td>
</tr>
<tr>
<td>David Peddle</td>
<td>Associate Vice President (Academic), Grenfell</td>
</tr>
<tr>
<td>Rhea Hutchings</td>
<td>Supervisor of Sustainable Development, City of Corner Brook</td>
</tr>
<tr>
<td>Paul Mills</td>
<td>Vice President, ACOA</td>
</tr>
<tr>
<td>Sheila Earle</td>
<td>Regional Planning Specialist, Innovation, Business and Rural Development</td>
</tr>
</tbody>
</table>
Robert Otto  Director, IBES, Department of Environment and Conservation
Sheldon Peddle  Executive Director, ACAP, Corner Brook
Jeff Whalen  ADM, Dept. of Natural Resources
Wayne Kelly  Director of Ecosystem Sustainability and Research, Forestry and Agrifoods Division
Cyril Organ  VP Academic & Learner Services, College of the North Atlantic
Darren Pike  Deputy Minister, Department of Education
Bruce Belbin  ADM, Advanced Education and Skills
Dennis Waterman  Associate Vice President (Administration and Finance), Grenfell
Javis Hulan  Manager, Facilities Management, Grenfell
Hon. Ross Wiseman  Minister, Department of Environment and Conservation
Keith Hiscock  Facilities Management, MUN
Karen Skinner  Director, Enterprise Development, ACOA
Chad Butt  Account Manager, ACOA
Paul Barnable  Director of Community Services, City of Corner Brook
Marion McCahon  Regional Partnership Planner, Office of Public Engagement, Gov. NL
Sandy Todd  Research Manager, Atlantic Cool Climate Crop Research Centre, Agriculture Canada
Peter Duinker  School for Resource and Environmental Studies (SRES), Dalhousie University
Sean St. George  Executive Director, Red Ochre Economic Development Board
Valerie Simms-Anderson  Executive Director, Humber Economic Development Board
Eugene Legge  President, NL Federation of Agriculture
Debra Coughlin  Economic Development Officer, Long Range Economic Development Board
Andrea Meyers  Economic Development Officer, Nordic Economic Development Corporation
Marie Ryan  Provincial Environment and Conservation - Policy and Strategic Planning
Wayne Turpin  Soiltec - NL Environmental Remediation Business
Ken Martin  ACOA - Director General - Regional Operations
Bill Grandy  ACOA - Director - Community Development
<table>
<thead>
<tr>
<th>Name</th>
<th>Position/Office</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bruce Pike</td>
<td>Canadian Forest Service - Deputy Director</td>
</tr>
<tr>
<td>Tom Rosser</td>
<td>Canadian Forest Service - Assistant Deputy Minister</td>
</tr>
<tr>
<td>Susan Ziegler</td>
<td>MUN - Dept. of Earth Science, MUN</td>
</tr>
<tr>
<td>Darrin Sooley</td>
<td>Fisheries and Oceans - Area Habitat Coordinator</td>
</tr>
<tr>
<td>Keith Clarke</td>
<td>Fisheries and Oceans - Science Branch, St. John's</td>
</tr>
<tr>
<td>Carl Noseworthy</td>
<td>Provincial Forestry Division - Center for Forest Science &amp; Innovation</td>
</tr>
<tr>
<td>Chris Power</td>
<td>Department of Municipal Affairs - Regional Engineer</td>
</tr>
<tr>
<td>Derrick Maddocks</td>
<td>Director - Pollution Prevention , Water Management, Dept of Env and Cons</td>
</tr>
<tr>
<td>Ian Bell</td>
<td>Environmental Scientist - Dept. of Env and Cons</td>
</tr>
<tr>
<td>Leonard House</td>
<td>Aquaculture Development Officer - Dept. of Fisheries and Aquaculture</td>
</tr>
<tr>
<td>Daryl Whalen</td>
<td>Director, Provincial Aquaculture Veterinarian, Dept of Fisheries and Aquaculture</td>
</tr>
<tr>
<td>Lourens Robberts</td>
<td>Director of Provincial Public Health Laboratory, Department of Health and Community Services</td>
</tr>
<tr>
<td>Don Downer</td>
<td>Independent Chair, Western Regional Waste Management Authority</td>
</tr>
<tr>
<td>Ed Evans</td>
<td>Manager, Central Newfoundland Waste Management Authority</td>
</tr>
<tr>
<td>Ted Lomond</td>
<td>Executive Director, Newfoundland and Labrador Environmental Industry Association</td>
</tr>
<tr>
<td>Glenn Sharpe</td>
<td>Abydoz Environmental Inc</td>
</tr>
<tr>
<td>Rob Whelan</td>
<td>Maxxam Analytics</td>
</tr>
<tr>
<td>Paul Staeben</td>
<td>Regional Manager - Pinchin LeBlanc Environmental</td>
</tr>
<tr>
<td>Group / Organization</td>
<td>Contact Person</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Division of Science, Grenfell Campus</td>
<td>Dr. Robert Gallant</td>
</tr>
<tr>
<td>Division of Social Science, Grenfell Campus</td>
<td>Dr. Sandra Wright</td>
</tr>
<tr>
<td>Division of Fine Arts, Grenfell Campus</td>
<td>Dr. Todd Hennessy</td>
</tr>
<tr>
<td>Division of Arts, Grenfell Campus</td>
<td>Dr. Ken Jackobsen</td>
</tr>
<tr>
<td>Faculty of Science, St. John’s Campus</td>
<td>Dr. Mark Abrahams</td>
</tr>
<tr>
<td>School of Graduate Studies, MUN</td>
<td>Dr. Faye Murrin</td>
</tr>
<tr>
<td>Canadian Forest Service</td>
<td>Dr. Brian Hearn</td>
</tr>
<tr>
<td>Dept. of Natural Resources (NL Gov)</td>
<td>Mr. James Evans</td>
</tr>
<tr>
<td>Agriculture - Agrifoods Canada</td>
<td>Dr. Sandy Todd</td>
</tr>
<tr>
<td>Dept of Environment and Conservation (NL Gov)</td>
<td>Mr. Jamie Chippett</td>
</tr>
<tr>
<td>Environment Canada (Atlantic)</td>
<td></td>
</tr>
<tr>
<td>Labrador Institute</td>
<td>Ms. Martha MacDonald</td>
</tr>
<tr>
<td>NL Environmental Industry Association</td>
<td>Mr. Ted Lomond</td>
</tr>
<tr>
<td>NL Federation of Agriculture</td>
<td>Mr. Paul Connors</td>
</tr>
<tr>
<td>Dalhousie University, Faculty of Agriculture</td>
<td>Dr. David Gray</td>
</tr>
<tr>
<td>University of Toronto, Graduate Studies</td>
<td>Elizabeth Smyth</td>
</tr>
<tr>
<td>University of Guelph, Ontario Agriculture College</td>
<td>Dr. Robert Gordon</td>
</tr>
</tbody>
</table>
Appendix F. Potential Faculty and Academic CVs

Faculty who may potentially contribute to the Master of Science in Agricultural, Forest and Environmental Science program are listed below, and their CV's are provided immediately following the list.

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Sudhir Abhyankar</td>
<td>Environmental Science, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Andre Arsenault</td>
<td>Canadian Forest Service, NRCAN, Corner Brook</td>
<td></td>
</tr>
<tr>
<td>Dr. Gary Bishop</td>
<td>Agriculture-Agrifoods Canada (AAFC)</td>
<td></td>
</tr>
<tr>
<td>Dr. Wade Bowers</td>
<td>Environmental Science, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Christine Campbell</td>
<td>Environmental Science, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Mumtaz Cheema</td>
<td>BERI, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Samir Debnath</td>
<td>Agriculture-Agrifoods Canada (AAFC)</td>
<td></td>
</tr>
<tr>
<td>Dr. Peggy Dixon</td>
<td>Agriculture-Agrifoods Canada (AAFC)</td>
<td></td>
</tr>
<tr>
<td>Dr. Julian Dust</td>
<td>Environmental Science, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Kate Edwards</td>
<td>Canadian Forest Service, NRCAN, Corner Brook</td>
<td></td>
</tr>
<tr>
<td>Dr. Erin Fraser</td>
<td>Environmental Science, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Lakshman Galagedara</td>
<td>BERI, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Brian Hearn</td>
<td>Canadian Forest Service, NRCAN, Corner Brook</td>
<td></td>
</tr>
<tr>
<td>Dr. Gary Kachanoski</td>
<td>President, Memorial University</td>
<td></td>
</tr>
<tr>
<td>Dr. Vanessa Kavanagh</td>
<td>Agrifoods Div., Dept of Natural Resources, Gov't of NL</td>
<td></td>
</tr>
<tr>
<td>Dr. Catherine Keske</td>
<td>BERI, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Mano Krishnapillai</td>
<td>Environmental Science, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Allan Kwabiah</td>
<td>Agriculture-Agrifoods Canada (AAFC)</td>
<td></td>
</tr>
<tr>
<td>Dr. Chen Lui</td>
<td>Environmental Science, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Joan Luther</td>
<td>Canadian Forest Service, NRCAN, Corner Brook</td>
<td></td>
</tr>
<tr>
<td>Dr. David McKenzie</td>
<td>Agriculture-Agrifoods Canada (AAFC)</td>
<td></td>
</tr>
<tr>
<td>Dr. Don-Roger Parkinson</td>
<td>Environmental Science, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Reg Parsons</td>
<td>Canadian Forest Service, NRCAN, Corner Brook</td>
<td></td>
</tr>
<tr>
<td>Dr. Bruce Pike</td>
<td>Canadian Forest Service, NRCAN, Corner Brook</td>
<td></td>
</tr>
<tr>
<td>Dr. Harunur Rashid</td>
<td>Environmental Science, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Geoff Rayner-Canham</td>
<td>Environmental Science, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Robert Scott</td>
<td>Sustainable Resource Management, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Julie Sircom</td>
<td>Environmental Science, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Dmitry Sveshnikov</td>
<td>Environmental Science, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Raymond Thomas</td>
<td>BERI, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Adrian Unc</td>
<td>BERI, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Ian Warkentin</td>
<td>Environmental Science, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Barry Wheeler</td>
<td>Canadian Forest Service, NRCAN, Corner Brook</td>
<td></td>
</tr>
<tr>
<td>Dr. Jianghua Wu</td>
<td>Sustainable Resource Management, Grenfell Campus</td>
<td></td>
</tr>
<tr>
<td>Dr. Susan Zeigler</td>
<td>Geography, Memorial University</td>
<td></td>
</tr>
<tr>
<td>Dr. Xinhao Zhu</td>
<td>Canadian Forest Service, NRCAN, Corner Brook</td>
<td></td>
</tr>
</tbody>
</table>

---

6 A complete list of academic CV's will be available in the final draft of the proposal.
R. Gary Kachanoski, PhD

Education:

**Degree** | **Discipline** | **University** | **Year**
--- | --- | --- | ---
B.Sc. (honors) | Biology | University of Saskatchewan | 1976
M.Sc. | Soil Science | University of Saskatchewan | 1980
Ph.D. | Soil Physics | University of California | 1984

**Academic Experience:**

**Position** | **Date** | **Location**
--- | --- | ---
President and Vice-Chancellor | 2010 to Present | Memorial University of Newfoundland
(85%) Professor and Bentley Research Chair (soil, water & environment) | 2007 to 2010 | Department of Renewable Resources, Univ. of Alberta, Edmonton, AB, Canada
(15%) Executive Director, Folkways Alive! | 2007 to 2010 | Faculty of Arts, Univ. of Alberta, Edmonton, AB, Canada
Vice-President (Research) | 2001 to 2007 | Univ. of Alberta, Edmonton, AB, Canada
Dean, College of Graduate Studies and Research | 1996 to 2001 | Univ. of Saskatchewan, Saskatoon, Saskatchewan, Canada
Department Chair and Professor | 1995 to 1996 | Dept. of Land Resource Science, Univ. of Guelph, ON, Canada
Director (Envir & Natural Resources Program) | 1994 to 1996 | Office of VP (Research), Univ. of Guelph, ON, Canada
Associate Professor | 1990 to 1994 | Dept. of Land Resource Science, Univ. of Guelph, ON, Canada
Adjunct appointment as Research Professor | *1990 to 1996 | Dept. of Earth Science, Univ. of Waterloo Centre for Groundwater Research (ON Centre of Research Excellence)
Assistant Professor (Granted Tenure 1987) | 1985 to 1990 | Dept. of Land Resource Science, Univ. of Guelph, ON, Canada

**RESEARCH AND SCHOLARLY ACTIVITIES**

Editor, Canadian Journal of Soil Science, 2009-2010;

Scientific Journals Committee, 2009-2010
(Policy for Canadian Journals of Plant Science, Animal Science, Soil Science);

President – Canadian Society of Soil Science, 2000

Associate Editor of Canadian Journal of Soil Science, 1993-1996;

Associate Editor of Soil Science Society of America Journal, 1992-1997;
Associate Editor European Journal of Soil Science, 1994-1999;

Associate Editor Vadose Zone Journal, 2008 - present;

Natural Sciences and Engineering Research Council of Canada (NSERC) Environmental Earth Sciences Grant Selection (09) Committee, 1997-2000;

NSERC Chair – Major Equipment /Major Installation Committee GSC (09), 2000;

NSERC Environmental Earth Sciences Re-Allocation Steering Committee, 2000;

Soil Science Society of America Kirkham Award Committee Member, 1998-2001;

Professional Agrologist (P.Ag.) 1998-present.

**GRADUATE STUDENT SUPERVISION**

a. Current Graduate Students

1 Ph.D.

b. Students who have graduated

8 M. Sc. Students
11 Ph.D. Students

c. Past Ph.D. Students

<table>
<thead>
<tr>
<th>Year</th>
<th>Name</th>
<th>Occupation After Graduation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>Dr. E. Gregorich</td>
<td>Senior Research Scientist, Agriculture Canada (Ottawa)</td>
</tr>
<tr>
<td>1993</td>
<td>Dr. I. Van Wesenbeeck</td>
<td>Senior Research Scientist, Dow Elanco Indianapolis, U.S.A.</td>
</tr>
<tr>
<td>1994</td>
<td>Dr. A. Ward</td>
<td>Senior Research Scientist (Nuclear Waste), Batelle Pacific Northwest Lab. (U.S.A. Department of Energy National Research Lab.) (Hanford, Washington)</td>
</tr>
<tr>
<td>1994</td>
<td>Dr. G. Parkin*</td>
<td>Professor, Department of Land Resource Science, University of Guelph</td>
</tr>
<tr>
<td>1997</td>
<td>Dr. D. Lobb</td>
<td>Professor, Department of Soil Sciences, University of Manitoba</td>
</tr>
<tr>
<td>1997</td>
<td>Dr. C. Hamlen</td>
<td>Consulting Firm (Environmental)</td>
</tr>
<tr>
<td>1998</td>
<td>Dr. B. Si</td>
<td>Associate Professor, Department of Soil Science, University of Saskatchewan</td>
</tr>
<tr>
<td>1999</td>
<td>Dr. D. Goorahoo</td>
<td>Associate Professor, Fresno State University</td>
</tr>
<tr>
<td>1999</td>
<td>Dr. F. Zhang*</td>
<td>Research Scientist, Batelle Pacific Northwest Lab (U.S.A. DOE National Research Lab)</td>
</tr>
</tbody>
</table>
2006 Dr. S. Woods Research Scientist (Irrigation), Alberta Agriculture Food and Rural Development, Lethbridge, Alberta

2008 Dr. M. Dyck Assistant Professor Department of Renewable Resources, University of Alberta

*co-supervisor

RESEARCH GRANTS AND CONTRACTS

Projects as Principal Researcher (University)

<table>
<thead>
<tr>
<th>Titles of Research Projects</th>
<th>Funding Source</th>
<th>Duration/Date</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial variability of transport processes in soil</td>
<td>NSERC (Discovery)</td>
<td>5 yrs. (2006-2011)</td>
<td>$213,500</td>
</tr>
<tr>
<td>Transport processes in soil</td>
<td>NSERC (Research)</td>
<td>4 yrs. (2001-2005)</td>
<td>$184,000</td>
</tr>
<tr>
<td>Spatial relationships of transport processes in soil</td>
<td>NSERC (Research)</td>
<td>4 yrs. (1997-2001)</td>
<td>$152,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(39,000/yr.)</td>
<td></td>
</tr>
<tr>
<td>Spatial relationships of transport processes in soil</td>
<td>NSERC (Research)</td>
<td>3 yrs. (1994-1997)</td>
<td>$101,325</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(33,775/yr.)</td>
<td></td>
</tr>
<tr>
<td>Time domain reflectometry multiplexing system</td>
<td>NSERC (Equipment)</td>
<td>1 yr. (1995)</td>
<td>$6,900</td>
</tr>
<tr>
<td>Tillage effects on transport processes in soil</td>
<td>NSERC (Research)</td>
<td>3 yrs. (1991-1993)</td>
<td>$96,117</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(32,039/yr.)</td>
<td></td>
</tr>
<tr>
<td>Spatial and temporal variability of transport processes in soil</td>
<td>NSERC (Research)</td>
<td>3 yrs. (1988-1991)</td>
<td>$78,117</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(26,039/yr.)</td>
<td></td>
</tr>
<tr>
<td>Tillage effects on spatial and temporal variability of soil</td>
<td>NSERC (Operating)</td>
<td>3 yrs. (1985-1988)</td>
<td>$67,623</td>
</tr>
<tr>
<td>properties</td>
<td></td>
<td>(22,541/yr.)</td>
<td></td>
</tr>
<tr>
<td>Non-containing electro-magnetic probe for soil EC</td>
<td>NSERC (Research)</td>
<td>1 yr. (1985)</td>
<td>$12,000</td>
</tr>
<tr>
<td>Time domain reflectometry cable tester</td>
<td>NSERC (Equipment)</td>
<td>1 yr. (1987)</td>
<td>$12,500</td>
</tr>
<tr>
<td>Prevention of nitrate contamination of groundwater from fertilizer</td>
<td>NSERC /Agric. Canada</td>
<td>3 yrs. (1990-1993)</td>
<td>$120,000</td>
</tr>
<tr>
<td>Project Description</td>
<td>Organization</td>
<td>Duration</td>
<td>Cost</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td>-----------------------------------</td>
<td>-------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Variable rate technology for N fertilizer application</td>
<td>Agri. Canada (Green Plan)</td>
<td>4 yrs. (1994-1997)</td>
<td>$170,000</td>
</tr>
<tr>
<td>Water and chemical management systems for turf grasses</td>
<td>Agri. Canada (Green Plan)</td>
<td>3 yrs. (1994-1996)</td>
<td>$129,000</td>
</tr>
<tr>
<td>Variable application technology for increased fertilizer-use efficiency</td>
<td>NSERC/Agric. Can</td>
<td>3 yrs. (1990-1993)</td>
<td>$135,000</td>
</tr>
<tr>
<td>Tillage and surface infiltration</td>
<td>Agric. Can.</td>
<td>1 yr. (1989)</td>
<td>$37,000</td>
</tr>
<tr>
<td>Effect of management on surface hydraulic properties.</td>
<td>Agric. Can.</td>
<td>1 yr. (1990)</td>
<td>$75,000</td>
</tr>
<tr>
<td>Tillage effects on quantity and quality of tile drainage water</td>
<td>Agric. Can.</td>
<td>3 yrs. (1989-1991)</td>
<td>$150,000</td>
</tr>
<tr>
<td>Field scale crop response to fertilizer</td>
<td>Potash Phosph. Inst.</td>
<td>2 yrs. (1993-1994)</td>
<td>$14,000</td>
</tr>
<tr>
<td>Impact of manure and fertilizer on nitrate contamination of groundwater</td>
<td>Ont. Min. Environ.</td>
<td>3 yrs. (1991-1994)</td>
<td>$210,000</td>
</tr>
<tr>
<td>Multi-channel, high efficiency gamma-spectroscopy equip. for 137 Cs analysis</td>
<td>Agric. Can.</td>
<td>1 yr. (1987)</td>
<td>$45,000</td>
</tr>
<tr>
<td>Additional high efficiency Li-Ge crystal for gamma spectroscopy system</td>
<td>Agric. Can.</td>
<td>1 yr. (1991)</td>
<td>$30,000</td>
</tr>
<tr>
<td>Application of 137 Cs as an erosion tracer in Ontario</td>
<td>Agric. Can.</td>
<td>1 yr. (1985)</td>
<td>$2,000</td>
</tr>
<tr>
<td>Management of field variability</td>
<td>Agric. Can.</td>
<td>4 yrs. (1988-1992)</td>
<td>$244,678</td>
</tr>
<tr>
<td>Tillage effects on event based soil and phosphorus losses</td>
<td>Ont. Min. Environ.</td>
<td>3 yrs. (1988-1991)</td>
<td>$201,000</td>
</tr>
<tr>
<td>Quantification of tillage translocation of soil</td>
<td>Agric. Can.</td>
<td>3 yrs. (1991-1993)</td>
<td>$76,000</td>
</tr>
<tr>
<td>Soil loss by tillage</td>
<td>Agric. Can.</td>
<td>1 yr. (1991)</td>
<td>$35,000</td>
</tr>
<tr>
<td>Nitrogen conserving farming systems</td>
<td>Ont. Min. Agric.</td>
<td>2 yrs. (1990-1992)</td>
<td>$160,000</td>
</tr>
<tr>
<td>Field scale fertilizer recommendations</td>
<td>University Saskatchewan College Agric.</td>
<td>3 yrs. (1997-2000)</td>
<td>$54,000</td>
</tr>
</tbody>
</table>
### Projects as Co-Researcher (University)

<table>
<thead>
<tr>
<th>Titles of Research Projects</th>
<th>Funding Source</th>
<th>Duration/Date</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe secure water supplies</td>
<td>Alberta Water Research Institute</td>
<td>3 yrs. (2009-2012)</td>
<td>$4,009,800</td>
</tr>
<tr>
<td>(C. Le, PI)</td>
<td></td>
<td></td>
<td>($300K personal)</td>
</tr>
<tr>
<td>Toxic elements (drinking water)</td>
<td>Canadian Water Network (NCE)</td>
<td>4 yrs. (2008-2012)</td>
<td>$626,440</td>
</tr>
<tr>
<td>(C. Le. PI)</td>
<td></td>
<td></td>
<td>($79K personal)</td>
</tr>
<tr>
<td>Discrete Water Chemistry</td>
<td>NSERC (equipment)</td>
<td>1 yr. (2008)</td>
<td>$58,997</td>
</tr>
<tr>
<td>Analyzer (S. Guideau PI)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternate management and N</td>
<td>Agric. Can.</td>
<td>4 yrs. (1988-1992)</td>
<td>$420,000</td>
</tr>
<tr>
<td>contamination of groundwater in sandy soils</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field scale modelling of water and solute transport</td>
<td>NSERC Strategic</td>
<td>3 yrs. (1990-1992)</td>
<td>$390,000</td>
</tr>
<tr>
<td>Remediation of contaminated drinking water wells</td>
<td>Agric. Can.</td>
<td>4 yrs. (1993-1997)</td>
<td>$173,000</td>
</tr>
<tr>
<td>Efficiency of flush and pump remediation technologies</td>
<td>Industrial solvents consortium</td>
<td>2 yrs. (1993-1994)</td>
<td>$30,000</td>
</tr>
<tr>
<td>Movement of chemicals and bacteria off/out of the rooting zone</td>
<td>Agric. Can. (Green Plan)</td>
<td>4 yrs. (1993-1997)</td>
<td>$593,200</td>
</tr>
</tbody>
</table>

### List of Publications (Since 2000)

Papers published in refereed journals:


**Titles of Books and Chapters in Books Which Have Been Published (Total = 13)**


Technical Reports:


Catherine M. H. Keske, Ph.D.

EDUCATION
2006  Doctor of Philosophy, Agricultural and Resource Economics, Colorado State University
2003  Master of Science, Mineral Economics, Colorado School of Mines
1994  Master of Science, Hearing and Speech Sciences, Vanderbilt University
1992  Bachelor of Science, Communication Disorders, magna cum laude, Bowling Green State Univ.

ACADEMIC/RESEARCH POSITIONS
2014-present  Memorial University of Newfoundland, Grenfell Campus
Associate Professor
Division of Social Sciences (Economics) and Boreal Ecosystem Research Institute (BERI)

2011-present  University of Colorado-Boulder
Senior Research Scientist and Affiliate, Institute of Arctic and Alpine Research (INSTAAR)

2008-present  Denver University Sturm School of Law,
Adjunct Professor, Natural Resource & Environmental Law

2004-2012  Colorado State University
2012  Associate Professor, Special Appointment, Dept. of Soil and Crop Sciences
2006-2012  Assistant Professor, Special Appointment, Dept. of Soil and Crop Sciences
2004-2006  Graduate Research Assistant, Dept. of Agricultural and Resource Economics

2003-2006  Colorado School of Mines
Adjunct Economics Professor

PUBLICATION AND GRANT SUMMARY (October 2014)
•  Refereed journal articles, either published or accepted and in press: 31
•  Refereed, published books and book chapters: 15
•  Refereed, published technical and extension reports: 48
•  Non-refereed, published scientific, technical, and outreach bulletins: 71
•  Externally funded grants:
  More than $11,000,000 as PI or Co-PI, 2005-2014
  More than $27,000,000 as Collaborator/Senior Personnel, 2005-2014
  34 Total (PI: 6; Co-PI: 15; Collaborator/Senior Personnel: 3)
•  PI/co-PI of funded workgroup, workshop, and mini-grants (eg. NSF, university internal): 11

SELECTED JOURNAL ARTICLES (Refereed)


Loomis, J.B. and C.M. Keske, 2009, Mountain substitutability and peak load pricing of high alpine peaks as a


**SELECTED AGRICULTURAL EXPERIMENT STATION BULLETINS (Refereed)**


**RESEARCH STATEMENT AND WORK IN PROGRESS**

I am an agricultural and forestry economist who studies contemporary resource issues. I incorporate a number of different economic methods into my research program and I frequently engage in interdisciplinary collaboration. Several of my recent research papers focus on forest recreation and tourism, energy pricing, soil conservation and nutrient management, community sense of place, and ecosystem service valuation. I am currently working on projects that involve the coupling of natural and human systems in the wildland urban interface (WUI); trade-offs between economic development and soil degradation at high elevations; and, the relationship between oil and gas development on home values. I enjoy international research and I have worked on projects in the U.S., China, West Africa (Mali), East Africa, and Costa Rica.

**SELECTED EXTERNAL CONTRACTS & GRANTS**


**PRINCIPAL INVESTIGATOR (Past)**


CO-PRINCIPAL INVESTIGATOR (Past)

STUDENT ADVISING/GRADUATE SUPERVISION
Ph.D. Advisees: Greta Lohman, Adviser CSU 2010-2012, IGERT MASB Fellow
Andrew Brandess, Adviser CSU 2011-2012, IGERT MASB Fellow

Ph.D. Independent Study/Project Supervision:
Paul Tanger, CSU IGERT Rotation Adviser CSU Spring 2010
Patrick Bixler, Independent Study Adviser CSU Spring 2011
Adam Mayer, Independent Study Advisor CSU Spring 2012
Andrew Brandess, CSU Spring 2012
Greta Lohman, CSU Spring 2011, Fall 2011 and Spring 2012

Master of Science:
2012: Andrew Brandess, Major Adviser CSU 2010-2012 (M.S. in Ag and Resource Economics 5/2012), USDA AFRI NIFA Fellow
Jeffrey Lasker, Committee Member (Master of Engineering 5/2013)
Cristian Robbins, Committee Member (Master of Engineering 5/2012)
Andrew Arrell, Major Adviser (Master of Agriculture 12/2012)

2011: Shannon Clark, Major Adviser CSU (Master of Agriculture 12/2011)
Stephen Goodwin, Committee Member (Master of Engineering 12/2011)
Christopher Henry, Committee Member (Master of Science in Forestry 8/2011)

2010: Greta Lohman, Major Adviser CSU (Master of Science in Soil and Crop Sciences 12/2010)
Morgan Davis, Committee Member CSU (Master of Engineering 12/2010)
Benjamin Geller, Committee Member CSU (Master of Engineering 12/2010)
Eric Cropper, Committee Member University of Wyoming (Master of Science in Agricultural and Resource Economics 5/2010)

2008: Rebecca Goldbach, Major Adviser, CSU (M.S. in Agricultural and Resource Economics (12/2008)
2007: Michael Verdune, Advising Committee Member, CU-Denver (M.S. in Economics 12/2007)

Bachelor of Science Honors Committees:
2008: Cassie Fiscus, CSU Honors Thesis Committee Member (B.S. 12/2008)

Clubs: University of Northern Colorado Snowboarding Club Faculty Adviser (2006/07)
UNC Outstanding Club President Nate Giska (Spring 2007)
Julie Sircom

Environmental Science Unit, Biology
Grenfell Campus, Memorial University
Corner Brook, NL A2H 6P9
(709) 639-6515
jsircom@grenfell.mun.ca

Home address
PO Box 232
Corner Brook, NL A2H 6C9
(709) 632-7978
jsircom@dal.ca

Education

Dalhousie University 2003 – 2009 Ph.D. Biology
Thesis title: Determinants of the biodiversity and composition of stream insect communities.
Supervisor: Dr Sandra Walde

Dalhousie University 1996 – 1999 M.Sc. Biology
Supervisor: Dr Sandra Walde

Acadia University 1985 – 1989 B.Sc. Biology
Thesis title: Recolonization by the amphipod Corophium volutator of mudflats in the Minas Basin.
Supervisor: Dr Graham Daborn

Additional post-secondary education

<table>
<thead>
<tr>
<th>Location</th>
<th>Year(s)</th>
<th>Program</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carleton University</td>
<td>2000 – 2002</td>
<td>Ph.D. Biology</td>
<td>Withdrew; funding problems</td>
</tr>
<tr>
<td>Simon Fraser University</td>
<td>1991</td>
<td>No degree program</td>
<td>Taking courses of interest</td>
</tr>
</tbody>
</table>

Awards
<table>
<thead>
<tr>
<th>Awarding body</th>
<th>Description of award</th>
<th>Year(s) held</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government of Ontario</td>
<td>Ontario graduate scholarship</td>
<td>2001</td>
</tr>
<tr>
<td>Carleton University</td>
<td>Graduate scholarship</td>
<td>2000</td>
</tr>
<tr>
<td>NSERC</td>
<td>Summer research fellowship</td>
<td>1987, 1988</td>
</tr>
<tr>
<td>Acadia University</td>
<td>Dean’s List scholarship</td>
<td>1987</td>
</tr>
<tr>
<td>Acadia University</td>
<td>Dean’s List</td>
<td>1987 – 1988</td>
</tr>
<tr>
<td>Acadia University</td>
<td>Entrance scholarship (renewable)</td>
<td>1985 – 1989</td>
</tr>
</tbody>
</table>

**Teaching experience**

**Assistant professor**

<table>
<thead>
<tr>
<th>Course title</th>
<th>University</th>
<th>Year(s)</th>
<th>Format and content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshwater Ecology ENVS 3130</td>
<td>Grenfell Campus, MUN</td>
<td>Winter 2012-2015</td>
<td>Lecture and lab*, student-led journal club style discussions. Water properties, chemistry, nutrients, organisms and ecosystems.</td>
</tr>
<tr>
<td>Principles of Ecology BIOL 2600</td>
<td>Grenfell</td>
<td>Fall 2012-2014</td>
<td>Lecture and lab*, several computer tutorials. Distributions, population models, communities and ecosystems.</td>
</tr>
<tr>
<td>Principles of Biology BIOL 1001</td>
<td>Grenfell</td>
<td>Fall 2011-2013</td>
<td>Lecture and lab†. History of life, phylogeny, survey of diversity, life chemistry, basic cellular processes †</td>
</tr>
<tr>
<td>Principles of Biology BIOL 1002</td>
<td>Grenfell</td>
<td>Winter 2012</td>
<td>Lecture and lab†. Basic cellular processes, DNA, Mendel, population genetics, evolution †</td>
</tr>
<tr>
<td>Biology of Vertebrates BIOL 2210</td>
<td>Grenfell</td>
<td>Fall 2011</td>
<td>Lecture and lab*. Survey of vertebrate taxa, evolutionary relationships and ecological importance.</td>
</tr>
<tr>
<td>Behavioural Ecology BIOL 495</td>
<td>Cape Breton University</td>
<td>Winter 2011</td>
<td>Lecture and lab†. Survey of behavioural ecology, including social behaviour, foraging, habitat and mate choice.</td>
</tr>
<tr>
<td>Ichthyology BIOL 485</td>
<td>CBU</td>
<td>Winter 2011</td>
<td>Lecture and lab†. Survey of fish diversity and evolution, their ecological and economic importance.</td>
</tr>
</tbody>
</table>
Chordate Zoology
BIOL 235
CBU
Winter 2011
Lecture and lab†. Survey of chordate taxa, evolutionary relationships and ecological importance.

Population Ecology
BIOL 3069
Dalhousie University
Fall 2009
Lecture and tutorial delivered by teaching assistant. Selection of population models including competition and disease.

*Present in laboratory, content and schedule developed in collaboration with an instructor.
†Laboratory taught by instructors; consultation with faculty on scheduling and content.
‡Biology 1001 and 1002 have been under revision since 2011; the apparent overlap in content is due to material being moved from one course to the other.

Supervisory experience
Co-supervisor for ENVS 4950 Independent Project, fall semester 2012
Supervisor for ENVS 4950 Independent Project, fall semester 2013
Currently supervising a Masters student through Environmental Science in St John's

Research interests
My research focuses on pollinators, primarily native bumble bees in commercial cranberry fields. This research is intended to provide growers with low-cost approaches to increasing yield by encouraging native pollinator populations, to reduce reliance on imported, non-native bumble bees. These have the potential to spread diseases and parasites to native bees, and to our currently healthy honey bee colonies. There are also opportunities to examine plant-pollinator interactions, pollinator behaviour at local and landscape scales, and pollinator diversity. With the help of BERI researchers, I plan to examine the nutritional content of the pollen and nectar of common forage plants to determine the optimal species composition to enhance native bee populations. Other projects include assessment of honey bees as cranberry pollinators, measuring the nutritional properties of honey produced by honey bees foraging on cranberry and other native crops, and a pilot study of clearcuts as transitory native bee habitat, in collaboration with Corner Brook Pulp and Paper.

Research funding

<table>
<thead>
<tr>
<th>Project title; collaborators</th>
<th>Funding agencies</th>
<th>Amount</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhancing native pollinators in commercial cranberry fields for increased yield Collaborator: Dr Barry Hicks, CNA</td>
<td>Research &amp; Development Corporation, NL</td>
<td>$100,000</td>
<td>January 2014 – December 2015</td>
</tr>
<tr>
<td>Pollination of commercial Cranberry (Vaccinium macrocarpon Ait.) in Newfoundland by native and introduced bees Collaborator: Dr Barry Hicks, CNA</td>
<td>Regional Collaboration Research Initiative, NL Department of Natural Resources</td>
<td>$37,020</td>
<td>June 2013 – April 2014</td>
</tr>
</tbody>
</table>
Detritus processing and priming effects in boreal forest streams: potential links to climate change  
**Collaborator: Dr Kate Edwards, CFS**

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Funding Source</th>
<th>Amount</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detritus breakdown in boreal forest streams: Potential links to climate change</td>
<td>Vice President Grenfell Campus Research Fund</td>
<td>$1,500</td>
<td>January 2013 – December 2013</td>
</tr>
</tbody>
</table>

CNA: College of the North Atlantic, Carbonera campus  
CFS: Canadian Forest Service, Corner Brook office

**Publications**

**Refereed publications – published**


**Technical reports**


### APPOINTMENTS

<table>
<thead>
<tr>
<th>Date</th>
<th>Position</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>09/2013</td>
<td><strong>Associate Professor of Soil Science (tenured)</strong></td>
<td>Memorial University of Newfoundland, Boreal Ecosystems Research Institute, Grenfell Campus, Corner Brook NL, Canada.</td>
</tr>
<tr>
<td>01/2015-12/2015</td>
<td><strong>Visiting Research Fellow</strong></td>
<td>University of Leeds, School of Geography, Faculty of Environment, Leeds, UK.</td>
</tr>
<tr>
<td>07/2014-12/2014</td>
<td><strong>Senior Cheney Fellow</strong></td>
<td>University of Leeds, School of Earth and Environment, Faculty of Environment, Leeds, UK.</td>
</tr>
<tr>
<td>08/2013</td>
<td><strong>Affiliated Associate Professor</strong></td>
<td>New Mexico State University, College of Agriculture, Consumer and Environmental Sciences, Department of Plant and Environmental Sciences, Las Cruces NM, USA.</td>
</tr>
<tr>
<td>07/2013-08/2013</td>
<td><strong>Associate Professor of Environmental Sciences (tenured)</strong></td>
<td>New Mexico State University, College of Agriculture, Consumer and Environmental Sciences, Department of Plant and Environmental Sciences, Las Cruces NM, USA.</td>
</tr>
<tr>
<td>02/2007-06/2013</td>
<td><strong>Assistant Professor of Environmental Sciences (tenure track)</strong></td>
<td>New Mexico State University, College of Agriculture, Consumer and Environmental Sciences, Department of Plant and Environmental Sciences, Las Cruces NM, USA.</td>
</tr>
<tr>
<td>05/2013-03/2014</td>
<td><strong>Adjunct Associate Professor (2013-2014)</strong></td>
<td>New Mexico State University, Molecular Biology Program (Interdepartmental Program), Las Cruces NM, USA.</td>
</tr>
<tr>
<td>2010 - 2014</td>
<td><strong>Adjunct Faculty member</strong></td>
<td>Energy Research Laboratory, New Mexico State University, Las Cruces NM, USA.</td>
</tr>
<tr>
<td>09/2012 - 09/2013</td>
<td><strong>Invited Associate Professor (2012-2013)</strong></td>
<td>Banat's University of Agricultural Sciences and Veterinary Medicine, Faculty of Horticulture and Forestry, Timisoara, Romania.</td>
</tr>
<tr>
<td>07/2005 - 01/2007</td>
<td><strong>Research Scientist (July 2005 to January 2007)</strong></td>
<td>Centre for Research on Environmental Microbiology, Department of Biochemistry, Immunology and Microbiology, Faculty of Medicine, University of Ottawa, Ottawa ON Canada.</td>
</tr>
<tr>
<td>09/2006 - 12/2006</td>
<td><strong>Lecturer (Sept. 2006 to Dec. 2006)</strong></td>
<td>University of Guelph, Kemptville Campus, Kemptville ON Canada.</td>
</tr>
<tr>
<td>05/2003 - 09/2006</td>
<td><strong>Special Graduate Faculty Member</strong></td>
<td>Graduate Faculty, University of Guelph, Guelph, ON Canada.</td>
</tr>
<tr>
<td>07/2002 - 06/2005</td>
<td><strong>Postdoctoral Fellow (July 2002 to June 2005)</strong></td>
<td>Centre for Research on Environmental Microbiology, Department of Biochemistry, Immunology and Microbiology, Faculty of Medicine, University of Ottawa, Ottawa ON Canada.</td>
</tr>
</tbody>
</table>

01/2002 - 05/2002 Teaching Assistant (Jan. 2002 to May 2002), Crop Sciences Department, University of Guelph, Guelph ON, Canada.

09/1999 - 12/2001 Teaching Assistant (nine semesters in the period Sept. 1999 to Dec. 2001), Land Resource Science, University of Guelph, Guelph ON, Canada.

05/1996 - 06/2002 Research Assistant (May 1996 to June 2002), Department of Land Resource Science, University of Guelph, Guelph ON, Canada.


SCIENTIFIC EXPERTISE


International co-operation for research activities (co-authors and collaborators from NAFTA region, EU region, Middle East)

FUNDING SOURCES (career):

Research and Development Corporation; University of Leeds; US Department of Energy; US National Parks Services; US National Institute of Health; US National Science Foundation; US Department of Agriculture; Health Canada; Environment Canada; Agriculture and Agrifood Canada; Ontario Ministry of Agriculture; Food and Rural Affairs; Ontario Ministry of Environment; Water Resources Research Institute; International Arid Land Consortium: International Science and Technology Center; BHP Billiton; WCI Environmental Solutions Inc.; GangaGen, Inc.; Dairy Farmers of Ontario; New Mexico Dairy Producers; New Mexico State University; University of Ottawa.

FUNDING (last 2 years):

1. PI, Understanding soil fertility under land-use change scenarios; implications for land management and introduction of novel crops, Research & Development Corporation Newfoundland and Labrador. $100,000 (2015-2016).

2. PI, Senior Cheney Fellowship, University of Leeds, (NOTE: awarded as one year salary & benefits, housing allowance, return flight, and £1000 conference costs, equivalent to about £85,000 or CAD $156,000; accepted at 6 months) (2014).

3. Co-I (consortium including multiple Co-I’s from the University of New Mexico, New Mexico State University, New Mexico Institute of Mining and Technology, Eastern New Mexico University, Santa Fe Community College and Santa Fe Institute with collaborators from the Los Alamos National Laboratory and the Sandia National Laboratory), Energize New Mexico, National Science Foundation (NSF) award #IA-1301346, $20,000,000 (2013-2018).


5. PI, Inventory of Soil Microbial and other Soil Faunal Ecosystem Components at the White Sands National Monument (WHSA) and Guadalupe Mountains National Park (GUMO). US National Park


PEER REVIEWED PUBLICATIONS (last 2 years)

1. Unnithan, VV*, Unc, A, Joe, V**, Smith, GB. 2014. Short RNA indicator sequences are not completely degraded by autoclaving, Scientific Reports, 4, 4070; DOI: 10.1038/srep04070


Popular or trade publications (last 2 years)


TEACHING AND ADVISING (last 2 years)

Academic advising (Advisory committee chair)

Post-doctoral scientists (NMSU): Dr. Mark Seger - from 2011

Doctoral students (PhD) (NMSU):

Lori-Kae Schwab Uchanski: “Soil microbial diversity in grazed arid grasslands following natural gas drilling”, graduated 2014

Mohammad E.W. Tahtamouni: “Functional and genetic diversities of soil and plant associated microbial communities across variable spatial scales in semiarid ecological regions”, graduated 2014

Veena V. Unnithan: “Role of N. salina in controlling wastewater microbial diversity in biofuel production systems”, graduated 2013

Andrew Potter. “Effects of varying harvest and feeding regimes on productivity of Nannochloropsis salina grown in municipal wastewater” (current)

Master students (MSc) (NMSU):

Helena Deswood: “Analysis of the microbial community in bladder cells of Atriplex canescens (Pursh) Nutt. through microscopy and metagenomics” - graduated 2014

Jessica Gregson: “Wastewater Metagenomics in a wastewater lgal System; Laboratory scale evaluations” - graduated 2014 (Molecular Biology Department)

Conrad Nelson: Course based MSc - graduated 2014

Academic advising (PhD, Advisory committee member):

Mohammed Farhangi - advised by Dr. S. Sinegani, Bu-Ali Sina University, Iran - graduated 2014

Jennifer Smith - advised by Dr. W. Boeing, NMSU- Range Science (current)

TEACHING (last 2 years):

Survey of Environmental Chemistry (MUN, Grenfell); Environmental Impacts of Land Use (NMSU); Topics in Agronomy (NMSU);
OTHER ACTIVITIES (last 2 years):
Professional societies:

Editorial Board member, Algal Research (impact factor 4.10), 2014-2017

Session Chair: Integrated modelling of contaminants in the vadose zone; Source, Fate, and Impact at ELS 2014 - the Earth Living Skin: Soil, Life and Climate Changes organized by the Soil System Sciences (SSS) Division of the European Geosciences Union, September 22-25, 2014, Bari, Italy.


Grant reviewer:
The United States - Israel Binational Agricultural Research and Development Fund (BARD, 2013/2014)

South African Medical Research Council (2013, 2014)

The California Department of Food and Agriculture (CDFA), Fertilizer Research and Education Program (FREP) (2012, 2013, 2014).


Patents: Provisional patent (Photosynthetically oxygenated waste to energy recovery apparatus and method of use, (POWER), 2014

HONORS (last 2 years):

Visiting Research Fellow (2015), Univ. of Leeds, School of Geography, Faculty of Environment,

Senior Cheney Fellow (2014), Univ. of Leeds, School of Earth and Environment, Faculty of Environment,

Inducted into Sigma Xi, The Scientific Research Society (2013)

Inducted into Gamma Sigma Delta, The Honor Society for Agriculture (2012)
Appendix G. Letters of Support

November 6, 2012

Dr. Antony Card
Associate Vice-President (Grenfell Campus) Research
20 University Drive
Grenfell Campus
Corner Brook, NL  A2H 6P9

Dr. Card,

The Newfoundland and Labrador Environmental Industry Association (NEIA) is pleased to support Grenfell Campus, Memorial University in its efforts to establish an Environmental Research Facility in Corner Brook. It is NEIA’s understanding that this project is part of a wider effort to develop greater research capacity and teaching supports within Memorial’s environmental science and environmental studies programs.

NEIA is a not-for-profit association of businesses that promotes the growth and development of the environmental sector in Newfoundland and Labrador. We represent firms operating in the areas as diverse as waste management, sustainable resource development, green building and green transportation. The growth of this sector depends on qualified professionals. Several firms within the sector have identified access to skilled human resources as a barrier to growth. A recent report published by GLOBE Advisors and Earth & Environmental, “An Analysis of the Economic Development Opportunities Associated with the Green Economy in Newfoundland and Labrador”, states that the environmental sector employs over 10,300 Newfoundlanders and Labradorians in over 1,100 private and public organizations. The report, even in its conservative estimates, predicts significant growth for the sector. The availability of qualified labour availability is a crucial factor in this growth. The current Grenfell initiative helps address these workforce challenges within the environmental sector in a number of ways. These facilities will ensure the high-quality of environmental related education by complimenting classroom teaching efforts and exposing students to the state of the art technology used within the sector. In addition, new facilities will assist Memorial in recruiting highly qualified faculty, laboratory technicians, graduate students, and postdoctoral fellows in environmental research. The presence of these skilled individuals not only contributes to an enhanced classroom experience, but also serves to establish Grenfell campus and the Corner Brook region as a centre of excellence for environmental research. These measures, we hold, will further enhance the supply qualified labour available to work in this growing sector.

The proposed facilities will also increase the capacity of Memorial faculty, staff and students to undertake the academically focused interest-based research which underpins private sector research and innovation. This has a two-fold effect. First, the research directly contributes to the information available to guide businesses, municipalities, non-governmental associations, and other groups in their decision making. This is particularly true for stakeholders in renewable resource sectors such as agricultural and forestry. Second, enhanced local research will serve as a catalyst for public discourse, contributing to better public awareness of environmental issues and ultimately, more effective public policy. The facilities will also support climate change research in Newfoundland and Labrador.
Improved academic environmental research will provide opportunities for private industries, and enhance public education on environmental issues. NEIA therefore supports the efforts of Grenfell Campus to establish enhanced environmental research facilities.

If you require any additional clarification or information, please do not hesitate to contact Ted Lomond, Executive Director at NEIA, at ted@neia.org or by phone at 709.772.3336.

Sincerely,

[Signature]

Frank Ricketts
Chair
February 18, 2013

Dr. Antony Card
Associate Vice President (Research)
Grenfell Campus, Memorial University
University Drive
Corner Brook, NL

Dear Antony:

Thank you for the opportunity to meet with Grenfell faculty last week to provide an overview of the Natural Resources Canada (NRCan) - Canadian Forest Service (CFS) research program, to discuss the research needs in the forest sector of the country and province, and ways that we can collaborate with Grenfell Campus to increase forest research capacity.

As you know, the CFS office in Corner Brook has had a strong working relationship with Grenfell Campus, its students, faculty, and administration over the last 15+ years. This is demonstrated by the fact that many CFS staff members served as Adjunct Professors at Grenfell Campus and co-supervised graduate students. Further, Grenfell and CFS are actively working together, in collaboration with the Provincial Department of Natural Resources - Forest Service, in the development of a Collaborative Research Agreement for enhanced forest research capacity which will pave the way for the creation of the Boreal Ecosystem Research Institute (BERI). BERI will augment the forest sector research capacity by means of increased research infrastructure, the hiring of additional forest sector research positions, and increased graduate programming in Environmental Science and Environmental Policy - initiatives critical to the success of BERI.

Accordingly, the Canadian Forest Service strongly supports your application for funding for BERI infrastructure. The CFS looks forward to increased research collaboration with Grenfell as we move forward with the creation of BERI.

Sincerely,

Dr. Brian Hearn
A/Director, CFS
February 8th 2013

Greg Wood, PhD
Consultant to the Vice President (Grenfell)
Grenfell Campus - Memorial University of Newfoundland
Corner Brook, NL Canada A2H 6P9

Dear Dr. Wood:

Re: Environmental Research Laboratory at Grenfell Campus - MUN

This letter is to confirm the support of the Forestry and Agrifoods Agency for the development of an environmental research laboratory at Grenfell Campus. An increased research capacity on the west coast of Newfoundland would be an asset to the region.

The analysis equipment proposed for the research facility will allow for the study of soil and water samples which could link with analysis requirements of the Wooddale Provincial Tree Nursery as well as other divisions within the Agency. These laboratories will increase Grenfell Campus research capabilities helping to attract highly qualified faculty. The proposed environmental research laboratory at Grenfell Campus offers great potential to grow local capacity on the west coast in forestry and agriculture related research.

The Agency looks forward to future partnerships with Grenfell Campus to address our research requirements.

Sincerely,

James Evans, RPF
CEO - Forestry and Agrifoods Agency
February 12, 2013

Dr. Antony Card
Associate Vice President (Research)
Grenfell Campus, Memorial University
University Drive
Corner Brook, NL

Dear Dr. Card:

Re: Support for Agricultural Initiatives at the Grenfell Campus

Thank you for the opportunity to meet with you and other Grenfell Campus and Memorial University faculty at the Agricultural Symposium in Corner Brook in November. Being invited to be the keynote speaker at your symposium was an honour and I trust that my talk met with your expectations. An important point I raised in my presentation was that universities in Atlantic Canada should be more deliberate about working together to support agriculture through closer research and academic planning and coordination of resources.

Following in that vein, the Faculty of Agriculture at Dalhousie University is eager lend support to your initiatives at Grenfell Campus toward the development of agriculture-focused research and graduate programs.

As you know, the Faculty of Agriculture has over one hundred years of experience in research and academic training in agriculture and food, and we would welcome ways to share our expertise and capacity to assist Grenfell Campus in the development of complementary and cooperative research and training projects in the future.

The construction of your new research facilities and the new faculty hiring with which you are currently engaged, provides outstanding opportunities for collaborative research projects between Dalhousie, Grenfell faculty and graduate students. The Faculty of Agriculture strongly supports these initiatives, and we look forward to strengthening our collaborative relationship with Grenfell Campus in the future.

Sincerely,

R. G. Donald, Ph.D., P.Ag.
Associate Dean, Research & External Relations
Faculty of Agriculture

cc. Dr. Harold Cook, Principal and Dean
Dr. Claude Caldwell, Associate Dean Academic

Office of the Associate Dean, Research • PO Box 550 • Truro NS. B2N 5E3. Canada
Tel 902.894.6066 • Fax 902.894.3480 • Email richard.donald@dal.ca • dal.ca/agriculture
Grenfell Campus, Memorial University
University Drive
Corner Brook, NL
A2H 6P9

Dear Dr. Card,

I am pleased to express Agriculture and Agri-Food Canada’s (AAFC) support for Memorial University’s initiative in creating a graduate program with a focus on agricultural research at its Grenfell Campus.

We thank you for sharing your plans to hire five new faculty members and to build and equip research laboratories that will support their research. We appreciate the opportunity to provide feedback on the strategic direction and the scientific capacities which you intend to staff.

These discussions have helped ensure that the new faculty and labs will complement the capacity that AAFC has at its Atlantic Cool Climate Crop Research Centre in St. John’s and the capacity that exists more broadly throughout the region. The new faculty and labs will also form the basis of future collaboration between our two organizations and contribute to industry and provincial government objectives of increasing the overall economic output of Newfoundland and Labrador’s agricultural sector.

AAFC is also pleased by your proposal to create a Research Chair in Sustainable Agriculture which should attract a senior scientist to lead the research at Grenfell. It is well understood that the environmental conditions, especially as they relate to managing soil and water, affecting agricultural activity in the province continue to provide challenges which can be overcome through additional research and development. The proposed environmental laboratories will be central in unlocking the potential in the province.

On behalf of AAFC, I would like to express support for the strong research program being proposed by Memorial University. We look forward to establishing strong partnerships with the University and the agriculture industry over the years to come.

Regards,

Christiane Deslauriers
Director General
Atlantic and Coastal Ecorone
Science and Technology Branch
Agriculture and Agri-Food Canada

Canada
December 21, 2012

Dear Dr. Card:

I am writing to express my strong support for the proposed Environmental Research Facility Business and Sustainability Plan. This facility will provide an important platform for the development of a knowledge based industry linked to the natural resources sector. The research supported through this facility will enable the province and Canada to gain the knowledge required to adapt and establish forward thinking policy relevant to those resources including forestry and agriculture. We are all keenly aware of our changing climate which is the primary driver of ecosystem processes including forest and agricultural systems.

The Grenfell Campus in Corner Brook is strategically located and has successfully implemented programs to facilitate environmental research aimed at understanding the impacts of climate change on resources and the resource industry. The Newfoundland and Labrador Boreal Ecosystem Latitudinal Transect (NL-BELT) was established in 2010 as part of an agreement between the Forest Service of the NL Department of Natural Resources, Corner Brook Pulp and Paper, and the Canadian Forest Service. This transect is one of five such transects established as part of the CFS National Network of Latitudinal Transects and is made up of three established and instrumented terrestrial and stream sites located within each of four major river watersheds spanning almost 5.5° latitude and mean annual temperature. The watersheds include the Grand Codroy, Humber River, Salmon River, and Eagle River in Labrador. Ongoing collaborative research is funded through multiple federal and provincial partners including NSERC, HRBP, CFSI, and CFI which have supported equipment, infrastructure, personnel, other research costs, and student support. Our ability to continue to expand this research hinges upon our ability to conduct experiments, analyses, and facilitate more complex field experimentation from Corner Brook. Too much of our current resources go to traveling and shipping large amounts of samples across the island. The proposed facility would reduce that burden and thereby enable better use of resources for conducting climate change and forestry related research. More importantly, it also would provide unique analytical capabilities relevant to this research and useful to the training of students who reside in Corner Brook.

The proposed five new faculty for the Grenfell campus are each in strategic areas that are sorely needed, representing major gaps in expertise in NL, and critical to the development of a knowledge based industry around natural resources. I am very...
excited about the prospect of collaborators in hydrology, soil, forestry and agricultural sciences. I also think that these natural resource based experts would nicely complement the current expertise at Grenfell and in St. John’s enabling a more well-rounded graduate and undergraduate program in Environmental Science. Though already offered at the St. John’s and Grenfell campuses, respectively, the development of this new facility will add a tremendous boost and needed component to both of these programs. Collaborative teaching across the campuses will enable the building of the already strong MSc and PhD programs in environmental science. Such collaboration has already been facilitated through the use of the new video conferencing link in the new research building at Grenfell to provide exchange of lectures and student interaction in my ENVS6000-Environmental Science and Technology course.

The established Humber River Basin Project is another example of the successful implementation of environmental research relevant to the province. The HRBP has supported co-supervised research by graduate and undergraduate students spanning faculty at Grenfell, St. John’s and researchers within the provincial and federal government. The range of natural science and socioeconomic research projects conducted under the HRBP have stimulated new research funding through agencies including NSERC, AIF, CFI, CFSI, MITACS, US-NSF and stimulated important long lasting collaborations across the campuses, with federal agency researchers (CFS, Environment Canada), and with international researchers (US, Germany, Australia). This initiative represents an important example of the potential for environmental research that can be stimulated and supported through this new facility.

The proposed research facility will further support ongoing research in environmental monitoring technologies. Research developing microfluidic devices coupled with analytic detection, initiated through HRBP support, is currently ongoing in St. John’s but could be expanded through the establishment of this new facility. Such analytical capabilities have important applications to environmental research and benefit most through coupled analytical and field infrastructure both in the laboratory and field. So again, this unique combination of a state-of-the-art laboratory facility with easy access to well established and active research sites would greatly facilitate this "lab on a chip" research.

The proposed new faculty and facility juxtaposed with the well established environmental research expertise, collaborations (federal, provincial and international), and field infrastructure in place along the west coast of NL will generate an important knowledge-based center. Such a center in Corner Brook will stimulate important research relevant to policies that will enable Canada and the province of NL to adapt to climate change in a way that assures the sustainability of agriculture and forestry. In doing so this research will also undoubtedly stimulate new technologies related to environmental monitoring relevant to agriculture, forestry and water quality. I am very excited about the prospects of the proposed Environmental Research Facility Business and Sustainability Plan and I hope you will give it your utmost consideration.
Please do not hesitate to contact me as I would be happy to provide further details regarding my support of this initiative.

Best regards,

Susan Ziegler
Associate Professor
Canada Research Chair in Environmental Science
709.864.2669
sziegler@mun.ca
Newfoundland and Labrador  
Federation of Agriculture

Dr. Greg Wood, Environmental Advisor  
Grenfell Campus, MUN  
1 University Drive  
Corner Brook, NL A2H 6P9

May 23, 2013

Dear Dr. Wood:

The Newfoundland and Labrador Federation of Agriculture (NLFA) would like to express its support for Memorial’s Grenfell Campus to carry out the research outlined in the proposal to the Atlantic Canada Opportunities Agency (ACOA) for new facilities.

If the application is successful, we will be provided greater research expertise, allowing for benefits to our industry and members, including improved on-farm competitiveness and profitability, better environmental sustainability, and an overall improvement in our local industry’s competitiveness in the national and global marketplace.

It has been indicated to the NLFA that our organization could serve in an advisory role with Grenfell related to research needs and directions. This level of input from industry demonstrates that the university is interested in industry’s research requirements and further strengthens our interest in seeing this project completed.

If you require any further information or would like to discuss in more detail, please do not hesitate to contact me.

Regards,

Eugene Legge  
President

"Farmers Helping Farmers"