SFU OFFICE OF THE VICE-PRESIDENT, ACADEMIC AND PROVOST

8888 University Drive, Burnaby, BC
Canada V5A 1S6

TEL: 778.782.3925
FAX: 778.782.5876

vpacad@sfu.ca
www.sfu.ca/vpacademic

MEMORANDUM

ATTENTION	Senate	**DATE**	August 20, 2014
FROM	Jon Driver, Vice-President, Academic and Provost, and Chair, SCUP	**PAGES**	1/1
RE:	Faculty of Environment: Full Program Proposal for Simon Fraser University-British Columbia Institute of Technology Master of Science in Ecological Restoration Joint Degree (SCUP 14-22)		

At its July 16, 2014 meeting, SCUP reviewed and approved the Full Program Proposal for a Simon Fraser University-British Columbia Institute of Technology Master of Science in Ecological Restoration Joint Degree within the Faculty of Environment, effective Fall 2015.

Motion:

That Senate approve and recommend to the Board of Governors the Full Program Proposal for a Simon Fraser University-British Columbia Institute of Technology Master of Science in Ecological Restoration Joint Degree within the Faculty of Environment, effective Fall 2015.

c: S. Markey

SFU Dean of Graduate Studies

Maggie Benston Student Services Centre 1100
8888 University Drive
Burnaby, BC
Canada V5A 1S6

TEL 778.782.3042
FAX 778.782.3080

report-dgs@sfu.ca
www.sfu.ca/Dean-GradStudies

MEMORANDUM

ATTENTION	SCUP	DATE	3 July 2014
FROM	Wade Parkhouse, Dean of Graduate Studies	No.	GS2014.12
RE:	Proposal for a MSc in Ecological Restoration		

W Parkhouse

At its meeting 5 May 2014, SGSC approved the proposal for a Master of Science in Ecological Restoration (MSc ER) and is recommending it to SCUP.

Effective Date: Summer 2015

Faculty of the Environment

Motion:
That SCUP approve and recommend to Senate the proposal for a Master of Science in Ecological Restoration

Timeline:

May 2013	Faculty of the Environment Gradute Program Committee unanimously approved a Notice of Intent (NOI) for the Master of Science in Ecological Restoration (MSc ER)
June 2013	SGSC approved the NOI
	SCUP approved the NOI
May 2014	SGSC approved the Full Program Proposal (FPP) once the new courses and unit split are finalized with BCIT

BRITISH COLUMBIA INSTITUTE OF TECHNOLOGY

SFU ENGAGING THE WORLD

Proposal

for a

Master of Science (M.Sc.) in Ecological Restoration

17th July 2014

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Executive Summary

Many ecosystem services and natural habitats have been severely impacted due to the cumulative impacts of previous and ongoing anthropogenic influences, for example: urban sprawl, industrial expansion, invasive species, and contamination of soils and water resources. These factors, and the need to improve habitat for threatened and endangered species, have led to the requirement for ecosystem restoration work across the province, Canada, and internationally. The MSc in Ecological Restoration outlined in this proposal will combine the applied technical (experiential) emphases at the British Columbia Institute of Technology (BCIT) with the fundamental (contextual) basic science and community engagement expertise at Simon Fraser University (SFU) to provide a unique joint-degree program that will fundamentally advance both the practice and science of ecological restoration. The four-semester (36 units - inclusive of a 6 unit capstone project), program will be offered at a premium fee, producing graduates that will be capable of using critical thinking, adaptive management, and research within an applied problem-solving framework. This combination of skills will be applied to the identification of factors responsible for degraded ecosystems and to the restoration of ecosystems functions, while advancing the scientific knowledge of this rapidly emerging discipline. Graduates will have the critical and theoretical skills needed to set priorities, develop a structured approach to restoring degraded ecosystems, and critically assess their success in highly complex and unpredictable environments with significant uncertainties.

Inherent in the proposed program are the development of essential skills for program management, communication, and respectful community consultation (please see the program map in Appendix 1). The program will leverage expertise at both institutions, and the setting of the region, to understand how to approach ecological restoration in diverse sociocultural and biophysical settings.

The strengths of the proposed program include:

- A unique interdisciplinary & inter-institutional curriculum;
- Positioned within a new and rapidly growing environmental discipline and industry;
- An interdisciplinary, hands-on approach to addressing pressing practical problems;
- A focus on using applied research to provide solutions to industry problems;
- The generation of strong industry connections via client-based research projects; and
- A unique program in Canada, and among only a few in North America (as outlined in Appendix 13).

The program has been developed by a joint Steering Committee, including: (From SFU) Leah Bendell, Biology; Dan Burns, Dean's Office; Duncan Knowler, REM; Sean Markey, Associate Dean/REM; Jonathan Moore, REM/Biology; Jeremy Venditti, Geography. (From BCIT) Ken Ashley, School of Construction and the Environment, Director Rivers Institute of BC; Doug Ransome, School of Construction and the Environment; Rob Stevens, Associate Dean, School of Construction and the Environment. The program will be a joint degree in full partnership with BCIT. Our objective, depending upon the Provincial approval process, is to launch the program Fall 2015.

1 Curriculum and Program Content

1.1 Program Aim

The aim of the proposed Master of Science in Ecological Restoration degree is to create a highly qualified talent pool urgently needed in Canada's ecological restoration industry. The master's program will provide students with the critical thinking and experiential skills to be leaders and educators in the rapidly developing ecological restoration industry. The unique, shared institutional curriculum will produce graduates with an integrated body of knowledge, methods, and tools for advancing the practice and science of restoring degraded ecosystems.

1.2 Program Goals

To achieve its objectives, the program will establish a unique interdisciplinary and inter-institutional curriculum that provides students with an integrated science-based body of knowledge and skills necessary to meet the challenge of delivering effective and successful restoration programs. Given that there are so few graduate programs with this specialization in North America, the proposed program will advance the knowledge and practice of ecosystem restoration in Canada and internationally.

The goals of the program are to provide students with the knowledge and skills to:

- Critically assess degraded ecosystems within different scales and locations (local to international) and identify primary causal factors contributing to the declining state of target ecosystems.
- Design a restoration prescription (unique to the target site and project goals) by integrating ecological principles (theoretical) and physical processes with applied restoration techniques and approaches.
- Develop and initiate detailed monitoring programs needed to assess the success of restoration programs and to identify approaches to guide the restoration process.
- Adapt and modify the restoration approach as deemed appropriate based on monitoring results within an adaptive management framework.
- Establish strong scientifically-based approaches (research skills) to enhance "reliable knowledge" (reduce uncertainties) in the field of restoration ecology (the scientific foundation of ecological restoration).
- Act as a team leader and engage in respectful community engagement and planning of ecological restoration projects.
- Operate with a historically informed and policy sensitive understanding of the cultural practices and protocols of First Nations peoples.
- Communicate effectively with all levels internal and external to their organization as required to successfully initiate and conduct restoration programs.
- Develop and apply project management guidelines for each stage of a restoration project.
- Display and encourage behaviour and comportment that reflects integrity, responsibility, and the values and ethics of professional restoration practitioners.

1.3 Program Structure and Length

The proposed program requires the completion of 36 units, at the graduate level, composed of ten courses for a minimum of 30 units (three of which are elective courses in the student's area of specialization), and a 6-unit capstone Applied Research Project. Only graduate-level courses will contribute to requirements for graduation. A dedicated Applied Research Committee composed of the program director and two faculty members (one each from BCIT and SFU) will oversee all student coursework and applied research project development. Students will require four academic semesters over two years to complete the degree requirements. Maximum completion times will conform to SFU policy.

The program is composed of three main areas: core program, area of specialization, and applied research project. All students will take the core program, which will include the following courses (ECOR courses are based at BCIT; ECO courses are based at SFU). Students will register at each institution:

- Concepts of Ecological Restoration and the Physical Environment, ECOR 9100
- Concepts of Ecological Restoration and the Biological Environment, ECO 611
- Planning and Monitoring for Ecological Restoration, ECOR 9110
- Field Applications of Restoration Principles, ECOR 9200
- Restoration of Terrestrial Ecosystems, ECOR 9210; *or* Restoration of Aquatic Ecosystems, ECOR 9220
- Graduate Seminars in Research Methods, ECO 621
- Project Management & Policy for Ecological Restoration, ECO 622
- First Nations & Social Perspectives of Ecological Restoration, ECO 641

Students select three courses, one core course and two electives, in their area of specialization. They must select either Restoration of Terrestrial Ecosystems *or* Restoration of Aquatic Ecosystems from the core program. They then select two courses from a number of elective courses in aquatic restoration or terrestrial restoration clusters at SFU from (Table 1). Course selection within their area of specialization will focus on integration of the physical and ecological components of ecological restoration. Within a student's area of specialization, the student will gain strong hands-on skills and theoretical knowledge needed to conduct successful restoration activities. Courses available as electives will have a minimum requirement of addressing five of the nine program goals. The two elective courses are offered in level 3 of the program, following completion of the ecological restoration specialty courses. The timing permits students to interpret the concepts and theories learned in these related disciplines (elective courses) in an ecological restoration framework.

Table 1. Courses available as electives from SFU.

Aquatic Cluster	Terrestrial Cluster
BISC 829 Conservation Ecology	BISC 829 Conservation Ecology

REM 625 Risk Assessment of Natural Resources	BISC 838 Population Ecology
STAT 650 Statistics for Resource Management	REM 611 Applied Population and Community Ecology[2]
EASC 601 Advanced Groundwater Geochemistry	GEOG 617 Soil Science
GEOG 611 Hydrology	REM 625 Risk Assessment of Natural Resources
GEOG 613 Fluvial Geomorphology	REM 610 Applied Environmental Toxicology & Environmental Management of Contaminants
GEOG 619 Ecogeomorphology and Hydrology	STAT 650 Statistics for Resource Management
EASC 70X Special Topics in Hydrology[1]	REM 670 Introduction to Forestry: Field Class in Forest Management
REM 670 Introduction to Forestry: Field Class in Forest Management	

NOTE: Elective courses will be negotiated with departments on an annual basis. Delivery options include using existing space within courses, or a second offering.

In their Applied Research Project, students will conduct extensive fieldwork, normally in collaboration with industry partners and academic supervisors. Within this relationship, students will assess the needs of their research project sponsor, conduct pre-restoration site assessment, develop a detailed restoration plan, and present the plan to their colleagues and project partners. By this collaborative process, students will incorporate the best available information, integrated with and adapted to the specific project partner's needs. Through both the coursework and their applied research project, students will gain exposure to all of the program goals (Appendix 2). Students will work with the cohort Applied Research Committee to identify sector partners and potential research topics. The Applied Research Committee may also identify project options if no suitable industry partner is available.

1.3.1 Course Work

The curriculum is designed to provide students coming into the program from a diversity of environmental and ecological backgrounds with a solid foundation in advanced knowledge and skills in both the biological and physical attributes of ecosystems, and the advanced knowledge of applied approaches fundamental to achieving successful restoration of damaged ecosystems. In addition, the curriculum will emphasize sound project management principles and incorporate development of communication plans to promote respectful community engagement and address varying social perspectives and protocols.

[1] Please note that there are a variety of EASC courses of potential relevance to the program.

[2] Noted as a core REM course that may require a second offering.

The detailed descriptions of the courses, which are developed specifically for this new program, are presented below (Appendix 1 & 8). Courses with the prefix ECOR will be taught at BCIT while courses with ECO will be taught at SFU. Course codes were selected to accommodate the four-digit course and three-digit code used by BCIT and SFU, respectively. All courses will be graded.

2 Learning Methodologies

Faculty in the Master of Science in Ecological Restoration program are committed to using learning methodologies that foster inquiry, critical thinking, analysis, problem solving, collaboration, teamwork, competent hands-on performance, reflective practice, and effective communication. BCIT and SFU encourage faculty to incorporate diverse and innovative teaching methodologies.

The proposed program will provide a well-structured positive learning environment, which will allow students to develop skills in critical thinking, analysis, problem-solving, and working productively in groups. Lectures, tutorials, group discussions, assignments and projects will form the instructional framework for acquiring knowledge, skills, and attitudes, and provide opportunities for learners to successfully achieve learning outcomes at an acceptable level of quality.

The courses in the proposed Master of Science in Ecological Restoration degree program will progress from a lecture-based model of delivery to a project-based, collaborative model. The fundamental technical courses cover advanced physical and biological concepts and theories. The applied technical courses provide students with the practical knowledge and skills to assess, manipulate, and adapt these theories to meet restoration goals. Because the curriculum emphasizes experiential, hands-on learning in natural environments, much of the instruction will be face-to-face instruction in the classroom, field, or in seminars. As courses will be scheduled in three-hour blocks, course delivery will be composed of traditional lectures, field sessions, seminars, and problem-based learning. Schaefer and Gonzales (2013) have discussed the advantageous approach to using problem-based learning to address the uncertainties in ecological restoration, and to emphasize critical-thinking skills while promoting an integration of perspectives and ideas when teaching ER concepts.[3]

In addition to standard course delivery, students will require a research project to be completed under the supervision of the Applied Research Committee. An oral presentation of the project will also be required. An inquiry-based learning method will be used for the research component of the program. Under the guidance of the Applied Research Committee and client, students will take initiative to define a research topic or restoration problem and prepare a research plan. By these means, students will learn how to conduct research independently.

Faculty at BCIT and SFU, coupled with sessional instructors, are well suited for this type of delivery. Faculty and sessional instructors are experts in their respective fields and have extensive experience applying ecological and physical theories to natural systems, through research opportunities or restoration

[3] Schaefer, V., and E. Gonzale. 2013 (Dec.). Using problem-based learning to teach concepts for ecological restoration. Ecological Restoration 31:412-418.

initiatives. They will be able to draw on numerous local examples, case studies, and the scientific literature to emphasize the learning outcomes for each course, and the program goals overall.

3 Faculty

BCIT has four fulltime faculty members who will be instructing in the proposed program, and one contract (half-time) instructor (Appendix 3). Three of the fulltime faculty members (Dr. Doug Ransome (wildlife management), Dr. Ken Ashley (lake restoration), Dr. Eric Anderson (marine ecology)) have doctorate degrees in their area of specialization and are well respected as experts in their fields. In addition, these three faculty members each have a minimum of 19 years work experience, and between 5 and 12 years' experience teaching at a post-secondary institution. All three faculty members have designed and instructed courses in BCIT's undergraduate degree in ecological restoration. The fourth fulltime faculty member (Dave Harper) has recently been hired as an assistant instructor within the Rivers Institute and within the degree program in ecological restoration at BCIT. Mr. Harper has a diploma and advance diploma in fish and wildlife management, and a degree in environmental engineering. He has over eight years' experience in conducting fish habitat restoration in B.C. A part-time faculty member (Dan Hogan) has a M.Sc. in geomorphology and is a register professional geoscientist. Mr. Hogan has 32 years of relevant work experience in restoration, monitoring, and applied research in stream channel assessment and 9 years teaching experience at post-secondary institutions, including BCIT's degree in ecological restoration.

To provide additional support for the proposed program, BCIT will hire additional faculty as needed to support the new courses, and to support administrative duties associated with the Graduate Program Committee and the Applied Research Committee. Additional administrative support within the School of Construction and the Environment will be made available as required.

Simon Fraser University has an extensive faculty that could teach into the proposed degree program. Four faculty members have been directly associated with the development of the proposed degree program, Dr. Sean Markey (community sustainability, economics, and economy), Dr. Leah Bendell (ecotoxicology), Dr. Jeremy Venditti (geomorphic and sedimentary processes), and Dr. John Moore (aquatic and fish ecology). Each have doctorate degrees in their area of specialization and are well respected as experts in their fields. In addition, these four faculty members each have a minimum of 14 years work experience, and between 6 and 24 years' experience teaching at a post-secondary institution. SFU will accommodate the teaching of new courses through their current faculty or by adjunct and sessional instructors.

The interdisciplinary nature of the program will involve faculty members from other programs. For example, BCIT faculty members from the undergraduate degree in ecological restoration, diploma program in Fish, Wildlife, & Recreation, and Rivers Institute are already engaged in the curriculum development and will participate in the program delivery. Similarly, members in both the Faculty of Environment and Faculty of Science at SFU have contributed to the curriculum development.

To fully support the development of the program, the School of Construction and the Environment at BCIT and Faculty of Environment at SFU will pursue hiring additional faculty (fulltime or sessional) to

meet the growing student enrolment, new elective courses and Applied Research Projects I & II. These faculty members will have demonstrated records of accomplishment in research and professional activities that indicate their leadership in their fields of expertise.

The faculty teaching in the new degree program (fulltime faculty or sessional instructors) will normally have an appropriate doctoral degree, or master's degree with current professional designation for their field of practice (e.g., P. Eng, R.P.Bio., P.Ag., R.P.F., P Geo.). These faculty members will be expected to assist in directing applied research projects within their area of expertise.

Faculty appointments are based on academic qualifications, industry experience, and applied research experience. Criteria for faculty selection will include:

- academic qualifications to teach graduate level courses in the program.
- significant industry experience in ecological restoration or related fields.
- proven ability in conducting research in ecological restoration or related fields.
- record of active applied research in areas related to the program.
- interest in teaching at the graduate level and supervising applied research projects.

Qualified faculty from other disciplines with significant experience or ongoing research programs in a related discipline area may also be offered appointments as adjunct faculty and project supervisors.

3.1.1 Program Administration and Governance

The program will be jointly administered by SFU and BCIT. BCIT and SFU have previous experience in developing joint degrees (e.g. Master's of Digital Media) that will provide a template for managing the administrative operations of the program. A Program Director and a Graduate Program Committee will have authority for the academic integrity and maintenance of the graduate program. The committee is composed of the following members:

- BCIT's School of Construction and Environment, Associate Dean
- SFU's Faculty of Environment, Associate Dean
- Program Director[4]
- BCIT's Program Champion
- SFU's Program Champion
- Student Representative

The Graduate Program Committee has the following responsibilities:

[4] The Program Director will be based at BCIT or SFU (appointed by the two Faculty Deans) and granted adjunct status at the other institution.

- Reviewing applications and advising prospective students on the details of programs and the admission process.
- Ensuring courses within the program are reviewed regularly and maintained.
- Implementing and enforcing the regulations, procedures, and policies related to graduate studies at BCIT and SFU.
- Providing direction and guidance to the Applied Research Committee.

The Graduate Program Committee recommends action upon:

- Applications for graduate study in the department.
- Applications for internal program scholarships.
- The subjects, courses, and research leading to a master's degree in that program.
- Requests for exceptions to usual procedures.
- Cases of failure to meet scholastic requirements.

4 Credential Recognition and Nomenclature

The program will be relevant to two professional associations. First, to practice as a professional biologist in British Columbia, one must be a member of the College of Applied Biology (the College). The proposed program is supported by the College and will facilitate graduates meeting their academic requirements for classification as a Registered Professional Biologist (R.P.Bio.; see letter of support in Appendix 4). To be eligible for certification by the College, applicants require 25 courses (15 of which have a biology focus), three years of work experience, and completion of a professional report. Courses focused on ecological restoration within the proposed program have been specifically designed to meet course requirements under the categories of Ecology, Applied Biology, and Biology Field Courses. In total, graduates meet the requirements for six of the 15 courses needed for their R.P.Bio credential. Most students in the program are expected to satisfy the remaining requirements through coursework they completed in their undergraduate studies. In addition, graduates from the proposed master's program can use their program to fulfill one year of the three years of work experience needed for accreditation. Similarly, graduates may submit the final report from their Applied Research Project to fulfill the requirements for a professional report.

Second, the Society for Ecological Restoration (SER), which is the flagship association for this discipline, is currently designing the SER Practitioners Certification Program (SER–PCP). Implementation of this program is identified as Strategic Initiative II in their 2012-2016 Strategic Plan. The Practitioners Certification Program will certify practitioners based on their overall professional competence, taking into consideration their education, training, experience, and professional involvement. The PCP offers a non-governmental institutional process that formally recognizes individuals who have demonstrated understanding and proficiency in their profession, and who skillfully apply the principles, procedures, and standards of ecological restoration in their project work. Although the PCP has not been formally initiated, the criteria for certification have been established. Applicants can apply for two levels of certification: Ecological Restoration Practitioner In Training and Certified Ecological Restoration Practitioner. Similar to the College of Applied Biology (above), the certification process does not certify programs, but individuals. To become a Certified Ecological Restoration Practitioner, applicants need

100 points composed of academic credentials, courses, and field experience, in addition to five years of work experience.

Graduates from the proposed master's program will have attained a minimum of 73 of the 100 points needed to satisfy the Education Achievement criterion (Appendix 5) for the PCP. The remaining 27 points will be satisfied by the entry requirements of applicants. Graduates will also satisfy a minimum of 13% of the five-year Professional-level Experience criterion. In addition, graduates will fully satisfy two of the five aspects needed to meet the Professional-level Experience criterion.

The name of the proposed program — M.Sc. in Ecological Restoration — is in line with both industry terminology and similar academic programs. It has the same name as the flagship society for this discipline, the Society for Ecological Restoration. In addition, of the eight institutions containing a graduate-level program in ecological restoration (see Appendix 13), six have "ecological restoration" or "restoration ecologically" in their title. The two undergraduate programs in Canada are titled either Bachelor of Science in Ecological Restoration or Bachelor of Technology in Ecological Restoration.

In February 2012, SFU and BCIT hosted a focus group of 36 government, private sector, NGO, First Nations, and academic participants to discuss the relevance and guiding principles for the program (Appendix 4). The strong statements of support for the proposed program during this session provided the impetus to begin program development. Additional discussions have been conducted with faculty members from the University of Victoria's Restoration of Natural Systems program.

In November 2013, three questionnaires were sent to industry representatives in BC and Alberta, and to BCIT's and SFU's alumni and current students. In the industry survey, 34% of respondents indicated they would prefer to hire a graduate with an M.Sc. to work in the ecological restoration field, and 46% indicated they would likely or definitely hire a graduate from the M.Sc. in Ecological Restoration program. The majority of industry respondents indicated that a graduate degree in ecological restoration would be (very) important (89%) or somewhat important (7%) for future employment. Three-quarters (74%) of alumni and student respondents believe that completing the M.Sc. in Ecological Restoration would increase their employment opportunity, while 39% were very interested in applying to the proposed program, and 39% were somewhat interested. With the support from industry, alumni, and students in survey responses, and taking into consideration that the proposed program is the only M.Sc. with this specialization in Canada, the potential for future employment of graduates in the field of ecological restoration is strong.

Additional support for the proposed M.Sc. in Ecological Restoration is reflected in letters of support provided in (Appendix 4):

- Dr. Thomas P. Sullivan, Professor in the Faculty of Forestry and Faculty of Land and Food Systems at the University of British Columbia. Dr. Sullivan's area of expertise is in integrating wildlife management with agriculture and forest management systems. He has published over 50 peer-reviewed, wildlife-research based publications in North America's premier ecology journals since 2000. Dr. Sullivan has been an Associate Editor for Canadian Journal of Forest Research and Wildlife Research, both international journals.

- Brian Springinotic, Chief Executive Officer, Habitat Conservation Trust Foundation. This organization is the premier non-government funding organization in BC supporting ecological conservation and restoration activities. This organization has invested over $140 million in conservation and restoration of BC's wildlife and fish habitats.

- Dan Buffet, Head of Conservation Programs – BC Coast, Ducks Unlimited Canada (DUC). Ecological restoration has been a foundation of DUC for over 75 years in Canada and has invested in 590 habitat conservation projects in BC, and over 9,000 projects nationally. DUC combines restoration projects with different forms of habitat protection to ensure long-term benefits for landowners and society.

- Patricia Thomson, Executive Director, Stanley Park Ecological Society.

- Greg Wilson (M.Sc. R.P.Bio.), Aquatic Species at Risk Biologists and Dr. Peter Tschaplinski (Ph.D. P.Ag.), Unit Head, Ecosystem Science, Ecosystem Protection, and Sustainability Branch, Ministry of Environment, Government of British Columbia.

- Eva Schindler, Team Leader Fish.& Wildlife Compensation Program, Ministry of Forests Lands and Natural Resources Operations, Government of British Columbia.

- Program Advisor Committee, Renewable Resources, Ecological Restoration Program, British Columbia Institute of Technology.

- Craig Wightman, Senior Fisheries Biologist, the British Columbia Conservation Foundation (BCCF), Vancouver Island. The British Columbia Conservation Foundation (BCCF) founded in 1969 to contribute significantly to the perpetuation and expansion of fish and wildlife populations through the efficient implementation of projects in the field. The BCCF has implemented over 5000 conservation projects in British Columbia since 1986.

5 Program Consultation and Needs Assessment

Ecological Restoration is a scientific discipline that has recently emerged due to the increasing need to restore damaged ecosystems. In Canada, adoption of the ecological restoration approach gained acknowledgement in the mid to late 1990s, with the formation of Ontario (http://chapter.ser.org/ontario/) and British Columbia (http://chapter.ser.org/britishcolumbia/) chapters under the Society for Ecological Restoration (http://www.ser.org/). Adoption of ecological restoration principles by industry and government began in mid to late 2000, as evidenced by the foundational documents developed by Parks Canada and the Province of BC and reflected by BC Ministry of Forests and Range (now called BC Ministry of Forests, Lands, and Natural Resource Operations; Appendix 7). Further evidence of the recent emergence of ecological restoration as a discipline in Canada is reflected in the initiation of Canada's first undergraduate degree programs with this specialization, both launched in 2009 (Ontario and British Columbia). Even though the concept and practice of ecological restoration have been around for decades, it only recently has been acknowledged as a professional discipline. Thus, there are few

opportunities to graduate with a degree specifically in ER in Canada and United States. There are even fewer opportunities to obtain a graduate degree with this specialization.

From an industry perspective, employment opportunities in environmental disciplines continue to grow very strongly. The strength in growth in this industry is very well supported by both ECO (Environmental Careers Organization) Canada's 2013 survey and BCIT/SFU's industry survey conducted for the proposed program (Appendix 7). Respondents (83%) to BCIT/SFU's industry survey indicated that interest in ecological restoration (substantially) increased during their employment period. Similarly, ECO Canada's 2013 survey found that most environmental employers (74.5%) intend to hire new environmental employees over the next two years (2014 and 2015). Eco Canada (2013) also reported that some employers found it especially difficult to fill positions for remediation specialists (remediation specialist includes restoration practitioners). In general, environmental employers in Canada anticipate 27% to 38% of the forecasted jobs in the natural resource sector will remain vacant, while 58% to 100% of the supervisory positions will remain vacant (Appendix 7).

In spite of the increasing needs in the industry, opportunities to gain graduate-level training in ecological restoration are limited in North America. Nelson et al. (2008)[5] surveyed 300+ academic institutions in North America with a focus on identifying the number of academic institutions offering a specialization in ecological restoration. They concluded that opportunities to graduate with a degree specifically in ER were extremely limited. They noted that only 11 institutions (4%) offered undergraduate degrees and only four (1%) offered graduate degrees. In other countries, even fewer educational opportunities exist. The BCIT-SFU joint master's degree will become the first master's degree specifically in ecological restoration offered in Canada, and BCIT and SFU are jointly one of only a few institutions to do so in North America.

However, as James Knight, the president of the Association of Canadian Community Colleges stated, "The people we need require a much more sophisticated level of education, and we're simply not there yet." The March (2013) issue of MacLean's Magazine indicated that 27% to 38% of the employment jobs in some natural resource sectors will go unfilled due to a lack of qualified people. The majority (58% to 100%) of the supervisory positions will be unfilled due to the lack of qualified applicants.

The proposed Master of Science in Ecological Restoration will provide a pool of highly trained specialists to meet both the needs of industry and government. As identified by Brian Springinotic, Chief Executive Officer of the Habitat Conservation Trust Foundation (see Appendix 4b), there are over $50 billion in resource development projects planned for British Columbia over the coming decades. However, with the aging cohort of conservation scientists, BC needs to train the next generation of scientists to help maintain a balance between resource development and ecosystem protection and restoration.

In February 2012, BCIT and SFU hosted an industry-based focus group of 36 government, private sector, NGO, First Nations, and academic participants to discuss the relevance and guiding principles for the

[5] Nelson C.R., T. Schoennagel, & E.R. Gregory. 2008. Opportunities for academic training in the science and practice of restoration within the United States and Canada. Restoration Ecology Vol. 16, No. 2, pp. 225–230

proposed master's program. The focus group strongly endorsed the concept of a master's program in ecological restoration and indicated that the timing was ideal for its development and initiation (Appendix 4).

There is a very strong need for the proposed program in British Columbia, and Canada as a whole.

Graduates from this proposed master's program will be competitive for employment in: the private sector, government (federal, provincial, regional, and municipal), and conservation organizations (Nature Conservancy of Canada, Audubon Society, Ducks Unlimited, British Columbia Wildlife Federation's Wetland Institute, Habitat Conservation Trust Fund, watershed stewardship groups, land trusts, and conservancy organizations).

5.1.1 Institutional, Regulatory or Professional Support and Recognition

BCIT-SFU Industry Focus Group
In February 2012, BCIT and SFU hosted an industry-based focus group of 36 government, private sector, NGO, First Nations, and academic participants to discuss the relevance and guiding principles for the proposed master's program. The focus group strongly endorsed the concept of a master's program in ecological restoration and indicated that the timing was ideal for its development and initiation (Appendix 4).

SER-Practitioners Certification Program
The Society for Ecological Restoration (SER) is developing a certification program for practitioners of ecological restoration (Appendix 5). The Practitioners Certification Program (PCP) is being designed to meet the needs of practitioners who are involved with all phases of ecological restoration, especially those typically involved with planning, implementation, and management of landscape-scale ecosystem restoration programs.

College of Applied Biology
To practice as a professional biologist in British Columbia, one must be a member of the College of Applied Biology (the College). To qualify for certification by the College, applicants require 25 courses (15 of which have a biology focus), three years of work experience, and completion of a professional report. Graduates of the proposed program will have satisfied six of the 15 biology courses needed for their Registered Professional Biologist (R.P.Bio) credential. For most students, the coursework they completed in their undergraduate studies is expected to satisfy the remaining requirements. In addition, graduates from the proposed master's program can use the program to fulfill one year of the three years' work experience needed for accreditation. Similarly, they can submit the final report from their Applied Research Project to fulfill the requirements for a professional report.

6 Admission and Transfer/Residency

6.1 Admission Requirements

The estimated number of students to enter the program each year is 20. Applicants applying for entry into the program will require:

- A four-year bachelor's degree in ecology, plant science, animal science, soil science, environmental science, resource science (land, water, fish and wildlife, forestry), physical geography, environmental engineering, or a related program from a recognized post-secondary institution.

- A cumulative grade point average of at least 3.0/4.33 (70%, B average), or a grade point average of at least 3.33/4.33 (77%, B+ average) based on the last 60 credits of undergraduate courses. In exceptional circumstances, a student may be admitted with lower formal qualifications when there is significant professional experience relevant to the proposed area of study (evaluated through a review of the applicant's resume and letters of reference).

- One introductory course each in ecology and statistics.

- Two upper-level courses in: biology, ecology (plant, fish, wildlife, restoration/reclamation, etc.), statistics, plants science, soil science, physical geography (hydrology, geomorphology, limnology, etc.), forest science, natural resource management, environmental science, or related courses.

- Students whose native language is not English will be required to satisfy the University and the graduate program committee as to their capability in English. (See GGR 1.3.12).

- Three references (academic or professional) supporting the student's academic suitability.

- Resume and official transcripts:
    - The transcript will be used to confirm grade-point averages and the strength of the academic background of applicants.
    - The proposed program has been designed both for applicants just entering the ecological restoration (ER) workforce and for experienced restoration practitioners wanting to upgrade their academic credentials. Applicants with extensive experience in ecological restoration but with lower academic qualifications will also have their work experience assessed, through a review of their resume and letters of reference. In some circumstances, an applicant may be accepted into the program based upon their academic performance in combination with their work experience.

- Applicants may be required to complete bridging courses to strengthen their academic background prior to admittance into the master's program.

- Applicants who completed post-secondary studies outside of Canada, the United States, or England will require a comprehensive evaluation of their credentials by the International Credential Evaluation Service (ICES) at BCIT.

Given the diverse and disparate backgrounds applicants will have prior to applying to the program, applicants will be assessed individually by the Graduate Program Committee. Through this assessment the committee with identify areas of strength and weaknesses. Applicants with previous courses in ecological restoration would be classified as strong candidates for entry into the master's program. If weaknesses have been identified, applicants will have the opportunity to strengthen their application through bridging courses or by completing a qualifying semester. Bridging courses may require completion prior to entry into the program or, otherwise, taken concurrently with the program. If

bridging courses are taken concurrently with the program, they will not contribute to the 36 units required for graduation. The Applied Research Committee will assess bridging options on an individual basis.

6.1.1 Residency

Students will satisfy residency requirements of SFU.

Appendices

Appendix 1: Program Map

Course Descriptions

Given the complexity of, and disparity in, ecological restoration, projects will involve a wide assortment of disciplines, ranging from plant ecology, to wildlife ecology, to fish ecology, through to stream morphology, geomorphology, and hydrology (to identify only a few). The wide ranging physical and ecological disciplines encompassed by ecological restoration are often seen as unique areas of specialization. Many of our applicants will have strengths in some areas but be weak in other areas.

Level one

To set the initial stage, two core courses include an interpretation and assessment of the fundamental theories and concepts of the physical and biological disciplines (Appendix 1; Program Map). Concepts of ER & the Physical Environment and Concepts of ER & the Biological Environment will provide a key foundation for the ER-specific courses in level 2. These two courses will provide an understanding of theories and concepts fundamental to ecological restoration and how to measure them in the field. The third course in level one is Planning and Monitoring for ER. This course provides a step-by-step process for planning, implementing, and monitoring ER activities.

Level two

Level two courses start off with a two-week intensive field course to provide hands-on training, in addition to that provided in level one courses. The combination of level one courses and the Field Applications of Restoration Principles course provides the strong foundation in physical and biological concepts, coupled with the framework to organize and design restoration activities, and to monitor their success. Students then select between two courses: Restoration of Terrestrial Ecosystems or Restoration of Aquatic Ecosystems. Through these courses, students learn the ER-specific concepts, approaches, and tools to restoring degraded ecosystems. These courses build upon level one courses (Concepts of ER & the Physical Environment and Concepts of ER & the Ecological Environment), and students will learn how to manipulate these concepts to attain their restoration goals. The course in Graduate Seminars in Research Methods provides the tools and critical thinking skills to ensure students formulate their restoration activities in a scientifically defensible approach. This course will also provide the skills needed to distinguish between poorly conducted and well conducted research, when assessing different approaches and generating a restoration plan. The Project Management & Policy for ER course provides an understanding of rules, policies, and regulations around conducting restoration activities, ensuring provincial and federal regulations have been met. This course also provides the skills needed to manage and plan a restoration activity, accommodate uncertainty in decision making, and risk assessment.

Level three

Level three provides opportunity for students to select two electives from among a suite of electives provided by SFU (Table 1; Section 4.3), to gain advanced training in their area of specialization (aquatic or terrestrial). In addition, students start the conceptualization and development of

their applied research project. For this first of two courses (Applied Research Project I), students will identify a restoration project and client (Program Map). They will use the skills learned in levels 1 and 2 to conduct the initial site assessments to identify the stressors on their site, reference ecosystems, and formulate a restoration plan.

Level four

In level four, students continue with the development of the restoration plan for their Applied Research Project II course, adapting the plan to meet their client's needs, given the constraints and stressors identified in level 3. The conclusion of the program would be the final restoration plan (with oral presentation). It is essential to the success of the implementation of a restoration plan to involve the community and to communicate extremely well to all interested partners. Thus, the only in-class course in level four is First Nations & Social Perspectives of ER. Through this course, students will explore the diverse human-nature relationships and how to communicate and integrate the needs of the various communities into the implementation of their restoration activities. Conflict resolution will be explored, as well as developing and fostering partnerships.

The proposed program has been specifically designed to provide balance among theoretical concepts, with applied approaches and hands-on training. Given the diverse systems graduates will be working with, the emphasis of the program is to: train graduates to identify the problem, critically assess the information available to guide the development of a restoration plan, develop a scientifically-defensible approach to restore the target ecosystem, and interact with the communities involved and develop strong partnerships. A critical learning outcome is the development of critical-thinking skills that permit graduates to adapt their approaches and restoration plans, both regionally and internationally, to the highly-diverse field of ecological restoration while being scientifically defensible. In addition, a key outcome is a strong interaction with client-sponsored projects with real-world uncertainties and issues. Graduates will learn to be adaptable, resourceful, and to communicate well, while maintaining a high level of professionalism and scientific rigour. These skill sets will be highly transferable to many disciplines beyond the specific field of ecological restoration.

The proposed program is unique in the wide range of disciplines from which applicants will come into the program. Applicants may have an undergraduate degree strongly based in the pure sciences or applied sciences, with specialization in the physical environment or biological environment, or with a terrestrial emphasis or aquatic emphasis. As this is the only graduate program specializing in ecological restoration in Canada, applicants may have an academic background from a wide range of academic institutions. The combination of BCIT and SFU offering this joint credential further emphasizes the integration, breadth and diversity of concepts and knowledge shared during the program, and is enhanced by the numerous group projects, seminars, and discussions integrated into the course designs.

Program Map – Master of Science in Ecological Restoration

Program Cluster	Level 1 15 weeks; Fall term	Level 2 15 weeks; Winter term	Level 3 15 weeks; Fall term	Level 4 15 weeks; Winter term	Unit Totals (%)
Applied Sciences (Technical Skills)	**ECOR 9100** (3 units) Concepts of ER & the Physical Environment	**ECOR 9200** (3 units) Field Applications of Restoration Principles	**Elective 1** (3-5 units) (SFU course)		**15 units (42%)**
	ECO 611 (3 units) Concepts of ER & the Ecological Env		**Elective 2** (3-5 units) (SFU course)		
Specialty — Ecological Restoration	**ECOR 9110** (3 units) Planning and Monitoring for Ecological Restoration	**ECOR 9210**: Restoration of Terrestrial Ecosystem ***or*** (3 units) **ECOR 9220**: Restoration of Aquatic Ecosystems			**6 units (17%)**
Research & Critical Thinking Skills		**ECO 621 (**3 units) Graduate Seminars in Research Methods			**3 units (8%)**
Project Management		**ECO 622** (3 units) Project Management & Policy for Ecological Restoration			**3 units (8%)**
Social Environment Skills				**ECO 641** (3 units) First Nations & Social Perspectives of Ecological Restoration	**3 units (8%)**
Graduating Project			**ECOR 9300 (**3 units) Applied Research Project I	**ECOR 9400 (**3 units) Applied Research Project II	**6 units (17%)**
TOTALS	**9 units**	**12 units**	**9-13 units**	**6 units**	**36-40 units 100%**

Appendix 2: Program Goals Integration

Goals	Monitoring for Ecological Restoration	Project Management & Policy	Field Applications	First Nations & Social	Research Methods	Physical Restoration	Biological Restoration	Elective Course*	Elective Course 2	Applied Research Project
Critically assess degraded ecosystems within different scales and locations (local to international) and identify primary causal factors contributing to the declining state of target ecosystems.	x	x	x		x	x	x			x
Design a restoration prescription (unique to the target site and project goals) by integrating ecological principles (theoretical) and physical processes with applied restoration techniques and approaches.	x	x	x		x	x	x			x
Develop and initiate detailed monitoring programs needed to assess success of restoration programs and to identify approaches to guide the restoration process.	x	x	x		x	x	x			x
Adapt and modify the restoration approach as deemed appropriated based on monitoring results within an adaptive management framework.	x	x	x		x	x	x			x
Establish strong scientifically-based approaches to reduce uncertainties in the field of restoration ecology.	x	x	x		x	x	x			x
Act as a team leader in community engagement and planning of ecological restoration programs.		x		x	x		x			x
Communicate effectively with all levels internal and external to their organization as required to successfully initiate and conduct restoration programs	x	x	x		x	x	x			x
Develop and apply project management guidelines for each stage of a restoration project.	x	x	x	x	x					x
Display and encourages behaviour and comportment that reflects integrity, responsibility, and the values and ethics of professional restoration practitioners.	x	x	x	x	x	x	x			x

- All elective courses must address at least five out of nine program goals.

Appendix 3: Faculty Qualifications and Curriculum Vitae

Faculty/Instructor	Professional Certification/Academic Qualification/Professional Development	Relevant Experience	Role/Position in Program
Douglas B. Ransome (BCIT)	Ph.D. (UBC) Forest Sciences (Wildlife Manage.) M.Sc. (UBC) Forest Sciences (Wildlife Manage.) B.Sc. (Guelph) Wildlife Management (Honours) B.Sc. (Windsor) General Biology Registered Professional Biologist (1995)	21 years of relevant work experience in studying wildlife responses to land management, wildlife inventories & population dynamics of wildlife. 12 years teaching experience at post-secondary institutions.	Faculty/Instructor
Ken Ashley (BCIT)	Ph.D. (UBC) Civil/Environmental Engineering M.A.Sc. (UBC) Civil/Environmental Engineering M.Sc. (UBC) Zoology/Aquatic Ecology B.Sc. (UBC) Zoology/Aquatic Ecology Registered Professional Biologist	30 years of relevant work experience restoring lakes, reservoirs, streams, rivers and estuaries. 5 years teaching experience at a post-secondary institution.	Faculty/Instructor
Eric Anderson (BCIT)	Ph.D. (University of Wyoming) Zoology and Physiology M.Sc. (University of Wyoming) Zoology and Physiology B.Sc. (University of Puget Sound) Mathematics and Biology	19 years of relevant work experience in restoration, monitoring, and applied ecological research. 12 years teaching experience at post-secondary institutions.	Faculty/Instructor
Dan Hogan (BCIT)	M.Sc. (UBC) Geomorphology B.A. (UBC) Geography Registered Professional Geoscientist	32 years of relevant work experience in restoration, monitoring, and applied research in stream channel assessment and processes. 9 years teaching experience at post-secondary institutions.	Faculty/Instructor
Sean Markey (SFU)	Ph.D. (SFU) Geography M.A. (York University) Environmental Studies B.A. (UBC) Political Science	18 years of relevant work experience in sustainability development, resource communities, and social economy. 15 years teaching experience at post-secondary institutions.	Faculty/Instructor

Faculty/Instructor	Professional Certification/Academic Qualification/Professional Development	Relevant Experience	Role/Position in Program
Leah Bendell (SFU)	Ph.D. (Toronto) Ecology/Geochemistry, B.Sc.(Toronto) Zoology/Chemistry,	24 years of relevant work experience in Ecotoxicology including monitoring and applied research 14 years teaching experience at post-secondary institutions	Faculty/Instructor
Jonathan Moore (SFU)	Ph.D. (Washington) Aquatic & Fisheries Science B.A (Carleton College) Biology	14 years of relevant work experience in fish biology and ecology, including monitoring and applied research 6 years teaching experience at post-secondary institutions	Faculty/Instructor
Dave Harper (BCIT)	B.Tech. (BCIT) Environmental Engineering Degree Advanced Diploma (BCIT) Fish Wildlife & Recreation Diploma: (BCIT) Fish, Wildlife, & Recreation Program Registered Professional Biologist (in progress)	8 years experience conducting habitat restoration, fish habitat assessments, and aquatic monitoring.	Faculty/Assistant Instructor
Dana Lepofsky (SFU)	Ph.D. Anthropology, University of California, Berkeley, 1994 M.A. Anthropology, University of British Columbia, 1985 B.A. Anthropology with Honors, University of Michigan, 1980	19 Years experience	Faculty/Instructor

DR. DOUGLAS B. RANSOME CURRICULUM VITAE

I. Education

Ph.D. (Forest Sciences): July 2001
The University of British Columbia, Department of Forest Sciences
- Supervisor: Dr. T.P. Sullivan
- Thesis: Population ecology and resource limitation of northern flying squirrels and Douglas squirrels
- Overview: My doctoral research focused on improving our understanding of population regulation of northern flying squirrels (primary prey of spotted owls) and Douglas squirrels, how they are influenced by forest management practices, and the implications for spotted owl management.

M.Sc. (Forest Sciences): May 1994
The University of British Columbia, Department of Forest Sciences
- Supervisor: Dr. T.P. Sullivan
- Thesis: Food Limitation and Habitat Preference of Northern Flying Squirrels and Red Squirrels
- Overview: This research improved our understanding of population regulation of flying squirrels and red squirrels and their habitat preference (old-growth vs. second-growth forests) near Vernon, B.C.

B.Sc. (Biological Sciences): June 1988
The University of Guelph, Faculty of Biological Sciences
- Specialization in Specialized Honors Wildlife Biology.

B.Sc. (Biological Sciences): June 1987
The University of Windsor, Faculty of Biological Sciences
- Specialization in population and community ecology.

II. Awards

1992 – 1993	VanDusen Graduate Fellowship in Forestry
1995 – 1998	Science Council of British Columbia, Burnaby, B.C. G.R.E.A.T. Scholarship

lll. Work Experience

- **Program Head: Ecological Restoration**

2012 – present *BCIT – Renewable Resources*
- Oversee admissions and program changes to the recently-developed bachelor program in ecological restoration.

- **Instructor: Wildlife Ecology & Management**

2003 – present *BCIT – Fish, Wildlife, & Recreation Program*
- Design and teach concepts of wildlife management to 2nd-year diploma students. Introduce concepts and theories to provide the scientific base on which the technical training of the program focuses.

- Integration of course materials with other curriculum components to provide delivery of a comprehensive natural resources training program.
- Network with experts outside of personal research expertise to provide a well-balanced, functional series of course designs, linking knowledge with student and employer needs.
- Instruct students on appropriate experimental designs in wildlife research/inventory following RISC Standards, emphasizing how to reduce bias in data collection.
- Instruct students on the ecology and inventory protocols for red- and blue-listed species of concern in B.C.
- Emphasize technical/scientific report-writing skills and the importance of critical thinking in knowledge-gathering.
- Design courses in Research Methods and Ecological Restoration for 3rd-year students in the B. Tech. degree in Ecological Restoration at BCIT.

- **Research Scientist**

1997 – present DBR Forestry-Wildlife Integrated Management/Applied Mammal Research Institute

- Monitoring Townsend's voles in old-field habitat to quantify their response to revegetation efforts (in progress).
- Long-term monitoring of voles and hares throughout the Northern and Southern Interior Forest Regions in B.C. to establish their population dynamics and susceptibility of underplanted dead pine stands to damage (in progress).
- Conduct population monitoring and DNA analysis of mountain beavers to enhance our understanding of their population dynamics (density, reproduction, survival, movement) in the Lower Mainland of B.C. (in progress).
- Conduct vegetation analyses, linking population dynamics of small mammals and habitat use to vegetation characteristics (in progress).
- Established research trials examining the response of squirrels and vegetation to green-tree retention 30 years after harvest (completed in 2007).
- Establish research trials examining the response of small mammals, hares, ungulates, and squirrels to spacing trials in Prince George, Kamloops, Williams Lake, Kelowna, and Summerland, B.C. (completed in 2005).
- Establish research trials to examine the population dynamics of small mammals in group selection silvicultural systems in Engelmann spruce-subalpine fir forests (completed in 2007).
- Identify the distribution of mountain beavers (*Aplodontia rufa rufa*), a species at risk in B.C., in the Lower Mainland of B.C. (completed in 2004).
- Survey proposed harvest blocks for mountain beavers and make management recommendations (to industry & MoFR; on going).
- Research the effectiveness of 3 anti-feedants to reduce elk damage to forest plantations in northern Alberta (completed in 2002).
- Assisted Goat Mountain Resources with aerial surveys of mountain goats along the coast of B.C. (completed in 2002).
- Peer review research proposals for the Forest Sciences Program (PricewaterhouseCoopers & B.C. Ministry of Forests and Range).
- Peer review manuscripts submitted to the Journal of Mammalogy, Forest Ecology and Management, and Canadian Journal of Forest Research; evaluate experimental design and quality of the scientific publications (on going).
- Review final reports for the forest industry on ungulate winter range and spotted owls.

- **Postdoctoral Fellow**

2001 – 2003 *University of British Columbia*

- Establish research trials examining the influence of thinning lodgepole pine (4 densities) on population dynamics of small mammals, habitat use by ungulates, and crop-tree growth (see publications below).

- **Doctoral Student**

1995 – 2001 *University of British Columbia*

- Design, procure funding for, and implement a comprehensive research program.
- Implement intensive live-trapping studies for small and medium sized mammals, habitat characterizations including hypogeous fungi sampling, and wildlife inventories.
- Interact with Government Agencies, forest companies, international researchers, and the general public regarding funding, research objectives, results and interpretations.
- Hire, train, and supervise field technicians.
- Analyze results and write detailed management oriented reports.
- Oversee spending and develop unique methods to resolve problems while reducing expenditures.
- Locate, review, and critically evaluate scientific information.

- **Sessional Lecturer - Instructor**

1994 – 1995 *University of British Columbia*

- Instruct FSRT 495 - Forestry-Wildlife: Integrated Management Principles of Managing Forests for Biological Diversity. This was a fourth-year course focusing on integrating wildlife management principles with forestry practices. The course incorporated field studies designed to examine biodiversity in managed forests, with subsequent data analysis and technical report writing.
- Instruct FRST 546 – Research Methods. This was a graduate level course exposing students to research philosophies with special emphasis on applied wildlife research and proposal writing.

- **Research Biologist**

1994 –1996 (Winter) Pure and Applied (PAW) Wildlife Research and Consulting, Burnaby, B.C.

- Conducted ground and aerial surveys of bald eagles throughout the Squamish and Brackendale area of B.C.

- **Research Technician**

1994, 1991 *University of British Columbia*

- Conducted live-trapping of small mammals, ungulate pellet counts, stand characterization, and vegetation surveys in Boston Bar, Kelowna, Salmon Arm, Williams Lake, Prince George, and Houston B.C. Trial purposes included response of select wildlife species to semio-chemicals, vegetation management, and stand spacing.

IV. Publications

Sullivan, T.P., D.S. Sullivan, P.M.F. Lindgren, **D.B. Ransome**. Submitted. Stand structure and small mammals in intensively managed forests: Scale, time, and testing extremes. Submitted to Forest Ecology & Management.

Antoinette J. Piaggio, A.J., B.A. Coghlan, A.E. Miscampbell, W.M. Arjo, **D.B. Ransome**, and C.E. Ritland. In print (June 2013). Molecular phylogeny of an ancient rodent family (Aplodontiidae). Journal of Mammalogy.

Ransome, D.B. 2010. Investigation of starling populations in British Columbia and assessment of the feasibility of a trapping program in the Lower Mainland: A report prepared for British Columbia Blueberry Council, Abbotsford, British Columbia.

Ransome, D.B., and T.P Sullivan. 2010 (2009, 2008, 2007). Managing mammal damage agents in MPB-killed stands. Forest Practices Branch, Ministry of Forests and Range, Victoria, B.C.

Sullivan, T.P., D.S. Sullivan, P.M.F. Lindgren, **D.B. Ransome**. 2012. If we build habitat, will they come? Woody debris structures and conservation of forest mammals. Journal of Mammalogy, 93(6):1456-1468.

Sullivan, T.P., D.S. Sullivan, P.M.F. Lindgren, **D.B. Ransome**, J. Bull, and C. Ristea. 2011. Bioenergy or biodiversity: Woody debris structures and maintenance of red-backed voles on clearcuts. Biomass and Bioenergy 35: 4390-4398.

Sullivan, T.P., D.S. Sullivan, P.M.F. Lindgren, and **D.B. Ransome**. 2010. Green-tree retention and life after the beetle: Stand structure and small mammals 30 years after salvage harvesting. Silva Fennica 44: 749-774.

Ransome, D.B., P.M.F. Lindgren, H. Armleder, M.J. Waterhouse, and T.P. Sullivan. 2009. Small mammal response to group selection silvicultural systems in Engelmann spruce-subalpine fir forests: 14 years post harvest. Can. J. For. Res. 39: 1698-1708.

Sullivan, T.P., D.S. Sullivan, P.M.F. Lindgren, and D.B. **Ransome**. (2007) Long-term responses of ecosystem components to stand thinning in young lodgepole pine forest: IV. Relative habitat use by mammalian herbivores. For. Ecol. Manage. 240: 32-41.

Sullivan, T.P., D.S. Sullivan, P.M.F. Lindgren, and D.B. **Ransome**. (2006) Influence of repeated fertilization on forest ecosystems: Relative abundance and habitat use by snowshoe hares. Can. J. For. Res. 36: 2080-2089.

Sullivan, T.P., D.S. Sullivan, P.M.F. Lindgren, and D.B. **Ransome**. (2006) Influence of repeated fertilization on forest ecosystems: Relative habitat use by mule deer and moose. Can. J. For. Res. 36: 1395-1406.

Sullivan, T.P., D.S. Sullivan, P.M.F. Lindgren, and D.B. **Ransome**. (2006) Long-term responses of ecosystem components to stand thinning in young lodgepole pine forest: III. Growth of crop trees and coniferous stand structure. For. Ecol. Manage. 228: 69-81.

Lindgren, P.M.F., D.B. **Ransome**, D.S. Sullivan, and T.P. Sullivan. 2006. Plant community attributes 12 to 14 years following pre-commercial thinning in a young lodgepole pine forest. Can. J. For. Res. 36: 48-61. (SFM)

Sullivan, T.P., D.S. Sullivan, P.M.F. Lindgren, and D.B. **Ransome**. 2005. Long-term responses of ecosystem components to stand thinning in young lodgepole pine forest II. Diversity and population dynamics of forest floor small mammals. Forest Ecology and Management 205:1-14.

Ransome, D.B., P.M.F. Lindgren, D.S. Sullivan, and T.P. Sullivan. 2004. Long-term responses of ecosystem components to stand thinning in young lodgepole pine forest. I. Population dynamics of northern flying squirrels and red squirrels. Forest Ecology and Management 202:255-367.

Ransome, D.B., and T.P. Sullivan. 2003. Population dynamics of *Glaucomys sabrinus* and *Tamiasciurus douglasii* in old-growth and second-growth stands of coastal coniferous forest. Canadian Journal of Forest Research 33:587-596.

Ransome, D.B., and T.P. Sullivan. 2003. Effects of food and den-site supplementation on populations of northern flying squirrels (*Glaucomys sabrinus*) and Douglas squirrels (*Tamiasciurus douglasii*). Journal of Mammalogy 85:206-215.

Ransome, D.B., and T.P. Sullivan. 2002. Short-term population dynamics of *Glaucomys sabrinus* and *Tamiasciurus douglasii* in commercially-thinned and unthinned stands of coastal coniferous forest. Canadian Journal of Forest Research 32:2043-2050.

Sullivan, T.P., S.D. Sullivan, D.B. **Ransome**, and P.M.F. Lindgren. 2003. Impact of removal trapping on abundance and diversity attributes in small mammal communities. Wildlife Society Bulletins 31:464-474.

Ransome, D.B. and T.P. Sullivan. 1997. Food limitation and habitat preference of *Glaucomys sabrinus* and *Tamiasciurus hudsonicus*. Journal of Mammalogy 78(2):538-549.

Sullivan, T.P., D.S. Sullivan, P.M.F. Lindgren, and D.B. **Ransome**. 2009. Variable retention and life after the beetle: Stand structure and small mammals 30 years after salvage harvesting. Ecological Applications (Submitted).

Sullivan, T.P., D.S. Sullivan, P.M.F. Lindgren, and D.B. **Ransome**. 2009. Long-term responses of mammalian herbivores to stand thinning and fertilization in young lodgepole pine forest. Forestry (Submitted).

Ransome, D.B. and T.P. Sullivan. 2010. Managing mammal damage agents in underplanted beetle-killed northern pine forests: Snowshoe hares and habitat alteration (in preparation).

Ransome, D.B. and T.P. Sullivan. 2010. Managing mammal damage agents in underplanted beetle-killed northern pine forests: Vole populations and plantation protection (in preparation).

Ransome, D.B. 2010. Snowshoe hares' (*lepus americanus*) relationship to cover, a test of the predatory-sensitive foraging theory (in preparation).

V. Presentations

Presented: Anticoagulant Rodenticides Impacts on Non-Target Wildlife, Ongoing Challenges. 2014. Vancouver, BC,

Presented: Pacific Agricultural Show, 2013, 2012, 2011. Managing starlings and voles in blueberry crops. Abbotsford, B.C.

Presented: Washington Agricultural Show, 2013. Managing voles in blueberry crops. Linden, WA

Participant: Managing Wildlife Damage (Conference), April 2004. USDA/APHIS/WS, National Wildlife Research Center, Olympia, WA

Presented: Northern Spotted Owl Workshop, January 21–22, 2004. Vancouver, B.C.

Attended/Presented: Advances in Forest Management; From Knowledge to Practices. Sustainable Forest Management Network, Shaw Conference Centre, Edmonton Alberta, November 13-15, 2002.

Presented: Intensive Forest Management Workshop. "Natural and Economic Science Integration", April 18 and 19, 2002, Telus Centre, University of Alberta, Edmonton.

Participant: Spotted Owl Habitat Management Workshop, October 1997.

Participant: Spotted Owl Research and Inventory Advisory Committee, October 1997.

Participant: Society of Northwestern Vertebrate Biology, March 20-23 1996; Pacific Northwest Amphibian and Reptile Consortium – Training Session.

Participant: Spotted Owl Research and Adaptive Management Workshop, December 1995.

Presented: Society of Northwestern Vertebrate Biology March 23-25, 1995.

VI. Memberships

- Association of Professional Biologist of British Columbia, R.P.Bio. (1995 - present)
- Society of Ecological Restoration
  - Director, BC Chapter
- The Wildlife Society, Bethesda, MD
- American Society of Mammalogists (Kansas)
- Director, British Columbia Waterfowl Society, Lower Mainland, B.C.
- Wildlife Federation of B.C.

DR. KEN M. ASHLEY CURRICULUM VITAE

1. EDUCATION

INSTITUTION	DATE	DEGREE
Univ. of B.C.	1993-2002	Ph.D. Civil/Environmental Engineering
Univ. of B.C.	1984-89	M.A.Sc. Civil/Environmental Engineering
Univ. of B.C.	1976-81	M.Sc. Zoology/Aquatic Ecology
Univ. of B.C.	1972-76	B.Sc. Zoology/Aquatic Ecology

2. EMPLOYMENT HISTORY

YEAR	DUTIES	EMPLOYER
2012 – present	Director, Rivers Institute	BC Institute of Technology
2011-2012	Senior Scientist	Northwest Hydraulics Ltd.
2010-present	Instructor,	BC Institute of Technology Ecological Restoration
2009	Environmental Engineer	Self Employed
2008	Manager, Special Projects Living Rivers	Prov. of B.C. Ministry of Environment
2005 - 2007	Environmental management of water and wastewater systems	Greater Vancouver Regional District
1991-2005	Whole-lake fertilization research, marine derived nutrients, experimental river fertilization research, hypolimnetic aeration	Prov. of B.C. MoE Fisheries
1987-1990	Whole-lake fertilization	Prov. of B.C. MoE Fisheries

	research, gas transfer research	
1985-1986	Artificial circulation research, Broodstock lake surveys	Prov. of B.C. MoE Fisheries
1979-1984	Artificial circulation research	Prov. of B.C., MoE Fisheries
1977-1978	Hypolimnetic aeration research	Prov. of B.C. Fisheries Branch
1976	Experimental limnology (mesocosm experiments)	Dr. Bill Neill I.A.R.E./U.B.C.

3. RESEARCH INTERESTS

Ecosystem level experimental limnology (e.g., hypolimnetic aeration, artificial circulation, lake and river fertilization), ecosystem monitoring, water quality guidelines and objectives, public health engineering

Habitat restoration

Freshwater ecology of salmonids

Climate change

Environmental engineering (e.g., gas transfer mechanisms, physical limnology, circulation processes in small lakes, design of artificial circulation equipment)

4. PUBLICATIONS

Primary Journals

1. **Ashley, K.I.** 1983. Hypolimnetic aeration of a naturally eutrophic lake. Can. J. Fish. Aquat. Sci. 40:1343-1359.

2. **Ashley, K.I.** 1984. Hypolimnetic aeration and zooplankton depth distribution. Can. J. Fish. Aquat. Sci. 41:1856-1857.

3. **Ashley, K.I.** 1985. Hypolimnetic aeration: practical design and application. Water Research 19:735-740.

4. **Ashley, K.I.** , S. Hay and G. Scholten. 1987. Hypolimnetic aeration: field test of the empirical sizing method. Water Research 21:223-227.

5. **Ashley, K.I.** 1988. Hypolimnetic aeration research in British Columbia. Verh. Internat. Verein. Limnol. 23:215-219.

6. **Ashley, K.I.** and K.J. Hall. 1990. Factors influencing oxygen transfer in hypolimnetic aeration systems. Verh. Internat. Verein. Limnol. 24:179-183.

7. **Ashley, K.I.** , D.S. Mavinic and K.J. Hall. 1990. Effects of orifice size and surface conditions on oxygen transfer in a diffused aeration system. Environ. Tech. Let. 11:609-618.

8. **Ashley, K.I.** , K.J. Hall and D.S. Mavinic. 1991. Factors influencing oxygen transfer in fine pore diffused aeration systems. Water Research 25:1479-1486.

9. **Ashley, K.I.** , K.J. Hall and D.S. Mavinic. 1992. Comparative study of oxygen transfer in coarse bubble diffused aeration. Water Research 26:1289-1295.

10. Soltero R.A., L.M. Sexton, **K.I. Ashley** and K.O. McKee. 1994. Partial and full lift hypolimnetic aeration of Medical Lake, WA to improve water quality. Water Research 28:2297-2308.

11. Lawrence, G.A**., K.I. Ashley**, N. Yonemitsu and J.R. Ellis. 1995. Natural dispersion and the fertilization of small lakes. Limnology and Oceanography 40:1519-1526.

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55. Pieters, R., L.C. Thompson, L. Vidmanic, S. Harris, J. Stockner, H. Andrusak, M. Young, **K. Ashley**, B. Lindsay, G. Lawrence, K. Hall, A. Eskooch, D. Sebastian, G. Scholten and P.E. Woodriff. 2003. Arrow Reservoir Fertilization Experiment – Year 2 (2000/2001) Report. Fisheries Project Report No. RD 87. Ministry of Water, Land and Air Protection, Province of British Columbia.

56. Pieters, R., L. Vidmanic, S. Harris, J. Stockner, H. Andrusak, M. Young, **K. Ashley**, B. Lindsay, G. Lawrence, K. Hall, A. Eskooch, D. Sebastian, G. Scholten and P.E. Woodriff. 2003. Arrow Reservoir Fertilization Experiment – Year 3 (2001/2002) Report. Fisheries Project Report No. RD 103. Ministry of Water, Land and Air Protection, Province of British Columbia.

57. Andrusak, H., S. Matthews, I. McGregor, **K. Ashley**, R. Rae, A. Wilson, , D. Sebastian, G. Scholten, P. Woodruff, L. Vidmanic, J. Stockner, G. Wilson, B. Jantz, J. Webster, H. Wright, C. Walters and J. Korman. 2004. Okanagan Lake Action Plan Year 8 (2003) Report. Fisheries Project Report No. RD 108. Ministry of Water, Land and Air Protection, Province of British Columbia.

58. Andrusak, H., S. Matthews, I. McGregor, **K. Ashley**, R. Rae, A. Wilson, J. Webster, G. Andrusak, L. Vidmanic, J. Stockner, D. Sebastian, G. Scholten, P. Woodruff, B. Jantz, D. Bennett, H. Wright, R. Withler, S. Harris. 2005. Okanagan Lake Action Plan Year 9 (2004). Report. Fisheries Project Report No. RD 111. Ministry of Environment, Province of British Columbia.

59. Schindler, E.U., R. Pieters, L. Vidmanic, H. Andrusak, D. Sebastian, G. Scholten, P. Woodruff, J. Stockner, B. Lindsay and **K. I. Ashley**. 2006. Arrow Lakes Reservoir Fertilization Experiment, Years 4 and 5 (2002 and 2003). Fisheries Project Report RD 113. Ministry of Environment, Province of British Columbia.

60. Schindler, E.U., **K. I. Ashley**, R. Rae, L. Vidmanic, , H. Andrusak, D. Sebastian, G. Scholten, P. Woodruff, F. Pick, L. M. Ley, and P. Hamilton.. 2006. Kootenay Lake Fertilization Experiment Years 11 and 12 (2002 and 2003). Fisheries Project Report No. RD 114. Ministry of Environment, Province of British Columbia.

61. Schindler, E.U., R. Rae, **K. I. Ashley**, L. Vidmanic, D. Sebastian, H. Andrusak, G. Scholten, P. Woodruff, J. Stockner, F. Pick, L. M. Ley, P. Hamilton, G.F. Andrusak and L. Fleck. 2007. Kootenay Lake Fertilization Experiment, Year 13 (North Arm) and Year 1 (South Arm) (2004) Report. Fisheries Project Report No. RD 117, Ministry of Environment, Province of British Columbia.

62. Schindler, E.U., L. Vidmanic, D. Sebastian, H. Andrusak, G. Scholten, P. Woodruff, J. Stockner, **K. I. Ashley** and G.F. Andrusak. 2007. Arrow Lakes Reservoir Fertilization Experiment, Years 6 and 7 (2004 and 2005) Report. Fisheries Project Report RD 121. Ministry of Environment, Province of British Columbia.

63. Schindler, E.U., H. Andrusak, **K.I. Ashley**, G.F. Andrusak, L. Vidmanic, D. Sebastian, G. Scholten, P. Woodruff, J. Stockner, F. Pick, L.M. Ley and P.B. Hamilton. 2007. Kootenay Lake Fertilization Experiment, Year 14 (North Arm) and Year 2 (South Arm) (2005) Report. Fisheries Project Report No. RD 122. Ministry of Environment, Province of British Columbia.

64. **Ashley, K.I.** and C. Helbing. 2008. Environmental wastewater research fund for British Columbia. Watermark 17:38-39.

65. Schindler, E.U., D. Sebastian, L. Vidmanic, H. Andrusak, J. Stockner, M. Bassett and **K.I. Ashley.** 2009. Arrow Lakes Reservoir Fertilization Experiment. Fisheries project Report No. RD 125. Fisheries Science and Allocation, Ministry of Environment, Province of British Columbia.

66. Schindler, E.U., D. Sebastian, G.F. Andrusak, H. Andrusak, L. Vidmanic, J. Stockner, F. Pick, L.M. Ley, P.B. Hamilton. M. Bassett and **K.I. Ashley**. 2009. Kootenay Lake Fertilization Experiment, Year 15 (North Arm) and Year 3 (South Arm) (2006) Report. Fisheries Project Report No. RD 126. Fisheries Science and Allocation, Ministry of Environment, Province of British Columbia.

67. Schindler, E.U., D. Sebastian, H. Andrusak, L. Vidmanic, S. Harris, G.F. Andrusak, F. Pick, L.M. Ley, P.B. Hamilton, D. Johner, P. Woodruff, M. Bassett and K.I. Ashley. 2010. Kootenay Lake Nutrient Restoration Program, Year 16 (North Arm) and Year 4 (South Arm) (2007) Report. Fisheries Project Report No. RD 127, Ministry of Environment, Province of British Columbia.

68. Schindler, E.U., D. Sebastian, L. Vidmanic, H. Andrusak, J. Stockner, M. Bassett and K.I. Ashley. 2010. Arrow Lakes Reservoir Nutrient Restoration Program, Year 9 (2007) Report. Fisheries Project Report No. RD 128, Ministry of Environment, Province of British Columbia.

69. Schindler, E.U., D. Sebastian, H. Andrusak, L. Vidmanic, G. F. Andrusak, M. Bassett, T. Weir and K. I. Ashley. 2011. Kootenay Lake Nutrient Restoration Program, Year 17 (North Arm) and Year 5 (South Arm) (2008) Report. Fisheries Project Report No. RD 131. Ministry of Forests, Lands and Natural Resource Operations, Province of British Columbia.

70. Schindler, E.U., D. Sebastian, L. Vidmanic, H. Andrusak, M. Bassett and K.I. Ashley. 2011. Arrow Lakes Reservoir Nutrient Restoration Program, Year 10 (2008) Report. Fisheries Project Report No. RD 132, Ministry of Environment, Province of British Columbia.

Theses

1. **Ashley, K.I.** 1981. Effects of hypolimnetic aeration on functional components of the lake ecosystem. M.Sc. Thesis, Zoology Dept., University of British Columbia. 120 pp.

2. **Ashley, K.I.** 1989. Factors influencing gas transfer in diffused aeration systems and their application to hypolimnetic aeration. M.A.Sc. Thesis, Civil Engineering Dept., University of British Columbia. 115 pp.

3. **Ashley, K.I.** 2002. Comparative analysis of oxygen transfer in full lift and Downflow Bubble Contact hypolimnetic aerators. Ph.D. Thesis, Civil Engineering Dept., University of British Columbia. 298 pp.

6. AWARDS and SIGNIFCANT ACHIEVEMENTS

1992 – Short listed to100 top candidates in Canada for the **Canadian Astronaut Program, Mission Payload/Mission Specialist.**

1997 - **Murray A. Newman Award for Excellence in Aquatic Science**. Awarded annually by the Vancouver Aquarium Marine Science Centre for Significant Achievement in Aquatic Research.

1999 – **Fisheries Professional of the Year**. Awarded annually by peer nomination in the Ministry of Fisheries, Province of British Columbia.

2001 – **Seth Diamond Award**. Awarded annually by the University of Idaho-Moscow and University of Montana-Missoula for innovative interdisciplinary research in fisheries, wildlife and forestry.

2004 – **25 Year Government Service Award**, presented by Lt. Gov. Iona Campagnola, Victoria, BC.

2007 – **Keynote speaker** at River Restoration Northwest Annual Conference in Washington State.

2007 – Two **Certificates of Recognition**, Policy and Planning Department, Greater Vancouver Regional District

7. UNIVERSITY APPOINTMENTS

University of Idaho-Moscow, Moscow, Idaho, USA: Adjunct Professor, Department of Fish, Wildlife and Range Resources. Appointment date: 2002.

University of British Columbia, Vancouver, BC, Canada: Adjunct Professor, Dept. of Civil and Environmental Engineering. Appointment date: 2004.

8. PROFESSIONAL ASSOCIATIONS

American Fisheries Society (Certified Fisheries Scientist No. 1968)
Canadian Society of Limnology
International Association for Theoretical and Applied Limnology

9. COMMITTEES

1992-1993: Chair, Vancouver Island Hydro-Fisheries Technical Committee
1992-1993: Technical Advisor, Lower Mainland Region Hydro-Fisheries Technical Committee
1992-1993: Technical Advisor, Southern Interior Region Hydro-Fisheries Technical Committee
1992-2005: Provincial Member, Technical Advisor, Peace-Williston Fish and Wildlife Compensation Program Fisheries Technical Committee
1992-2005: Provincial Member, Scientist, Columbia Basin Fish and Wildlife Compensation Program Fisheries Technical Committee
1994: Provincial Scientist, BC Utilities Commission Kemano Completion Project Technical Team
1995: Provincial Scientist: Kemano Completion Project Classified Technical Review Team
1995-2005: Okanagan Lake Action Plan/Large Lakes Committee
2002-2005: Chair, Habitat Conservation Trust Fund, Fisheries Technical Review Committee
2006: External Advisor, Habitat Conservation Trust Fund, Fisheries Technical Review Committee
2005-2007: Burrard Inlet Environment Action Plan Technical Committee
2005-2007: Fraser River Estuary Management Plan Technical Committee
2008: Chair, External Review Panel for BCIT Degree Program in Ecological Restoration
2010-2011: External Advisor, Habitat Conservation Trust Fund, Fisheries Technical Review Committee
2011: Science Advisor, Cohen Commission on Fraser River Sockeye

DR. ERIC ANDERSON CURRICULUM VITAE

Faculty, *BC Institute of Technology, Ecological Restoration Program*
Instructor, *University of Washington, Friday Harbor Laboratories*
Research Fellow, *Pacific WildLife Foundation*

Degrees & Academic Programs

University of Wyoming **2002–2009**

PhD Degree in Zoology and Physiology

Dissertation: Contrasts in nutrient metabolism and foraging strategies of Surf and White-winged Scoters in nearshore marine habitats.

Research description: Continental populations of scoters (*Melanitta* spp.) have declined by 60% since the 1970s for reasons unknown. In the boreal forest of Alaska and Canada, I assessed cross-seasonal allocation of marine nutrients to scoter reproduction. From British Columbia to SE Alaska, I studied the energetic value of herring spawning events to scoter migration and reproduction. In northern Puget Sound, I evaluated functional habitat dependencies of scoters on alternative benthic habitats (particularly seagrass).

University of Wyoming **2000–2002**

MSc Degree in Zoology and Physiology 2002

Thesis: Influences of elk on upland aspen, riparian willow, and associated landbirds in and near Jackson Hole, Wyoming.

Research description: Feeding programs for elk have occurred for over 100 years throughout western Wyoming. My study assessed ecological effects of these feeding programs on forest and riparian habitats as well as landbird communities.

Utah State University, Teton Science School 1997–1998
Graduate Program in Field Science Education

University of Puget Sound 1990–1994
BS Degree in Mathematics and Biology *Summa Cum Laude*

Northeastern University, School for Field Studies 1994
Field Studies Program in Environmental Science

Fellowships

NATIONAL SCIENCE FOUNDATION (NSF)
GK-12 Program in STEM **Graduate Teaching Fellow 2007–2008**
Program description: As a graduate fellow, I developed and delivered science curricula to enrich content and instruction in the fields of science, technology, engineering, and mathematics (STEM).

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)
Wyoming NASA Space Grant Consortium **Graduate Research Fellow 2006–2007**
Research topic: Integrating satellite-monitored movements, remote sensing of habitat, and surface-based observations to assess impacts of changes in coastal regions on declining sea ducks.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)
National Estuarine Research Reserve System **Graduate Research Fellow 2003–2006**

Research topic: Integrating estimates of seasonal foraging behavior, diet, physiological condition, and movements to assess functional dependencies of scoters (*Melanitta* spp.) on marine resources.

Selected Work & Research Experience

British Columbia Institute of Technology (Ecological Restoration Program) Burnaby, BC

Faculty 2011–present

Simon Fraser University (Centre for Wildlife Ecology) Burnaby, BC

Post-doctoral Research Associate 2008–2012

Core research areas:

Vulnerability of sea ducks to proposed offshore wind farm activities in Haida Gwaii, BC
Principle funders: Natural Resources Canada, Environment Canada, NaiKun Wind Energy Group
Graduate student on whose committee I served: Eric Palm, MSc, SFU
Technicians I supervised: Kimi Jaatinen, Matthew Wilson

Refining marine contaminant studies of Pacific scoters: integrating analyses of distributions, diet, and condition
Principle funders: USFWS Sea Duck Joint Venture, University of Illinois, Washington Dept. of Fish and Wildlife
Graduate student on whose committee I serve: Jessi Hallman, MSc candidate, Southern Illinois University
Technicians I supervised: Jenn Barrett, Sam Quinlan

Energetics and vulnerability to human impacts of molting sea ducks in the Puget Sound-Georgia Basin
Principle funders: USFWS Sea Duck Joint Venture, Washington Dept. of Fish and Wildlife
Graduate students with whom I collaborate: Rian Dickson, MSc candidate, SFU
Heather Tschaekofske, MSc candidate, Evergreen State University
Technicians I supervised: Jenn Barrett, Christiane Palluau, Sam Quinlan, Melanie Wilson

Environment Canada (Pacific Wildlife Research Centre) Vancouver, BC

Research Associate 2011–2012

I organized and conducted studies of Brant (*Branta bernicla*) migration through the Fraser River Delta, British Columbia. This entailed developing protocols for and conducting numerical censuses, surveys of age and sex ratios, band observations, and assessments of environmental disturbances. I am also analyzing results from these and related past studies that I will include in a report to Environment Canada and in peer-reviewed manuscripts.

University of British Columbia (Department of Forest Sciences) Vancouver, BC

Post-doctoral Research Associate 2011

I coordinated a multi-partner assessment of Western Grebe (*Aechmophorus occidentalis*) status in British Columbia. This entailed identifying critical information gaps, replicating historical censuses, organizing a focal meeting of regional experts to identify priorities for monitoring and research, and writing a status review for submission to Environment Canada. Our ongoing work includes analyzing available results for inclusion in peer-reviewed manuscripts, and developing new field studies.

University of Wyoming, National Science Foundation Bering Sea, AK

Research Associate 2007

During a 5-week icebreaker cruise, I collaborated on studies of water chemistry and benthic invertebrate community dynamics for a multidisciplinary study of climate change effects on Arctic benthic food webs.

Craighead Beringia South Jackson Hole, WY
Research Associate 1999

I collaborated on studies of Red-tailed Hawk productivity and adult migration.

Teton Science School Jackson Hole, WY
Research Associate 1997–1999

I coordinated a MAPS bird-banding station, used VHF telemetry to monitor movements of American Martens, developed and coordinated several research seminars, and co-developed a new research program.

The Nature Conservancy Eglin Air Force Base, FL
Vegetation Ecologist on Longleaf Pine Restoration Project 1996

I worked on a study of vegetation, avian, invertebrate, and soil recovery after alternative restoration treatments.

The Nature Conservancy Lander, WY
Vegetation Ecologist on Red Canyon Ranch & Sweetwater Preserves 1995

I developed a long-term vegetation monitoring program with TNC National Rangeland Ecologist, conducted pilot studies on several rare plant species, and developed several photo-monitoring programs for vegetation.

Publications

Peer reviewed

Lovvorn, J. R., **E. M. Anderson**, A. R. Rocha, W. W. Larned, J. M. Grebmeier, L. W. Cooper, J. M. Kolts, and C. A. North. 2014. Changing winds and dispersion of pack ice affect access to prey and physiological condition of bottom-feeding marine birds. Ecological Applications *In press*.

Dickson, R. D., **E. M. Anderson**, and D. Esler. 2014. Status report on the Western Grebe (*Aechmophorus occidentalis*). Committee on the Status of Endangered Wildlife in Canada. *In press*.

Anderson, E. M., E. K. Lok, R. D. Dickson, E. C. Palm, Savard, J.-P.L., Bordage, D., and Reed, A. 2014. Surf Scoter (*Melanitta perspicillata*). *In* The birds of North America. No. 363. Edited by A. Poole and F. Gill. The Birds of North America, Inc., Philadelphia. *In review*.

Dickson, R. D., D. Esler, J. Hupp, **E. M. Anderson**, J. R. Evenson, and J. Barrett. 2014. Dynamics of body mass and foraging effort of Surf Scoters (*Melanitta perspicillata*) and White-winged Scoters (*M. fusca*) during remigial moult. Ibis *In review*.

Uher-Koch. B. D., D. Esler, R. D. Dickson, J. W. Hupp, J. R. Evenson, **E. M. Anderson**, J. Barrett, J. A. Schmutz. 2014. Survival of Surf Scoters and White-winged Scoters during remigial molt. Journal of Wildlife Management *In review*.

Wilson, S. D., **E. M. Anderson**, A. Wilson, P. Arcese, and D. F. Bertram. 2013. Citizen science reveals an extensive shift in the winter distribution of migratory Western Grebes. PLOS ONE 8:e65408.

Palm, E. C., D. Esler, **E. M. Anderson**, M. T. Wilson, T. W. Williams, and O. Love. 2013. Baseline corticosterone in wintering marine birds: methodological considerations and ecological patterns. Physiological and Biochemical Zoology 86:346–353.

Palm, E. C., D. Esler, **E. M. Anderson**, T. D. Williams, and M. T. Wilson. 2013. Variation in physiology and energy management of wintering White-winged Scoters in relation to local habitat conditions. Condor 115:750–761.

Palm, E. C., D. Esler, **E. M. Anderson**, and M. T. Wilson. 2012. Geographic and temporal variation in diet of wintering White-winged Scoters. Waterbirds 35:577–589.

Anderson, E. M., and J. R. Lovvorn. 2012. Seasonal size dynamics of prey mediate complementary functions of mussel and seagrass habitats for an avian predator. Marine Ecology Progress Series 467:219–232.

Dickson, R. D., D. Esler, J. Hupp, **E. M. Anderson**, J. R. Evenson, and J. Barrett. 2012. Phenology and duration of remigial moult in Surf Scoters (*Melanitta perspicillata*) and White-winged Scoters (*M. fusca*) on the Pacific coast of North America. Canadian Journal of Zoology 90:932–944.

Anderson, E. M., D. Esler, W. S. Boyd, J. R. Evenson, D. R. Nysewander, D. H. Ward, R. D. Dickson, B. D. Uher-Koch, C. S. VanStratt, and J. W. Hupp. 2012. A preliminary assessment of the predator seascape for scoters: predation rates, timing, and predator composition. Canadian Journal of Zoology 90:42–50.

Anderson, E. M., and J. R. Lovvorn. 2011. Contrasts in energy status and marine foraging strategies of White-winged Scoters (*Melanitta fusca*) and Surf Scoters (*M. perspicillata*). Auk 128:248−257.

Anderson, E. M., J. R. Lovvorn, D. Esler, W. S. Boyd, and K. C. Stick. 2009. Using predator distributions, diet, and condition to evaluate seasonal foraging sites: sea ducks and herring spawn. Marine Ecology Progress Series 386: 287–302.

Anderson, E. M., J. L. Bower, D. R. Nysewander, J. R. Evenson, and J. R. Lovvorn. 2009. Changes in avifaunal abundance in a heavily used wintering and migration site in Puget Sound, Washington, during 1966–2007. Marine Ornithology 37:19–27.

Anderson, E. M., and J. R. Lovvorn. 2008. Gray whales may increase feeding opportunities for avian benthivores. Marine Ecology Progress Series 360:291–296.

Anderson, E. M., J. R. Lovvorn, and M. T. Wilson. 2008. Reevaluating marine diets of Surf and White-winged scoters: interspecific differences and the importance of soft-bodied prey. Condor 110:285–295.

Anderson, E. M. 2007. Changes in bird communities and willow habitats associated with fed elk. Wilson Journal of Ornithology 119:400–409.

Anderson, E. M., J. R. Lovvorn, D. R. Nysewander, and J. R. Evenson. 2007. Seasonal habitat requirements of Surf and White-winged scoters in Puget Sound. *In* S. Brace and J. Longo (editors) Proceedings of the 2007 Puget Sound Georgia Basin Research Conference, Vancouver, British Columbia.

Anderson, E. M., J. R. Lovvorn, D. Esler, W. S. Boyd, D. R. Nysewander, and J. R. Evenson. 2005. The value of herring spawning events to spring conditioning of scoters in the Puget Sound-Georgia Basin. *In* S. Brace and D. Fraser (editors) Proceedings of the 2005 Puget Sound Georgia Basin Research Conference, Seattle, Washington.

Peer reviewed – *in preparation*

Anderson, E. M., D. Esler, E. K. Lok, S. E. W. De La Cruz, and J. Y. Takekawa. When guts fly: dynamics of gizzard size in a marine bird with a short-hop migration strategy.

Anderson, E. M., P. Arcese, S. D. Wilson, and D. F. Bertram. Decadal trends in Western Grebe populations wintering in the marine waters of southern British Columbia.

Anderson, E. M., D. Esler, S. Slattery, and J.-M. Devink. Do White-winged Scoters use marine nutrients for reproduction?: Evidence from three boreal nesting areas.

Anderson, E. M., D. Esler, E. C. Palm, and E. K. Lok. Piscivory in the marine diets of bottom-feeding sea ducks: an overlooked trophic relation.

Anderson, E. M., D. Esler, R. D. Dickson, J. S. Barrett, and J. R. Evenson. Plasma metabolites indicate sea ducks endogenously regulate energy balance during wing molt.

Anderson, E. M., D. Esler, J. R. Evenson, R. D. Dickson, J. S. Barrett. Energetics and vulnerability to human impacts of molting Surf and White-winged scoters in the Puget Sound-Georgia Basin.

Hallman, J., M. Brooks, **E. M. Anderson**, J. R. Lovvorn, and J. R. Evenson. Relative contaminant burdens of Pacific scoters molting in industrialized and un-impacted sites.

Hallman, J., M. Brooks, **E. M. Anderson**, J. R. Lovvorn, and J. R. Evenson. Overwinter contaminant burdens of Surf Scoters and White-winged Scoters in the Salish Sea.

Lewis, T. L., P. L. Flint, R. D. Dickson, C. S. VanStratt, B. D. Uher-Koch, **E. M. Anderson**, D. Esler, D. H. Ward, J. W. Hupp, and J. R. Evenson. Contrast of double versus single-prong attachment of VHF transmitters in marine diving birds.

Tschaekofske, H. J., J. R. Evenson, and **E. M. Anderson**. Prey selection and its relationship to habitat and foraging strategy of molting White-winged Scoters (*Melanitta fusca*) and Surf Scoters (*M. perspicillata*) in Puget Sound, WA, and the Strait of Georgia, BC.

Theses

Anderson, E. M. 2009. Contrasts in nutrient metabolism and foraging strategies of Surf and White-winged scoters in nearshore marine habitats. PhD Dissertation, University of Wyoming, Laramie.

Anderson, E. M. 2002. Influences of elk on upland aspen, riparian willow, and associated landbirds in and near Jackson Hole, Wyoming. MSc Thesis, University of Wyoming, Laramie.

Reports

Anderson, E. M. 2011. Pacific Black Brant studies on the Fraser River Delta, Strait of Georgia, BC. Final Report for Environment Canada, Pacific Wildlife Research Centre.

Anderson, E. M., P. Arcese, S. D. Wilson, and D. F. Bertram. 2011. Western Grebes in British Columbia: status update and prospectus of monitoring and research needs. Environment Canada, Institute of Ocean Sciences Technical Report.

Esler, D., **E. M. Anderson**, and E. C. Palm. 2011. Research evaluating habitat value of the Dogfish Bank Area, Haida Gwaii for sea ducks: potential effects of offshore wind farm development. A progress report and plan for future activities. Simon Fraser University, Environment Canada, NaiKun Wind Energy Group.

Anderson, E. M., D. Esler, M. L. Brooks, J. Hallman, and J. R. Evenson. 2010. Refining marine contaminant studies of Pacific scoters: integrating analyses of distributions, diet, and condition. A final report of research funded during FY2010 by USFWS, Sea Duck Joint Venture.

Anderson, E. M. 2010. Sea duck diet and physiology in the proposed NaiKun wind farm area. Final report of contract awarded by Environment Canada, Science and Technology Branch.

Esler, D., **E. M. Anderson**, and E. C. Palm. 2010. Research evaluating habitat value of the Dogfish Bank area, Haida Gwaii for sea ducks: potential effects of offshore wind farm development. Report to NaiKun Wind Energy Group, Inc. and Hemmera Environmental Service Consultants.

Anderson, E. M., J. R. Lovvorn, D. R. Nysewander, J. R. Evenson, and J. L. Bower. 2009. Marine birds in the Padilla Bay National Estuarine Research Reserve: a compilation and synthesis of recent surveys. Padilla Bay National Estuarine Research Reserve Reprint Series.

Anderson, E. M., D. Esler, and J. R. Evenson. 2009. Energetics and vulnerability to human impacts of molting Surf and White-winged Scoters in the Puget Sound-Georgia Basin. A final report of research funded during FY2009 by USFWS, Sea Duck Joint Venture.

Anderson, E. M., and J. R. Lovvorn. 2007. Seasonal habitat requirements of Surf and White-winged Scoters in northern Puget Sound, Washington. A final report of research funded during FY2005 by USWFS, Western Washington Fish and Wildlife Office, Puget Sound Program.

Anderson, E. M. 2007. Integrating satellite-monitored movements, remote sensing of habitat, and surface-based observations to assess impacts of changes in marine areas on declining sea ducks. Wyoming NASA Space Grant Consortium, Final Report for Graduate Research Fellowship.

Anderson, E. M. 2006. Seasonal habitat requirements of Surf and White-winged Scoters in northern Puget Sound, Washington. NOAA National Estuarine Research Reserve System, Final Report for Graduate Research Fellowship Program.

Anderson, E. M., and J. R. Lovvorn. 2006. Seasonal habitat requirements of Surf and White-winged Scoters in Puget Sound. A final report of research funded during FY2006 by USFWS, Sea Duck Joint Venture.

Anderson, E. M., J. R. Lovvorn, D. Esler, W. S. Boyd, D. R. Nysewander, and J. R. Evenson. 2005. The role of herring spawning grounds as marine protected areas for Scoters (*Melanitta* spp.) in the Puget Sound-Georgia Basin. A final progress report of research funded by the SeaDoc Society of the Wildlife Health Center at the UC Davis School of Veterinary Medicine.

Esler, D., S. Slattery, J.-M. DeVink, and **E. M. Anderson**. 2005. Tracing Sources of Nutrients and Energy for Clutch Formation by White-winged Scoters. A final report of research funded during FY2005 by USFWS, Sea Duck Joint Venture.

Anderson, E. M., J. R. Lovvorn, D. Esler, W. S. Boyd, D. R. Nysewander, and J. R. Evenson. 2005. The value of herring spawn vs. alternative prey to Surf Scoters and White-winged Scoters in the Puget Sound-Georgia Basin. A final report of research funded during FY2005 by USFWS, Sea Duck Joint Venture.

Anderson, E. M., and J. R. Lovvorn. 2004. Scoter use of eelgrass and herring spawn in Puget Sound. A final report of research funded during FY2003 by USWFS, Western Washington Fish and Wildlife Office, Puget Sound Program.

Grants

Anderson, E. M. 2013. Nest site creation and ecological role of Bald Eagles in urban estuaries. Habitat Conservation Trust Foundation.

Anderson, E. M., and D. Esler. 2012. Status report for Western Grebes (*Aechmophorus occidentalis*). COSEWIC Secretariat, Canadian Wildlife Service, Environment Canada.

Anderson, E. M., D. Esler, M. L. Brooks, and J. R. Evenson. 2010. Refining marine contaminant studies of Pacific scoters: integrating analyses of distributions, diet, and condition. USFWS Sea Duck Joint Venture.

Anderson, E. M. 2009. Sea duck diet and physiology in the proposed NaiKun wind farm area. Environment Canada, Science and Technology Branch.

Anderson, E. M., D. Esler, J. R. Evenson, D. R. Nysewander. 2009. Energetics and vulnerability to human impacts of molting Surf and White-winged Scoters in the Puget Sound-Georgia Basin. USFWS Sea Duck Joint Venture.

Anderson, E. M. 2006. Integrating satellite-monitored movements, remote sensing of habitat, and surface-based observations to assess impacts of changes in coastal regions on declining sea ducks. Graduate Research Fellowship, Wyoming NASA Space Grant Consortium.

Anderson, E. M. 2006. Roles of coastal resources in enabling scoters (*Melanitta* spp.) to regulate their condition throughout the annual cycle. Berry Center in Ecology Fellowship.

Anderson, E. M., J. R. Lovvorn, and others. 2006. Seasonal habitat requirements of Surf and White-winged Scoters in Puget Sound. USFWS Sea Duck Joint Venture.

Lovvorn, J. R. and **E. M. Anderson**. 2005. Scoters (*Melanitta* spp.) and eelgrass habitat. Puget Sound Program, USFWS, Western Washington Fish and Wildlife Office.

Anderson, E. M., J. R. Lovvorn, and others. 2005. The value of herring spawn vs. alternative prey to Surf and White-winged Scoters in the Puget Sound-Georgia Basin. USFWS Sea Duck Joint Venture.

Esler, D., S. Slattery, **E. M. Anderson**, J. R. Lovvorn, J.-M. Devink. 2005. Tracing sources of nutrients and energy for clutch formation by White-winged Scoters. USFWS Sea Duck Joint Venture.

Anderson, E. M. J. R. Lovvorn, D. Esler, S. W. Boyd, D. R. Nysewander. 2004. The role of herring spawning grounds as Marine Protected Areas for scoters (*Melanitta* spp.) in the Puget Sound-Georgia Basin. SeaDoc Society, UC Davis, Wildlife Health Center.

Anderson, E. M. 2003–2005. Relative roles of eelgrass vs. hard-mixed substrates as habitat for scoters (*Melanitta* spp.) in Puget Sound. Graduate Research Fellowship, NOAA National Estuarine Research Reserve System.

Lovvorn, J. R., and **E. M. Anderson**. 2003. Characterizing scoter (*Melanitta* spp.) habitat requirements. Puget Sound Program, USFWS, Western Washington Fish and Wildlife Office.

Anderson, E. M., and R. A. Beezer. 1994. Undergraduate research on sustainable development in rural Nepal. Slater Research Grant, University of Puget Sound.

Anderson, E. M., and R. A. Beezer. 1993. Undergraduate research in the Department of Mathematics and Computer Science, University of Puget Sound. Murdock Corporation.

Contributed Papers / Presentations

Wilson, S. D., **E. M. Anderson**, A. Wilson, P. Arcese, D. F. Bertram. 15 August 2012. Declines or redistribution? Population trends of Western Grebes wintering along the Pacific Coast. *5th North American Ornithological Conference*, Victoria, BC.

Anderson, E. M., P. Arcese, S. D. Wilson, D. F. Bertram, J. R. Evenson, and L. I. Vilchis. 25 October 2011. Western Grebes in the Salish Sea: status update and prospectus of monitoring and research needs. *2011 Salish Sea Ecosystem Conference*, Vancouver, BC.

Uher-Koch, B., D. Esler, J. Hupp, D. H. Ward, C. S. VanStratt, R. D. Dickson, K. Brodhead, W. S. Boyd, J. R. Evenson, S. Iverson, M. Kirk, T. Lewis, **E. M. Anderson**, and J. Schmutz. 14 September 2011. Latitudinal and seasonal variation in nonbreeding survival of Surf and White-winged scoters. *4th International Sea Duck Conference*, Seward, AK.

Dickson, R. D., D. Esler, J. Hupp, **E. M. Anderson**, J. R. Evenson, and J. Barrett. 14 September 2011. Wing moult in Surf and White-winged scoters. Spatial and seasonal variation in nonbreeding scoter diet along the Pacific coast. *4th International Sea Duck Conference*, Seward, AK.

Palm, E. C., D. Esler, **E. M. Anderson**, and W. S. Boyd. 13 September 2011. Environmentally-mediated energy management and physiology of wintering White-winged Scoters. Spatial and seasonal variation in nonbreeding scoter diet along the Pacific coast. *4th International Sea Duck Conference*, Seward, AK.

Anderson, E. M., D. Esler, J. W. Hupp, D. H. Ward, K. Brodhead, R. D. Dickson, E. C. Palm, B. D. Uher-Koch, and C. S. VanStratt. 13 September 2011. Spatial and seasonal variation in nonbreeding scoter diet along the Pacific coast. *4th International Sea Duck Conference*, Seward, AK.

Esler, D., J. Barrett, D. Gunn, E. Lok, R. Dickson, C. VanStratt, B. Uher-Koch, E. Anderson, J. Hupp, D. Ward, J. Hodges, and D. Groves. 7 April 2011. Sea ducks in southeast Alaska and implications for conservation. *Annual Meeting of the Alaska Chapter of the Wildlife Society*, Juneau, AK.

Dickson, R. D., D. Esler, J. W. Hupp, **E. M. Anderson**, J. R. Evenson, and J. Barrett. 17 November 2010. Sitting ducks?: the challenges of wing moult for Surf and White-winged scoters. *Alaska Bird Conference*. Anchorage, AK.

Dickson, R. D., D. Esler, J. W. Hupp, **E. M. Anderson**, J. R. Evenson, and J. Barrett. 9 September 2010. Remigial moult of Surf Scoters (*Melanitta perspicillata*) and White-winged Scoters (*M. fusca*) on the Pacific coast of North America. *1st World Seabird Conference*. Victoria, BC.

Anderson, E. M., J. R. Lovvorn, D. Esler, and W. S. Boyd. 9 August 2007. Pacific scoters and herring spawning events: contribution of a pulsed marine prey to seasonal body reserves. *125th Stated Meeting of the American Ornithologists' Union*. Laramie, WY.

Anderson, E. M., J. R. Lovvorn, D. Esler, W. S. Boyd, D. R. Nysewander, and J. R. Evenson. 4 April 2007. Declining scoters and the role of marine resources on the N. American Pacific Coast. *University of Wyoming, Graduate Student Symposium*. Laramie, WY.

Anderson, E. M., J. R. Lovvorn, D. R. Nysewander, and J. R. Evenson. 28 March 2007. Seasonal habitat requirements of surf and white-winged scoters in Puget Sound. *2007 Georgia Basin Puget Sound Research Conference*. Vancouver, BC.

Anderson, E. M., J. R. Lovvorn, D. Esler, W. S. Boyd, D. R. Nysewander, and J. R. Evenson. 7 November 2005. The value of herring spawning events to spring conditioning of scoters in the PSGB. *Second North American Sea Duck Conference*. Annapolis, MD.

Anderson, E. M., J. R. Lovvorn, D. Esler, W. S. Boyd, D. R. Nysewander, and J. R. Evenson. 29 March 2005. The value of herring spawning events to spring conditioning of scoters in the PSGB. *2005 Puget Sound Georgia Basin Research Conference*. Seattle, WA.

Esler, D., W. S. Boyd, T. L. Lewis, S. A. Iverson, and **E. M. Anderson**. 5 November 2003. Physiological and behavioral responses of scoters to herring spawn. *North American Duck Symposium*. Sacramento, CA.

Anderson, E. M., and S. H. Anderson. 24 September 2002. Influences of supplementally fed elk on aspen and landbirds in Jackson Hole, WY. *Third North American Ornithological Conference*. New Orleans, LA.

Anderson, E. M., and S. H. Anderson. 27 November 2001. Wild ungulates, aspen, willow, and landbirds in Jackson Hole, WY. *The Wildlife Society Wyoming State Conference*. Laramie, WY.

Anderson, E. M., and S. H. Anderson. 25 September 2001. Effects of wild ungulates on landbirds and their aspen habitat in Jackson Hole, WY. *The Wildlife Society 8th Annual Conference*. Reno, NV.

Invited Lectures (Academic)

Foraging strategies of congeneric sea ducks over winter: body size, energetics, and diversity of marine habitat needs — Delta, BC
Environment Canada, Pacific Wildlife Research Center, Seminar Series — 13 April 2010

Foraging strategies of congeneric sea ducks over winter: body size, energetics, and diversity of marine habitat needs — Burnaby, BC, 7 April 2010
Centre for Wildlife Ecology, Simon Fraser University, Seminar Series

Evaluating marine habitat needs of Pacific scoters — Laramie, WY
University of Wyoming, Ornithology Cours — 8 February 2007

Seasonal value of eelgrass to scoters: research progress and prospectus — Mount Vernon, WA
Padilla Bay National Estuarine Research Reserve — 15 March 2006

Dietary sources of seasonal scoter reserves: fatty acid analyses — Annapolis, MD
Second North American Sea Duck Conference, Panel Speaker — 7 November 2005

Declining sea ducks and the role of herring spawning events in the PSGB — Tacoma, WA
University of Puget Sound, Science Seminar Series — 15 March 2005

Eelgrass, herring spawn, and scoter declines in the PSGB: a prospectus for study — Mount Vernon, WA
Padilla Bay National Estuarine Research Reserve — 7 March 2005

Using stable isotopes to evaluate diets of marine birds — Bellingham, WA
Western Washington University, Seabird Ecology Seminar — 15 February 2005

Eelgrass, herring spawn, and scoter declines in the PSGB: a prospectus for study — Olympia, WA
USFWS, Western Washington Fish and Wildlife Office — 27 January 2005

Scoters, eelgrass, and herring spawning events: are the declines related? Bellingham, WA
Western Washington University, Seabird Ecology Seminar 21 February 2004

Invited Lectures (Non-Academic)

From herring to Gray Whales: one bird's partnerships in a changing sea West Vancouver, BC
Lighthouse Park Preservation Society 5 April 2014

Disappearing act: Declines of Western Grebes in the Salish Sea and the search for explanations Vancouver, BC
Nature Vancouver 6 March 2014

From herring to Gray Whales: one bird's partnerships in a changing sea Vancouver, BC
Vancouver Bird Week, Vancouver Public Library, Stanley Park Ecology Society, 8 May 2013

A tale of a whale…and a seabird Langley, WA
Philanthropic Educational Organization, Guest Speaker Series 2 May 2010

Gray whales: declines, recovery, and ecological relationships Langley, WA
OrcaNet, Welcome the Whales Festival, Keynote Speaker 27 April 2010

"Changing marine ecosystems, and seabird declines Coupeville, WA
Audubon Society of Whidbey Island, Seminar Series 1 April 2009

Identifying marine foods critical to declining sea ducks Mount Vernon, WA
Padilla Bay NERRS, Annual Board Meeting, Keynote Speaker 10 October 2008

Eelgrass, spawn, and scoters: related declines in the Puget Sound-Georgia Basin? Semiahmoo, WA
4th Annual "Wings Over Water" Northwest Birding Festival 24 March 2006

Declining sea ducks and the role of herring spawning events in the PSGB Port Townsend, WA
Port Townsend Marine Science Center, Guest Lecturer Program 7 July 2005

The value of herring spawning events to spring conditioning of scoters in the PSGB Semiahmoo, WA
3rd Annual "Wings Over Water" Northwest Birding Festival 2 April 2005

A century of single-species management and the implications for songbirds Jackson, WY
National Museum of Wildlife Art, Winter Speaker Series 7 March 2002

Scholarships & Research Awards

Seven-time recipient of **UW Dept. of Zoology Summer Research Assistantship** 2002–2008)

Five-time recipient of **C.P. and Evelyn S. Plummer Scholarship** from Haub Institute for the Environment and Natural Resources 2001–2007

George T. Baxter Fellowship for Research Distinction in Aquatic Biology 2007

Margaret and Sam Kelly Ornithology Research Scholarship 2006

First Place Honors, Graduate Student Oral Presentation, 2005 Puget Sound Georgia Basin Research Conf.

American Ornithologists' Union Student Membership Grant 2002–2005

Four-time recipient of **UW Graduate School Travel Award** 2002–2005

Two-time recipient of **Scott-Walter, UW Dept. of Zoology Travel Fund Award** 2002 & 2005

Cooper Ornithological Society Honorary Student Membership Grant 2002–2004

Dean's Advancement Fund/Paul Stock Grant-In-Aid 2002

L. Floyd Clarke Scholarship for Merit in Thesis Research 2001

Seven-time **Steven H. Hunter Memorial Scholar** 1991–1994

Eight-time **University of Puget Sound Trustee Scholar** 1990–1994

Eight-Time **University of Puget Sound Dean's List Honors** 1990–1994

Phi Kappa Phi National Honor Society **Outstanding Undergraduate Achievement Award** 1994

Hearst Writing Prize in Natural Sciences 1994

Edward G. Goman Outstanding Senior Achievement in Mathematics Award 1994

Edward G. Goman Outstanding Junior Achievement in Mathematics Award 1993

Meritorious Winner of *Mathematical Contest in Modeling* 1994

Phi Kappa Phi National Honor Society **Outstanding Sophomore Achievement Award** 1992

Teaching Awards & Certifications

Teaching Excellence Award (7 Nominations) at British Columbia Institute of Technology 2012

Extra Mile Award (1 Nomination) at British Columbia Institute of Technology 2012

Fellowship in Science Education with National Science Foundation 2007–2008

Program Description: As a graduate fellow, I developed and delivered science curricula to enrich content and instruction in the fields of science, technology, engineering, and mathematics (STEM). NSF developed this program recognizing that, in addition to being competent researchers, graduate students in the sciences must be able to communicate with a variety of audiences. This program entails graduate students bringing their research and practice into classrooms in order to develop authentic and timely science curricula. Further, graduate students inspire transformation in formal and informal learning environments and stimulate interest in science and engineering.

Program in College Teaching at University of Wyoming, College of Education 2008

Outstanding Biology Graduate Lab Instructor at University of Wyoming 2000–2001

Award for Teaching Excellence at Teton Science School/Utah State University 1997–1998

Graduate Program in Environmental Education at Teton Science School 1997–1998

Program Description: This 50-week graduate program integrated academic course work in education and a range of natural science disciplines with an intensive mentored teaching practicum. The central focus of this program was to develop competencies of in four areas: education, field ecology, professional leadership, and commitment to community. The teaching practicum focused on instruction, curriculum design, and reflective practice in order to develop skilled educators within the context of an institutional and programmatic foundation. The teaching practicum was supported by understanding of ecology and pedagogy that was developed within additional graduate program courses, and included over 400 hours of field and classroom instruction to undergraduate and high school students. Education courses included: *Introduction to Field Science Teaching*, *Principles of*

Place-Based Education, *Advanced Instructional Strategies*, *Advanced Elements of Field Ecology Course Design*, and *Capstone Teaching Practicum*.

Teaching Experience

Multiple locations • Guest Lecturer *see* INVITED LECTURES above

BC Institute of Technology, Fish, Wildlife and Recreation Program Burnaby, BC

• Instructor *Applied Research in Ecological Restoration* (29 mentored projects)
2012–2014
(Renewable Resources 8303, 6 credits)

• Instructor *Applied Research in Wildlife Ecology* (9 mentored projects)
2011–2014
(Renewable Resources 3230, 4230, 6 credits each)

• Instructor *Population and Community Ecology*
2012–2014
(Renewable Resources 8001, 3 credits)

• Instructor *Conservation Biology*
2012–2013
(Renewable Resources 8103, 4 credits)

• Instructor *Restoring Disturbed Landscapes*
2012–2013
(Renewable Resources 7003, 3 credits)

• Instructor *Natural Resource Measurements*
2012
(Renewable Resources 1105, 4 credits)

• Instructor *Applied Ecology*
2012–2014
(Renewable Resources 2117, 4.5 credits)

• Instructor *Wildlife Ecology and Conservation*
2011
(Renewable Resources 3220, 7 credits)

University of Washington, Friday Harbor Laboratories San Juan Island, WA

• Instructor *Ecology and Conservation of Marine Birds and Mammals*
Summers 2011–2013
(Dept. of Biology 492, 9 credits)

I co-organized, developed curriculum for, and am instructing this lecture-, field-, and lab-based course. Core topics include: 1) the systematics, morphology, physiology, and ecology of local species; 2) field identification and research techniques for studies of populations, energetics, and other topics; 3) relationship of tides and other environmental variables to animal distribution and abundance; and 4) status and conservation of local species. The course culminates in students designing, conducting, and presenting results of an independent research project.

California State University Monterey Bay Hilo, Hawai'i

• Instructor *Environmental Wildland Studies* (Environmental Science Dept. 370, 6 credits)
Spring 2011

I co-organized, developed curriculum for, and instructed this and the following two courses that integrate lectures and field studies. This course focuses on study of environmental problems affecting natural and human-impacted ecosystems. Students participated in extensive field research of flora and fauna, and in evaluation of environmental policy options.

• Instructor *Environmental Field Survey* (Environmental Science Dept. 371, 6 credits)
Spring 2011

In this course, students engaged in on-site analyses of environmental impacts to wildlife and their habitat. Core concepts included environmental studies, wildlife management, and public land planning. Students participated in all aspects of environmental assessments, including study design, field data collection, analyses, and environmental report writing.

• Instructor *Wildlands Environment & Culture* (Environmental Science Dept. 372, 6 credits)
Spring 2011

This course explored relationships between cultural groups and environmental issues. Through case studies and field research, students assessed foundations of culture-specific uses of natural resources and outcomes of related environmental policies.

National Science Foundation, University of Wyoming Dharamsala, India

• Graduate Teaching Fellow
Spring 2008

I co-organized, developed curriculum for, and instructed this program designed to enrich science education through research into community health issues for students in Tibetan refugee schools. Curriculum included lectures detailing the scientific process, field sampling and laboratory analyses of water quality parameters, and presentations to community members of core findings.

National Science Foundation Laramie, WY

• Graduate Teaching Fellow
2007–2008

Through the NSF GK-12 Program and in collaboration with secondary-level teachers, I developed curriculum for and instructed science courses in Wyoming public schools. Programs were based both on my own research, as well as on critical contemporary topics such as climate change. My objectives were to increase science literacy, awareness of careers in science, and enrollment in college science programs.

University of Wyoming Laramie, WY

• Lecturer *Animal Biology* (Biology Dept. 2022, 4 credits)
Spring 2003

I developed curriculum for and instructed this integrative course for life science majors that focused on evolution, anatomy, physiology, and ecology of animals. This course further developed concepts of cell biology, molecular biology, and genetics introduced in an earlier course. I also instructed associated labs, which focused on dissections of animal specimens.

• Laboratory Instructor *Animal Biology* (Biology Dept. 2022)
Spring 2006

• Laboratory Instructor *Wetland Ecology* (Zoology and Physiology Dept. 4550) Fall 2004

A graduate-level course that focused on marine and freshwater wetland classification, policy, and function. The latter topic integrated concepts from biogeochemistry, vertebrate and invertebrate taxonomy and ecology, and vegetation ecology. Methods of studying wetland function (including use of stable isotopes) were also discussed. Representative wetlands were studied during weekly field studies.

• Laboratory Instructor *Wetland Ecology* (Zoology and Physiology Dept. 4550) Fall 2003

• Laboratory Instructor *General Biology* (Biology Dept. 1010) Fall 2002

An introductory course that explored fundamental concepts of biology, including basic chemistry of living systems, cell structures and functions, energy relations, genetics, molecular biology, ecology, population dynamics, and evolutionary theory. Many labs included study of living invertebrate and vertebrate organisms.

• Laboratory Instructor *Animal Biology* (Biology Dept. 2022) Spring 2001

• Laboratory Instructor *General Biology* (Biology Dept. 1010) Fall 2000

Teton Science School Jackson, WY

• Instructor *Combining Research and Education in Science Teaching (CREST)* 2001

During my MSc program I co-developed a course to expose secondary-level teachers from throughout the US in ecology, field science methods, and experimental design. As a critical component of this course, I mentored teachers as they developed ongoing field studies for their students.

• Instructor Undergraduate and high school courses 1997–1999

As a graduate student and subsequently as an education and research associate, I gained extensive experience developing and teaching several field-based courses. Courses lasted from 1 to 5 weeks and core topics included wetland ecology, physiology, ornithology, mammalogy, vegetation ecology, geology, winter ecology, and snow science.

Memberships

Society for Conservation Biology (2001) Cooper Ornithological Society (2003)

The American Ornithologists' Union (2003) The Wildlife Society (2001)

Society for Ecological Restoration (2012, 2013, 2014)

Extramural Activities

Four-time Department of Zoology and Physiology Graduate Representative to UW Graduate Advisory Board

Selected as Graduate Representative of Faculty Search Committee

Two-time Department of Zoology and Physiology Graduate Representative to Faculty

I am passionate about exploring, and some recent adventures include the following:

Sea kayaking around the Hornstrandir peninsula of Iceland

Developing a water quality monitoring program with Tibetan refugee students in Dharamsala, India

Sea kayaking over the course of five trips from Santa Rosalia to Isla Espiritu Santo, Mexico

Studying water chemistry and benthic invertebrates in the Bering Sea from a US Coast Guard Icebreaker

Canoeing the Yukon-Charley Rivers National Preserve from Eagle to Circle City, Alaska

Sea kayaking the Harriman Fjord in Prince William Sound, Alaska

Backpacking through Croatia, Bosnia, Slovenia, and Montenegro
Ski touring on the Ruth Glacier of Denali, Alaska
Mountain biking the Kokopelli Trail from Fruita, Colorado to Moab, Utah
Sea kayaking the Sognefjord of southern Norway

As a volunteer, I have **taught ecology** and contributed to **ecological restoration and monitoring projects** with organizations such as:

The Nature Conservancy *Environment Canada, Pacific Yukon Research Centre*
US Forest Service *Simon Fraser University, Centre for Wildlife Ecology*
Port Townsend Marine Science Center *Padilla Bay National Estuarine Research Reserve*
The Audubon Society *The Road Less Traveled*

DANIEL HOGAN CURRICULUM VITAE

Background

2010-present	Head, Hydrology Program and Standards, BC Ministry of Environment
2010-present	Part-time Instructor, British Columbia Institute of Technology, Ecological Restoration Program
2007-present	Adjunct Professor, University of British Columbia, Department of Geography.
1999-2007	Adjunct Professor, University of British Columbia, Department of Forest Resources Management
1993-2010	Research Geomorphologist B. C. Ministry of Forests, Research Branch
1992-1993	A/Manager, Forest Hydrology Research B. C., Ministry of Forests, Research Branch
	Forest Hydrology Instructor University of British Columbia, Faculty of Forestry
1990-1992	Regional Research Hydrologist B. C. Ministry of Forests, Vancouver Forest Region
1985-1990	Geomorphologist **D. L. Hogan** and Associates, Ltd. Watershed Geomorphology and Hydrology Research
1982-1985	Project student Geomorphologist/Graduate student Fish-Forestry Interaction Program/UBC
1978-1982	Climatologist/Instructor Envirocon Ltd/Douglas College

Affiliations	Association of Professional Engineers and Geoscientists of BC Professional Geoscientist (P.Geo., in good standing since 1991).
	American Geophysical Union (member number 11101366).
	Canadian Water Resources Association
Education	M. Sc. (Geomorphology) 1985

-University of British Columbia

B. A. (Geography) 1976
-University of British Columbia

Experience

B. C. Ministry of Environment

Responsible for the provincial commitments to the National Hydrometric Network, under the Canadian-Provincial Hydrometric Agreement. Includes all aspects related to the operation of the extensive provincial hydrometric network.

B. C. Forest Service:

1) Research

Long term stream channel studies:
-research program includes major on-going collaborative studies dealing with fish/forestry interactions, specifically stream channel responses to natural and management related disturbances. Study sites at Carnation Creek (30 years of data from western Vancouver Island), Queen Charlotte Islands (10 years of data) and Stuart-Takla (10 years of data from northern interior). All of these projects have generated huge data bases, much more analysis is required to realize the full potential of this resource. These data bases are ideally suited for student projects (many have already been undertaken but there is a much greater potential);
-the study of small interior streams (Fubar and Km 16 creeks) near Smithers, B. C. (1991 to present, in collaboration with the Prince Rupert Forest Region).
-the study of intermediate sized interior streams (Donna Creek,) near MacKenzie, B. C. (1991 to present, in collaboration with the Prince Rupert Forest Region).
-Watershed Sediment Transfer studies, continuing refinement of the real time channel response model (WilGans).

Intermediate duration studies:
- retrospective historical channel change evaluations;
-Chilako River channel adjustments review to resolve multiple-use (agriculture, forestry, transportation corridors, urbanization) conflicts;
-Williams Creek (near Terrace BC), historical review of specific channel reaches to resolve sediment source issues (forestry on steep slopes, agriculture on alluvial fans, transportation corridors on floodplains) suspected of influencing fisheries resources of Lakelese watershed.

-evaluation and implementation of channel monitoring methods at Heller Creek (Kamloops Forest Region) and Bird Creek (Nelson Forest Region);

-investigation of sediment routing methods, Hanna and Tintina creeks, near Stewart B. C.;
-sediment budget studies in the Tsitika River, near Port McNeil on northern Vancouver Island;
-Smit/Peel Creek study to insure protection of downstream marine environments (Killer Whale rubbing beaches);
-Study of the functional role of large woody debris (LWD) in all biogeoclimatic zones of the province (FRBC project 1996-2001).

Short term studies:
Primarily related to understanding river processes over longer time scales using aerial photographs;

-Skeena River, a retrospective study of floodplain development along the lower Skeena River (Terrace to the river mouth) using historical aerial photographs. Applied to silviculture planning;

-Yakoun River, a retrospective study of river channel and riparian area conditions along the lower Yakoun River (Port Clements to the river mouth) using historical aerial photographs. Applied to rate-of-cut considerations in the Forest Development Plan;
-Collaborated on several other historical aerial photograph studies of river conditions (Copper, Adam, Eve, Oyster, Tsitika, and others).

Adaptive Management
-provide study design advice and training to past and on-going studies of small streams in the Prince George Forest Region. Involves training contractors in the use of specialized low level aerial photography techniques and analytical methods.

2) Consulting to the Regions and Districts

-Watershed Assessments. Conducted throughout the province, to determine logging impacts in hydrologically sensitive areas (e.g., Chilako River, Williams Creek, Gordon River, Egmont forest lands, Yakoun River, see list below);

-Channel Assessments. Conducted throughout the province, to determine logging impacts in geomorphically sensitive areas (e.g., Silver Creek (fire), Gordon River, Donna Creek, Yakoun River, Sachs and Hanns creeks, see list below);

-Gully Assessment. As the original author of the Gully Assessment Procedure, provided training in its applications.

-Riparian issues on small, intermediate and large sized streams.

-Forestry operational problems concerning hillslope-stream channel interactions, province-wide (e.g., Caren Range, Laussier River).

-Watershed Restoration Program. Provide specialized advice concerning watershed restoration techniques, practices and effectiveness monitoring (co-chair of the original WRP Technical Review and Evaluation Working Group);

-Responsible for developing, testing and implementing (training) B.C. Forest Practices Code fieldguides dealing with stream channels, gully systems and specific watershed assessment components and background to the Riparian Management Area Guidelines;

-Participate in Environmental audits of the implementation and effectiveness of the Forest Practices Code regulations dealing with stream systems, interior districts.

3) Policy advise and support

-provided scientific advice during the development of the Coastal Fish-Forestry Guidelines, as requested.
-routinely provide technical background to Forest Practices Code regulations dealing with landscape planning (Reg [14], watersheds (Reg [14.1-6]),gullies, streams [Reg 14.9], riparian areas (Reg [ ]).
-provided scientific advice during the development of the Interior Fish-Forestry Guidelines.
- routinely asked about the scientific basis supporting Forest Practices Code issues,
-policy makers expect the researchers to identify future issues.
- provided scientific advice during the development of the Forest and Range Prctices Act.

4) Extension

-Invited and fully supported to make presentations and participate in a river ecosystem workshop in Umeo, Sweden (Sept.-Oct., 2005).

-Formal internal extension programs. Developed and implemented several major training programs (e.g., Landslide Prone Terrain, training package delivered to all coastal and several interior districts, Gully

Assessment procedure used in the Coastal Fish/Forestry Guidelines training, Watershed Assessment Procedure training package, Channel Conditions and Prescription Assessment training), Expert Witness course development and delivery, karst terrain management training course development and delivery.

-Informal extension. Regularly train ministry staff in watershed, stream channel, riparian assessments and fluvial forms and processes.

-External extension. Presentation of scientific papers at conferences, workshops, symposia, etc. throughout the Pacific Northwest. Invited to speak at 3 major conferences per year, on average.

-Develop, test and deliver training programs to technical, management and scientific staff. Usually concludes with training others to the point where they can deliver the courses.

5) Public debate

-Participated by providing scientific and technical expertise in many public debates concerning the hydrologic and geomorphic implications of forestry activities. These include:

-Chilako River Watershed Stewardship Committee(Prince George),

-Lakelse Watershed Stewardship Committee(Terrace).

-Carmanah valley development plans (Port Alberni, Nanaimo),
-Tsitika Follow-up committee (Nanaimo, Campbell River),
-Chapman/Grey Community Water Supply Watershed public meetings, Sechelt B. C.
-Gordon River forestry plan (Duncan)
-Yakoun River Land Use Plan (Queen Charlotte City)
- Egmont forestland dispute (Egmont)

6) Expert Witness

Frequently called on to conduct site inspections and be prepared to give expert witness testimony in court (e.g., Lens Creek, Olympic Creek, Km 15 Creek, Donna Creek, Everrette Creek), dealing with hydrological and geomorphic problems associated with forestry activities.

Completed development and delivered a forestry-focuses expert witness course in 2007 (stems from the legal requirements of the Forest and Range Practices Act).

Teaching (in addition to the extension activities listed above):

1) Full courses
   - Forest Hydrology, FRST 385 (UBC 1992), teaching evaluation attached;
   - Terrain and Channel Assessment for Ecological Restoration, RENR 8201 (BCIT, 2010)
   - Introduction to Earth Sciences (Douglas College 1980), teaching evaluation attached;
   - Hydrolgical Systems EENG 8804(BCIT short module), teaching evaluation attached;
2) Guest lectures
   -Several undergraduate and graduate level courses at UBC, Department of Geography (Hassan, Moore), semi-annually
   - Applied Environmental Geoscience, EASC 411 (SFU Earth Sciences, for Brent Ward)
   -Ecology (SFU, Ken Lertzman)
   - Headwater Ecosysytems/Hydroriparian Ecosystems, FRST 589/505 (UBC, each year class taught, for John Richardson et. al.)
   - Coastal Temporate Rainforest Ecology, Marine Science 401.2 Special Topic (UVic, each year class taught, for Jim Pojar/Andy MacKinnon)
   - Hydrology (UVic, for A. Chapman)
   - Environmental Restoration Course ER 330 (UVic, for Peter Ashmore)
   - Environmental Hydrology (BCIT, for Robert Laird)
   - Stream Channel Morphology (Module 5 Institute of Forest Engineering British Columbia/Forest Management Institute of British Columbia, each year module offered, for Robert Bowden)
   - Forest Engineering Hydrology FOPR 388 (UBC, Younes Alila)
   - Bioresource Engineering (for R. Petrell)
-
3) Commitment to student development

   -Graduate students, recent co-supervision of students

   K. R. Scherer (2004-2009)

   S. May (2005-2006)

   D. Brayshaw (2006+)

   J. Phillips (2004+)

   K. Trainor (2001)

D. Luzi (2000)

P. Hudson (on-going, UNBC).

- Participation in the development, funding and completion of other M.Sc. theses

  S. Rice (UBC)

  A. Choeng (UBC)
  B. S. Bird (The University of Western Ontario).

- Assistance with identification of a thesis topic and potential field sites
  F. Brardinoni
  S. Young
  Y. Martin
  C. Nister
  T. Millard

- Several under-graduate students.

Publications

Johnston, N. T., Bird, S. A., **Hogan, D. L.** and E. A. MacIsaac. 2011. Mechanisms and source distances for the input of large woody debris to forested streams in British Columbia, Canada. Can. J. For. Res., 41, 2231-2246.

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Hogan, D. L. (in prep.) Low level air photographs from balloon platforms and unipods: Applications in geomorphology.

DR. LEAH BENDELL CURRICULUM VITAE

Educational Background

1990 Ph.D.	Ecology/Geochemistry, University of Toronto, Canada Accumulation of metals by invertebrates and fish
1982 B.Sc.	Zoology/Chemistry, University of Toronto, Canada

Employment History at Academic Institutions

September 2003 - Current	Professor, Ecology/Geochemistry, Simon Fraser University
September 1999 - August 2003	Associate Professor, Ecology/Geochemistry, Simon Fraser University
July 1998 - September 1999	Assistant Professor, Ecology/Geochemistry, Simon Fraser University
July 1993 - June 1998	NSERC-URF (University Research Fellow). Assistant Professor, Ecology/Geochemistry, Simon Fraser University
April 1990 - December 1992	NSERC-PDF (Post Doctoral Fellow), Ecology/Geochemistry, University of Ottawa

Completed Works (since 2007)

Refereed Journal Publications

McKormick, J., St.Clair, T., and **L.I. Bendell**. 2013. Trace metal concentrations and partitioning in biofilm; implications for metal bioavailability to shorebirds. Ecotoxicology. DOI: 10.1007/s10646-013-1166-6

Barlow, C., **L.I. Bendell**, C. Duckham, and Koo, V., 2013. Trace metal concentrations and patterns within three urban aquatic ecosystems. Water Air and Soil Pollution DOI: 10.1007/s11270-013-1856-y

Duckham, C., **L.I. Bendell**. 2013. Legacy of anti-fouling paints in Vancouver Harbour. Bulletin of Environmental Contamination and Toxicology DOI:10.1007/s00128-013-1082-8

Bendell, L.I. 2013. Evidence for the decline of the native littleneck as a consequence of the intentional introduction of the Manila clam for shellfish aquaculture. Estuaries and Coasts http://link.springer.com/article/10.1007/s12237-013-9677-1

Chan, K, **L.I. Bendell** 2013. Potential effects of an invasive bivalve, Nuttallia obscurata, on biogeochemical cycling in the intertidal. Journal of Experimental Marine Biology and Ecology,http://dx.doi.org/10.1016/j.jembe.2013.03.013

Brunham, W. and **L.I. Bendell**. 2011. The effect of temperature on the accumulation of cadmium, copper, zinc and lead by Typha latifolia and Scirpus acutus; a comparative analysis. Water, Air and Soil Pollution. 19: 417-428 DOI: 10.1007/s11270-010-0717-1

Wan, P. and **L.I. Bendell**. 2011. Use of aerial photography and GIS to estimate the extent of an anthropogenic footprint. Journal of Coastal Conservation. 15: 417-431 On-line-DOI: 10.1007/s11852-010-0101-8 .

Bendell, L.I. 2011. Sea Ducks and Aquaculture-the cadmium connection. Ecotoxicology. 20:474-478: 10.1007/s10646-010-0584-y

Bendell L.I. 2011 Trace metal depositional patterns from an open pit mining activity as revealed by archived avian gizzard contents. Science of the Total Environment. 409:1193-1197:10.1016/j.scitotenv.2010.12.014

Feng, C.X., Cao, J and **L.I. Bendell** 2010. Exploring spatial and temporal variations of cadmium concentrations in Pacific Oysters from British Columbia. Biometrics DOI: 10.1111/j.1541-0420.2010.01534.x

Bendell, L.I. 2010. Cadmium in shellfish-the British Columbian experience a mini-review. Invited contribution-Special issue on cadmium health aspects. Toxicology Letters. 198"7-13. On-line-DOI: 10.1016/j.toxlet.2010.04.102.

Bendell, L.I., C. Duckham, T. L'Eserpence, J. Whiteley. 2010. Changes in the geochemical attributes of the foreshore as a consequence of intertidal shellfish aquaculture. Marine Ecology Progress Series. 404:91-108.

Cook, N., and **L.I. Bendell**. 2010. Predator preference in the moonsnail I. Journal of Shellfish Research. 29: 223-232.

Bendell, L.I. 2009. Cadmium in shellfish from the Pacific Northwest. Food Additives and Contaminants. 2: 121-139

Christie, J. and **L.I. Bendell**-Young 2009. Using C and N stable isotopes to determine the role of diet variability on cadmium exposure in oysters located in Barkley Sound (Canada). Marine Environmental Research. 68: 97-105.

Bendell, L.I., and Feng. C. 2009. Spatial and temporal variation in cadmium concentrations and burdens in the Pacific oysters sampled form the Pacific Northwest. Marine Pllution Bulletin 58: 1137-1143.

Widmeyer, J., and **L.I. Bendell**-Young. 2008. Use of stable isotopes to indicate feeding preferences in the pacific oyster. Archives of Environmental Contamination and Toxicology. 55: 442-452

Widmeyer, J. and **L.I. Bendell**-Young. 2007. Contrasting cadmium uptake by filter-feeding mussels between two ecosystems; the role of salinity. Aquatic Toxicology. 81 (2): 144-151

Whiteley, J., and **L.I. Bendell**-Young 2007. Ecological Implications of Intertidal Mariculture: Observed Differences in Bivalve Community Structure between Farm and Reference Sites. Journal of Applied Ecology. 44: 495-505.

Books

Waters in Peril. **L.I. Bendell**-Young and P. Gallaugher co-editors. 2001 Kluwer academic publishing.

Contributions to the Media

Outreach video;Baynes Sound, Alot to be lost

://www.youtube.com/watch?v=g5NSm3goUiA

"Knowledge Network"; The Leading Edge. "Toxins on the half-shell". Produced by Mary Bissell

"Knowledge Network"; the Leading Edge.."Happy as a Clam": The Sustainable Shellfish Initiative; Spring 2006.

Works In Progress

Refereed Journal Publications

Palomera-Garcia, C., and **L.I. Bendell** 2014. Effects of land use activities in a tropical river system as revealed by stable isotope analysis. Ecological Applications

Books

Bendell, L.I., McKeachie, S. 2014. Trashing the Sound; the not so green industry of farming the foreshore. In preparation for Island Publishers

Works Submitted for Publication

Refereed Journal Publications

Bendell, L.I., K. Chan, S. Crevecoeur, and C. Prigent. 2014. The effects of invasive bivalves on the cycling of nutrients in the intertidal within a warming climate. Marine Environmental Research

St. Clair, T., Baird P.,Ydenberg, R., Elner, R., and **Bendell, L.I.** 2014. Trace elements in Dunlin as related to habitat use. Ecotoxicology.

Adeline Piot1*, Philippe Archambault1, Christian Nozais2, Christopher W. McKindsey3, **Leah Bendell,** 2014
"Intertidal shellfish farming and its influence on benthic ecosystem properties" Aquaculture

Bendell, L.I. 2013. Changes to the intertidal community as a result of the shellfish aquaculture industry. Coastal Management

Invited presentations (at workshops) (since 2007 only)

March 2013	Introduction to Andrew Weaver; Green Party MLA. Oak Bay Gordon Head Greens are introducing Andrew Weaver to Northshore Greens at a Meet and Greet. Leah Bendell Young, a North Vancouver resident and biology professor at SFU will also be talking—about the intersection of politics and science; the muzzling of Canadian scientists.
May 2012	Centre for Coastal Science and Management Open House - Interconnected Problems Need Interconnected Solutions. Ecological RestorationBendell, Director, Environmental Sciences, SFU5 minute presentation
September 2011	Stanley Park Ecological Society; Workshop on recommendations for the restoration of Beaver Lake. Report available at://stanleyparkecology.ca/wp-content/uploads/downloads/2012/02/BEAVERLAKE_sediments_2011.pdf
May 2011	Centre for Coastal Studies Open House. Restoration of a Sound a 5 minute presentation

May 2010	**Bendell, L.I.** 2010. Spatial and temporal trends of Cd in the Pacific Oyster. Cadmium in shellfish from the Pacific Northwest; status and trends. Workshop, SFU, Burnaby BC May 3rd
October 2009	36th Aquatic Toxicity workshop, La Malbai, Quebec. Sept. 29th to Oct. 2nd, 2009. **Bendell, L.I.** 2009. 36th Aquatic Toxicity workshop, La Malbai, Quebec. Can we determine the relative importance of diet-borne versus water-borne metals to filter-feeders under field conditions? Sept. 29th to Oct. 2nd
December 2008	Mollusc Aquaculture Dialogue,Victoria, BC. December 10th and 11th at the University of Victoria. **Bendell, L.I.** 2008. The sustainable shellfish aquaculture initiative
September 2007	SeaGrant workshop. September 2007. Seattle, USA. **Bendell, L.I.** 2007. Ecological consequences of the shellfish industry.
May 2007	Land and oceans; interactions in the coastal zone (LOICZ). Vancouver B.C. May 30th 2007. SFU, Harbour Centre. **Bendell, L.I.** 2007. Ecology versus the shellfish industry

Invited participant (workshops/working groups) (since 2011 only)

May 2013	Philosophers' Café	Pursuit of happiness: What future does this generation want. , 14 May 2013 7:00 PM current government actions directing us to this future? During the past year, the federal government has taken actions that appear to place economic well-being over environmental well-being. Will this order of priority achieve the desired goal, or are we sacrificing our environment for short-term profit? In the long term, will we have compromised a fragile environment that we so highly depend on?
May 2012	Symposium on Teaching and Learning: Leading Change @ SFU16-17, 2012 SFU Burnaby www.sfu.ca/tlcentre. Plenary Session Practicing Engagement: A Panel Discussion Faculty Panelists: Leah Bendell (Biological Sciences/ Environmental Science), Catherine Black (French), Andrew Gemino (Business), and Mary-Ellen Kelm (History)
April 2011	CHONe (Canadian Healthy Oceans Network) Network Conference in Montreal April 28-30, 2011. Theme Leader/PI presentations; Linking structure and function within the intertidal.

Current Research/Project Funding - Received

Contract/Grant: Operating Grant **Awarded:** 2011 **Period:** 2011 - 2016
Project Title: Linking community composition to ecosystem function on the intertidal
Funding: NSERC **Annual:** 26,000.00 **Total:** 130,000.00
Involvement: Principal Investigator

Contract/Grant: Conference Grant **Period:** 2013 - 2013
Project Title: Oceans vision 2013
Type: Internal **Annual:** 4000.00 **Total:** 4000.00
Involvement: Co-Investigator **Collaboration:** P. Gallaugher, Centre for Coastal Studies and Management; co-applicant
Institution of Co-Investigator(s): SFU

Contract/Grant: Travel Grant **Awarded:** 2012 **Period:** 2012 - 2012
Project Title: Travel to Griffith University (Australia) and Waikato University (New Zealand) to establish a collaborative program in Ecological Restoration
Funding: VP Academic **Type:** Internal **Annual:** 10,000.00 **Total:** 10,000.00
Involvement: Joint Investigator **Collaboration:** Established contacts at Griffith and Waikato for the development of an international program in Ecological Restoration
Institution of Co-Investigator(s): Griffith University, Brisbane, AustraliaUniversity, Hamilton, New Zealand

Contract/Grant: Teaching and Learning Grant **Awarded:** 2012 **Period:** 2012 - 2012
Project Title: Development of community engaged second year lab and field course in environmental science205
Funding: TLC **Type:** Internal **Annual:** 10,000.00 **Total:** 10,000.00
Involvement: Joint Investigator **Collaboration:** In collaboration with Thomas Rodregen, PhD. candidate REM
Institution of Co-Investigator(s): SFU

Contract/Grant: Strategic Grant **Awarded:** 2008 **Period:** 2008 - 2011
Project Title: On linking structure to function in the intertidal
Funding: NSERC **Type:** External **Annual:** 28,000.00 **Total:** 84,000.00
Involvement: Co-Investigator **Collaboration:** Member of the Canadian Healthy Oceans Research Network (CHONe) with 55 other researchers with a focus on marine ecology and healthy marine ecosystems.
Institution of Co-Investigator(s): UBC, UVic, Memorial, SFU, Dalhousie, Alberta. Also included are DFO.

Contract/Grant: Operating Grant **Awarded:** 2005 **Period:** 2005 - 2009
Project Title: Biogeochemistry of cadmium in the pacific northwest
Funding: NSERC **Type:** External **Annual:** 28,000.00 **Total:** 140,000.00
Involvement: Principal Investigator **Collaboration:** NSERC Discovery 2005 application

Contract/Grant: Strategic Grant **Awarded:** 2002 **Period:** 2002 - 2007
Project Title: Towards a sustainable shellfish industry
Funding: NSERC **Type:** External **Annual:** 131,000.00 **Total:** 655,000.00
Involvement: Principal Investigator
Institution of Co-Investigator(s): Simon Fraser University

Contract/Grant: Equipment Grant **Awarded:** 2002 **Period:** 2003 - 2005
Project Title: PNC-CAT light source; Application of synchrotron radiation techniques, MFA (major facilities access grant)
Funding: NSERC **Type:** External **Annual:** ~150,000.00 **Total:** 450,000.00
Involvement: Joint Investigator **Collaboration:** PI is Dr. Daryl Crozier, Dept. of Physics, SFUam one of 10 co-investigators (co-applicants)
Institution of Co-Investigator(s): SFU, UoA,

DAVID HARPER CURRICULUM VITAE

EDUCATION

BC Institute of Technology, Burnaby, BC

Environmental Engineering Degree Program *2005 – [2014]*

Advanced Diploma of Technology: Renewable Resource Management – Co-Operative Education Program *2004 – 2005*

Graduated with honours

Diploma of Technology: Renewable Resources – Fish, Wildlife and Recreation 2002 – 2004

Ozmer Catt Memorial Award (2004)

Langara College, Vancouver, BC 2001 – 2002

Computer Programming and Environmental Sciences

Selkirk College, Castlegar, BC 1994/95, 1997/98

University Transfer Courses

Psychology Award of Excellence and Biology Scholarship

WORK EXPERIENCE

British Columbia Institute of Technology, Burnaby, BC May 2013 - present

Assistant Instructor

- Ecological Restoration Degree Program and Rivers Institute

BC Conservation Foundation, Surrey, BC

Fisheries Habitat Technician May – Sept. 2005, July 2006 – May 2013

- Habitat Restoration, Stream Nutrient Enrichment, Stock Assessment
- Fish Habitat Assessment & Prescriptions, Fish and Benthic Sampling, Snorkel Surveys, Water Chemistry/Algae Monitoring, Stream Flow Monitoring, Hydrologic Mapping
- Project Management, Proposal/Report Writing, Public Consultation and Communication
- Contract work with Instream Fisheries Research Inc., EcoFish Research Ltd., and Summit Environmental Consultants Inc.

EBB Environmental Consulting Ltd., Tsawwassen, BC Summer 2004 – 2005

Field Technician

- Stream/Site Rehabilitation, Environmental Monitoring
- Wildlife/Habitat Management, Trapping and Sampling

Ducks Unlimited Canada, Surrey BC June 2004 – Dec 2004

Summer Student – Technician

- Waterfowl Capture, Tagging and Foraging Research
- Vegetation Sampling, Invasive Vegetation Removal

Fraser Valley Regional District, Chilliwack, BC May 2003 – Dec 2003

- Student Park Ranger
- Public relations and conflict management, park planning, repairs, maintenance

CERTIFICATES / TRAINING

- Electrofishing Certificate – Crew Supervisor
- WCB Occupational First Aid Level 1 and Transportation Endorsement
- Swiftwater Rescue Technician – Level 1
- Chainsaw Safety and Maintenance
- BC Fire Suppression S-100,130,190,232
- W.H.M.I.S. certificate
- Transportation of Dangerous Goods certificate
- BC Conservation and Outdoor Recreation Education certificate
- Canadian Firearms Safety Course and Possession Acquisition License
- Annual Hunting/Fishing Licences
- Level II Coaching certificate
- Canadian Hockey Association Advanced Coaching certificate
- Certified Designated Trainer course

DR. JONATHAN MOORE CURRICULUM VITAE

Department of Biological Sciences, Resource and Environmental Management, Simon Fraser University

PROFESSIONAL EXPERIENCE

Assistant Professor 2011-present
Liber Ero Chair of Coastal Science and Management
Research group member: Earth2Ocean, EBERG, Coastal Studies
Departments: Department of Biological Sciences, Resource and Environmental Management
Simon Fraser University

Assistant Professor 2008-2010
Department of Ecology and Evolutionary Biology
University of California Santa Cruz

Post-doctoral Fellow 2007
National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle
Advisor: Michelle McClure
Project: *Biodiversity and Extinction in Columbia River Salmon*

Graduate Research Assistant 2000-2006
Alaska Salmon Program, University of Washington.
Field Research Assistant
Desert Spring Aquatic Communities, Sue Mauger and Dr. Judy Li, Oregon. 1998
Desert Island Ecology, Dr. Gary Polis, Baja, Mexico. 1997
Stream Vertebrate Ecology, Dr. Stan Gregory, Andrews Research Forest, Oregon. 1996

EDUCATION

Ph.D. University of Washington Seattle, WA 2006
School of Aquatic and Fishery Sciences, Biology department
Advisor: Daniel Schindler
Dissertation: *Diverse Impacts of a Dominant Species: Ecosystem engineering by salmon*

B.A. Carleton College Northfield, MN 1999
Major: Biology
Distinction on thesis, Phi Beta Kappa, Magna Cum Laude
.

TEACHING EXPERIENCE

Simon Fraser University
Conservation and Ecology of Coastal BC (REM 475) 2014
Stream Ecology (BIO 473) 2013
Conservation and Ecology of Coastal BC (REM 475) 2012

University of California Santa Cruz:
Ecology (BIOE 107, co-taught with Dr. Jim Estes) 2010
Freshwater Ecology (BIOE 155) 2008, 2009, 2010
Graduate Seminar; Topic: "Controversies in Ecology" (BIOL 293) 2008

Instructor:
Stable Isotopes in Ecology, short course *University of Washington* 2006
Limnology *University of Washington* 2005

FUNDING

Moore, J.W., and C. Carr-Harris. 2013. Skeena River estuary juvenile salmon sampling. SkeenaWild. $20,000.

Van Poorten, B., and J**.W. Moore**. 2013. Arrow Lakes stable isotope analysis. B.C. Ministry of the Environment. $12,836.

Gottesfeld, A.S., and D. Macintyre. 2013. Sockeye smolt enumeration at Babine Lake. Northern Fund. $135,375. ***J.W. Moore*** *serves as scientific advisor and wrote the majority of the proposal for this First Nations project.*

Moore, J.W., C. Carr-Harris, in partnership with Lax Kw'alaams First Nation. 2013. Skeena River sockeye salmon in the early marine ecosystem. Mitacs. $15,000.

Moore, J.W. 2012-2017. Biodiversity shifts and freshwater ecosystem dynamics. NSERC Discovery Grant. $130,000.

Moore, J.W. 2012. Coastal science and management research program. Canadian Foundation for Innovation. $150,000.

Moore, J.W. 2011-2014. Start-up. Simon Fraser University. $300,000.

Moore, J.W. 2011-2015. Liber Ero chair of Coastal Science and Management. $900,000.

Moore, J.W., and 3 others. 2010-2011. Investigations in Fisheries Ecology. JIMO/CIMEC. $2,048,075.

Moore, J.W., and 7 others. 2009-2010. Investigations in Fisheries Ecology. Joint Institute for Marine Observations (JIMO). $1,171,842.

Moore, J.W., S. Hayes, S. Sogard, N. Finnegan, and B. Dietterick. 2010-2011. Fire, food webs, and fish. RAPID grant, National Science Foundation. $150,000.

Finnegan, N., and **J.W. Moore.** 2010. Fire, food webs, and fish. University of California Santa Cruz. $15,000.

Moore, J.W., S. Sogard, and J.E. Merz. 2009-present. Evaluating and predicting habitat suitability for California salmon: improving models through a holistic perspective. California Energy Commission. $123,029.

Shaffer, S.A., **J.W. Moore**, and S.H. Hayes. 2008-present. Exploring the impacts of avian predators on central California salmonids. California Sea Grant. $256,870.

Barnett-Johnson, R., C.J. Donohoe, P.K. Weber, and **J.W. Moore**. 2008-present. Determining maternal origin and migratory histories of steelhead/rainbow trout from the Lower Mokelumne River using otolith microchemistry. EBMUD. $185,157.

Moore, J.W. 2008. Impacts of dominant native and invasive species on stream ecosystems. University of California Santa Cruz, Faculty Research Grant. $1,805.

Barnett-Johnson, R., M. Carr, **J.W. Moore**, P. Weber, and P. Raimondi. 2008. Identifying critical habitats, tracking movement, and quantifying dispersal of larval fish in freshwater and marine ecosystems using otolith geochemistry. IGPP Mini-Grant. $5,000.

Carlson, S.M., and **J.W. Moore**. 2008. Eco-evolutionary dynamics of the invasive New Zealand mudsnail. California Sea Grant. $8,233.

AWARDS AND HONORS

J. C. Stevenson Lectureship, Canadian Fisheries and Aquatic Sciences award 2013
National Research Council Postdoctoral Fellowship 2007
National Science Foundation Predoctorate Fellowship 2000-2005
Discover essay nominated for John Burroughs essay contest 2004
Best presentation by PhD student, School of Aquatic and Fisheries Sciences, UW 2003
Achievement Award for Graduate Students (ARCS) 2000-2003
Robert T. Paine Field Ecology Award, University of Washington 2003
Richard C. Snyder Award for Vertebrate Research, University of Washington 2002
Robert T. Paine Field Ecology Award, University of Washington 2001
Phi Beta Kappa, Carleton College 1999
GTE scholar-athlete award, Carleton College 1999
Environmental Sciences Research Support Grant, Carleton College 1997

PUBLICATIONS

Peer-reviewed publications

Citation

Moore, J.W., M.P. Beakes, H.K. Nesbitt, J.D. Yeakel, D.A. Patterson, L.A. Thompson, C. Phillis, D. Braun, C. Favarro, D. Scott, C. Carr-Harris, and W. Atlas. *In revision.* The emergent stability of watersheds. Target: Nature Communications.

Carr-Harris, C., **J.W. Moore**, and B. Shepert. *In revision*. Juvenile salmon in the Skeena River estuary, B.C., Canada, and impending industrial development. Target: Conservation Letters.

Phillips, D.L., R. Inger, S. Bearhop, A.L. Jackson, **J.W. Moore**, A.C. Parnell, B.X. Semmens, and E.J. Ward. *In revision*. Best practices for use of stable isotope mixing models in food web studies. Target: Oecologia.

Osterback, A.-M. K., D.M. Frechette, S.A. Hayes, M.H. Bond, S.A. Shaffer, and J.W. Moore. *In review.* Linking individual characteristics to survival and predation risk of threatened steelhead. Canadian Journal of Fisheries and Aquatic Sciences.

Favaro, C., J.W. Moore, J.D. Reynolds, and M.P. Beakes. *In review*. Urban fish assemblages, culverts, and potential rehabilitation with baffles. Canadian Journal of Fisheries and Aquatic Sciences.

Anderson, S.C. [2], **J.W. Moore**, M.M. McClure, N.K. Dulvy, A.B. Cooper. *In review.* Portfolio conservation of metapopulations under climate change. Proceedings of the Royal Society, B.

Moore, J.W., J.D. Yeakel[3], D. Peard, J. Lough, and M. Beere. *In review*. Life-history diversity and its importance to population stability and persistence of a migratory fish: steelhead in two large North American watersheds. Journal of Animal Ecology.

Phillis, C.C. [2], **J.W. Moore**, M. Buoro, S.A. Hayes, J.C. Garza, and D.E. Pearse. *In review*. Shifting thresholds: rapid evolution of migratory life histories in steelhead/rainbow trout, *Oncorhynchus mykiss*. Proceedings of the Royal Society, B.

McKone, M.J., **J.W. Moore**, C. Harbison, I. Holmen[1], H. Lyons[1], K. Nachbor[1], J. Michalak, M. Neiman, J. Nicol[1], and G. Wheeler[1]. *In review*. Rapid collapse of a population of Dieffenbachia, a plant used for tadpole-rearing by poison-dart frogs (*Oophaga pumilio*) in Costa Rican rain forest. Journal of Tropical Ecology.

Beakes, M.P.[2], **J.W. Moore**, S.H. Hayes, and S.M. Sogard. *In review.* Wildfire and the impacts of shifting stream temperature on salmonids. Ecosphere.

Moore, J.W., T.D. Lambert[2], W.N. Heady[2], S.E. Honig[2], A.-M. Osterback[2], C.C. Phillis[2], A.L. Quiros[2], N.A. Retford[2], and D.B. Herbst. *In press*. Anthropogenic land-use signals propagate through stream food webs in a California watershed. Limnologica.

Yeakel, J.D.[3], **J.W. Moore**, M. de Aguiar, and P. Guimarães. *Published online*. Stability and synchronization in river networks. Ecology Letters.

Beakes, M.P.[2], **J.W. Moore**, N. Retford[1], R. Brown, J.E. Merz, and S.M. Sogard. *Published online*. Evaluating statistical approaches to quantifying juvenile Chinook salmon habitat in a regulated California River. River Research and Applications

Beakes, M.P.[2], S. Sharon[1], R. Charish[1], **J.W. Moore**, W. Satterthwaite, E. Sturm, B. Wells, S. Sogard, and M. Mangel. 2014. Using scale characteristics and water temperature to reconstruct growth rates of juvenile steelhead (*Oncorhynchus mykiss*). Journal of Fish Biology 84: 58-72.

Scott, D.[2], **J.W. Moore**, L.-M. Herborg, C.C. Murray, N.R. Serrao[1]. 2013. Capture, genetics, isotopes, and policy consequences of a non-native snakehead in Canada. Management of Biological Invasions 4: 265-271.

Parnell, A.C., D.L. Phillips, S. Bearhop, A.L. Jackson, B.X. Semmens, E.J. Ward, **J.W. Moore**, and R.L. Inger. 2013. Bayesian stable isotope mixing models. Environmetrics 24: 387-399.

Semmens, B.X., E.J. Ward, A.C. Parnell, D.L. Phillips, S. Bearhop, R. Inger, and **J.W. Moore**. 2013. Clarifying the statistical basis and outputs of isotope mixing models: a response to Fry (2013). Marine Ecology Progress Series 490: 285-289.

Osterback, A.-M.[2], D.M. Frechette[2], A.O. Shelton, S.A. Hayes, M.H. Bond[2], S.A. Shaffer, and **J.W. Moore**. 2013. High predation on small populations: avian predation on imperiled salmonids. Ecosphere 4: 116.

Frechette, D.[2], A.L. Collins[2], J.T. Harvey, S.A. Hayes, D.D. Huff, A.W. Jones[2], A.E. Langford[1], **J.W. Moore**, A.-M. K. Osterback[2], N.A. Retford[1], W.H. Satterwaite, and S.A. Shaffer. 2013. Assessing the potential impact of avian predation on juvenile steelhead in a central California watershed. North American Journal of Fisheries Management 33: 1024-1038.

Heady, W.N.[2], and **J.W. Moore**. 2013. Tissue turnover and stable isotope clocks to quantify resource shifts in anadromous rainbow trout. Oecologia 172: 21-34.

Moore, K.D., and **J.W. Moore**. 2013. Restoration as enabling behavior. Conservation Letters 6: 1-5.

Moore, J.W., S.M. Carlson, L.A. Twardochleb[1], J.L. Hwan[2], J.M. Fox, and S.A. Hayes. 2012. Trophic tangles through time: opposing direct and indirect effects of an invasive omnivore on stream ecosystem processes. PLoS ONE: e50687.

Frechette, D.[2], A.-M. Osterback[2], S.A. Hayes, M.H. Bond[2], **J.W. Moore**, S.A. Shaffer, and J.T. Harvey. 2012. Assessing avian predation of juvenile salmonids using PIT tag recoveries and mark-recapture methods. Transactions of the American Fisheries Society 32: 1237-1250.

Moore, J.W., D.B. Herbst, W. Heady[2], and S.M. Carlson. 2012. Stream community and ecosystem responses to the boom and bust of an invading snail. Biological Invasions 14: 2435-2446.

Twardochleb, L.A.[1], M. Novak[3], and **J.W. Moore**. 2012. Using the functional response of a consumer to predict biotic resistance to invasive prey. Ecological Applications 22: 1162-1171. [***Awarded cover photo***]

Yeakel, J.D.[2], M. Novak[3], P. Guimaraes, N. Dominy, P. Koch, E. Ward, **J.W. Moore**, and B.X. Semmens. 2011. Merging resource availability with isotope mixing models: the role of neutral interaction assumptions. PLoS ONE 6: e22015.

Novak, M. [3], **J.W. Moore**, and R.A. Leidy. 2011. Nestedness patterns reveal the dual nature of community disassembly in California streams. Global Change Biology 17: 3714-3723.

Moore, J.W., S.A. Hayes, W. Duffy, S. Gallagher, C. Michel[2], and D. Wright. 2011. Nutrient fluxes and the recent collapse of coastal California salmon populations. Canadian Journal of Fisheries and Aquatic Sciences 68: 1161-1170.

Ward, E.J., B.X. Semmens, D.L. Phillips, and **J.W. Moore**. 2011. A quantitative approach to combine sources in stable isotope mixing models. Ecosphere 2: 1-11.

Flecker, A.S., P.B. McIntyre, **J.W. Moore**, J.T. Anderson, B.W. Taylor, and R.O. Hall, Jr. 2010. Migratory fishes as material and process subsidies in riverine ecosystems. American Fisheries Society Symposium 73: 559-592.

Moore, J.W., M. McClure, L.A. Rogers[2], and D.E. Schindler. 2010. Synchronization and portfolio performance in threatened salmon. Conservation Letters 3: 340-348.

Denton, K.P.[2], H.B. Rich, Jr., **J.W. Moore**, and T.P. Quinn. 2010. The utilization of a Pacific salmon subsidy by three populations of charr (*Salvelinus* spp.). Journal of Fish Biology 77: 1006-1023.

Moore, J.W., and D.E. Schindler. 2010. Spawning salmon and the phenology of emergence of stream insects. Proceedings of the Royal Society of London, Series B 277: 1695-1703.

Yeakel, J.D. [2], B.D. Patterson, K. Fox-Dobbs, M.M. Okumura, T.E. Cerline, **J.W. Moore**, P.L. Koch, and N.J. Dominy. 2009**.** Cooperation and individuality among man-eating lions. Proceedings of the National Academy of Sciences 45: 19040-19043.

Semmens, B.X., E. Ward, **J.W. Moore**, and C. Darimont. 2009.

Quantifying inter- and intra-population niche variability using hierarchical Bayesian stable isotope mixing models. PLoS ONE 4: e6187.

Zavaleta, E., J. Pasari[2], **J.W. Moore**, D. Hernández[3], K.B. Suttle[3], and C.C. Wilmers. 2009. Ecosystem responses to community disassembly. The Year in Ecology and Conservation Biology 1162: 311-333.

Semmens, B.X., and **J.W. Moore.** 2009. Improving Bayesian isotope mixing models: a response to Jackson et al. (2009). Ecology Letters 12: E6-E8.

Moore, J.W., D.E. Schindler, and C.P. Ruff[1]. 2008. Habitat saturation drives thresholds in stream subsidies. Ecology 89: 306-312.

Moore, J.W., and B.X. Semmens**. 2008. Incorporating uncertainty and prior information in stable isotope mixing models. Ecology Letters 11: 470-480.

Moore, J.W., and D.E. Schindler. 2008. Biotic disturbance and community dynamics in salmon-bearing streams. Journal of Animal Ecology 77: 275-284.

Moore, J.W., D.E. Schindler, J.L. Carter[1], J.M. Fox[1], J. Griffiths[1], and G.W. Holtgrieve. 2007. Biotic control of stream ecosystem fluxes: spawning salmon drive nutrient and matter export. Ecology 88: 1278-1291.

Scheuerell, M.D., **J.W. Moore**, D.E. Schindler, and C.J. Harvey. 2007. Varying effects of anadromous salmon on the trophic ecology of resident stream fishes in Alaska. Freshwater Biology 52: 1944-1956.

Moore, J.W. 2006. Animal ecosystem engineers of streams. BioScience 56: 237-246.

Francis, T.B. [1], D.E. Schindler, and **J.W. Moore**. 2006. Aquatic insects play a minor role in dispersing salmon-derived nutrients into riparian forests in southwestern Alaska. Canadian Journal of Fisheries and Aquatic Sciences 63: 2543-2552.

Brock, C.P., P.R. Leavitt, D.E. Schindler, S.P. Johnson, **J.W. Moore**, and P.D. Quay. 2006. Spatial variability of stable isotopes and fossil pigments in surface sediments of Alaskan coastal lakes: constraints on quantitative estimates of past salmon abundance. Limnology and Oceanography 51: 1637-1647.

Payne, L.X., and **J.W. Moore****. 2006. Mobile scavengers create hotspots of biological productivity in freshwater ecosystems. Oikos 115: 69-80.

Winder, M., D.E. Schindler, **J.W. Moore**, S.P. Johnson, and W.J.

Palen. 2005. Do bears facilitate transfer of salmon resources to aquatic macroinvertebrates? Canadian Journal of Fisheries and Aquatic Sciences 62: 2285-2293.

Moore, J.W., D.E. Schindler, and M.D. Scheuerell. 2004. Disturbance by spawning salmon of Alaskan stream and lake ecosystems. Oecologia 139: 298-308.

Moore, J.W., J.L. Ruesink, and K.A. McDonald. 2004. Impact of supply-side ecology on consumer-mediated coexistence. The American Naturalist 163: 480-487.

Moore, J.W., and D.E. Schindler. 2004. Nutrient export from freshwater systems by anadromous sockeye salmon. Canadian Journal of Fisheries and Aquatic Sciences 61: 1582-1589.

Moore, J.W., and J.L. Kenagy. 2004. Consumption of shrews, *Sorex* spp., by Arctic Grayling, *Thymallus arcticus*. Canadian Field-Naturalist 118: 111-114.

Schindler, D.E., M.D. Scheuerell, **J.W. Moore**, S.M. Gende, T.B. Francis, and W.J. Palen. 2003. Pacific salmon and the ecology of coastal ecosystems. Frontiers in Ecology and the Environment 1: 31-37.

Moore, J.W., D.E. Schindler, M.D. Scheuerell, J. Frodge, and D. Smith[1]. 2003. Lake eutrophication at the urban fringe: the Seattle region. Ambio 32: 13-18.

Book Chapters

Moore, J.W. 2006. Trout. *Edited by*: Boersma, P.D., S.E. Reichard, and A.N. Van Buren. Invasive Species in the Pacific Northwest. Pages 164-165. University of Washington Press, Seattle.

Moore, J.W. 2006. Crayfish. *Edited by*: Boersma, P.D., S.E. Reichard, and A.N. Van Buren. Invasive Species in the Pacific Northwest. Pages 100-101. University of Washington Press, Seattle.

Other Publications (non-peer reviewed)

Kapps, K.A., C.L. Atkinson, A. Rugenski, C. Baxter, K.S. Boersma, C.C. Carey, P.B. McIntyre, **J.W. Moore**, W.H. Nowlin, and C.C. Vaughn. 2012. Impacts of species addition and species loss on ecosystem function in freshwater systems. Bulletin of the Ecological Society of America 93: 402-408.

Moore, K.D, and **J.W. Moore**. The Gift of Salmon. 2003. Discover: 44-49.

Moore, J.W. 2001. Fly-Fishing from Scratch. Field and Stream 105: 20-21.

Superscripts
**Citations and impact factors taken from GoogleScholar, Jan 8, 2014. H-index is 18.*
***Shared first authorship*
[1]Undergraduate at time of research
[2]Graduate student at time of research (restricted to when I was a faculty member)
[3]Postdoctoral researcher at time of research (restricted to when I was a faculty member)

SERVICE

Conservation Service
Liber Ero postdoctoral program.
Designed and implemented national postdoctoral research program for conservation science. Current position: Advisory Board.

Scientific advisor for First Nations in Skeena and Fraser River watersheds.
Build capacity and serve in advisory role for key scientific and management decisions among First Nations groups. For example: "He gave valuable input into research that led to the proposed Morrison Mine being refused a BC Environmental Assessment Certificate." This is one of only two mine proposals that have denied by the province; this mine would have been built on the shoreline of Morrison Lake, home to sockeye salmon populations and other natural resources, in the headwaters of the Skeena watershed.

Member of *Aboriginal Independent Scientific Review Team*; a small group of lawyers, scientists, and First Nations community leaders providing scientific interpretation of proposed industrial developments in the Skeena River.

Invasive species legislation.
Collaborated with Ministry of Environment to study a nonnative snakehead fish found in Burnaby, B.C. Led to new legislation banning all snakeheads, and numerous other potentially invasive fishes, from possession, transport, trade, and breeding in British Columbia.

Scientific communication.
Moderator, Charting Healthy Oceans, Centre for Coastal Studies, SFU 2013.

Moderator and steering committee member, Open House, Centre for Coastal Studies, SFU 2013.

Steering committee, Speaking for the Salmon. Centre for Coastal Studies, SFU 2013.

Steering committee, Speaking for the Salmon. Centre for Coastal Studies, SFU 2011.

Organizer for Coast2Coast seminar series that linked 32 institutions across Canada, *Open Communication of Science*, IRMACS, 2012.

Service to Simon Fraser University
Tenure and Promotion, Biological Sciences, 2013.

Tenure and Promotion, REM, 2013.

Undergraduate committee, REM, 2012-present.

Search committee, Avalanche Chair. REM, 2013.

Search committee, lecturer. Biological Sciences, 2012.

Tenure and Promotion, REM, 2011-2012.

Steering committee, Ecological Restoration Program, Faculty of Environment, 2011-present.

Professional Service
Society Memberships
American Fisheries Society
North American Benthological Society
American Society of Limnology and Oceanography
Ecological Society of America

Editorial responsibilities
Subject matter editor for:
Oikos (2009 to 2014)

Guest editor for:
Ecological Applications (2012)

Grant reviewer for:
National Science Foundation (NSF)
National Geographic Society (NGS)
National Sciences and Engineering Research Council of Canada (NSERC)
University of Alaska Fairbanks student grant competition
Alaska SeaGrant

Manuscript reviewer for:
Aquatic Ecology, Biological Conservation, BioScience, Canadian Journal of Fisheries and Aquatic Sciences, Conservation Letters, Ecological Applications, Ecological Monographs, Ecological Research, Ecology, Ecology Letters, Ecosphere, Ecosystems, Functional Ecology, Freshwater Ecology, Frontiers in Ecology and the Environment, Global Change Biology, Journal of Animal Ecology, Journal of Applied Ecology, Journal of Freshwater Ecology, Journal of Limnology, Journal of the North American Benthological Society, Lake and Reservoir Management, Limnology and Oceanography, Marine Ecology, Marine Ecology Progress Series, North American Journal of Fisheries Management, Northwest Science, Oikos, Proceedings of the National Academy of Sciences, Proceedings from the Royal Academy of London, Scientific Reports.

PRESENTATIONS

Invited Conference and Seminar Presentations

Moore, J.W. 2014. *Stevenson lecture, invited keynote*. Bi-directional connectivity in river networks and watershed conservation. Canadian Conference for Fisheries Research and Canadian Limnological Society. Yellowknife, NWT.

Moore, J.W. 2013. *Invited presentation***.** Diversity and resilience in steelhead. Provincial Steelhead Management Meeting. Vancouver, BC.

Moore, J.W. 2013. *Invited seminar.* Diversity and stability in watersheds. Biological Department Seminar, University of Victoria. Victoria, BC.

Moore, J.W. and J.D. Olden 2012. *Invited talk*. Ecosystem-consequences of community disassembly in streams. Ecological Society of America. Portland, OR.

Moore, J.W. 2012. *Invited seminar.* Linking freshwater biodiversity to ecosystem stability and function. Simon Fraser University, IRMACS colloquium. Burnaby, BC.

Moore, J.W. 2012. *Invited keynote*. Material and process subsidies in coastal ecosystems. University of British Columbia workshop on subsidies. Vancouver, BC.

Moore, J.W. 2012. *Invited seminar*. Freshwater biodiversity shifts and ecosystem consequences. University of British Columbia. Vancouver, BC.

Moore, J.W. 2012. *Invited seminar*. Resilience and salmon ecosystems. Port Moody Ecological Society annual meeting. Port Moody, BC

Moore, J.W. 2011. *Invited seminar*. Freshwater biodiversity: controls and consequences from populations to ecosystems. University of Winsor. Windsor, ON.

Moore, J.W. 2011. (declined). *Invited keynote*, International Conference of Ecology and Conservation of Freshwater Fish, Portugal.

Moore, J.W. 2011. *Invited presentation*. Stable isotope ecology. Trinity College, Dublin, Ireland.

Moore, J.W. 2011. *Invited presentation*. Trophic cascades, detrital dynamics, and biotic resistance: signal crayfish in California streams. American Fisheries Society. Seattle, WA.

Beakes, M.P., S.A. Hayes, and **J.W. Moore**. *Invited presentation*. Wildfire and stream ecosystem dynamics. American Fisheries Society. Seattle, WA.

Moore, J.W. *Invited seminar*. 2011. Skeena Fisheries Science Commission. Terrace, BC.

Moore, J.W. 2010. *Invited seminar*. Freshwater biodiversity: controls and consequences from populations to ecosystems. Environmental Studies, University of California, Santa Cruz, CA.

Moore, J.W. 2010. *Invited seminar*. Freshwater biodiversity: controls and consequences from populations to ecosystems. Simon Fraser University. Burnaby, BC.

Moore, J.W. 2009. *Invited seminar.* Native salmon, invasive crayfish, and the disassembly of stream communities. Hopkins Marine Lab, Stanford University, CA.

Moore, J.W. 2009. *Invited seminar.* Ecosystem engineers in streams. University of California Berkeley. Berkeley, CA.

Moore, J.W. 2007. *Invited seminar*. The importance of species: salmon, ecosystem engineers, and streams. Western Washington University, Bellingham, WA.

Moore, J.W. 2007. *Invited seminar*. The importance of species: salmon, ecosystem engineers, and streams. Carleton College, Northfield, MN.

Moore, J.W. 2006. *Invited seminar*. Diverse impacts of a dominant species: ecosystem engineering by salmon on streams. Department of Ecology and Evolutionary Biology, University of California Santa Cruz, CA.

Moore, J.W. 2006. *Invited seminar.* Impacts of ecosystem engineers on streams: a case-study of nest-digging salmon in Alaska. Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, WA.

Moore, J.W. 2006. *Invited seminar.* Impacts of salmon on streams. Biology Department, Idaho State University, Pocatello, ID.

Moore, J.W. 2005. *Invited seminar.* Impacts of salmon on coastal ecosystems: A case study from the Bristol Bay region, Alaska. Flathead Lake Biological Station, University of Montana, MT.

Moore, J.W., and D.E. Schindler. 2005. *Invited presentation.* Impacts of bioturbation by spawning salmon on the community dynamics and ecosystem processes of Alaskan streams. North American Benthological Society, New Orleans, LA.

Moore, J.W. 2003. *Invited presentation.* Salmon in Alaskan Streams. 2003. ARCS. Seattle, WA.

Conference Presentations

Herborg, M., **J.W. Moore**, D. Scott, C. Clark-Murray, and N.R. Serrao. 2013. The Burnaby snakehead—how we caught it and what we learned. Marine Invasions. Victoria, BC.

Moore, J.W. 2013. Stability and diversity of Pacific salmonids. Canadian Society of Ecology and Evolution. Kelowna, BC.

Yeakel, J., M. Aguila, P. Guimaerez, and **J.W. Moore**. 2013. Synchronization and stability in watersheds. Canadian Society of Ecology and Evolution. Kelowna, BC.

Lichota, C, and **J.W. Moore**. 2013. Impacts of barriers in urban streams on fish assemblages. Canadian Society of Ecology and Evolution. Kelowna, BC.

Phillis, C., S.A. Hayes, **J.W. Moore**, and D. Pearse. 2013. From steelhead to trout in 25 generations: rapid evolution of a migratory life-history. Canadian Society of Ecology and Evolution. Kelowna, BC.

Beakes, M.P., and **J.W. Moore**. 2013. Evaluating the impacts of wildfire on California coastal stream food webs. American Fisheries Society, Western Division. Boise, ID.

Osterback, A.-M., D.M. Frechette, S.A. Hayes, M.H. Bond, S.A. Shaffer, and **J.W. Moore**. 2012. Subsidized predation on imperiled species: gulls, landfills, and salmonids. Ecological Society of America. Portland, OR.

Beakes, M.P., and **J.W. Moore**. 2012. Evaluating the impacts of wildfire on California coastal stream food webs. Ecological Society of America. Portland, OR.

Donohoe, C.J., R. Johnson, P.K. Weber, and **J.W. Moore**. 2012. Migratory composition and maternal orgin of natural and hatchery origin rainbow trout (*Oncorhynchus mykiss*) from the Lower Mokelumne River. American Fisheries Society. Cal-Neva.

Hayes, S.A., M.H. Bond, **J.W. Moore**, D.E. Pearse, and W.H. Satterthwaite. 2012. Exploring the if's, when's and where's of steehead estuarine and ocean habitat use. American Fisheries Society. Minneapolis, MN.

Nesbitt, H.K., and **J.W. Moore**. 2012. Dendritic biodiversity in a large watershed and portfolio effects in First Nation fisheries. Ecological Society of America. Portland, OR.

Phillis, C.C., D.E. Pearse, and **J.W. Moore**. 2012. Dam evolution: rapid evolution of fish migration in response to novel river barriers. Ecological Society of America. Portland, OR.

Phillis, C.C., D.E. Pearse, and **J.W. Moore**. 2011. Ecological consequences of rapid life-history evolution in rainbow trout. American Fisheries Society. Seattle, WA.

Phillis, C.C., D.E. Pearse, and **J.W. Moore**. 2011. Ecological consequences of rapid life-history evolution in rainbow trout. Ecological Society of America. Austin, TX.

Frechette, D.M., A.-M. Osterback, S.A. Hayes, S.A. Shaffer, **J.W. Moore**, and J.T. Harvey. 2011. Gulls eat fish: assessing predation risk of juvenile salmonids using radio-telemetry. American Fisheries Society. Seattle, WA.

Osterback, A.-M., D.M. Frechette, S.A. Hayes, M.H. Bond, S.A. Shaffer, and **J.W. Moore**. 2011. Subsidized predation on imperiled species: gulls, landfills, and salmonids. American Fisheries Society. Seattle, WA.

Moore, J.W., L.A. Twardochleb, S.M. Carlson, J. Fox, J. Hwan, and S. Hayes. 2010. Trophic cascades, detrital dynamics, and invasive crayfish. American Society of Limnology and Oceanography, North American Benthological Society. Santa Fe, NM.

Novak, M., R. Leidy, and **J.W. Moore.** 2010. Nestedness reveals dual nature of community disassembly. American Society of Limnology and Oceanography, North American Benthological Society. Santa Fe, NM.

Osterback, A.M., D.M. Frechette, S.A. Hayes, M.H. Bond, S.A. Shaffer, and **J.W. Moore**. 2010. Subsidized predators and imperiled prey: the impact of avian predators on salmonids. American Society of Limnology and Oceanography, North American Benthological Society. Santa Fe, NM.

Beakes, M.P., C. Cois, N. Retford, L. Twardochleb, and **J.W. Moore**. 2010. Incipient impacts of wildfire on a California stream. American Society of Limnology and Oceanography, North American Benthological Society. Santa Fe, NM.

Flecker, A., P.B. McIntyre, and **J.W. Moore**. 2010. Migratory fishes as material and process subsidies in riverine ecosystems. American Society of Limnology and Oceanography, North American Benthological Society. Santa Fe, NM.

Moore, J.W., S.M. Carlson, J. Fox, J. Hwan, and S. Hayes. 2009. Impacts of dominant native and invasive species on California stream ecosystems. Ecological Society of America. Albuquerque, NM.

Semmens, B.X., E.J. Ward, **J.W. Moore**, and C.T. Darimont. 2009. Analytic methods for incorporating intra- and inter-group variability in Bayesian stable isotope mixing models. Ecological Society of America. Albuquerque, NM.

Osterback, A.-M. K., D.M. Frechette, S. Hayes, M.H. Bond, S.A. Shaffer, and **J.W. Moore**. 2009. Subsidized predators and imperiled prey: the impact of avian predators on salmonids. Ecological Society of America. Albuquerque, NM.

Moore, J.W. 2008. Ecosystem engineering, eco-evolutionary dynamics, and salmon. Stanford/UCSC species interaction workshop.

Moore, J.W., M.M. McClure, and L.A. Rogers. 2008. Synchronization of a portfolio of salmon populations, Ecological Society of America. Milwaukee, WI.

Flecker, A.S., P. McIntyre, and **J.W. Moore.** 2008. Migratory fishes as key subsidies in stream ecosystems. American Fisheries Society. Ottawa, ON.

Moore, J.W. 2007. Threshold in stream subsidies: salmon eggs, trout, and potential conflicts between commercial and recreational fisheries. American Fisheries Society. San Francisco, CA.

Moore, J.W. 2007. Do salmon drive evolution in stream insects? Ecological Society of America. San Jose, CA.

Moore, J.W. 2006. *Doctoral dissertation*. Diverse impacts of a dominant species: ecosystem engineering by salmon in streams. Biology Department, University of Washington, Seattle, WA.

Moore, J.W. 2006. Biotic control of stream fluxes: spawning salmon drive nutrient and matter export. North American Benthological Society. Anchorage, AK.

Moore, J.W., and D.E. Schindler. 2005. Impacts of bioturbation by spawning salmon on the community dynamics and ecosystem processes of Alaskan streams. American Fisheries Society, Anchorage, AK.

Moore, J.W. and D.E. Schindler. 2005. Modification of stream habitats by spawning sockeye salmon. ASLO. Salt Lake City, UT.

Moore, J.W. and D.E. Schindler. 2004. Impacts of spawning salmon on the seasonal dynamics of Alaskan streams. Ecological Society of America meeting. Portland, OR.

Payne, L.X, and **J.W. Moore**. 2004. Mobile scavengers create hotspots of biological productivity in freshwater ecosystems. Ecological Society of America meeting. Portland, OR.

Ruff, C., **J.W. Moore**, and D.E. Schindler. 2004. Poster. Importance of salmon resources to Alaska fish: evidence from diets and stable isotopes. Ecological Society of America meeting. Portland, OR.

Moore, J.W., and D.E. Schindler. 2003. Impacts of spawning salmon on Alaskan stream ecology. Geology. Seattle, WA.

Moore, J.W., D.E. Schindler, and M.D. Scheuerell. 2003. Ecosystem consequences of disturbance by spawning salmon in Alaska. Ecological Society of America. Savannah, GA.

Moore, J.W., D.E. Schindler, and M.D. Scheuerell. 2002. Disturbance of stream and lake benthos by spawning salmon. American Society of Limnology and Oceanography. Victoria, BC.

Schindler, D.E., M.D. Scheuerell, **J.W. Moore**, R. Hilborn, T.P. Quinn, P.R. Leavitt, and V.L. St. Louis, 2002. Climate, marine-derived nutrients, and fisheries as drivers of pacific salmon population dynamics. American Society of Limnology and Oceanography. Victoria, BC.

Moore, J.W., D.E. Schindler, M.D. Scheuerell, J. Frodge, and D. Smith. 2001. Lake eutrophication at the urban fringe. Ecological Society of America meeting. Madison, WI.

DR. Sean Markey CURRICULUM VITAE

Simon Fraser University, 8888 University Drive, Burnaby BC V5A 1S6

Educational Background

2003	Ph.D.	Geography, Simon Fraser University, Canada Facing Uncertainty: Building Local Development Institutions in Rural British Columbia
1996	M.A.	Environmental Studies, York University, Canada
1992	B.A.	Political Science, UBC, Canada

Employment History at Academic Institutions

September 2005 - Current	Assistant Professor, Explorations in Arts and Social Sciences, Simon Fraser University
January 2004 - September 2005	Adjunct Professor, Arts and Social Sciences, Simon Fraser University
January 2002 - May 2004	Research Director, Centre for Sustainable Community Development, Simon Fraser University

Current Research Interests

Sustainable Community Development: This research program focuses on various dimensions of sustainable development, including: sustainable infrastructure; community planning and decision-making processes; First Nations sustainable community development; and integrated planning. [Sustainable infrastructure, decision-making, rural planning, urban planning]

Resource Communities: The purpose of this research program is to investigate the regional development impacts associated with the phenomenon of long distance commuting (LDC). LDC (also known as fly-in/fly-out, FIFO) refers to conditions of rural industry where the workplace is situated in a remote locale at a significant distance from the homes and communities of workers. The research will employ a regional development focus and theoretical foundation to investigate the economic and social impacts of LDC on rural and small town communities in northern British Columbia. The research will also investigate the dynamics of community - industry relations and jurisdiction relative to resource extraction and the generation of local benefits. [Rural development; economic restructuring; resource industry; community impacts]

Social Economy: The British Columbia and Alberta Social Economy Research Alliance (BALTA) establishes a broad regional partnership among five universities and nine social economy stakeholder organizations to engage in research to understand, measure, and promote the dynamics of the social economy. [Social economy; social enterprise]

Regional Development: The main questions of this research are: 1) How has Canadian regional

development (RD) evolved over the past two decades (since the creation of existing federal regional development agencies); 2) To what extent have Canadian RD systems incorporated the ideas of New Regionalism into their policy and? 3) What can we learn from the Canadian context about the merits or flaws of New?; 4) What innovations have been developed in Canadian RD that can contribute to the body of RD theory and practice nationally and internationally; 5) To what extent is RD in, particularly in four selected Canadian provinces and regions, characterized by knowledge and shared learning?; and 6) What factors enable or constrain knowledge flow and what current potential mechanisms exist for facilitating learning, knowledge flow and collaboration within RD networks? [Regional development, new regionalism, development governance, learning and innovation, networks]

Rural Development: This research focuses on issues and processes of community and regional development in northern British Columbia. [Regional development, economic development, community development, place-based development, rural, sustainability]

Completed Works

Book

Markey, S., Halseth, G., Manson, D. (2012). Investing in Place: Economic Renewal in Northern British Columbia. Vancouver: UBC Press.

Halseth, G., Markey, S., and D. Bruce (eds.) (2010). The Next Rural Economies: Constructing Rural Place in a Global Economies. Oxfordshire: Cabi Press.

Markey, S., J.T. Pierce, K. Vodden and M. Roseland. (2005). Second Growth: Community Economic Development in Rural British Columbia. Vancouver: UBC Press.

Journal Article

Heisler, K., Markey, S. (2012). Scales of Benefit: Political leverage in the negotiation of corporate social responsibility in mineral exploration and mining in rural British Columbia, Canada. Society and Natural Resources, on-line, September 20, 2012: 1-16.

Ryser, L., Markey, S., Halseth, G. (2012). Developing the Next Generation of Community-Based Researchers. Journal of Geography in Higher Education, on-line: 1-17.

Markey, S. and Heisler, K. (2011). Getting a Fair Share: Regional Development in a Rapid Boom-Bust Rural Setting. Canadian Journal of Regional Science, 33 (3):49-62.

Connelly, S., Markey, S., Roseland, M. (2011). Bridging Sustainability and the Social Economy: Achieving Community Transformation through Local Food Initiatives. Critical Social Policy, 31(2): 308-324.

Connelly, S., Markey, S., Roseland, M. (2011). Culture and Community: Sustainable Community Planning in the Rolling River First Nation. Journal of Aboriginal Economic Development, 7(2): 40-

54.

Heisler, K., Beckie, M., Markey, S. (2011). Expectations and Realities of Engaged Scholarship: Evaluating a Social Economy Collaborative Research Partnership. Journal of Community Engagement and Scholarship, 4(1).

Kristensen, F., Markey, S., Perry, S. (2010). "Our liquidity is trust, not cash": Credit Unions and the Rural Social Economy. Journal of Rural and Community Development, 5(3): 143-161.

Markey, S., Connelly, S., Roseland, M. (2010). 'Back of the Envelope': Pragmatic Planning for Sustainable Rural Community Development. Planning Practice and Research, 25(1): 1-23.

Markey, S., Halseth, G., Manson, D. (2010). Capacity, Scale and Place: Pragmatic Lessons for Doing Community-based Research in the Rural Setting. The Canadian Geographer, 54(2): 158-176.

Markey, S. and G. Halseth, D. Manson. (2009). Contradictions in Hinterland Development: Challenging the Local Development Ideal in Northern British Columbia. Community Development Journal, Vol. 44(2): 209–229.

Connelly, S., Markey, S., Roseland, M. (2009). Strategic Sustainability: Addressing the Community Infrastructure Deficit. Canadian Planning and Policy, 18(1): Supplement 1-23.

Markey, S. and G. Halseth, D. Manson. (2008). Closing the Implementation Gap: A Framework for Incorporating the Context of Place in Economic Development Planning. Local Environment, 13(4): 337-351.

Mader, K., and Markey, S. (2008). "Winging it" is not enough: Building capacity within the social enterprise sector. Making Waves, 19(3): 25-29.

Markey, S., Halseth, G., Manson, D. (2008). Challenging the Inevitability of Rural Decline: Advancing the Policy of Place in Northern British Columbia. Journal of Rural Studies, 24: 409-421.

Markey, S. and G. Halseth, D. Manson. (2007). The (Dis)Connected North: Persistent Regionalism in Northern British Columbia. Canadian Journal of Regional Science, XXX: 1.

Markey, S. and G. Halseth, D. Manson. (2006). The Struggle to Compete: From Comparative to Competitive Advantage in Northern British Columbia." International Planning Studies, 11(1): 19-39.

Halseth, G., Manson, D., Markey, S., Lax, L., Buttar, O. (2006). The Connected North: Findings from the Northern BC Economic Vision and Strategy Project. Journal of Rural and Community Development, Vol. 2(1).

Markey, S. (2005). "Building Local Development Institutions in the Hinterland: A Regulationist Perspective from British Columbia, Canada." International Journal of Urban and Regional Research, 29(2): 358-374.

Markey, S., K. Vodden, S. Ameyaw. (2001). "Understanding Community Capacity: Planning,

Research and Methodology." Journal of Aboriginal Economic Development, Vol. 2(1): 43-55.

Markey, S., J.T. Pierce, K. Vodden. (2000). "Resources, People and the Environment: A Regional Analysis of the Evolution of Resource Policy in Canada." Canadian Journal of Regional Science, Vol. 23 (3): 427-454.

Chapter, Report

Connelly, S., Green, K., Markey, S., Roseland, M. (2012). Peaks and Valleys on the Prairies: Optimism and resistance to sustainable community development in Craik (SK). In Becky, M., Hvenegaard, G., Mündel, K. Taking the Next Steps. Edmonton: University of Alberta Press.

Connelly, S., Roseland, M., Markey, S. (2012). Building Community Capacity for Strategic Sustainability. In Tigran Haas (ed.) Sustainable Urbanism and Beyond: Rethinking Cities for the Future. New York: Rizzoli International Publications, Inc., 144-148.

Markey, S., Storey, K. and Heisler, K. (2011). Fly-in/Fly-out resource development: Implications for community and regional development. In D. Carson, R. Rasmussen, P. C. Ensign, A. Taylor and L. Huskey (Eds). Demography at the Edge: Remote human populations in developed nations. Farnham, England: Ashgate Publishing, 213-236.

Connelly, S., Roseland, M., Markey, S. (2011). Building Community Capacity for Strategic Sustainability. In Tigran Haas (ed.) Sustainable Urbanism and Beyond: Rethinking Cities for the Future. New York: Rizzoli.

Markey, S., Corriveau, S., Cody, M., and Bonfield, B. (2011). Social Enterprise Legal Structure: Options and Prospects for a 'Made in Canada' Solution. Calgary: Institute for Nonprofit Studies, Mount Royal University.

Heisler, K., Beckie, M., Markey, S. (2011). Chapter 8: "Pushing the Boundaries? Community-University Engagement and the British Columbia-Alberta Research Alliance" in the Social Economy in Community-University Research Partnerships: reflections on the Canadian Social Economy experience, edited by Peter V. Hall and Ian MacPherson, 159-180.

Markey, S. (2010). Fly-in, Fly-out Resource Development: A New Regionalist Perspective on the Next Rural Economy. In G. Halseth, S. Markey, D. Bruce The Next Rural Economies: Constructing Rural Place in a Global Economy. Oxfordshire: Cabi Press.

Halseth, G., Markey, S., Reimer, B., Manson, D. (2010). Introduction: The Next Rural Economies. In G. Halseth, S. Markey, D. Bruce The Next Rural Economies: Constructing Rural Place in a Global Economy. Oxfordshire: Cabi Press.

Markey, S., Halseth, G. and Manson, D. (2010). Disjuncture in Rural Renewal: Theory and Practice. In D. Winchell, D. Ramsey, R. Koster, and G. Robinson (eds.) Sustainable Rural Community Change: Geographical Perspectives from North America, the British Isles, and Australia. Brandon: Rural Development Institute.

Markey, S. (2008). Addressing Poverty and Competitiveness through Place-based Development in Surrey, British Columbia. White Paper prepared to support the Surrey Regional Economic Summit organized by the City of Surrey and the Surrey Board of Trade, Thursday, September 18, 2008.

Reimer, B. and Markey, S. (2008). Place-based Policy: A Rural Perspective. Montreal: Concordia University. Report prepared for Human Resources and Social Development Canada.

Connelly, S., Roseland, M., Markey, S. (2008). Strategic Sustainability: Seizing the Opportunities of Canada's Infrastructure Deficit. Burnaby: Centre for Sustainable Community Development. Report prepared for Infrastructure Canada.

Markey, S., Halseth, G., Manson, D. (2006). Re-orient to Readiness: Overcoming Barriers to Implementation in the Northwest Region of British Columbia. Vancouver: Western Economic Diversification.

Markey, S. (2004). "Local Benefits from Land Use and Resource Extraction," in J. Clogg, G. Hoberg, A.O. O'Carroll, Policy and Institutional Analysis for Implementation of the Ecosystem-based Management Framework. Vancouver: Coast Information Team.

Halseth, G., Lax, L., Manson, D., Buttar, O., and Markey, S. (2004) The Connected North: Moving from northern strength to northern strength — A report from the Northern Economic Vision and Strategy Project. Vancouver, BC: Prepared for Western Economic Diversification Canada.

Works Accepted for Publication / Production / or Presentation

Book

Gismondi, M., Connelly, S., Markey, S., Roseland, M. (eds.) (forthcoming). Seeds of Transition: The Convergence of the Social Economy and Sustainability. Athabasca: Athabasca University Press.

Journal Article

Heisler, K., Markey, S. (forthcoming). Navigating Jurisdiction: Local and Regional Strategies to Access Economic Benefits from Mineral Development. The Canadian Geographer.

Significant Contributions to your Field

2012 Investing in Place: Economic Renewal in Northern British Columbia Northern British Columbia is a place of rich cultures, diverse communities, and a strong sense of identity. The future of this vast, resource-rich region and the people who call it home could be either driven by a narrow economic agenda or guided by innovative, place-based solutions that seek to build viable communities and resilient local and regional economies. in Place is about creating the foundations for renewing northern British Columbia's rural and small-town economies. Markey, Halseth, and Manson argue that renewal is not about nostalgic reliance on the policies and economic strategies of the past -- rather, it is about building a pragmatic and innovative vision for development, one that

acknowledges both the opportunities and the challenges posed by resource development and global and technological change. policy-makers and residents alike the path to renewal lies in place-based development, which consists of people working together at all levels of the community and region to take advantage of local opportunities in a sustainable, responsible way.

2010 The Next Rural Economies:Rural Place in Global Economies Rural policy in industrialized countries is currently undergoing significant. 'Place-based economies', where the unique attributes and assets individual places determine their attractiveness for particular types of and investments, are increasingly important for rural development and understandings of competitiveness and conceptualizations of a new underline the importance of making strategic investments in rural infrastructure. Next Rural Economies debates the future of rural development and successes and failures to inform research, policy and community. Case studies present discussions of the current state of rural community economic restructuring and provide research and policy directions for resilient and sustainable rural economies. Topics considered seasonal economies, amenity migration, IT industries, sustainable green energy, education and transportation developments. Challenging with alternative ways of looking and reacting to rural community, this book will be necessary for researchers and policy makers, geography, economic development and community development.

2008 Space to Place: The Next Rural Economies Conference, Prince George, May 15-16, 2008 I served as a co-organizer for the conference. The conference brought together twenty-three rural and small town scholars from eight OECD countries to present and discuss the dynamics of place-based development in the rural context. We are currently producing and edited volume based upon the conference papers.

2005 Second Growth: Community Economic Development in Rural British Columbia Second Growth advances understanding of local development by addressing two important deficiencies in the community economic development (CED) literature. First, CED is a rapidly expanding field that requires enhanced theoretical direction and historical analysis. Second Growth introduced a "renovation" of staples theory as applied to local economies. Second, there is a need for systematic case study analysis of CED strategies in rural, small-town conditions. As communities struggle to confront complex forces of change, sound theoretical frameworks and tested best practices are important tools in facilitating the prospects for a second growth in rural and small-town communities.

Conferences, Workshops and Presentations

Delivered Paper

August 2013	Canadian Association of Geographers. "Sense of Place: Now What?"
June 2013	ANSER. "From Theory to Practice: Identifying and Activating Community Capital for Sustainable Local Economic Development" (with Gretchen Hernandez

	and Alberto Mollinedo)
April 2013	AAG. "Hollowing Out the Community: Examining the Local Impacts of Long Distance Labour Commuting in a Northern Canadian Small Town" (presented by Greg Halseth)
June 2012	ICLEI (Local Governments for Sustainability) World Congress, Belo Horizonte, Brazil. "Place-based Development for Sustainability."
October 2011	Canadian Rural Restructuring Foundation, St. John's. "Finding Place Among the Placeless: the Role Regional Development in the Peace River Region, northern British Columbia."
May 2011	C-U Expo, Waterloo. "Creating a Social Economy Community of Practice: The BALTA Experience" (presented by Mary Beckie and Stuart Wulff).
April 2011	American Association of Geographers, Seattle. "Minetown, Milltown, Railtown, No Town: Fly-in, Fly-out Resource Development in Northern British Columbia."
March 2011	Western Division of the Canadian Association of Geographers, Vancouver. "Developing the Next Generation of Community-based Researchers" (with Greg Halseth and Laura Ryser).
October 2010	Canadian Rural Restructuring Foundation, Brandon. "Getting a Fair Share: Regional Development in a Rapid Boom-Bust Rural Setting"
June 2010	Association for Non-profit and Social Economy Research (ANSER), Montreal. "Pushing the Boundaries? Community-University Engagement and the British Columbia and Alberta Research Alliance on the Social Economy" (with Karen Heisler and Mary Becky)
June 2010	Canadian Association of Geographers, Regina. "Getting a Fair Share: Regional Development in a Rapid Boom-Bust Rural Setting"
June 2010	Association for Non-profit and Social Economy Research (ANSER), Montreal. "Credit Unions and the Social Economy: Being Competitive and Building Capacity" (with Freya Kristensen and Stewart Perry)
October 2009	Canadian Society for Ecological Economics, Vancouver. "Reciprocity is Green: Sustainable Development and the Social Economy" (with Mark Roseland)
May 2008	From Space to Place: The Next Rural Economies Conference, Prince George. "Fly-in, Fly-out Resource Development: A New Regionalist Perspective on the Next Rural Economy"
May 2008	Canadian Association of Geographers, Quebec City. "Back of the Envelope: Confronting the Complexity of Sustainable Rural Development"
October 2007	World CIRIEC Research Conference On the Social Economy. Victoria. "Community Reinvestment and the Challenges of Scaling-up the Social Economy"
October 2007	Canadian Rural Revitalization Foundation: Connecting Communities: Rural and

	Urban. Vermillion, AB. Reconceptualizing Fly-in, Fly-out 'workcamps': Dynamic Impacts on Rural and Small Town Communities
July 2007	The Sixth Quadrennial Conference of British, Canadian, and American Rural Geographers. "Disjuncture in Rural Renewal: Theory and Practice in Northern British Columbia"
June 2006	Canadian Association of Geographers. "The Struggle to Compete: From Comparative to Competitive Advantage in Northern British Columbia"
June 2003	Canadian Association of Geographers. "Building Local Development Institutions in Rural British Columbia"
June 2001	Canadian Association of Geographers. "Reaching Across the Divide: The Role of Universities in Building Capacity for Community Economic Development"
June 2000	Canadian Association of Geographers. "Promoting CED for Forest- based Communities"
November 1999	BC Studies: BC at the Millennium. "Promoting CED for Forest-based Communities"
July 1999	International Geographer Union, Commission on the Sustainability of Rural Systems. "Community Economic Development in Rural British Columbia First Nation Communities"
May 1999	Society for Human Ecology. "Community Capacity Assessment for Sustainable Community Economic Development"

Keynote Address

December 2013	Peace River Regional District, Interagency Communications Workshop. "Navigating Fly-in, Fly-out Labour Impacts"
June 2013	SNCIRE (Skeena-Nass Centre for Innovation in Resource Economics). "Investing in Place: Resource Impacts and Benefits in Northwest BC"
November 2009	BC, Alberta Social Economy Alliance (BALTA). "The Strong and Weak Social Economy" (with Mark Roseland)
April 2009	Capturing Opportunities, Manitoba Rural Business and Community Forum, Brandon, Manitoba. "We Know Enough: From Sustainable Planning to Sustainable Development"
March 2008	SFU Surrey, Speakers Forum. "Urban and Rural Renewal: Addressing Canada's Sustainability Deficit"
June 2006	Canadian Bureau of International Education, Community Economic Development Ukraine Project, Uzhgorod, Ukraine. "Governance and Process Management in Community Economic Development"
November 2005	Infrastructure Canada: Boom-bust Economies and Northern Infrastructure, Norman

	Wells, NWT. "If you build it, they still might not come: Boom-Bust and the role of infrastructure in rural areas"
March 2005	Community Development Institute, UNBC: Community Speaker Series, Prince George & Kitimat. "Cows in the City and Other Rural Development Strategies"
March 2002	Policy Research Initiative, Graduate Research Award. "Second Growth: Rural and Small Town Economies in British Columbia"

Invited Speaker

October 2011	The Leslie Harris Centre of Regional Policy & Development," St. John's. "Minetown, Milltown, Railtown… No Town: Community Benefits and Impacts from Resource Development"
October 2011	Department of Geography, Memorial University, St. John's. "Investing in Place: Economic Renewal in Northern British Columbia"
March 2011	Canadian CED Network Regional Conference. "Get Curious! A think tank exploring how municipal governments support Community Economic Development."
April 2008	Bolivian Specialization in CED Project, Cochabamba, Bolivia. "Community Economic Development: Principles and Politics"
April 2007	Surrey Environmental Film Festival. "Sustainable Community Development"
November 2006	SFU Philosopher's Cafe, Surrey. "Expansion from here to eternity? Should the South Fraser region continue to accept unbridled development and population increases?"
September 2005	Surrey Chamber of Commerce: Community Forum. "An Introduction to Vibrant Surrey"
November 2004	SFU Centre for Dialogue: Rural-Urban Interdependenc. "Rural-Rural Interdependence in Northern British Columbia"
September 2003	Rural Secretariat Advisory Council: New Ways of Thinking: Towards an Integrated Policy Framework. "Rural Development in British Columbia"

Workshop Presenter

July 2006	SFU Faculty of Education, Prince George MA Cohort : Course Workshop. "Sustainable Community Development in Northern BC"
May 2006	Malaspina College Knowledge Mobilization Project, Workshop for the Vancouver Island Economic Development Association. "Second Growth, or Second Growth? Community Economic Development in Rural British Columbia"
June 2002	Canadian Bureau of International Education, Civil Society and Community Roots Project, Lviv, Ukraine. "Introduction to Community Economic Development"

Research/Project Funding - Received

Contract/Grant: Research Grant **Awarded:** 2012 **Period:** 2012 - 2019 **Project Title:** On the Move: Employment-Related Geographical Mobility in the Canadian Context **Funding:** SSHRC **Type:** External. **Involvement:** Co-Investigator **Collaboration:** Dr. Barb Neis **Institution of Co-Investigator(s):** Memorial University

Contract/Grant: Research Grant **Awarded:** 2013 **Period:** 2013 - 2014 **Project Title:** From Theory to Practice: Identifying and Activating Community Capitals for Sustainable Local Economic **Funding:** IDRC **Type:** External. **Involvement:** Principal Investigator

Contract/Grant: Research Grant **Awarded:** 2013 **Period:** 2013 - 2014 **Project Title:** Multiplying Tier 2 Results **Funding:** CIDA **Type:** External. I**nvolvement:** Principal Investigator

Contract/Grant: Research Grant **Awarded:** 2011 **Period:** 2011 - 2013 **Project Title:** Working 'away': Community and family impacts of skilled trades workers from Mackenzie BC who work outside of the town for extended periods **Funding:** SSHRC **Type:** External. **Involvement:** Co-Investigator **Collaboration:** Dr. Greg Halseth **Institution of Co-Investigator(s):** UNBC

Contract/Grant: Research Grant **Awarded:** 2010 **Period:** 2010 - 2013 **Project Title:** Canadian Regional Development: a Critical Review of Theory, Practice and Potentials **Funding:** SSHRC **Type:** External. **Involvement:** Co-Investigator **Collaboration:** Drs. Kelly Vooden, David Douglas, Bill Reimer **Institution of Co-Investigator(s):** Memorial, Guelph, Concordia

Contract/Grant: Research Grant **Awarded:** 2008 **Period:** 2009 - 2012 **Project Title:** Long Distance Commuting: Development Implications for Rural Regions in Northern British Columbia **Funding:** SSHRC **Type:** External. **Involvement:** Principal Investigator

Contract/Grant: Research Grant **Awarded:** 2010 **Period:** 2010 - 2011 **Project Title:** A Separate Legal Structure for Social Enterprise: Options for a 'Made in Canada' Solution. **Funding:** Institute for Nonprofit Studies Research Program, Mount Royal University **Type:** External. **Involvement:** Principal Investigator **Collaboration:** Co-investigator, Stacy Corriveau **Institution of Co-Investigator(s):** BC Centre for Social Enterprise

Contract/Grant: Research Grant **Awarded:** 2006 **Period:** 2006 - 2011 **Project Title:** British Columbia and Alberta Social Economy Research Alliance **Funding:** SSHRC **Type:** External. I**nvolvement:** Joint Investigator **Collaboration:** Co-applicants:Lewis, Dr. Darcy Mitchell, Mark Anielski, Dr. Michael Gismondi, Dr. Mark Roseland, John Restakis **Institution of Co-Investigator(s):** Canadian Centre for Community RenewalRoads University

Contract/Grant: Research Grant **Awarded:** 2008 **Period:** 2008 - 2008 **Project Title:** Place-

based Policy: The Rural Perspective. Co-investigator with Bill Reimer, Concordia University, $15,000. **Funding:** Human Resources and Social Development Canada **Type:** External. **Involvement:** Joint Investigator **Collaboration:** Co-investigator with Dr. Bill Reimer **Institution of Co-Investigator(s):** Concordia University

Contract/Grant: Strategic Grant **Awarded:** 2006 **Period:** 2006 - 2008 **Project Title:** Strategic Sustainability and Community Infrastructure **Funding:** Infrastructure Canada/SSHRC **Type:** External. **Involvement:** Joint Investigator **Collaboration:** Co-investigator with Dr. Mark Roseland **Institution of Co-Investigator(s):** SFU

Contract/Grant: Fellowship **Awarded:** 2005 **Period:** 2005 - 2006 **Project Title:** Prospects for Regional Development in Northern BC **Funding:** President's Research Grant **Type:** Internal. **Involvement:** Principal Investigator

Contract/Grant: Research Grant **Awarded:** 2005 **Period:** 2005 - 2006 **Project Title:** From Planning to Action: Reconciling Community Development Strategies with Regional Assets and Infrastructure. **Funding:** Western Economic Diversification **Type:** External. **Involvement:** Joint Investigator **Collaboration:** Co-investigator with Dr. Greg Halseth **Institution of Co-Investigator(s):** UNBC

Active Service to Simon Fraser University

Departmental Committees

September 2005 - Current	Chair, Centre for Sustainable Community Development, Sterring Committee
September 2005 - Current	Committee member, Explorations in Arts and Social Sciences, Steering Committee
September 2007 - May 2008	Committee Member, SFU Surrey Recruiting Committee
June 2006 - 2006	Committee Member, Regional Science Program Development Committee
January 2006 - May 2006	Hiring Committee, Centre for Sustainable Community Development/Urban Studies

Faculty Committees

September 2012 - Current	Chair, GPC
September 2012 - Current	Committee Member, DAC
September 2010 - April 2011	NWCCU Accreditation Process, Community and Citizenship Theme Team

University Committees

2012 - Current	Committee Member, SAR

October 2012 - Current	Committee Member, Graduate Rules
January 2012 - Current	Committee Member, SGSC
April 2013 - December 2013	Committee Member, Search Committee: VP Research

Membership in the Academic Community

Canadian Institute of Planners (2010-Current)

Canadian Regional Science Association (2009-Current)

Canadian Community Economic Development Network (2008-Current)

Canadian Association of Geographers (2006-Current)

Service to the Community At Large

2010 - Current	Board Member, Vancity Community Foundation - VCF is a public foundation that makes grants to charitable organizations, with a focus on affordable housing and homelessness, community asset building and non-profit social enterprise.
2005 - July 2011	Board Member, Vibrant Surrey is a coalition of agencies (three levels of government, non-government organizations, businesses) working to address poverty and issues related to poverty in Surrey. I serve as a member of the board, representing SFU Surrey. In 2007, we secured a 5-year, $500,000 matching grant from the McConnell Foundation for organizational and project development.
September 2005 - 2006	Advisory Committee, Surrey Social Purchasing Portal - Helped to establish the SSPP, a non-profit organization that supports buy-local programs in Surrey and works to provide employment opportunities within Surrey businesses for hard-to-employ individuals.

Curriculum Vitae
for
Dana Sue Lepofsky

Personal Information
University Address
Department of Archaeology
Simon Fraser University
Burnaby, B.C. V5A 1S6

Education
Ph.D. Anthropology, University of California, Berkeley, 1994
Ph.D. program in Anthropology, University of Washington 1986-1988 (transferred to UC, Berkeley)
M.A. Anthropology, University of British Columbia, 1985
B.A. Anthropology with Honors, University of Michigan, 1980

Academic Appointments
1 Sept. 2011 - Department of Archaeology, SFU, Professor
1 Sept. 2002 - Department of Archaeology, SFU, Associate Professor
1 Sept. 1995 – Department of Archaeology, SFU, Assistant Professor
Jan – April 1995 – Department of Anthropology, UBC, Sessional Instructor

Research Publications

Refereed Edited Volumes

Turner, Nancy and Dana Lepofsky (editors) 2013. Ethnobotany in British Columbia. *BC Studies* vol 179. [editorship shared equally]

Quinlan, Marsha and Dana Lepofsky (editors) 2013. Explorations in Ethnobiology: The Legacy of Amadeo Rea. *Contributions in Ethnobiology* 1. [editorship shared equally]

Lepofsky, Dana (editor) 2009. Indigenous Resource Management: Past, Present, and Future. Journal of Ethnobiology, special issue. vol 29.

Refereed Journal Articles

*Groesbeck, A.S., K. Rowell, D. Lepofsky, A.K. Salomon. in press. Ancient clam gardens increased shellfish production: Adaptive strategies from the past can inform food security today. *PlosOne.*

*McKechnie, I., D. Lepofsky, M.L. Moss, V.L. Butler, T.J. Orchard, G. Coupland, F.Foster, M. Caldwell, and K. Lertzman. 2014. Archaeological Data Provide Alternative Hypotheseson Pacific Herring (Clupea pallasii) Distribution,Abundance, and Variability. *PNAS* 111(9).

Lepofsky, D. and N. Lyons. 2013. "The Secret Past Life of Plants": Paleoethnobotany in British Columbia, In. Ethnobotany in British Columbia, edited by N. Turner and D. Lepofsky *BC Studies* 179: 39-83.

Turner, N., D. Deur, and D. Lepofsky. 2013. Plant Management Systems of British Columbia First Peoples, In. Ethnobotany in British Columbia, edited by N. Turner and D. Lepofsky *BC Studies* 179: 107-133.

*Lepofsky, D. and M. Caldwell. 2013. Indigenous Marine Resource Management on the Northwest Coast of North America. *Ecological Processes* 2:1-12. http://www.springer.com/alert/urltracking.do?id=L1fbaf21Mc87d02Sa

Lepofsky, D., S. Formosa, M. Lenert, D. Schaepe, M. Blake. 2013. Mapping Sxwóxwiymelh, SW British Columbia. *J. of Field Archaeology* 38:309 – 323.

Speller, Camilla, Lorenz Hauser, Dana Lepofsky, Daniel Peterson, Jason Moore, Antonia Rodriguez, Madonna Moss, Iain McKechnie, Dongya Y. Yang. 2012. High Potential for Using DNA from Ancient Herring Bones to Inform Modern Fisheries Management and Conservation. *PLOS One* 7:1-13.

Caldwell, Megan, Dana Lepofsky, Georgia Combes, John Harper, John Welch, Michelle Washington*. 2012. A Bird's Eye View of Northern Coast Salish Intertidal Resource Management Features. Journal of Island and Coastal Archaeology. 7:219–233.

King, Amanda and Dana Lepofsky, David Pokotylo* 2011. Archaeology and Local Governments: The Perspectives of First Nations and Municipal Councilors in the Fraser Valley, B.C. Canadian Journal of Archaeology 35: 258–291.

Welch, J., D. Lepofsky, and M. Washington. 2011. Assessing Collaboration with the Sliammon First Nation in a Community-Based Heritage Research and Stewardship Program. *Archaeological Review from Cambridge* 26.2: 171-190.

Lepofsky, Dana and Jennifer Kahn. 2011. Cultivating an Ecological and Social Balance: Elite Demands and Commoner Knowledge in Ancient Maohi Agriculture, Society Islands. American Anthropologist 113(3): 319-335.

Wyndham, Felice, Dana Lepofsky, and Sara Tiffany. 2011. Taking Stock in Ethnobiology: Where Do We Come From? What Are We? Where Are We Going? Journal of Ethnobiology 31:110 -127.

Springer, Chris and Dana Lepofsky* 2011. People and Pithouses: Social identities in an isolated pithouse in the Harrison Watershed, SW British Columbia. Canadian Journal of Archaeology.

Welch, John, Dana Lepofsky, Georgia Combes, and Craig Rust* 2011. Treasure Bearers. Personal foundations for effective leadership in Northern Coast Salish Heritage Management. Heritage and Society 4(1):83-114.

Weiser, Andrea and Dana Lepofsky* 2009. Ancient Land Use and Management of Ebey's Prairie, Whidbey Island, Washington, In. Traditional Resource Management: Past, Present, and Future, edited by D. Lepofsky. Journal of Ethnobiology 29:161-166.

Lepofsky, Dana. 2009. Traditional Resource Management: Past, Present, and Future, In. Traditional Resource Management: Past, Present, and Future, edited by D. Lepofsky. Journal of Ethnobiology 29:184-212.

Lepofsky, Dana, David Schaepe, Anthony Graesch, Michael Lenert, Patricia Ormerod, Keith Carlson, Jeanne Arnold, Michael Blake, Patrick Moore, and John Clague*. 2009. Exploring Stó:lō-Coast Salish interaction and Identity in ancient houses and settlements in the Fraser Valley, British Columbia American Antiquity 74:595-626.

Lepofsky, Dana. 2008. Deconstructing the Mccallum Site. BC Studies 158:3-31.

Lepofsky, D. and K. Lertzman. 2008. Documenting Ancient Plant Management in the Northwest of North America. Botany 86:129-145.

Lepofsky, D., T. Trost, and J. Morin* 2007. Coast Salish Interaction: A view from the inlets. Canadian Journal of Archaeology 31:190-223.

Lepofsky, D. and K. Lertzman. 2005. More on Richness and Diversity in Archaeobiological Assemblages. Journal of Ethnobiology 25:175-188.

Lepofsky, D., K. Lertzman, D. Hallett, and R. Mathewes.* 2005. Climate Change and Culture Change on the Southern Coast of British Columbia 2400-1200 B.P.: An Hypothesis. American Antiquity 70: 267-293.

Lepofsky, D. and N. Lyons* 2003. Modeling ancient plant use on the Northwest Coast: Towards an understanding of mobility and sedentism. *Journal of Archaeological Science* 30: 1357 - 1371.

Lepofsky, D., E. Heyerdahl, K. Lertzman, D. Schaepe, and B. Mierendorf. 2003. Climate, Humans, and Fire in the History of Chittenden Meadow. *Conservation Ecology* 7:5. [online] URL:http://www.consecol.org/vol7/iss3/art5

Lepofsky, D., N. Lyons, and M. Moss* 2003. The use of driftwood on the North Pacific Coast: An example from Southeast Alaska. *Journal of Ethnobiology* 23:125-141.

Lepofsky, D. 2003. The Ethnobotany of cultivated plants of the Maohi of the Society Islands. *Economic Botany* 57: 73-92.

Hallett, D.J., D. Lepofsky, R.W. Mathewes, K.P. Lertzman* 2003. 11,000 years of fire history and climate in the mountain hemlock rainforests of southwestern British Columbia based on sedimentary charcoal. *Canadian Journal of Forest Research* 33:292-312.

Ostapkowicz, J., D. Lepofsky, R. Schulting, and S. McHalsie. 2002. The use of cattail (Typha latifolia L.) down as a sacred substance by the Interior and Coast Salish. *Journal of Ethnobiology*. 21:77-90.

Lertzman, L, D. Gavin, D. Hallett, L. Brubaker, D. Lepofsky, and R. Mathewes* 2002 Long-term fire regime estimated from soil charcoal in coastal temperate rainforests *Conservation Ecology* 6(2): 5. [online] URL: http://www.consecol.org/vol6/iss2/art5

Lepofsky, D. M. Blake, D. Brown, S. Morrison, N. Oakes, and N. Lyons* 2000. The archaeology of the Scowlitz site, Southwestern British Columbia. Journal of Field Archaeology. 27(4):391-416. [released in 2002]

Lepofsky, D., M. Moss, and N Lyons* 2001. The unrealized potential of paleoethnobotany in the archaeology of Northwestern North America: Perspectives from Cape Addington, Alaska. Arctic Anthropology. 38(1): 48-59.

Lepofsky, D. 1999. Gardens of Eden? An Ethnohistoric Reconstruction of Maohi (Tahitian) Cultivation. Ethnohistory.46:6-22.

Lepofsky, D., P.V. Kirch, and K.P. Lertzman. 1998. Metric Analyses of Prehistoric Morphological Change in Cultivated Fruit and Nuts: An Example from Island Melanesia. Journal of Archaeological Science 25:1001-1014.

Lepofsky, D., P. Kirch, and K. Lertzman. 1996. Stratigraphic and palaeobotanical evidence for prehistoric human-induced environmental disturbance on Mo'orea Island, French Polynesia. Pacific Science 50 (3):253-273.

Lepofsky, D., K. Kusmer, B. Hayden and K. Lertzman. 1996. Reconstructing prehistoric socioeconomies from paleoethnobotanical and zooarchaeological data: An example from the British Columbia Plateau. Journal of Ethnobiology. 16(1):31-62.

Lepofsky, D. 1995. A radiocarbon chronology for prehistoric agriculture in the Society Islands. Radiocarbon 37 (3):917-930.

Kirch, P.V. and D. Lepofsky. 1993. Polynesian Irrigation: Archaeological and Linguistic Evidence for Origins and Development. Asian Perspectives 32:183-204.

Lepofsky, D., 1992. Arboriculture in the Mussau Islands, Bismarck Archipelago. Economic Botany 46:192-211.

Lepofsky, D., H. Harries, and M. Kellum, 1992. Early coconut from Moorea Island, French Polynesia. Journal of the Polynesian Society 101:299-308.

Lepofsky, D., 1989. Eating eggs on Eloaua: The Initiation of a mutualistic relationship. Journal of Ethnobiology 9:229-231.

Lepofsky, D., N.J. Turner and H.V. Kuhnlein, 1985. Determining the Availability of Traditional Wild Plant Foods: An Example of Nuxalk Foods, Bella Coola, B.C. Ecology of Food And Nutrition 16:223-241.

*Papers with student collaborators

Reviewed Book Chapters and other publications.

Lepofsky, D. and M. Lenert. In press. Choppers in Context: The archaeology of the Mccallum site, SW BC. In. *Archaeology of the Fraser Valley*, edited by M. Rousseau and R. Carlson. Archaeology Press, Burnaby.

Lepofsky, D., Sue Formosa, M. Ritchie. In press. Radiocarbon dates in the Fraser Valley. In. *Archaeology of the Fraser Valley*, edited by M. Rousseau and R. Carlson. Archaeology Press, Burnaby.

Blake, Michael, Dana Lepofsky, and Nicole Oakes. In press. Burial Mounds of the Fraser Valley, In. *Archaeology of the Fraser Valley*, edited by M. Rousseau and R. Carlson. Archaeology Press, Burnaby.

Ritchie, Morgan and Dana Lepofsky In press. Social change in Coast Salish society: A view from Hiqelem, In. *Archaeology of the Fraser Valley*, edited by M. Rousseau and R. Carlson. Archaeology Press, Burnaby.

Lepofsky, Dana and Kevin Feeney. 2013. Ten principles of ethnobiology: An Interview with Amadeo Rea, In. Explorations in Ethnobiology: The Legacy of Amadeo Rea, edited by M. Quinlan and D. Lepofsky. *Contributions in Ethnobiology* 1.

Lepofsky, Dana and Marsha Quinlan. 2013. Preface. In. Explorations in Ethnobiology: The Legacy of Amadeo Rea, edited by M. Quinlan and D. Lepofsky. *Contributions in Ethnobiology* 1.

Nabhan, G., F. Wyndham, D. Lepofsky. 2011. Ethnobiology Emerging from a Time of Crisis. *J. of Ethnobiology.*

Lepofsky, D. 2011. Everyone loves archaeology. SAA Record. November Issue: 17 – 19.

Fowler, Catherine, and D. Lepofsky. 2011. Traditional Resource and Environmental Management, pp. 285-304. In. *Ethnobiology*, edited by G. Anderson. Wiley-Blackwell.

Lepofsky, D. D. Hallett, K. Washbrook, A. McHalsie, K. Lertzman, and R. Mathewes. 2005. Documenting precontact plant management on the Northwest Coast: An example of prescribed burning in the central and upper Fraser Valley, British Columbia. In *Keeping it Living: Traditions of Plant Use and Cultivation on the Northwest Coast*, edited by D.E. Deur and N.J. Turner, pp. 218-239. University of Washington Press, Seattle.

Lepofsky, D. 2004. The Northwest. In *Plants and People in Ancient North America*, edited by P. Minnis, pp. 367-464. Smithsonian Institution Press, Washington.

Lepofsky, D. and S. Peacock. 2004. A Question of Intensity: Exploring the Role of Plant Foods in Northern Plateau Prehistory, In. *Complex Hunter-Gatherers: Evolution and Organization of Prehistoric Communities on the Plateau of Northwestern North America*, edited by B. Prentiss and I. Kuijt. University of Utah Press.

Lepofsky, D., M. Moss, and N. Lyons. 2004. The Paleoethnobotanical Remains from the Cape Addington Site. In. *The Cape Addington Site*, edited by M. Moss. Univ. of Oregon.

Lepofsky, D. 2002. Plants and Pithouses: archaeobotany and site formation processes at the Keatley Creek village site, In. Hunter-gatherer Archaeobotany: Perspectives from the Northern Temperate Zone, edited by Sarah LR Mason & Jon G Hather, pp. 62-73. Institute of Archaeology, University College of London, London.

Lepofsky, D. 2000a. Site Formation Processes at Keatley Creek: The Paleoethnobotanical Evidence, In. The Ancient Past of Keatley Creek Site, vol 1., Taphonomy, edited by B. Hayden, pp. 105-134. Archaeology Press, SFU.

Lepofsky, D. 2000b. Socioeconomy at Keatley Creek: The Botanical Evidence, In. The Ancient Past of Keatley Creek Site, vol 2, Socioeconomy, edited by B. Hayden, pp. 75-86. Archaeology Press, Simon Fraser University

Hallett, D., D. Lepofsky, K. Lertzman, and R. Mathewes. 1999. Holocene Fire History of the Mountain Hemlock Zone, Based on High Resolution Charcoal Analysis of Lake Sediments and Soil. Ecological Society of America, Annual Meeting Abstracts, p. 101.

Lepofsky, D. and B. Pegg. 1996. Archaeological and Ethnographic Research in the Kowesas Watershed, In The Kowesas Watershed Assessment. Ecotrust, Portland, Oregon, pp. 38-44.

Lepofsky, D., 1988. A Re-examination of Lapita Settlement Patterns, in Archaeology of the Lapita Cultural Complex: A Critical Review, edited by P.V. Kirch and T.L. Hunt, Burke Museum Special Research Report.

Lepofsky, D. 1986. The Effects of Development in the Georgia Strait on Traditional Plant Use, in Inland Waters: Perspectives on the Sound. The Institute of the American West.

Academic Conference Presentations (2010 onwards)

Note: this list does not include the many public presentations to community and school groups.

Delivered Papers and Posters

2014 Changing Ways, Constant Companions: The Ancient DNA, Ethnohistory, and Archaeology of Tla'amin Dogs. Kasia Zimmerman, Dana Lepofsky, Antonia Rodrigues, Megan Caldwell, Nyra Chalmer, Chris Springer, and Dongya Yang. Northwest Anthropological Meetings, Bellingham, WA.

2014 Mountain Top to Ocean Floor: The Eco-cultural History of Hauyat. Julia Jackley, Dana Lepofsky, Jennifer Carpenter, Nancy Turner. Northwest Anthropological Meetings, Bellingham, WA.

2014 Archaeology and Heritage Pilot Project: Connecting to the Past to Protect the Future. Nyra Chalmer, Chris Picard, Ginevra Toniello, Dana Lepofsky, Helen Clifton, Kyle Clifton, Cam Hill, and Bruce Reece. Northwest Anthropological Meetings, Bellingham, WA.

2014 The Clam Garden Network: Documenting Traditional Mariculture Practices on the Northwest Coast. Dana Lepofsky, Skye Augustine, Nathan Cardinal, Amy Groesbeck, Marco Hatch, Julia Jackley, Eric Mclay, Misha Puckett, Kristen Rowell (UW), Anne Salomon, Nicole Smith, and Elroy White. Northwest Anthropological Meetings, Bellingham, WA.

2014 From Cultural Keystone Species to Threatened Species: The Place of Pacific Herring in Northern Coast Salish Social Ecological Systems. Alisha Gauvreau, Dana Lepofsky, and Michelle Washington. Northwest Anthropological Meetings, Bellingham, WA.

2014 Move Over Salmon: New Perspectives on Indigenous Fisheries along the Northwest Coast. McKechnie, Iain, Dana Lepofsky and Madonna L. Moss. Society for American Archaeology 79th Annual meeting, Austin, Texas. April 25.

2014 Shifting baselines in Puget Sound: population abundance of Pacific herring and its use by Native Americans over the millennia. Eleni Petrou, Dana Lepofsky, Dongya Yang, Bob Kopperl, Dennis Lewarch, Lorenz Hauser. Salish Sea Conference, Seattle, WA.

2014 Ancient Mariculture in the Salish Sea: Documenting the Past for the Future. Dana Lepofsky, Skye Augustine, Nathan Cardinal, Amy Groesbeck, Marco Hatch, Julia Jackley, Eric McLay, Michelle Puckett, Kirsten Rowell, Anne Salomon, Nicole Smith, and Elroy White. Salish Sea Conference, Seattle, WA.

2014 Hazelnut (*Corylus cornuta*) on the Northwest Coast: An Ethnobiological Profile. Chelsey Geralda Armstrong, Dana Lepofsky, Nancy Turner and Dongya Yang. Society of Ethnobiology, Cherokee, NC.

2014 Hazelnut (*Corylus cornuta*) on the Northwest Coast: An Ethnobiological Profile. Chelsey Geralda Armstrong, Dana Lepofsky, Nancy Turner and Dongya Yang. Canadian Archaeological Association, London ON.

2013 Ancient Mariculture in British Columbia: Documenting the Past for the Future (D. Lepofsky, S. Augustine, N. Cardinal, Am Groesbeck, M. Puckett, K. Rowell, A. Salomon, N. Smith, E. White, Society of Ethnobiology, Denton.

2013 Traditional Ecological Knowledge and Climate Change: A review (V. Savo and D. Lepofsky), Society of Ethnobiology, Denton.

2013 Transforming the Beach, Transforming Our Thinking: Ancient Clam Gardens in Northern Quadra Island, B.C. (M. Puckett, D. Lepofsky, A. Groesbeck, K. Rowell, A. Salomon, BC Studies, Vancouver.

2013 A Visual Representation of Radiocarbon Dates in the Fraser Valley (D. Lepofsky, S. Formosa, M. Ritchie), In Archaeology of the Lower Fraser River Region, BC Studies, Vancouver.

2013 Cultural Transformations in the Northern Salish Sea: Understanding Tla'amin Heritage through Archaeology, Ethnohistory, and Modern Perceptions, session organizer and participant. BC Studies, Vancouver.

2013 "The Herring School: Connecting communities through the science and history of a cultural keystone species, In. Practices and Implications of Research With Indigenous Participants and Collaborators. BC Studies, Vancouver.

2013 Ecosystem enhancements? Ancient aquaculture practices in British Columbia provide insights and baselines for today's management. (Groesbeck, A., M. Puckett, D. Lepofsky, A. Salomon, K. Rowell) Ecological Society of America, Minnesota.

2012 The Herring School: Bringing together culture, ecology, and governance to support sustainability (Dana Lepofsky and others). Society of Ethnobiology, Denver, May 2012.

2011 Archaeological Perspectives on Northern Coast Salish Intertidal Resource Management (Megan Caldwell, Dana Lepofsky, Georgia Combes, John R. Harper, John R. Welch, and Michelle Washington) in session on "Cultivation of Marinescapes on the Pacific Northwest Coast", IMCC meetings, Seattle, May 2011.

2011 Can past traditions of coastal First Nations inform a more sustainable future for coastal communities and ecosystems today?:An Empirical Quantification of Ancient Mariculture in BC (Groesbeck, A.S., Salomon, A.K., Lepofsky, D.S., Rowell, K.). Salish Sea Conference, Seattle.

2011 The Archaeology of Herring (Lepofksy, D., M. Moss, I. McKechnie, T. Orchard, A. Cannon, M. Caldwell, F. Foster). The Herring Workshop, Burnaby, B.C. 30 Aug – 2 Sept, 2011.

2011 Cultivating an ecological and social balance: Elite demands and commoner knowledge in ancient Ma'ohi agriculture, Society Islands. (Lepofsky, D. and J. Kahn). Plenary Session, Society of Ethnobiology, May 4-7, 2011, Columbus, Ohio

2011 Exploring Xelhalh as a place of centralized power among the Sto:lo-Coast Salish (Schaepe, David M. Michael Blake, Sue Formosa, Dana Lepofsky, Anthony P. Graesch, and Naxaxalhts'i [Albert 'Sonny' McHalsie[). March 30—April 3, 2011, Sacramento, California.

2011 The Built Environment of the Northern Coast Salish: An Archaeological View form Desolation Sound, British Columbia (Springer, C., M. Caldwell, D. Lepofsky, S. Johnson, and M. Washington). Paper presented at the Society for American Archaeology Conference, March 30—April 3, 2011, Sacramento, California.

2011 A Regional Understanding of Northern Coast Salish Intertidal Resource Management (Caldwell, M., D. Lepofsky, M. Washington). Paper presented at the Society for American Archaeology Conference, March 30—April 3, 2011, Sacramento, California.

2011 Zooarchaeological Analysis of Willingdon Beach Site, a possible Defensive site in SW B.C. (vanMerlin, A., M. Caldwell, D. Lepofsky). Poster presented at the CAA conference, **May 18– 22, 2011, Halifax, Nova Scotia.**

2010 Present Knowledge, Past Behaviour: Understanding Ancient Traditional Resource Use and Environmental Management Systems (Caldwell, Megan, Dana Lepofsky and Michelle Washington). Paper presented at the New Zealand Ecological Society Conference 2010, November 22-25, 2010, Dunedin, New Zealand.

2010 "Reconstructing past abundance, diversity, and use of herring in the Pacific Northwest of North America", (Speller, C., D. Lepofsky, A. Benson, M. Washington, M. Caldwell, J. Welch, D. Yang). International Council for Archaeozoology, 11th Annual Conference, Paris, France, August 23-28, 2010.

2010 "From Sea to Shore: Visualizing Intertidal Resource Abundances on the Southern British Columbia Coast" (Caldwell, M., D. Lepofsky, G. Combes, J. Harper, J. Welch, M. Washington). International Council for Archaeozoology, 11th Annual Conference, Paris, France, August 23-28, 2010.

2010 "Everyone Loves Archaeology: Bridging Communities Through Archaeological Research" Invited Panel on Environmental Education. EECOM Conference, Burnaby.

2010 Working the Tides: Linking Intertidal Features and Terrestrial Sites on BC's Southern Coast (Megan Caldwell, Dana Lepofsky, Georgia Combes, John R. Harper, Michelle Washington, and John R. Welch). Canadian Archaeological Association, Calgary.

2010 A Bird's-Eye-View of Traditional Tla'amin Intertidal Resource Management (Megan Caldwell, Dana Lepofsky, Georgia Combes, John R. Harper, Michelle Washington, and John R. Welch). Society of Ethnobiology, Victoria, B.C.

2010 Resource Intensification at the Bridge River Site: A case study in subsistence practices within a complex hunter-gatherer village (Lisa Smith, Anna Prentiss, Dana Lepofsky, Eric Carlson, Naoko Endo). Society of American Archaeology meetings, St. Louis.

Symposium Organizer

2010 The Past, Present and future of Pacific Marine Resource Management (with Megan Caldwell), Society of Ethnobiology, Victoria, B.C.

Service (2007 onwards)

2013 – current Co-editor, *Journal of Ethnobiology*.

2013 – current Environmental Science Steering Committee, Simon Fraser University

2013-2014 Program Committee, Society for American Archaeology Annual Meeting, Austin Texas.

2012- current Organizer, Archaeology Departmental seminar, Simon Fraser University

2012 Conference organizer, "The Herring School Workshop", September 4, Burnaby, B.C.

2011 Conference organizer, "The Herring School Workshop", Aug 31- Sept 2, 2011, Burnaby, B.C.
2009- 2013 Series Editor, "*Contributions in Ethnobiology*", Society of Ethnobiology.
2009-2010 Conference co-organizer, 33rd Annual meeting Society of Ethnobiology, 5-8 May, 2010, Victoria, B.C.
2009-2011 President. Society of Ethnobiology.
2007- 2009 President-elect. Society of Ethnobiology.
2007 Co-organizer, BC Archaeology Forum, Vancouver, B.C.
2007-2008 Chair, Local Planning Committee, Society of American Archaeology.

Research Funding

External

2014 - 2016 Washington Sea Grant. $220,000. "Shifting baselines in Puget Sound: population diversity of Pacific herring and its use by Native Americans over the millennia". (co-PI with Lorenz Hauser).
2013 Wenner Gren. $24,500. "Ancient Mariculture Among the Coastal First Nations of British Columbia: Integrating Archaeological, Ecological, and Traditional Knowledge."
2011 SSHRC Partnership Development Grant. $192,450. "The herring school: bringing together culture, ecology, and governance to support sustainability on BC's Central Coast".
2011 SSHRC Standard Research Grant. $80,384. "Ancient resource management among Northern Coast Salish"
2011 SSHRC Aid to Research Workshops and Conferences in Canada. $24,324. "The Herring School Workshop." (with Martin Robards and Ken Lertzman).
2011 SSHRC Public Outreach: Dissemination Grant. $49,752. "The herring school: visualizing culture, ecology, and management to support sustainability on BC's Central Coast".
2010- 2018 Tula Foundation. Major funding for creation of Hakai Research Network. $8,000,000 for the Network as a whole.
2009-2011 National Geographic Research Grant. $20,000 USD. "Reconstructing past abundance, diversity, and use of herring in the Pacific Northwest: a multi-disciplinary approach to cultural and biological conservation" Co-principal Investigator (with Dongya Yang)
2009-2010 National Geographic Research Grant. $21,060 USD. "Documenting Ancient Management of Marine Resources Among the Tla'Amin of SW BC: Integrating Archaeological, Ecological, and Traditional Knowledge". Principal Investigator.
2009-2010. Jacobs Fund. $6,600. with Megan Caldwell. "Traditional Ecological Knowledge of Intertidal Resource Management in Tla'amin Territory, British Columbia".
2003 – 2006 Social Science and Humanities Research Council (SSHRC). $216,270. Aboriginal collective identity across time, space, and academic disciplines: Exploring Interactions among the Sto:lo of southwestern British Columbia. In collaboration with Michael Blake (University of British Columbia), Jeanne Arnold (UCLA), Dave Schaepe (Sto:lo Nation and UBC), Pat Moore (UBC), and John Clague (SFU).

2001 – 2003. Wenner-Gren Foundation. $ 3,023 (2,000 USD). The Emergence of Status Inequality at the Keatley Creek site, British Columbia. Bill Prentiss, Principle Investigator. This grant was awarded to Dr. Prentiss (University of Montana). We collaborated on the writing of the portion of the grant that funds my paleoethnobotanical research. The amount shown is for my research.

2001 – 2003. National Science Foundation. $5,918 (3,915 USD). The Emergence of Status Inequality at the Keatley Creek site, British Columbia. Bill Prentiss, Principle Investigator. This grant was awarded to Dr. Prentiss (University of Montana). We collaborated on the writing of the portion of the grant that funds my paleoethnobotanical research. The amount shown is for my research.

2000 – 2001. Global Forest. $5,000. Public Outreach for 2000 Archaeology Field School. Joint Investigator in collaboration with Tsleil-Waututh Nation.

2000 – 2001. B.C. Heritage Trust. $15,000. People's Work: Community Archaeology in Tsleil-Waututh Territory. Joint Investigator in collaboration with Tsleil-Waututh Nation.

1999 – 2000. Skagit Environment Endowment Commission. (SEEC). $27,360. A Preliminary Investigation of the Fire History and Cultural Occupation of Chittenden Meadows, Upper Skagit River Valley, B.C. Joint Investigator in collaboration with Ken Lertzman, Emily Heyerdahl (SFU), Dave Schaepe (Sto:lo Nation), and Robert Mierendorf (National Parks Service).

1996 – 1998. Social Science and Humanities Research Council (SSHRC). $88,700. Coast Salish Household Archaeology: The Scowlitz Site, Southwestern, B.C. Principal Investigator. In collaboration with Dr. Michael Blake (University of British Columbia), Sto:lo Nation, Scowlitz First Nation.

1996 – 1998. Forest Renewal British Columbia (FRBC). $197,307. The Natural and Cultural Fire History of the Central and Upper Fraser River Valley. Principal Investigator in collaboration with Ken Lertzman, Rolf Mathewes (SFU) and Sonny McHalsie, Kevin Washbrook (Sto:lo Nation).

Internal

2013 SFU Community Engagement Initiative. $10,000.

2013 Small SSHRC. $9980. The social and ecological context of ancient mariculture in Heiltsuk traditional territory, British Columbia. Principal Investigator.

2012 Collaborative Teaching Fellow Program Grant for "Tla'amin-SFU-USaskatchewan Field School: Integrating Heritage and Environment through Archaeology and History". $19,795

2011 SFU Conference Grant for "The Herring School Workshop", Burnaby. $1500.

2010 SFU Conference Grant for Society of Ethnobiology Meeting, Victoria. $1000

2010 – 2011 SFU/VPR-VPR 4A Grant, $10,000.

2009- 2010 Small SSHRC $6,075. Archaeological survey, mapping and testing in Tla'amin First Nation territory, British Columbia. Principal Investigator.

2001 – 2003. Small SSHRC $4,911. Zooarchaeological and paleoethnobotanical analysis of the Strathcona Park site: a Coast Salish summer village in Indian Arm. Principal Investigator.

1998 – 1999. Small SSHRC $4,995. The Temporal History and Social Role of Prehistoric Burial Mounds at the Scowlitz Site, Southwestern British Columbia. Principal Investigator, in collaboration with Scowlitz First Nation.

1996 – 1997. Presidents Research Grant. $10,904. The Chilliwack River Valley Archaeological Survey

Awards and Honors

1997 Honored by Sto:lo Nation in formal longhouse ceremony for archaeological work in Sto:lo territory.

1994 Barbara Lawrence Award, Society for Ethnobiology

Member of Professional Societies:

Canadian Archaeological Association
Society of Ethnobiology
Society for American Archaeology
Society for Economic Botany
Archaeology Society of British Columbia

Graduate Students for Whom I am the Senior Supervisor

Student Name	Degree (Status)	Thesis Title/Topic
Gauvreau, Alisha	MA (Current)*	Herring Use among the Heiltsuk
Verhagen, Misha	MA (Current)	Clam Gardens on Quadra Island
Chalmer, Nyra	MA (Current)	Household and Village Organization Among the Northern Coast Salish
Caldwell, Megan	PhD (Current)*	Ancient Marine Management and Use Among the Northern Coast Salish.
Springer, Chris	PhD (Current)	Identity and Interaction Among the Northern Coast Salish
Sheppard, Jon	MA (Current)	An Archaeological Survey of Pithouse Settlements on the Middle Fraser.
Williams, Louise	MA (Current)	Putting it Back Together: The Archaeology of the Locarno Beach Site
Jackley, Julia	MA (Current)	Writing Indigenous History: The Archaeology of KlehKwaNum
Pierson, Nova	MA (Completed 2011)	Zooarchaelogical Applications of Marine Resource Management in Burrard Inlet
Johnson, Sarah	MA (Completed 2010)	Cultural Landscape of Grace Harbour, Tla'amin Traditional Territory
Ritchie, Patrick	MA (Completed 2010)	From House to Watershed: The Cultural Landscape of the Sts'ailes People
Springer, Chris	MA (Completed 2010)	Tracking Identity in a Harrison Valley Pithouse
King, Amanda	MA (Completed 2008)	Archaeology and Local Governments: The Perspectives of First Nations and Municipal Councillors in the Fraser Valley, BC
Lenert, Michael	PhD (Completed	Hunter-Gatherer Household and Village Organization at

	2007)*	Sxwóxwiymelh, BC
King, Shannon	MA (Completed 2007)	What's the Point? A Morphological Study of Small Bone Points from Nuu-chah-nulth Territory, Vancouver Island, B.C.
Weiser, Andrea	MA (Completed 2006)	Exploring 10,000 Years of Human History on Ebey's Prairie, Whidbey Island, WA
Trost, Teresa	MA (Completed 2005)	Forgotten Waters: A Zooarchaeological Analysis of the Cove Cliff Site (DhRr 18), Indian Arm, B.C
Brown, Douglas	PhD (Timed out 2005)	Household Archaeology at the Scowlitz site, Upper Fraser Valley, B.C.
Oakes, Nicole	PhD (Timed out 2005)	Burial Mounds in the Fraser Valley
MacKechnie, Iain	MA (Completed 2005)	Five Thousand Years of Fishing at a Shell Midden in the Broken Group Island, Barkely Sound, B.C.
Frank, Ian	MA (Completed 2000)	An Archaeological Investigation of the Galene Lakes Area in the Skagit Range of the North Cascade Mountain, Skagit Valley Park, B.C.
Lyons, Natasha	MA (Completed 2000)	Investigating Ancient Socioeconomy in Sto:lo Territory: A Palaeoethnobotanical Analysis of the Scowlitz Site, SW, B.C.

* Indicates co-supervision.

Courses taught since coming to SFU

Arch 100 (Ancient People and Places)
Arch 201 (Introduction to Archaeology)
Arch 378 (Pacific NW of America)
Arch 365 (Ecological Archaeology) –
Arch 433 (Background to Fieldwork)
Arch 434 (Mapping and Recording)

Arch 435 (Fieldwork Practicum)
Arch 479 (Directed Readings)
Arch 480 (Directed Labs)
Arch 872/873 (Readings in Prehistory)
Arch 893 (Directed Readings)
Arch 876 (Research Design)
Arch 896 (Readings in Archaeology)

Appendix 4: Correspondence and Related Documents

Appendix 4a. SFU-BCIT Focus Group Summary
Appendix 4b. Letters of Support

Appendix 4a. SFU-BCIT Focus Group Summary

Focus Group Summary Report on a SFU/BCIT Graduate Program in Ecological Restoration

February 10, 2012, SFU, Vancouver

April 5th 2012

1.0 Summary

Simon Fraser University and the British Columbia Institute of Technology are exploring the possibility of offering a collaborative professional graduate program in Ecological Restoration that may deal with a variety of types of Ecological Restoration (e.g. aquatic, terrestrial, marine/estuarine) and a variety of contexts (e.g. international, urban). Such a program would emphasize application of theory and be course and project intensive rather than research intensive. To that end, SFU and BCIT held a workshop, February 10th 2012. Representatives from key sectors (government, private sector, NGO's, First Nations and academia) were asked to present their ideas with respect to relevant skills and knowledge that a graduating student would require. A key outcome was a prioritization of the key aspects of such a program with this list of priorities then guiding the development of a possible SFU/BCIT collaborative professional graduate program in Ecological Restoration.

Dialogue focused around four key questions:

- What does your sector see as important skill sets for a graduate of a professional program in ecological restoration?
- How should we balance applied and academic content?
- What are the important elements of natural and social sciences that should be included?
- How flexible should the program be? For example, in addition to intensive courses, should it include on-line components, field courses and/or projects?

The following represents a summary of the dialogue surrounding each of the four questions. Key points have been extracted from the discussions and are presented as a first attempt at capturing and prioritizing necessary components of a professional graduate program in ecological restoration. A more detailed outline of the workshop discussions follows on page 5.

First and foremost, it was unanimously recognized that Ecological Restoration is a rapidly growing field and such a program is well timed and needed.

Question 1. What does your sector see as important skill sets for a graduate of a professional program in ecological restoration?

Our earth is experiencing rapid change, at different scales and within different time frames. As the scale becomes larger, time slows down and space becomes larger (for example, from a tree, to patches in a forest, to the entire forest, to the watershed that encompasses the forest, to the continent,

to the earth). A program in Ecological Restoration must be placed within this context; a rapidly changing world, which moves within different scales with respect to space and time.

Ecological Restoration is interdisciplinary and teamwork is essential. No one person can achieve all required skills within a two year program. Passive (protection) and active (repair, recovery and follow through) are integral components of a restoration program. Ecological Restoration is an iterative process that requires monitoring, adaptation, evaluation and reapplication.

The important skill sets include global (e.g., ability to communicate [writing, speaking], policy planning) to sector and discipline specific (e.g., statistical, molecular, and geospatial tools, ecology, hydrology, geomorphology and soil science), of which the latter are grounded in good experimental design. Ability to engage and work with communities is necessary as is collaboration with First Nations who often share similar goals in stewarding our environment.

Question 2. How should we balance applied and academic content?

A key strength of the program is the partnership between SFU and BCIT. This partnership blends the applied with the academic creating a well-rounded and unique graduate program in Ecological Restoration. Importance of hands-on skills is recognized and could be incorporated into a long-term field project (practicum/case study) which seeks out collaborations with other groups (NGO's, FNs, community non-profits) and will provide an opportunity of the application of scientific skills to a real-life situation (e.g., wetland, stream, estuarine restoration).

Teach the science, but incorporate the skills of communication, collaboration and team building.

Question 3. What are the important elements of natural and social sciences that should be included?

Natural Sciences: Understanding of ecological processes and the scales at which these processes operate.
Social Sciences: Community and multi-stakeholder engagement through effective communication.
Additional: Project/program organization and management. Law/policy/governance and economics.

Possibly summarized as:
A student in Ecology Restoration would be a person: *"with a solid foundation in science knowledge and strong in communication and community engagement; would be adaptable and resilient; a solution seeker, who is professional, ethical, and a critical thinker with strong project management skills, capable of a collaborative approach, and who is aware of other perspectives and governments".*

Question 4. How flexible should the program be? For example, in addition to intensive courses, should it include on-line components, field courses and/or projects?

"Flexibility" was identified as a key component of a proposed program in Ecological Restoration.

Core courses would be identified (e.g., one that deals with different scales which follows the "life cycle" of an ecosystem under stress; from initiation of the stress, the ability of the ecosystem to resist/buffer/accommodate change (resilience), exhaustion, collapse and what happens after collapse).

Field courses (practicums, Co-Ops) were identified as ideal ways to blend the applied with the academic, application of fundamental principles, for example lake ecology to lake restoration.

Specialization in one area of interest would build on core and practicum experience. Areas of specialization for example could be; Aquatic (lakes, rivers, streams, estuaries), Terrestrial, Urban and Rural. Specialization requires a wide diversity of courses allowing students to tailor their interests. Use of other courses at other institutions (Western Deans' Agreement which allows graduate students to take courses at other institutions), graduate student exchange programs (national, international), and on-line access would allow for this diversity.

Continuing education in the field of Ecological Restoration was identified as a key component of a successful program.

2.0 Summary of Focus Group Comments

BCIT/SFU Graduate Program on Ecological Restoration, February 10, 2012, SFU Vancouver

PROGRAM STRUCTURE

Suggested names: Ecological Systems Management, Ecological Protection and Restoration

Be realistic about what you can include (i.e. solid foundation and ability to learn)
Build upon entering students' background (e.g. engineering, biology, BCIT)
Program needs to have a focus
Built on existing SFU/BCIT strengths that do not to compete with other Ecological Restoration (ER) programs but complement

Provide wide diversity of courses and flexibility
Utilize courses at other institutions globally, including University of Victoria

Year 1 – core skills followed by Year 2 – specialization within ER, (with 4 – 6 possible areas)
Students start in the first term together, to establish a cohort
Core classes to bring cohort together
Some central courses offered as special one-week intensives

Recommend 1/3 applied, 2/3 academic with hands-on training
Have a balance between ER skills and management skills

Articulate what prerequisite knowledge students must have
Identify target audience as those with only undergraduate degrees and/or upgrading of professionals
Target program to working ER professionals (e.g. certificate programs)
Consider associated program for upper level managers giving them ER basics
Combine working professionals and students in program cohort

Provide program credit for attending workshops and conferences
Ensure the program has a professional designation (i.e. Society of Ecological Restoration, P.Bio.)
Program should dovetail with existing/emerging programs and continuing education
Use existing SFU/BCIT courses as much as possible
Incorporate scholarships particularly for people from rural and First Nations communities
How do you design for students with less academic and more technical and applied (e.g. BCIT)

CONTENT

General

Develop overall learning outcomes with flexibility, ensure academic quality control
Have science foundation with strong communication and management components
Technical skills get you in the door, need communication/management skills to stay in the room
Generalists do well but they need a specialist foundation/skill

Needs to reflect our values in B.C., Canada and internationally
Needs to be interdisciplinary
Interface with research questions (Effectiveness? Value? Scale-up? Climate Change? Adaptation?)
Understand scale of time, physical scale in project/program design
Address effect of rapid ecosystem change in ER strategy (e.g. climate change and biodiversity)
Understand knowledge in terms of the known, uncertain and unknown
Use an integrated approach across sectors, addressing issues like climate change and biodiversity
Need to understand the research and complexity
Understand system function, collapse and resilience (e.g. ecological, financial, social)
Use historic landscapes/watershed processes to understand ER (e.g. sensitive, climate change)
Focus on community based restoration
Incorporate ecological protection with restoration is key
Aquatic focus in BC is important and ability to create a niche
Emphasize Water Restoration and leave terrestrial because too industry specific
Include Canadian North content
Include First Nations history, culture and perspectives

Environmental Science

Population and Community Ecology
Geology, Geomorphology
Traditional Ecological Knowledge and integration with science
Watershed processes both biological and physical

Ecological Restoration

Ecosystems/adaptive management understanding scales
Strategic preparation and implementation of ER plans, projects and programs for maximum impact
Assessment, monitoring and evaluation of projects and programs
Environmental impact assessment

Ecological Restoration Specialty Areas

Limnology
Aquatic biology and ichthyology
Species at risk, keystone species, indigenous species
Principles of soil science and reclamation
Sediment budget analysis
Water resource science and management
Forestry management
Stream restoration techniques
Wetland construction and restoration
Slope stability, bank stabilization, erosion and sediment control
Rangeland restoration
Riparian vegetation restoration and remediation
Estuary processes Riparian
buffers Acquiring/purchasing
habitat
Knowledge of offsets and the offset market
Natural features protection
Environmental engineering/hydraulics

Social Sciences

Policy planning and analysis
Environmental regulation and law
Environmental ethics and philosophy
Governance structures and processes
First Nations history and culture
Measuring the value of environmental services
Tools to evaluation economic, social and environmental factors

International

Need to consider transfer of knowledge to other countries like China and India.
Teach domestic and international students international/inter-cultural collaboration
Provide skills/knowledge for domestic students to work abroad (but they must learn by doing)
Build on knowledge and skills in community engagement and communication
Partner with IDRC

General Skills

Technical writing, documentation and written communication skills
Verbal communication and facilitation, marketing

Building and working within teams
Project development and management
Conflict resolution
Building and working with partnerships
Engaging local and First Nation communities
Working with/directing construction crews
Safety
Hands-on skills (e.g. running equipment in ER)

Tools for Ecological Restoration

Molecular techniques
Geospatial tools (e.g. GIS, remote sensing)
Modeling
Experimental design
Databases
Statistical Analysis
Restoration software programs
New technologies to support collaboration

PROJECTS/PRACTICA/INTERNSHIPS

Students need to understand the industry and have knowledge of the different sectors
Must have community involvement to keep it relevant and meaningful and build capacity
Interdisciplinary teamwork is critical
Develop on-going cooperative projects with industry Develop
projects and internships in specialized areas
Project/Coop/internships must have deliverables upon completion
Set-up a hands-on semester which is a "open" term for field projects, internships etc. (summer?)
All students complete a 1-week intensive field station course (e.g. Malcolm Knapp, Bamfield)

PEDAGOGY

Engage professionals as course developers, instructors, guest speakers and/or field trip leaders
Use professors from different universities, each assigned course lectures via web
Engage mentors
Consider using an eco-theatre course where students run a mock ER workshop
Use case studies, read/critique technical reports and proposals
Integrate statistics, quantitative tools and communication technologies in courses and projects
Part of curriculum needs to be team-based utilizing applied skills in a team project

ATTRIBUTES OF GRADUATES

- Generalists with good science/ER foundation, not specialists
- Big picture thinkers on projects/programs
- Ability to embrace change and uncertainty
- Critical thinkers
- Able to think outside box and seek solutions
- Able to use analytic/quantitative skills and work with these specialists
- Good managers, relationship builders and agents of change
- Ability to work effectively within multi-disciplinary teams
- Adaptive with high standards/professionalism
- Possesses an environmental ethic
- Have excellent observational skills – seeing, analyzing and processing
- Leadership ability in ER and environment

3.0 Ecological Restoration Steering Committee:

Ken Ashley, Instructor, Ecological Restoration Program, BCIT

Leah Bendell, Director, Environmental Sciences, & Professor, Biological Sciences, SFU*

Dan Burns, Manager, Curriculum and Academic Planning, Faculty of Environment, SFU*

Patricia Gallaugher, Director, Centre for Coastal Science and Management, SFU*

Mike McPhee, Instructor, Ecological Restoration, Douglas College

Jonathan Moore, Liber Ero Chair in Coastal Science and Management, SFU

Doug Ransome, Program Head, Ecological Restoration Program, BCIT*

Rudy Reimer, Instructor, Archeology, SFU

Rob Stevens, Associate Dena, School of Construction and Environment, BCIT

Jeremy Venditti, Assistant Professor, Geography, SFU

Laurie Wood, Coordinator Centre for Coastal Science and Management, SFU*

*Focus Group Steering Committee

Hosted by the Faculty of Environment, Simon Fraser University and the School of Construction and Environment, British Columbia Institute of Technology

Ecological Restoration Graduate Program Focus Group
February 10, 2012
AGENDA

Room 1600, Canfor Policy Room, SFU Harbour Centre, 515 W. Hastings

10:00 am refreshments available at 9:30	**Welcome and Introduction** John Pierce, Dean of Environment, Simon Fraser University Rob Stevens, Associate Dean, Natural Resources, School of Construction and the Environment, British Columbia Institute of Technology Introduction of Participants
10:30 am	**Ecology as the Cornerstone for a graduate Program in Ecological Restoration** Buzz Holling, Emeritus Eminent Scholar and Professor, Ecological Sciences, University of Florida
10:50	**Sector Perspectives on Ecological Restoration Knowledge/Skill Requirements** Five to ten minute presentations followed by discussion Mark Zacharias, Assistant Deputy Minister, Environment, Sustainability and Strategic Policy, BC Ministry of Environment Craig Orr, Executive Director, Watershed Watch Salmon Society Camille Rivard-Sirois, Biologist, Habitat Projects, Okanagan Nation Alliance Dave Heller, Formerly with US Forest Service Hans Schreier, Professor Emeritus, Institute for Resources, Environment and Sustainability, UBC Barry Chilibeck, Ecohydraulic Engineer, Northwest Hydraulic Consultants
12:15	Hosted Working Lunch (dialogue continues) Open discussion on program content, structure and pedagogy
1:30	**Professional Graduate Program in Ecological Restoration Priorities** Facilitated by: Ken Ashley, Instructor, School of Construction and Environment, BCIT Jeremy Venditti, Assistant Professor, Geography, SFU Dan Burns, Manager, Curriculum and Academic Planning, Faculty of Environment, SFU Jonathan Moore, Liber Ero Chair in Coastal Science and Management, SFU
2:30	**Concluding Remarks**

List of Participants

Ken Ashley, Instructor, School of Construction and the Environment, BCIT
Leah Bendell, Director, Environmental Sciences, and Professor, Biological Sciences,
SFU Richard Boase, Environmental Protection Officer, District of North Vancouver
Tamara Bonnemaison, Chair, Ecological Restoration Society, BC Chapter
Dan Brown, Graduate, Ecological Restoration,
BCIT Dan Buffet, Senior Biologist, Ducks
Unlimited
Dan Burns, Manager, Curriculum and Academic Planning, Faculty of Environment,
SFU Barry Chilibeck, Ecohydraulic Engineer, Northwest Hydraulic Consultants
Alison Eveley, Natural Resource Management Specialist, MetroVancouver
Patricia Gallaugher, Director, Centre for Coastal Science and Management,
SFU Philippe Gerard, Director of Advancement, Faculty of Environment,
SFU
Ken Hall, Professor Emeritus, Institute for Resources, Environment and Sustainability, UBC
Dave Heller, Formerly with US Forest Service
Buzz Holling, Emeritus Eminent Scholar and Professor, Ecological Sciences, Univ. of Florida
Courtenay Kellock, Graduate, Ecological Restoration, BCIT
Al Martin, Director of Strategic Initiatives, BC Wildlife
Federation Michael McPhee, Instructor, Ecological Restoration,
Douglas College Arnie Narcisse, Executive Director, Lower
Nicola Indian Band
Jonathan Moore, Liber Ero Chair in Coastal Science and Management, SFU
Craig Orr, Executive Director, Watershed Watch Salmon Society
George Pess, Research Fishery Biologist, Northwest Fisheries Science Centre,
NOAA Darcy Pickard, Essa Technologies
John Pierce, Dean, Faculty of Environment, SFU
Dave Polster, Polster Environmental Services
Doug Ransome, Program Head, Ecological Restoration Program,
BCIT Derek Ray, Geomorphologist, Northwest Hydraulic
Consultants
Rudy Reimer, Instructor, Archeology, SFU
Camille Rivard-Sirois, Biologist, Habitat Projects, Okanagan Nation Alliance

Tommy Rodengen, Graduate Student, Biological
Sciences, SFU Sean Smukler, Assistant Professor, IRES,
UBC

Hans Schreier, Professor Emeritus, IRES, UBC

Rob Stevens, Associate Dean, School of Construction and Environment,

BCIT Toby St. Clair, Graduate Student, Biological Sciences, SFU

Jeremy Venditti, Assistant Professor, Geography, SFU

Laurie Wood, Coordinator, Centre for Coastal Science and Management, SFU

Mark Zacharias, ADM, Environment, Sustainability and Strategic Policy, BC Ministry of Environment

Appendix 4b: Letters of Support

- Dr. Thomas P. Sullivan, Professor in the Faculty of Forestry and Faculty of Land and Food Systems at the University of British Columbia.
- Brian Springinotic, Chief Executive Officer, Habitat Conservation Trust Foundation.
- Dan Buffet, Head of Conservation Programs – BC Coast, Ducks Unlimited Canada (DUC).
- Patricia Thomson, Executive Director, Stanley Park Ecological Society.
- Greg Wilson (M.Sc. R.P.Bio.), Aquatic Species at Risk Biologists and Dr. Peter Tschaplinski (Ph.D. P.Ag.), Unit Head, Ecosystem Science, Ecosystem Protection, and Sustainability Branch, Ministry of Environment.
- Eva Schindler, Team Leader Fish & Wildlife Compensation Program, Ministry of Forests Lands and Natural Resources Operations.
- Program Advisor Committee, Renewable Resources, Ecological Restoration Program, British Columbia Institute of Technology.
- Craig Wightman , Senior Fisheries Biologist, The British Columbia Conservation Foundation (BCCF), Vancouver Island.

THE UNIVERSITY OF BRITISH COLUMBIA

Department of Forest and Conservation Sciences
Faculty of Forestry
3rd Floor, Forest Sciences Centre
3041 – 2424 Main Mall
Vancouver, B.C. Canada V6T 1Z4
Tel: (604) 822-2507 Fax: (604) 822-9102

January 24, 2014.

Dr. Douglas B. Ransome,
BC Institute of Technology,
Burnaby, BC.

Dear Douglas:

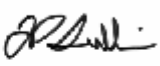
Re: The proposed Master of Science degree in Ecological Restoration

Thank you for informing me of the proposed Master of Science (M.Sc.) degree in Ecological Restoration to be offered through your Institute and Simon Fraser University. After reviewing the concept paper, I am most impressed by this initiative and believe it is a much-needed addition to our academic environmental-conservation programs in BC and Canada.

As noted, there is a critical need to improve habitat for threatened and endangered species through ecosystem restoration efforts across BC, Canada, and internationally. Restoration ecology has become a key discipline in need of rapid advancement. Across Canada, the United States, and the European Union, local and national governments have adopted an ecological restoration approach to their operations. We need to restore our degraded ecosystems such that ecosystem integrity is re-established and goods and services they once provided can again be realized. This is also the essence of sustainability of development: to provide for today while not compromising the ability of future generations to provide for themselves. Therefore, there is a strong need for graduates trained in the foundation and techniques of this new and rapidly growing discipline.

I see this program as dove-tailing with several environmental and conservation undergraduate programs at the three major academic institutions in BC. A graduate program in EcologicalRestoration will be a unique offering and should be readily populated by post-graduate students.

Yours sincerely,



Thomas P. Sullivan
Professor
Wildlife Ecology and Conservation
E-mail: tom.sullivan@ubc.ca

HABITAT
CONSERVATION TRUST
FOUNDATION

January 17, 2014

Sean Markey,
Associate Dean,
Faculty of the Environment
Simon Fraser University
TASC2 Suite 8800
Burnaby, BC V5A 1S6

Rob Stevens
Associate Dean,
School of Construction and the Environment
British Columbia Institute of Technology
3700 Willingdon Avenue
Burnaby, BC V5G 3H2

Via Email

Dear Sirs:

I am writing in support of the Master of Science (M.Sc.) Degree in Ecological Restoration being jointly proposed by your organizations.

The Habitat Conservation Trust Foundation (HCTF) has a long history of investing in ecological restoration and enhancement projects across British Columbia, and has directly invested over $140M in such projects, focused on conserving, restoring or enhancing wildlife populations and habitats.

The history of this province is one of natural resource development, which invariably has impacts on our natural ecosystems. While British Columbians and Canadians have clearly benefitted from this development, ecosystem functions have been lost or degraded as a result. With over $50 billion in resource development projects planned for BC over the coming decades, and high public expectations regarding protection of environmental quality, it is essential that we train and educate the next generation of scientists to ensure that we can meet both goals of economic development and ecosystem protection and restoration.

By virtue of the work we do, HCTF is connected to the network of biologists and scientists who work in the field of ecosystem restoration. Two trends that are emerging are 1) a demographic aging of the current cohort of conservation scientists; and 2) a significant decline in the science capacity of provincial

107-19 Dallas Road Victoria British Columbia V8V 5A6
WWW.HCTF.CA 1-800-387-9853

resource agencies. BC residents have high expectations that environmental quality will not be degraded as the economy expands. If we are to strike a reasonable balance between resource development and ecosystem protection and restoration, we need to train and deploy the next generation of scientists to help strike this balance.

If you have any questions regarding the Foundation, or additional rationale for our support for this proposal, please feel free to contact me.

Regards,

Brian Springinotic
Chief Executive Officer

CC: Douglas Ransome, Program Head: B. Tech. in Ecological Restoration, British Columbia Institute of Technology

Ducks Unlimited Canada
Conserving Canada's Wetlands

Douglas B. Ransome,
Program Head: B. Tech. in Ecological Restoration
British Columbia Institute of Technology
3700 Willingdon Avenue,
Burnaby, B.C. V5G 3H2

January 24, 2014

Re: BCIT-SFU Masters Program in Ecological Restoration

Dear Mr. Ransome:

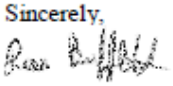
This letter confirms Ducks Unlimited Canada's (DUC) support for the proposed joint BCIT-SFU Master of Science (M.Sc.) in Ecological Restoration. The proposed program will fill a recognized need of ecological restoration practitioners that have the full complement of skills to build resilient environments for people and wildlife. These skills will not only contribute to restore what has been lost, but also better inform future decisions on land use decisions.

DUC's supports the intended outcomes of the proposed program to strengthen the linkages between technical and applied science aspects of ecology and engineering, theory with practical knowledge, and blending the natural science of planning, implementing and evaluation with the social science of working with people and landowners on the landscape. Ecological restoration has been a foundation of DUC for over 75 years in Canada and is the basis for our investment in 590 habitat conservation projects in BC, and over 9,000 projects nationally. DUC combines restoration projects with different forms of habitat protection to ensure long term benefits for landowners and society.

Over the past decade DUC has partnered with faculty and students from both BCIT and SFU on a variety of student projects, student internships and master projects. This linkage between DUC and academic institutions creates a mutual benefit for both participants. DUC looks forward to a stronger relationship with BCIT and SFU on joint projects and or initiatives through this program.

DUC is the leader in wetland conservation. A registered charity, DUC partners with government, industry, non-profit organizations and landowners to conserve wetlands that are critical to waterfowl, wildlife and the environment. DUC uses sound science to conserve, restore and manage vital wetland areas that keep our country healthy, strong and prosperous. For over 75 years, DUC has been making a real and meaningful difference on the landscape through on-the-ground habitat work, research, education and policy efforts.

Sincerely,



Dan Buffett,
Head of Conservation Programs – BC Coast
Ducks Unlimited Canada

Unit #511 – 13370 78th Ave, Surrey, BC, V3W 0H6
Direct: 604-592-5003, Toll Free: 1-800-665-DUCK (3825), Fax: (604) 592-0930,
E-mail: d_buffett@ducks.ca, Website: ducks.ca

STANLEY PARK ECOLOGY SOCIETY
Connecting people with nature since 1988

2nd Floor, Stanley Park Dining Pavilion, PO Box 5167, Vancouver, BC V6B 4B2
P (604) 257-6908 **F** (604) 257-8378 **E** info@stanleyparkecology.ca **W** stanleyparkecology.ca

Douglas B. Ransome, Ph.D., R.P.Bio.
Ecological Restoration, Program Head
Faculty, Department of Renewable Resources
British Columbia Institute of Technology
3700 Willingdon Avenue, Burnaby, BC V5G 3H2

January 25, 2014

Dear Dr. Ransome,

I am writing to provide the unqualified support of Stanley Park Ecology Society for the proposed MSc program in Ecological Restoration (ER), a joint initiative of the British Columbia Institute of Technology and Simon Fraser University. These institutions are uniquely suited to play complementary roles in developing a high quality program in ER: SFU is strongly qualified to develop knowledge of theoretical foundations, while BCIT has the experience and resources to develop applied concepts and skills. Very few institutions in North America offer an advanced degree in ER. However, increasing recognition of the critical need to restore degraded ecosystems strongly suggests an expanding need and employment opportunities for restoration professionals.

BCIT has a long-standing reputation for providing very high quality training for a range of natural resource professions. BCIT graduates compare favorably with their peers from other institutions in terms of technical, communication, and professional skills needed to successfully manage a range of projects. Over many years, Stanley Park Ecology Society has co-supervised with BCIT faculty many successful undergraduate projects. Of particular note, students in the BCIT undergraduate program in ER have developed and implemented exceptional restoration plans for a range of sites in Stanley Park. I am confident that the joint BCIT-SFU MSc program will build on the strengths of this undergraduate program, and thus play an essential role in developing leaders in the expanding field of ER.

Thank you so much for your valuable support; it is making a direct legacy for the resiliency of Stanley Park.

Most sincerely,

Patricia Thomson
Executive Director

Connecting People with Nature

January 28, 2014

Dr. Douglas Ransome
Program Head, Ecological Restoration
Fish, Wildlife, and Recreation Program
British Columbia Institute of Technology
3700 Willingdon Avenue
Burnaby, B.C. V5G 3H2

Re: Support for developing Masters Degree level program in Ecological Restoration.

Dear Dr. Ransome,

We are writing to express our support for BCIT's plan to develop a Master of Science Degree in the Ecological Restoration Program, in conjunction with Simon Fraser University.

We have substantial experience in research, implementation, monitoring and the development of guidelines and standards relating to watershed function and restoration, and understand the need to develop ongoing expertise. Naturally functioning ecosystems have high intrinsic value, and maintaining ecosystem function is necessary to achieve the Ministry's goals in species and ecosystem conservation, and fish and wildlife management, while supporting positive economic outcomes through natural resource developments.

As you have proposed, training an effective ecosystem restoration professional starts with a comprehensive academic foundation in ecosystem function and basic habitat restoration science, combined with hands-on experience with all aspects of project implementation. The ongoing development of expertise in ecological restoration will help to continually implement lessons learned from past restoration experiences, and develop new and innovative restoration techniques.

Whether BCIT-SFU program graduates work in academia, industry, or for a management agency, they will be fundamental to safeguarding the essential investments in watershed and estuarine restoration. We look forward to the launch and future success of your new BCIT-SFU Master of Science Degree program in Ecological Restoration.

Sincerely,

Greg Wilson, M.Sc, R.P.Bio.
Aquatic Species-at-Risk Biologist

Dr. Peter Tschaplinski, Ph.D. P.Ag.
Unit Head, Ecosystems Science

Ministry of Environment Ecosystems Protection & Sustainability Branch
Mailing Address: PO Box 9338 Stn Prov Govt Victoria BC V8W 9M1
Telephone: 250-387-9731 Facsimile: 250-387-9750 Website: www.gov.bc.ca/env

January 31, 2014

Doug Ransome
BCIT Program Head
B. Tech. in Ecological Restoration
British Columbia Institute of Technology

Subject: Support for Master of Science (M.Sc.) Degree in Ecological Restoration

Dr. Ken Ashley provided me with a copy of the concept paper for proposing a Master of Science Degree in Ecological Restoration, a joint initiative between the British Columbia Institute of Technology and Simon Fraser University. I am writing this letter of support towards your initiative.

I am currently a Team Leader within the Ministry of Forests, Lands and Natural Resource Operations supervising five staff, two of them are wildlife biologists, and two are fish biologists. We deliver on the ground ecological restoration work as mitigation for BC Hydro impoundments in the Columbia. One of the fish biologists is a recent hire who will be the lead biologist in delivering two large scale nutrient restoration programs on Kootenay Lake and Arrow Lakes Reservoir. (I would like to add that your director of the Rivers Institute, Dr. Ken Ashley was instrumental in the implementation of these programs).

Our recent hire obtained experience by working with me as a technician for four years and then moved on to pursue her Master of Science Program in Natural Resources Environmental Studies from the University of Northern British Columbia. The combination of the experience gained in assisting with a large scale ecological restoration project and the additional technical expertise from their Master's program provides an excellent combination of having the skill set required to delivering and leading a restoration program.

The program outlined in your concept paper would provide the skills to individuals pursuing careers in ecological restoration and ensure they were competitive in future opportunities within the government system.

I have a suggestion regarding your program which is defining performance measures within the restorative works that the students would be pursuing. Performance measures along with cost-benefit analyses are items that funding providers are requesting toward ecological restoration initiatives.

If you have any additional questions, please do not hesitate to contact me.

Sincerely,
Eva Schindler
Team Leader – FWCP – Section - MoFLNRO

Ministry of Forests, Lands and Natural Resource Operations
Resource Management Kootenay-Boundary
Mailing/Location Address: #401 333 Victoria Street Nelson BC V1L 4K3
Telephone: 250 354-6333
Facsimile: 250 354-6332

E-mail
To: Doug Ransome
Program Head, Ecological Restoration Program.
Received February 1st, 2014.

January 31, 2014.

To whom it may concern:

As a member of the Advisory Committee for Ecological Restoration, I wanted to convey the Committee's enthusiastic support for the proposed M.Sc. in Ecological Restoration, a collaborative program with the Faculty of Environment at Simon Fraser University. The Committee unanimously endorsed the proposal both for its need and as an extension to educational opportunities offered by the two Institutions.

From the description of the proposed program that we have seen, it appears to be a well thought-out program that would provide students with a well-balanced approach merging theoretical concepts with excellent applied skills. With the anticipate significant increase in natural resource extracted planned for British Columbia, and Canada as a whole, there will be a critical need for well-trained restoration ecologists to guide this development and minimize the potential negative impacts to the environment. The BCIT-SFU collaboration has identified a niche that is not being offered at this level and focus elsewhere in Canada (that we are aware of) and are quite confident the proposed program will produce highly-trained graduates to fill a much-need role in these proposed developments. As such, we do believe that students graduating from the proposed program would be very likely to find related employment in an employment environment lacking any other competition. Furthermore, as the governments (provincial and federal) emphasize development and economic growth, society will demand highly-trained experts to guide development and these restoration activities.

Once again, we enthusiastically support the development of the M.Sc. in Ecological Restoration. Please let me know if the Committee can be of further assistance in seeing this important program become an integral part of the overall program.

Sincerely,

Dr. Ken Hall, Professor Emeritus

Dept. of Civil Engineering

The University of British Columbia

Ecological Restoration Advisory Committee

January 31, 2014

Dr. Douglas Ransome
Program Head, Ecological Restoration Program
School of Construction and the Environment
BC Institute of Technology
3700 Willingdon Avenue
Burnaby, BC V5G 3H2

Dear Doug:

I have read the *Proposal for a Master of Science (MSc.) in Ecological Restoration* (January 22, 2013), prepared by staff of the BC Institute of Technology and Simon Fraser University. I am a current member of the BCIT Advisory Committee for Ecological Restoration, with more than 40 years of applied fisheries management and habitat restoration experience in the province.

I wish to express my strong personal and professional support for the proposed MSc. program as a very positive step in developing "leaders of tomorrow" in the rapidly evolving discipline of ecological restoration. The proposal's well-structured course content, skill elements and integrated multi-disciplinary philosophy are exactly the right approach for effectively restoring degraded terrestrial and aquatic ecosystems in BC, and elsewhere.

The BCIT-SFU proposal team has clearly recognized today's need for successfully combining a strong theoretical science background with applied practical knowledge in ecological problem diagnosis, assessment of remedial options, need for social and regulatory license, and effective communications/monitoring as the basis for successful restoration outcomes. Future MSc. graduates whom embody these important traits will be highly recruited and valued by prospective employers.

The proposed MSc. program will the first of its kind in Canada, and one of very few in North America. As such, graduates should enjoy a significant advantage in the competition for both entry and leadership positions in the industry (i.e., government, private sector and NGO's). My organization would certainly be among those interested in such well-trained and accredited restoration practitioners.

In summary, I enthusiastically endorse development of the MSc. Program in Ecological Restoration. Please advise if I can be of any further help in moving this proposal forward in the near future.

Yours truly,

J.C. Wightman, RPBio.
Senior Fisheries Biologist
BC Conservation Foundation
Nanaimo, BC

www.livingrivers.ca

Appendix 5: Regulatory, Licensing, Credentialing, or Professional Bodies – Current Requirements or Standards

- Society for Ecological Restoration
- College of Applied Biology

SOCIETY FOR ECOLOGICAL RESTORATION

SER ECOLOGICAL RESTORATION PRACTITIONERS CERTIFICATION PROGRAM AND PROPOSED REQUIREMENTS FOR CERTIFICATION

Abridged Version Dated 1/9/14

Developed by the SER Ad-hoc Certification Committee for the Purpose of Vetting the Requirements for Certification

The Society for Ecological Restoration (SER) is developing a certification program for practitioners of ecological restoration. Ecological restoration practitioners are defined as "persons who are actively engaged in the various phases and aspects of ecological restoration and who are knowledgeable in the concepts of restoration ecology and the principles and practices of ecological restoration".

The Practitioners Certification Program (PCP) is being designed to meet the needs of ecological restoration practitioners who are involved with the planning, design, implementation-construction, maintenance, and monitoring of ecological restoration projects and those practitioners who are typically involved with the planning, implementation and management of landscape-scale ecosystem restoration programs. This program will also benefit those sectors of our society that authorize (e.g., permit) ecological restoration work and give assurance to sponsors of ecological restoration projects/programs that the practitioners whom they engage are recognized by their peers for their knowledge, expertise and experience.

The proposed levels of certification and titles are:

- Level 1 – Designation as an Ecological Restoration Practitioner In-Training (ERPIT)
  - Applicants for ERPIT must meet either the education or experience requirements for Level 2 certification (or a combination of education and experience). The applicant must also meet the foundations of the profession requirements and the administrative requirements.

- Level 2 – Certification as a Certified Ecological Restoration Practitioner (CERP)
  - Applicants for CERP must meet both the educational requirements and the experience requirements for Level 2 certification. The applicant must also meet the foundations of the profession requirements and the administrative requirements.

Proposed Certification Requirements[6]

Applicants for each level (ERPIT, CERP) must achieve the minimum standards for that level for each of the following three elements:

[6] These proposed requirements for the certification of ecological restoration practitioners are still considered to be preliminary and tentative. They will be subject to additional review and revisions by the Ad-hoc Certification Committee and/or the Society for Ecological Restoration Practitioners Institute.

- Educational Achievement – a combination of academic credentials and accumulation of knowledge relevant to the profession of ecological restoration;
- Professional-level Experience – experience performing restoration project and/or program work, not only in terms of the number of years of experience but also in terms of the depth and breadth of an applicant's experience;
- Foundations of the Profession – knowledge and understanding of the fundamental concepts of ecological restoration presented in SER foundation documents, knowledge of, and agreement to adhere to, the SER Code of Ethics, and agreement to the PCP Disciplinary Policy.

Educational Achievement Element

Educational achievement is measured by a tiered point-based system intended to provide flexibility for applicants to meet the educational achievement requirements. The Educational Achievement Point System consists of two components, Credential Points and Knowledge Points:

- Credential Points – points earned for an academic degree, certificates in ecological restoration or restoration ecology, and advanced degrees in subject areas related to ecological restoration;
- Knowledge Points – points earned for knowledge of essential subject areas, highly recommended subject areas, and additional beneficial subject areas.

Applicants for CERP are required to earn a certain total number of Educational Achievement Points (combined Credential Points and Knowledge Points):

- ERPIT = No specific total number of points is required.
    - Requires a combined number of Educational Achievement Points and Experience Points on a sliding scale. (detailed in the SER original document).
- CERP = 100 points

Credential Points are awarded for the highest basic academic degree (Tier 1), certificates in programs related to restoration (Tier 2), and advanced degrees in programs related to restoration (Tier 3).

Knowledge Points can be earned in three ways:

- Collegiate Coursework[7] – points earned for having taken college and/or university courses in subject areas relevant to ecological restoration;
- Specialized Training – points earned for having taken short courses and workshops offered by academic institutions, for-profit companies, non-profit organizations and governmental agencies dealing with subject areas relevant to ecological restoration;
- Self-directed Learning and Experiential Learning – Points earned for having mastered an essential subject area relevant to ecological restoration through self-directed learning activities and/or experience as evidenced through submittal of documentation.

The calculation of Knowledge Points for collegiate coursework, short courses and workshops is based on the concept of "Instructional Contact Hours". Instructional Contact Hours are the hours a student spends in class. To calculate Knowledge Points divide the number of "Instructional Contact Hours" by 10. For

[7] College and university courses for which points can be earned must be 200-level or above.

example, a 3-credit course conducted over a 15-week semester involves 45 contact hours equaling 4.5 points whereas a 1-day 8-hour workshop would equal 0.8 points (Table 2).

Professional Level Experience Element

Applicants are expected to have professional-level experience regardless of the type of position they currently hold. Professional-level experience can be obtained while working, volunteering or interning for any kind of entity that conducts or sponsors ecological restoration projects or restoration-related projects including a governmental agency, private business, non-profit organization, community-based organization, academic institution or tribal entity. Thus, it is possible for qualified volunteers and volunteer coordinators to be become certified along with consultants, government agency personnel, NGO staff and academic instructors.

Applicants are required to have gained a certain minimum number of years of full-time equivalent (FTE) experience performing restoration project work at a professional-level. The number of years of FTE experience required depends on level of certification sought by the applicant. Full-time equivalent (FTE) experience is defined as working (paid or unpaid) full-time (40 hours per week) at a professional level on restoration project/program related activities. Since many practitioners devote only part of their work time to restoration project/program work they will need to assign a Full Time Equivalency Percentage (FTE%) to each position listed.

- Level 1 - ERPIT – no set minimum experience requirement
    - Applicant must qualify based on sliding scale of Educational Achievement Points and number of years of FTE experience (see below)
- Level 2 - CERP – five (5) years FTE

Applicants who have spent time working on restoration projects while enrolled in an academic program (e.g., an ecological restoration curriculum or college capstone projects that emphasize involvement in community-based restoration project work) will be allowed to count that time (documentation required) towards their length of experience requirement.

This type of experience requirement is designed to evaluate depth and breadth of an applicant's experience. Applicants will be required to provide documentation of the types of ecological restoration project experience they have gained through their employment, volunteer work and student internships as related to the various phases and aspects of ecological restoration.

- Level 1 - ERPIT – This requirement does not apply to applicants for ERPIT.
- Level 2 - CERP – The specific number of phases and aspects required for applicants for CERP is addressed below.

There are many phases of an ecological restoration program applicants should experience (Table 1). Thus applicants will be access on the completeness of their experiences.

Table 1. Phases and aspects of an ecological project or program evaluated for certification as an certified Ecological restoration Practitioner by the Society for Ecological Restoration.

Phases and Aspects of Ecological Restoration Projects and Programs	
Phases	**Aspects**
1. Conceptual Planning Phase	Preliminary Project Site Inventory/Assessment/Monitoring
	Analysis of Causes of Degradation, Damage and Disturbance
	Identification of Kinds of Physical and Biotic Interventions Needed (incl. Resilience Recovery Strategies and Methods)
	Stakeholder Involvement/Outreach Efforts
	Identification of Required Permits, Deed Restrictions and Other Legal Constraints
	Financial Involvement (Funding, Grants, etc.)
	Establishment of Project Goals
2. Planning and Design Phase	Detailed Analysis of Project Site Conditions
	Reference Site Selection, Reference Model Creation, Analysis of Reference Site
	Finalization of Project Goals, Establishment of Project Objectives and Determination of Attributes to be Restored
	Preparation of Project Concept Plans, Detailed Plans, Specifications, Bid Documents
	Environmental and Construction Permit Applications
	Preparation of Performance Standards and Design of Monitoring Program (incl. Monitoring Protocols)
	Identification of Labor, Equipment and Biotic Resource Needs
	Scheduling of Tasks and Budgeting of Implementation/Construction
3. Implementation - Construction Phase	Collection, Growing, and Maintenance of Propagules (e.g., plant materials, animals)
	Procurement of Materials and Equipment
	Worker Training/Supervision and Volunteer Coordination
	Site supervision
	Site Preparation, Modification and Installation of Physical Structures and Infrastructure
	Invasive Species Removal/Control
	Planting, Transplantation and Propagule Protection
	Documentation of As-Built Conditions
4. Maintenance, Monitoring and Management Phase	Site Inspections
	Invasive Species Management
	Post-Implementation Maintenance (e.g., Plant Materials and Protection Devices)
	Monitoring of Site Conditions & Biota to Evaluate Success
	Implementation of Remedial Actions and Adaptive Management
5. Evaluation & Reporting Phase	Analysis of Monitoring Data and to Determine Attainment of Performance Standards
	Preparation of Project Reports, Permit Closure
	Preparation and Publication of Case Study

There is no minimum requirement for ERPIT. Applicants for CERP will be expected to meet the following criteria:

- Show experience in a minimum (threshold) number of aspects to get credit for a phase (refer to Table 3 below);
- Show experience in a minimum of 3 of the 5 phases;
- Show experience in at least 50% (16) of the 31 listed aspects.

Comparison of the proposed M.Sc. in Ecological Restoration with Requirements for CERP Certification

Educational Achievement Criterion

A comparison of the points needed for certification as Certified Ecological Restoration Practitioner with the proposed program indicates that the proposed program will satisfy 73 of the 100 points needed for the education achievement criterion (Table 2). In addition, five of the eight essential subject-area categories will have been fully satisfied by the proposed program. The program will also satisfy 50% of two of the remaining categories (Hydrology and Soil Science). The remaining requirements will primarily be met by the entry requirements (Section 6.1) or through courses taken during the applicant's undergraduate program.

Table 2. Comparison of points provided by the proposed M.Sc. in Ecological Restoration and points required within essential subject areas to meet certification requirements as a Certified Ecological Restoration Practitioner (CERP) by the Society for Ecological Restoration. Points are based upon 1 point for each 10 hours contact time within a course.

Essential Subject Areas for Knowledge Points	BCIT/SFU M.Sc. in ER	Course Title	Required Points for CERP
Biological Sciences (Plant Sciences, Aquatic Biology, Wildlife Biology)	13.5	ECO 611: Concepts of ER and the Biological Environment SFU Electives	13.5 points
Ecology	4.5		4.5 points
Ecological Restoration	9.0	ECOR 9110: Planning and Monitoring for Ecological Restoration ECOR 9210/20: Restoration of Terrestrial or Aquatic Ecosystems	8.0 points
Hydrologic Science	2.25	ECO 611 Concepts of ER & the Physical Environ.	4.5 points
Soil Science	2.25	ECO 611 Concepts of ER & the Physical Environ.	4.5 points
Quantitative Sciences and Sampling Design	9.0	ECO 621: Graduate Seminars in Research Methods ECOR 9200: Field	4.5 points

		Application of Restoration Principles	
Planning and Project Management	4.5	ECO 622 Project & Policy for Ecological Restoration	4.5 points
Restoration-relevant Social Sciences	4.5	ECO 641: First Nations and Social Perspectives of Ecological Restoration	4.5 points
Total Number of Points	45.0		48.5 points
Credential Points			
Bachelor Degree	12		
Master Degree in ER	16		
Total	73		100 points

Professional Level Experience Element

Graduates from the proposed M.Sc. program in Ecological Restoration will be able to use their two-term Applied Research Project towards meeting the 5 years Full-time Equivalence needed for certification at the Certified Ecological restoration Practitioner level. Through this course, students will address a minimum of 12 aspects of a restoration program. Of the five main phases of a restoration program (Table 1), students completing the Applied Research Project will fully satisfy two of the main phases (Table 3). More phases may be satisfied depending upon the goals of specific student projects.

Table 3. Comparison of the total number of aspects in a full restoration activity, number required to meet CERP criteria, and the number meet by BCIT/SFU's Applied Research Project in the Proposed M.Sc. of Ecological Restoration.

Phases (see the preceding table)	Total Number of Aspects	Number of Aspects Required to Qualify for Each Phase	Number of Aspects Cover by the Proposed BCIT/SFU M.Sc. through the Applied Research Project
1 Conceptual Planning	7	2	7
2 Planning & Design	8	3	5
3 Implementation - Construction	8	3	0
4 Maintenance, Monitoring & Management	5	2	0
5 Evaluation & Reporting	3	1	0
Total	31	11	12

College of Applied Biology

Registered Professional Biologist Applicants

The following is a summary of membership requirements for those wishing to submit an application for membership in the College as an RPBio. Further details of each requirement can be found on the forms referenced in each section.

1. **Academic** - successful completion of a Bachelor's degree from a recognized post secondary institution in Biology or in another biological science which includes 25 science courses, 15 of which must be in biology, as set out in Schedule 3 of the Rules (https://www.cab-bc.org/files/Schedule%203.pdf). All applicants are encouraged to complete the Academic Worksheet as a means of determining whether they meet these requirements (http://open-accreditation.cab-bc.org/). For more detailed information on specific course requirements select the high lighted courses in Schedule 3.

- **Accredited Programs -** Some post-secondary Institutions have had their programs assessed by the College. Students graduating from these programs will only need to submit original transcripts and do not require course descriptions.

2. **Work Experience** – 3 years of work in applied biology which demonstrates the applicant has progressed beyond following prescriptions to exercising professional level judgment and discretion. All applicants are encouraged to complete the Work Experience worksheet as a means of determining whether they meet the requirement (https://www.cab-bc.org/pdfs/work-experience.pdf).

3. **Professional Report** - one and up to three professional biology reports or publications in applied biology which contain elements described in section 1.3 of Schedule 3 of the Rules. A M.Sc. or Ph.D. thesis in applied biology will usually be accepted as meeting this requirement and is preferred by the Credentials Committee than the papers published from the thesis. All applicants *must complete* the Report Worksheet (https://www.cab-bc.org/pdfs/professional-report-worksheet.pdf). In addition if you are not lead Author on any submitted reports or papers you must submit an Authorship Declaration as part of the application to the College (https://www.cab-bc.org/application-forms/report-authorship-declaration). There are 3 specific areas which must be demonstrated in the report submission:

a) Design and implement a project.
b) Analyze and interpret data using quantitative or descriptive methods.
c) Develop, design and provide a rationale for conclusions and recommendations in a clear and understandable manner.

For more detailed information on considerations for submitting a report go to Report Guidelines (https://www.cab-bc.org/files/Report%20Guideline.pdf).

4. **Indictable Offense Declaratio**n – submission of this form is mandatory (https://www.cab-bc.org/pdfs/indictable-offence-declaration.pdf). You may complete and send in this form electronically by going to Electronic Declaration (https://www.cab-bc.org/application-forms/indictable-offence-declaration).

5. **References** – All applicants must submit references from three individuals they have know for a minimum of 6 months who are knowledgeable about their professional experience as a biologist. The College Reference Form must be used (https://www.cab-bc.org/pdfs/reference-form.pdf). It is preferred that the College Reference form be sent to the College directly from the chosen referee. However the applicant may forward the reference to the College if the College Reference form is in a sealed envelope with the referee's signature on the back of the sealed envelope. The RPBio application form will provide the means for the applicant to forward the College Reference form directly to their chosen referee (https://www.cab-bc.org/pdfs/application%20for%20membership.pdf).

Worksheet and reference form links are on the application form for your convenience.

Appendix 6: Employability Skills Matrix

Course	Communication	Teamwork	Professional & Ethical Behaviour	Legislation & Policy	Critical Thinking & Adaptability	Monitoring / Field Measurements	Research Design and sampling	Project Management	Field Techniques for ER	Theories and Concepts of ER		
ECOR 9110[8] – Planning and Monitoring for ER	X	X			X	X	X	X	X	X		
ECO 622 – Project Management & Policy for ER			X	X				X				
ECOR 9200 – Field Applicants of Restoration Principles		X	X		X	X	X			X		
ECOR 9210 – Restoration of Aquatics Systems *or* ECOR 9220 – Restoration of Terrestrial Systems	X	X			X	X	X	X	X	X		
ECO 621 – Graduate Seminars in Research Methods					X	X	X					
ECER 9300 – Applied Research Project 1 & 2	X		X		X	X	X	X	X	X		
ECO 641 – First Nations & Social Perspectives of ER	X	X	X	X								
ECOR 9100 – Concepts of ER & the Physical Environment									X	X		
ECO 611 – Concepts of ER & the Ecological Environment									X	X		
SFU – Optional Course	X								X	X		
SFU – Optional Course	X								X	X		

Appendix 7: Needs Assessment Report

BRITISH COLUMBIA
INSTITUTE OF TECHNOLOGY

NEEDS ASSESSMENT

For the Proposed Program:

Master of Science (M.Sc.) in Ecological Restoration

January 2014

Table of Contents

Introduction

Purpose and Process

The purpose of this needs assessment report is to determine and validate the need for a M.Sc. in ecological restoration in British Columbia. Information was collected through:

- A literature review.
- Surveys of industry.
- Survey of recent graduates and current students in the ecological restoration degree program at BCIT and Faculty of Environment at SFU. A focus group.

A literature review was conducted through the scientific journals and other periodicals identifying the need for practitioners trained in ecological restoration.

The surveys were conducted online from December 3rd, 2013 to January 3rd, 2014. Forty-two respondents from industry, and 61 graduates and students from BCIT and SFU participated in the surveys.

In February 2012, BCIT and SFU hosted an industry-based focus group of 36 government, private sector, NGO, First Nations, and academic participants to discuss the relevance and guiding principles for the proposed master's program (Appendix 4).

Industry and Occupational Analysis; Labour Demand

According to Statistics Canada (2012), total employment in B.C.'s goods sector fell 2.0%; however, jobs increased in utilities (+9.2%), and forestry, fishing, mining quarrying, oil & gas (+9.2%). Between the years 2006 and 2010, employment in the Professional, Scientific and Technical Services category (which includes jobs in environmental services) has increased by 22%. In addition, employment in this category has risen every year from 1996 to 2010 (Statistics Canada, 2011). The BC Labour Market Outlook (2010–2020) predicts that jobs in Natural and Applied Sciences and Related Occupations will grow at a rate of 1.6% annually in British Columbia (Work BC, 2011).

ECO Canada's *2013 Profile of Canadian Environmental Employment* provides the most recent and comprehensive estimate to date of environmental employment and the use of environmental skills in Canada. As a foundational report that measures environmental labour (supply) with the need for skilled employees (demand), this study aligns with ECO Canada's mandate to promote the development of the Canadian environmental sector through targeted and informed human resource strategies (see section 7 for a summary of this report). The following points indicate that the environmental-employment sector is strongly growing in Canada.

- Most employers (74.5%) intend to hire new environmental employees over the next two years (2014 & 2015), both for newly created roles and replacement positions following staff departures and retirements.

- 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 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.

- Employers in this survey did not expect to have difficulty hiring as a result of the levels of experience they were looking for. However, among those who did anticipate this challenge, a majority expected to face the most difficulty when hiring for intermediate and senior level roles.

- As a result, industry stakeholders should focus on establishing programs that attract workers to intermediate and senior level positions. These initiatives should also account for the environmental subsectors that are likely to have the greatest increased demand for workers, including: Waste Management, Health & Safety, Site Assessment & Reclamation, and Sustainability.

An Article in MacLean's Magazine (March, 2013: Good Clean Work: http://www2.macleans.ca/2013/03/18/good-clean-work/) noted that Canada's green economy is growing fast, with more than 700 companies, they noted an eleven percent jump in employment between 2008 and 2010. The following points indicate that the environmental-employment sector is strongly growing in Canada.

- The green-jobs sector is now comparable to the booming oil and gas extraction sector and has exceeded the aerospace industry for employment.

- More than 12% of Canada's workforce has some sort of environmental initiative within its work.

- More than 4% of the workforce spends >50% of their time on environmental activities.

- Seventeen percent of Canadian companies employ one or more environmental professional.

- Growth in environmental jobs is unlikely to slow as the green-energy industry expands.

- Ninety-eight percent of the jobs required post-secondary education.

Another article in MacLean's Magazine (March, 2013: A closer look at the single biggest long-term threat to Canadian economic growth: http://www2.macleans.ca/2013/03/15/why-canada-doesnt-work/) discussed the massive shortage of qualified workers. The following points provide support that employment opportunities will increase in Canada:

- Numerous studies warn Canada is facing a massive shortage of skilled workers over the next few decades as millions of baby boomers hit retirement age and exit the workforce. [For further support of this point, see the Letter of Support from Brian Springinotic, Chief Executive Officer, Habitat Conservation Trust Foundation (Appendix 4)].

- The Canadian Chamber of Commerce estimates that there will be 1.5 million skilled job *vacancies* in 2016, and 2.6 million by 2021.

- As a result, experts say a dramatic rethink of how our post-secondary system works is in order. Though Canada's universities are among the best in the world, critics argue for a much greater focus on colleges and polytechnic universities, since the latter are better plugged into the business community.

- A recent report by the Canadian Imperial Bank of Commerce suggested as much as one-fifth of Canada's labour market already suffers from too few qualified workers, particularly in the health care, mining, business services and advanced manufacturing sectors. The average unemployment rate for those jobs is just one per cent, while workers in those positions are seeing wage gains of nearly four per cent annually, more than double that of the broader economy—a telltale sign of a labour shortage.

- Evidence of the shortage is already popping up in day-to-day life. In Alberta, the booming oil sands have sucked workers away from dozens of other occupations, some of which are already experiencing shortages.

- High-tech skills are becoming a prerequisite for many jobs. James Knight, the president of the Association of Canadian Community Colleges estimates nearly 75 per cent of jobs now being created in Ontario require a post-secondary education, but that only about 58 per cent of the population has one. The people we need require a much more sophisticated level of education, and we're simply not there yet.

- The follow statistics show the percentage of job openings that are forecasted to go unfilled in the natural resource sector, with more vacancies than actual job seekers:

    - Logging and forestry worker – 27% (see the note below)

    - Mine service workers and operators of oil and gas drilling – 36%

    - Position in agriculture, horticulture and aquaculture – 38%

- Supervisor in mining, oil, and gas – 58%
- Supervisor in logging and forestry – 100%

- James Knight, the president of the Association of Canadian Community Colleges stated that colleges are particularly well-suited to bridging the divide between academics and training because they already work closely with industry to develop their programs.

In an article published by Kathryn Boothby, For Postmedia News (Saturday, May 11, 2013; Nothing fishy about ecological restoration), Cheryl Knight, executive director with the Calgary-based Petroleum Human Resources Council of Canada stated that "There are also growing opportunities for green jobs in the resource sector. "One interesting trend that we are seeing is significant growth in what we call sustainability-related jobs; for example, environmental technician jobs in the oilsands are expected to increase by 89 per cent over the next 10 years." (http://www2.canada.com/vancouversun/news/archives/story.html?id=9bdfecc3-fdb3-40be-8feb-95e73eb6680c&p=1).

A conference was co-hosted by the Columbia Mountains Institute of Applied Ecology and the British Columbia Chapter of the Society for Ecological Restoration in Cranbrook, British Columbia (October 12-13, 2007:). The conference was titled: Ecological Restoration in Southeastern British Columbia: Grasslands to Mountaintops. (http://www.cmiae.org/_PDF/Ecosystem_restoration_2007_conf_summary.pdf).

> Greg Anderson (BC Ministry of Forests and Range, Invermere, British Columbia) gave a talk about ecological restoration in forestry. He stated that, from the forestry perspective: "This is an exciting initiative for British Columbia. In launching the ecosystem restoration program, the province will deepen its expertise in fire-maintained ecosystem restoration, with future application of the concepts of ecosystem restoration to other ecosystems of concern in the province. The proverbial 'snowballll' is definitely rolling for ecosystem restoration within the BC Ministry of Forests and Range! (page 26 bottom).

Similarly, Parks Canada recently (2008) released its guidelines for incorporating ecological restoration goals into Canada's protected natural areas; titled *Principles and Guidelines for Ecological Restoration in Canada's Protected Natural Areas*. This document represented the first-ever Canada-wide guidance for ecological restoration practices. The principles and guidelines for ecological restoration presented in the document were to be interpreted and applied within the context of the legislation and policy of relevant jurisdictions (see Appendix I of the document). The vast majority of Canadian protected areas jurisdictions recognize the importance of maintaining the ecological integrity of their terrestrial protected areas network (in whole or in part) by including specific reference in appropriate legislation and policy (Environment Canada 2006). These guidelines provide the framework to restore ecological integrity to Canada's protected natural areas (http://www.pc.gc.ca/progs/np-pn/re-er/pag-pel.aspx).

Department of Fisheries and Oceans Canada also recently (2009) produced a document to guide and enhance restoration activities within fish habitats. DFO identified a growing need for a manual that would encompass watershed management and fish habitat conservation, protection and enhancement. Their document was titled: Ecological Restoration of Degraded Aquatic

Habitats: A Watershed Approach: They already had a guide from the 1990s guiding fish habitat improvements, but realized the need to evolve the approach to restoring fish habitats. (http://www.dfo-mpo.gc.ca/library/321286.pdf).

The province of British Columbia recently developed their guiding principles for ecological restoration programs in British Columbia. The document tilted: Ecological Restoration Guidelines for British Columbia was prepared for the Terrestrial Ecosystem Restoration Program (TERP) in British Columbia, Ministry of Water, Land and Air Protection, Victoria, B.C. in 2009. The document outlines the approaches and guidelines for initiating and conducting restoration projects in B.C. (http://www.env.gov.bc.ca/wld/documents/fia_docs/restorationguidelines.pdf).

A survey was completed online from December 3rd, 2013 to January 3rd, 2014 by restoration practitioners in government (municipal, provincial, & federal), industry and consultants, and non-government organizations (NGO). According to the forty-two respondents there is a strong growing need for post-graduate training in ecological restoration. The following are primary results from the survey:

- Of the 42 respondents:
    - 36 were from industry and consultants,
    - 8 were from NGOs,
    - 7 were from municipal and provincial government.
- Twenty percent had between three and ten-year's experience, 74% had more than ten-year's experience.
- Over half of the respondents employed over 25 people, while 30% employed between ten and twenty five people.
- Vast majority (83%) stated that the interest in ecological restoration had increased (42%) and increased substantially (40%) during their employment. Twelve percent stated it had remained the same.
- Respondents indicated that ecological restoration activities comprised less than 25% of their work activities (36% of respondents), between 26% and 50% (38% of respondents), and greater than 51% (26% of the respondents).
- Majority (60%) indicated that they see the time allocated to ecological restoration activities increasing or increasing substantially in the future.
- Majority of the respondents indicated that having a graduate degree in ecological restoration would be (very) important (64%) and somewhat important (31%).
- Twenty-four percent of the respondents indicated they would definite or very likely hire a graduate with a M.Sc. in ecological restoration; twenty-two stated they likely would, and 51% stated they possibly would.

- All respondents stated having work experience was (very) important (97%).

Labour Supply

In spite of the increasing needs in the industry, opportunities to gain graduate-level training in ecological restoration are limited in North America (NA). Nelson et al. (2008)[9] surveyed 300+ academic institutions in NA with a focus on identifying the number of academic institutions offering a specialization in ecological restoration (ER). They concluded that opportunities to graduate with a degree specifically in ER were extremely limited. They noted that only 11 institutions (4%) offered undergraduate degrees and only four (1%) offered graduate degrees. In other countries, even fewer educational opportunities exist. During the benchmarking, only six graduate programs were noted in the United States, and two closely-related programs in Canada (Section 4.6.2). The BCIT-SFU joint master's degree will become the first master's degree specifically in ecological restoration offered in Canada, and BCIT and SFU are jointly one of only a few institutions to do so in North America.

Currently, there are only two institutions offering an undergraduate degree in ecological restoration in Canada (BCIT and Trent University). University of Victoria, Lethbridge College and Fleming College offer a diploma in ecological restoration. University of Victoria and Niagara College both offer a certificate in ecological restoration.

Thus, the opportunity to gain advance training in this new and rapidly growing industry is quite limited in Canada, and North America, in general.

Student Analysis

Target Students

Surveys of both graduates and students from BCIT and SFU were conducted to profile student groups for which the proposed program is intended, as well as to verify student interest in the program. In the surveys:

- 35 out of 46 (76%) students and 12 out of 15 (80%) graduates expressed their interest in pursuing a MSc. in Ecological Restoration..
- 35 out 46 (76%) students and 10 out of 15 (66%) graduates expressed they would recommend the proposed program to other potential candidates.

[9] Nelson C.R., T. Schoennagel, & E.R. Gregory. 2008. Opportunities for academic training in the science and practice of restoration within the United States and Canada. Restoration Ecology Vol. 16, No. 2, pp. 225–230

- 13 out of 36 (36%) industry participants (self-employed not included) indicated that the possibility for their staff to enroll in the proposed program.
- Majority of respondents indicated that a graduate degree in ecological restoration would be (very) important (89%) and somewhat important (7%) for future employment.
- Three quarters of the respondents believe that completing the M.Sc. in Ecological Restoration would increase their employment opportunity; while 39% were very interested in applying to the proposed program, and 39% were somewhat interested.
- Of the 46 current students surveyed, only 7 indicated they were not interested in pursuing the proposed program.

Conclusions and Recommendations

Ecological Restoration is a scientific discipline that has recently emerged due to the increasing need to restore damaged ecosystems. In Canada, this adoption of an ecological restoration approach has really gained acknowledgement in the mid to late 1990 with the formation of an Ontario (http://chapter.ser.org/ontario/) and British Columbia (http://chapter.ser.org/britishcolumbia/) chapters under the Society of Ecological Restoration (http://www.ser.org/). Adoption of ecological restoration principles by industry and government really started in the mid to late 2000; as evident by the foundational documents developed by Parks Canada and the Province of B.C. and reflected by BC Ministry of Forests and Range (above). Further evidence for the recent emergence of ecological restoration as a discipline in Canada has been reflected in the initiation of Canada's first undergraduate degree programs with this specialization, both launched in 2009 (Ontario and British Columbia). Even though the concept and practice of ecological restoration have been around for decades, it only recently has been acknowledged as a professional discipline. Thus, there are few opportunities to graduate with a degree specifically in ER in Canada and United States. There are even fewer opportunities to graduate with a graduate degree with this specialization.

However, from an industry perspective, employment opportunities in environmental disciplines continue to grow very strongly. The strength in growth in this industry is very-well supported by both the ECO Canada's 2013 survey, and the survey conducted for the proposed program (within BC). Respondents (83%) to our industry survey indicated that interest in ecological restoration had (substantially) increased during their employment period. In addition, numerous recent documents have discussed the growing trend in environmental (green) employment opportunities (above).

However, as James Knight, the president of the Association of Canadian Community Colleges stated, "The people we need require a much more sophisticated level of education, and we're simply not there yet." The March (2013) issue of MacLean's Magazine indicated that 27% to 38% of the employment jobs in some natural resource sectors will go unfilled due to a lack of qualified people. Majority (58% to 100%) of the supervisory positions will be unfilled due to the lack of qualified applicants.

The proposed Master of Science in Ecological Restoration will provide a pool of highly-trained specialists to meet both the needs of industry as well as government and non-government employment opportunities. As identified by Brian Springinotic, Chief Executive Officer of the Habitat Conservation Trust Foundation (see Appendix 4b), there are over $50 billion in resource development projects planned for British Columbia over the coming decades. However, with the aging cohort of conservation scientist, BC needs to train the next generation of scientists to help maintain a balance between resource development and ecosystem protection and restoration.

Clearly, there is a very strong need for the proposed program in British Columbia, and Canada as a whole.


ECO CANADA
Environmental Careers Organization
Profile of Canadian Environmental Employment
LABOUR MARKET RESEARCH STUDY
2013
Canada
Funded by the Government of Canada's Sector Council Program

The following summary is from ECO Canada's *2013 Profile of Canadian Environmental Employment. The original document can be found* http://eco.ca/publications/ . Pages references are in reference to the original document.

ECO Canada's *2013 Profile of Canadian Environmental Employment* provides the most comprehensive estimate to date of environmental employment and the use of environmental skills in Canada. As a foundational report that measures environmental labour (supply) with the need for skilled employees (demand), this study aligns with ECO Canada's mandate to promote the development of the Canadian environmental sector through targeted and informed human resource strategies.

The *2013 Profile of Canadian Environmental Employment:*

(1) Provides a comprehensive estimate of the total number of environmental employees in Canada, and compares this number to national employment;
(2) Documents which sectors employ the most environmental employees and why;
(3) Establishes a demographic profile of environmental employees;
(4) Identifies the specific sectors and occupations that will experience the most future demand; &
(5) Provides recommendations that will promote the environmental sector's future success.

The report is based on ECO Canada's *2013 Survey of Canadian Employers*. Thousands of business owners and human resource (HR) managers from all major industry groups across Canada participated in the survey. Their responses were used to identify the number of environmental employees in specific environmental occupations and to predict the rate of growth for environmental employment overall. The full report can be found at: http://eco.ca/publications/ .

Primary Findings

Over 730,000 environmental professionals in Canada spend at least 50% of their work time performing environmental activities, representing just over 4% of the total Canadian labour force. Since ECO Canada's previous study in 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.

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. For the purposes of this study, environmental employees are defined as workers who spend at least some of their time (but not necessarily half of their time) on environmental activities. The following industries have the highest proportion of environmental employees (based on NAICS Codes):

- 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%).

An estimated 460,000 Canadian establishments (19.6% of all Canadian establishments) employ at least one environmental employee, up from 17% in 2010.

What is the Future Demand for Environmental Employees?

The demand for workers with environmental skills will increase in the near future. 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. Employers in this survey did not expect to have difficulty hiring as a result of the levels of experience they were looking for. However, among those who did anticipate this challenge, a majority expected to face the most difficulty when hiring for intermediate and senior level roles.

Environmental Sector Has Significant Growth Potential

Since the demand for environmental employees is clearly on the rise, stakeholders in the environmental sector need to be prepared to accommodate this growth. Policy-makers, industry leaders and educators must ensure that there are enough workers with environmental skills in order for the environmental industry to continue to grow and contribute positively to the Canadian economy. A viable, balanced environmental labour market depends on workforce development strategies that engage previously under-utilized labour sources, such as Aboriginal communities and recent immigrants. The existing environmental workforce is also fairly young, with a healthy influx of students into post-secondary environmental programs. As a result, industry stakeholders should focus on establishing programs that attract workers to intermediate and senior level positions. These initiatives should also account for the environmental subsectors that are likely to have the greatest increased demand for workers, including: Waste Management, Health & Safety, Site Assessment & Reclamation, and Sustainability.

Environmental Skills are Becoming More Mainstream

As the general Canadian population becomes increasingly engaged with environmental issues, a growing number of Canadian employers are also aware of what constitutes environmental employment. However,

environmental work activities may have become so mainstream in some industries that these activities are less likely to be perceived as expressly "environmental." Although this may be a natural byproduct of the increased integration of environmental practices into all work areas, there is a risk that employers may eventually take environmental skills for granted and fail to recognize specialized environmental knowledge or expertise. Over time, the decreased awareness of uniquely environmental work could lead to a reduced emphasis on environmental stewardship and sustainability. Thus, environmental professionals must make sure they are being recognized as a distinct labour market within the Canadian economy. Environmental Professional (EP) certification is one way to meet this goal. The continued development of **National Occupational Standards (NOS)**, which define environmental employment and required environmental competencies, is another solution.

Environmental Work is Becoming More Specialized

Although the overall number of environmental professionals has increased, these professionals now work in different areas. Today, environmental work is more centralized in industry groups such as Professional, Scientific and Technical Services, Administration & Support, and Waste Management & Remediation. One possible explanation for this finding is that environmental professionals now perform increasingly specialized work and have found employment opportunities in a more select group of industries. Another potential reason is that more niche environmental consulting establishments have emerged to meet the demand for environmental expertise. Employers in these industries may prefer to outsource their environmental work to the specialized consulting firms, since a neutral third party can help them accomplish different objectives.

Next Steps

(1) Stakeholders must continue to invest in training programs and professional certification for environmental professionals.

Considerable workforce development is needed to ensure that there will be enough environmental professionals with the right skills to meet future demand, particularly for senior level positions. Training programs must address the unique needs of different labour force segments, such as newcomers to Canada and Aboriginal communities, to ensure that future environmental workers have equivalent skill levels. In addition, these programs should focus on developing the skills that will be needed for high-demand, high-growth environmental sub-sectors. Professional certification provides one inexpensive means for employers to verify that future job candidates meet industry standards for required skills and knowledge.

(2) Post-secondary institutions should attract students to programs that focus on Environmental Professional Services.

Although a significant number of students are entering environmental programs in Canada and the environmental workforce is relatively young, educators must provide clear guidance on viable career paths. Students need to be aware of the top occupations that will have high future demand and relevant areas of study that will help them train for these careers.

(3) Further research is needed on how to attract transitioning workers to environmental work.

Since transitioning workers can help fill the demand for experienced environmental workers, researchers need to understand how demand in the environmental sector corresponds to other industries. Future research could identify declining industries and assess whether workers in these areas are a good fit for the environmental sector.

(4) Professionals must continue to support their professional designations and industry associations.

As environmental work becomes more mainstream, environmental professionals will need to ensure that they are recognized as a distinct professional group with a unique role to play across different industries. Certification provides an excellent rallying point around which professionals can promote the importance and relevance of their specialized expertise.

Some Key Statistics from the Report: http://eco.ca/publications/

- The number of environmental professionals working in Canada has increased from 70,000 in 1993 to 682,289 in 2010, to 730,371 in 2013 (a 7% increase since 2010, page 15).
- The proportion of environmental employees that specialize in the following areas (selected based upon their relevance to ecological restoration) were (page 20):
    - Site assessment and reclamation – 21%
    - Natural resource management – 13%
    - Fisheries and wildlife – 11.6%
- Approximately 14% of environmental employees are 55 years of age and older (page 23). Total expected retirement in the next ten years was 19% (page 38).
- Approximately 9% of the environmental employee workforce have a post-graduate degree (page 27); with site assessment and reclamation (including restoration) having approximately 15% of the workforce with post-graduate degrees (page 28)
- **Over 40%** of employers anticipate that the total number of environmental employees will increase over the next two years (page 32).
- For large employers (> 100 employees), **half** anticipate hiring more environmental employees in the next two years.
- Twenty percent of the employees hired are recent students (page 33).
- The proportion of employers anticipating to hire, within the following sub-sectors, in the next two years were (page 34):
    - Site assessment and reclamation – 23%
    - Natural resource management – 14%
    - Fisheries and wildlife – 12%
    - All sub-sections combined – 75%
- Over 11.5% of environmental employers have experienced difficulty hiring environmental employees for occupations in high demand. These occupations range from highly trained specialized roles such as Environmental Engineers and Remediation Specialists, to more technical roles.
- Environmental employers identified senior level positions were the most difficult to fill. Of those employers noting difficulty in filling positions, 27% identified senior positions the hardest to fill (the target for graduates from the proposed M.Sc. program)(page 36).
- The sub-sectors that are associated with more traditional activities in Environmental Protection and Resource Management, such as Air Quality, Water Quality, Energy, Fisheries and Wildlife, and Natural Resource Management (all aspect of ecological restoration), will have the highest anticipated shortage of senior-level candidates.

Discussion (some relevant excerpts from the Discussion, starting page 41)
Since 2010, the number of Canadian establishments with environmental employees on staff has grown significantly. Furthermore, a large proportion of these establishments expect these numbers to grow in the near future. To meet this future demand, there must be an adequate supply of workers who hold the right skills and knowledge to fill environmental roles.

Several environmental sub-sectors will account for most of the demand for environmental employees, including Waste Management, Environmental Health and Safety, Site Assessment and Reclamation, and Sustainability. Within these sub-sectors, employers will be hiring for a number of high-demand occupations, and they already anticipate difficulty finding enough candidates for these. Most of these occupations fall under the category of Environmental Professional Services, including Environmental Engineers, Environmental Technicians/Technologists, Project Managers, and Lab Technicians/ Technologists.

In some sub-sectors, employers will experience a shortage of experienced environmental employees. These sub-sectors include more traditional areas of environmental activity, such as Air Quality, Water Quality, Energy, Fisheries and Wildlife, and Natural Resource Management.

Since many of the occupations that will be in high demand fall under the umbrella of Environmental Professional Services (EPS), ECO Canada has conducted an upcoming follow-up study on this particular occupational group. This upcoming report found that the majority of EPS positions fall into four main categories: Environmental Technicians/Technologists, Project Managers, Environmental Coordinators, and Environmental Engineers. The occupations within these categories will account for the most future environmental job vacancies. HR strategies should focus on attracting environmental employees to these positions, with targeted communications for post-secondary institutions to help attract students to high-demand areas.

There is a strong need for experienced, senior-level environmental employees in specific sub-sectors, and Canada's transitioning workforce may be one source to help fill this gap.

Since the Canadian economy is heavily based on natural resource extraction, the Canadian public and government pay more attention to environmental issues in associated industries. For example, oil extraction from Alberta's oil sands continues to be an area of strong public and political interest, warranting additional engagement from the environmental workforce.

Appendix 8: Course Outlines

Appendix 11A: Core Program
Appendix 11B: Electives

Appendix 11A: Core Program

The following courses compose the core program:

- Concepts of Ecological Restoration and the Physical Environment, ECOR 9100
- Concepts of Ecological Restoration and the Biological Environment, ECO 611
- Planning and Monitoring for Ecological Restoration, ECOR 9110
- Field Applications of Restoration Principles, ECOR 9200
- Restoration of Terrestrial Ecosystems, ECOR 9210; *or* Restoration of Aquatic Ecosystems, ECOR 9220
- Graduate Seminars in Research Methods, ECO 621
- Project Management & Policy for Ecological Restoration, ECO 622
- First Nations & Social Perspectives of Ecological Restoration, ECO 641
- Applied Research Project I & II (ECOR 9300, 9400)

BRITISH COLUMBIA INSTITUTE OF TECHNOLOGY

Course Outline

Faculty of Environment

ECOR 9100

Program: Ecological Restoration

Concepts of Ecological Restoration and the Physical Environment

Prerequisites:		**Course is a prerequisite for:**	
Course #	Acceptance into the M.Sc. Program	ECO 622	Project Management & Policy for ER
		ECOR 9200	Field Applications
		ECOR 9210	Restoration of Terrestrial Ecosystems
		ECOR 9220	Restoration of Aquatic Ecosystems
		SFU	Electives 1 & 2
		ECOR 93009/400	Applied Research Project 1 & 2
		ECO 621	Graduate Seminars in Research Methods

Hours/Week:	3	**Lecture:**	3	**Labs**	**Total Hours:**	45	**Level:**	M.Sc.
					Total Weeks:	15	**s:**	3

Course Description:

This course focuses on scientific study of the physical environment, with an emphasis on its effects on living organisms and their restoration. We will examine concepts of rivers and their attributes; inland waters and limnology; geomorphology; and terrestrial processes. Through lecture and field experiences, students will become familiar with physical and chemical processes in water, especially those that have a direct effect on biological organisms. Concepts of the biological environment, with a specific focus on restoration, will be emphasized in another course. Field sessions outside of scheduled class time will be required.

Course Learning Outcomes

- Explain the concepts and principles of physical environment relevant to ecological restoration.
- Apply the concepts and principle in assessment and evaluation of degraded ecosystems
- Integrate the concepts and principle in design restoration activities.

Topics included:

- River processes and channel geomorphology:
  - river channel and catchment,
  - river sediment system,
  - coupling and connectivity in river basin sediment systems,
  - channel adjustment: concepts of change,
  - river channel geomorphology and tools to manage channels & flood plains,
  - the role of river classification and typology in river management,
  - river sedimentation processes; flood plain interactions and riparian habitat,

- restoration techniques;

- Lake processes and limnology:
  - science of limnology and its multidisciplinary nature, and the complex issues affecting modem water resource management,
  - fluxes of nutrients and materials to and within lakes,
  - pelagial and littoral zones and their dynamics; sediments and paleolimnology,
  - eutrophication and heavy metal pollution,
  - structure and dynamics of major plant and animal communities;

- Terrestrial Processes:
  - soil classification and properties,
  - analyses of the origin of soil erosion,
  - soil erosion and control, basic definition and classification of erosion according to factor, form and intensity,
  - protection from erosion,
  - erosivity of precipitations, soil erodibility as a function of soil property (inherent) and soil utilization,
  - anti-erosion measures - characteristics, selection, localization, parameterization,
  - biogeoclimatic classification system for BC terrestrial habitats.

Evaluation

Midterm exam	25%	**Comments:**
Final exam	25%	Class participation is based upon class
Individual assignments	20%	attendance, participation in discussions, and
Group projects	20%	contribution to group projects
Class participation	10%	
Total	100 %	

Text(s) and Equipment:

Required: Class handouts

Recommended:

Course Record:

Developed by: Dan Hogan (Authoring Instructor) Date: December 15th, 2013

SFU SIMON FRASER UNIVERSITY
THINKING OF THE WORLD

Course Outline

Faculty of Environment

ECO 611

Program: Ecological Restoration

Concepts of Ecological Restoration and the Biological Environment

Prerequisites:		**Course is a prerequisite for:**	
Course #	Acceptance into the M.Sc. Program	ECO 622	Project Management & Policy for ER
		ECOR 92200	Field Applications
		ECOR 9210	Restoration of Terrestrial Ecosystems
		ECOR 9220	Restoration of Aquatic Ecosystems
		SFU	Electives 1 & 2
		ECO 621	Graduate Seminars in Research Methods
		ECOR 9300/9400	Applied Research Project 1 & 2

Hours/Week:	3	**Lecture:**	3	**Labs**	**Total Hours:**	45	**Level:**	M.Sc.
					Total Weeks:	15	**s:**	3

Course Description:

Ecology is the application of ecological principles to study and evaluate the effects and consequences of human activities on communities, ecosystems, landscapes, and the biosphere. These principles and concepts are being manipulated and managed to meet ecological restoration goals. This course will review general ecology, including theories relevant to the individual, the population, and the community, and their interaction and relationship with the physical (abiotic) environment. Further, we will consider those aspects of particular importance to ecological restoration. Case studies will be used to emphasize the link with these concepts and their application to ecological restoration. Ecological concepts and application with a specific emphasis on restoration will be emphasized in future courses. Field sessions outside of scheduled class time will be required.

Course Learning Outcomes

- Explain the concepts and principles of biological environment relevant to ecological restoration.
- Apply the concepts and principle in assessment and evaluation of degraded ecosystems
- Integrate the concepts and principle in design restoration activities.

Topics included:

- The individual:
  - bioenergetics, habitat selection, energy conservation, habitat structure and other physical attributes of habitat, Individual fitness, individual behaviour, adaptations and heredity,
  - natural selection,
  - migrations, travel corridors, dispersal;

- The population:
  - logistic growth curves, population dynamics, limited resources, population regulation,
  - fine filter approach (species-specific approaches) for managing populations;
- The community:
  - island biogeography & habitat fragmentation,
  - competition within and among species, predation,
  - invasive species management,
  - species area relationship, succession and trajectories,
  - structure and dynamics of major plant and animal communities (terrestrial, stream, lakes)
  - course filter (ecosystem approach) for managing biodiversity;
- The interconnectedness:
  - primary and secondary productivity,
  - invasive species,
  - biodiversity (genetic diversity, species richness, species density),
  - ecosystem decay.

Evaluation

Midterm exam	25%	**Comments:**
Final exam	25%	Class participation is based upon class
Individual assignments	20%	attendance, participation in discussions, and
Group projects	20%	contribution to group projects
Class participation	10%	
Total	100 %	

Text(s) and Equipment:

Required: Class handouts

Recommended:

Course Record:

Developed by: Jonathan Moore (Authoring Instructor) Date: December 15th, 2013

BRITISH COLUMBIA INSTITUTE OF TECHNOLOGY

Course Outline

School of Construction and the Environment

ECOR 9110

Program: Ecological Restoration

Planning and Monitoring for Ecological Restoration

Prerequisites:		**Course is a prerequisite for:**	
Course #	Acceptance into the M.Sc. Program	ECOR 9200	Field Applications
		ECOR 9210	Restoration of Terrestrial Ecosystems
		ECOR 9220	Restoration of Aquatic Ecosystems
		ECO 622	Project Management & Policy for ER
		SFU	Electives 1 & 2
		ECO 621	Graduate Seminars in Research Methods
		ECOR 9300/9400	Applied Research Project 1 & 2

Hours/Week:	3	**Lecture:**	3	**Seminars**	**Total Hours:**	45	**Level:**	M.Sc.
					Total Weeks:	15	**s:**	3

Course Description:

Designed for students with experience in ecological restoration, this course develops broad knowledge and skills needed to plan and implement restoration activities. The course begins by reviewing a step-by-step process applicable to a wide range of ecosystems for developing, implementing, monitoring, and refining on-the-ground restoration projects. We will focus especially on designing defensible monitoring programs needed to assess restoration success, including appropriate use of statistical design (e.g., controls, sampling design) and qualitative information (e.g., photo monitoring). Students will identify and critically review a restoration plan in terms of this step-by-step process. A major component of this course entails students incrementally developing a restoration and monitoring plan for a degraded site in the Lower Mainland of British Columbia.

Course Learning Outcomes

At the end of this course the student will be able to:

1. Clearly understand and develop the components of a successful restoration plan
2. Use effective written and oral communication to present and critically review restoration plans
3. Design a rigorous monitoring program for use in assessing restoration success
4. Assess restoration success by interpreting quantitative results of monitoring

Evaluation

Review of restoration plan (presentation)	30%	**Comments:**
Restoration plan (written report)	30%	
Restoration plan (presentation)	10%	
Monitoring plan (written report)	30%	
Total	100 %	

Text(s) and Equipment:

Required:

Recommended:

Course Record:

Developed by: Eric Anderson (Authoring Instructor) Date: December 14th, 2013

BRITISH COLUMBIA INSTITUTE OF TECHNOLOGY

Course Outline

School of Construction and the Environment

ECOR 9200

Program: Ecological Restoration

Field Applications of Restoration Principles

Prerequisites:		**Course is a prerequisite for:**	
ECOR 9100	Concepts of ER & the Physical Environment	ECOR 9110	Planning and Monitoring for ER
ECO 611	Concepts of ER & the Biological Environment	SFU ECOR 9300/9400	Electives 1 & 2 Applied Research Project 1 & 2

Hours/Week:	22.5	**Lecture:**	**Lab**	22.5	**Total Hours:**	45	**Level:** M.Sc.
					Total Weeks:	2	**s:** 3

Course Description:

This course is specifically designed to provide you hands-on training and application of techniques used in restoring habitats and associated monitoring. Techniques will include vegetation sampling, water sampling (multiparameter meters, flow meters, turbidity meters, etc.), sampling for ground-water levels, fish and wildlife sampling, chainsaw safety, coarse woody debris, habitat structure, CABIN, and G.P.S. Course design will include modules that need to be completed before class, to enhance the hands-on training. The course will run as a two-week field course at the beginning of level 2 (September).

Course Learning Outcomes

At the end of this course the student will be able to:

- Design a sampling plan for a physical and ecological environment.
- Conduct sampling of a physical and ecological environment.
- Analyze and interprets the sampling data.

Evaluation

Assignments	25%	Class participation is based upon class attendance and full participation in field exercises. A professional work ethic will be a strong factor in the assessment and mastery of the skill set.
Final exam	50%	
Class participation	25%	
Total	100 %	

Text(s) and Equipment:

Required: Class hand outs

Course Record:

Developed by: Ken Ashley (Authoring Instructor) Date: January 1st, 2014

BRITISH COLUMBIA INSTITUTE OF TECHNOLOGY

Course Outline

School of Construction and the Environment

Program: Ecological Restoration

ECOR 9210

Restoration of Terrestrial Ecosystems

Prerequisites:		**Course is a prerequisite for:**	
ECOR 9100	Concepts of ER & the Physical Environment	SFU ECOR 9300/9400	Electives 1 & 2 Applied Research Project 1 & 2
ECO 611	Concepts of ER & the Biological Environment		
ECER 9110	Planning and Monitoring for Ecological Restoration		

Hours/Week:	3	**Lecture:**	3	**Seminars**	**Total Hours:**	45	**Level:**	M.Sc.
					Total Weeks:	15	**s:**	3

Course Description:

The Pacific Northwest is a global ecological "hotspot" because of its relatively healthy native ecosystems, a high degree of biodiversity, and the number and scope of restoration initiatives that have been undertaken there. This course gathers and presents the best examples of state-of-the-art restoration techniques and projects. You will be profiling a chosen ecosystem (e.g., bunchgrass system, Garry Oak system, old-growth forests, riparian), and researching and presenting case studies of restoration projects conducted in each of the chosen systems. You will conduct seminars on physical and ecological issues in a chosen case study about the restoration techniques used (were they successful or not), how the case study did/did not follow critical steps associated with a formal restoration plan, incidences of adaptive management, presence/absence of strong experimental designs, challenges and solutions, and uncertainties, etc. Through this course you will learn about appropriate restoration techniques to be used in different ecosystems, while critically reviewing relevant works and strengthening past approaches.

Course Learning Outcomes

At the end of this course the student will be able to:

- Identify critical stressors leading to degraded ecosystems (physical and ecological) in case studies.
- Evaluate strengths and weaknesses of the restoration activities for multiple case studies.
- Develop a restoration plan aimed at ameliorating the stressors identified in the case studies (enhancing the strengths and removing the weakness).
- Construct a rigorous monitoring program for use in assessing the success of a proposed restoration plan.
- Through an oral presentation, successful defend the scientific merit of a restoration and monitoring plans.

Evaluation

Case study review)	30%	**Comments:**
Restoration plan (written report)	30%	
Monitoring plan (written report)	10%	
Oral Presentation of Restoration/Monitoring plan	30%	
Total	100 %	

Text(s) and Equipment:

Required:

Recommended:

Course Record:

Developed by: Douglas Ransome (Authoring Instructor) Date: December 10th, 2013

BRITISH COLUMBIA INSTITUTE OF TECHNOLOGY

Course Outline

School of Construction and the Environment

ECOR 9220

Program: Ecological Restoration

Restoration of Aquatic Ecosystems

Prerequisites:		**Course is a prerequisite for:**	
ECOR 9100	Concepts of ER & the Physical Environment	SFU ECOR 9300/9400	Electives 1 & 2 Applied Research Project 1 & 2
ECO 611	Concepts of ER & the Biological Environment		
ECER 9110	Planning and Monitoring for Ecological Restoration		

Hours/Week:	3	**Lecture:** 2	**Lab:** 1	**Total Hours:**	45	**Level:**	M.Sc.
				Total Weeks:	2	**s:**	3

Course Description:

This course will give an overview of limnology and focus on specific aspects of applied limnology and environmental engineering required to undertake ecological restoration of lakes, reservoirs, rivers and streams. The overview lectures discuss lake formation and basin morphometry, stratification and circulation, water chemistry (including nutrient and carbonate chemistry), BOD tests, and hypolimnetic oxygen depletion. Applied aspects of the course include experimentally determining re-aeration rates and sizing of hypolimnetic aeration/oxygenation and destratification systems, calculation of nutrient loading programs for streams, rivers, lake and reservoir enrichment, calculation of heat budgets, use of nutrient-loading models to assess eutrophication risk, and use of Streeter-Phleps oxygen sag curves to assess oxygen depletion in organically enriched rivers and streams. You will participate in lectures, lab experiments, group and individual study sessions to work through problem sets.

Course Learning Outcomes

At the end of this course the student will be able to:

- Explain the concepts and principles of limnology relevant to ecological restoration.
- Apply the concepts and principle in assessment and evaluation of degraded aquatic ecosystems.
- Collect data to assess a degraded aquatic ecosystem.
- Analyse and interpret aquatic data.
- Integrate the concepts and principle in design restoration activities for aquatic ecosystems.

Topics include:

- iflakes
- gas transfer theory,
- estimating re-oxygenation parameters: KLa, SOTR, SAE and SOTE,
- hypolimnetic oxygen depletion rates,
- sizing and construction of hypolimnetic aeration and oxygenation systems,
- oxygen sag cures in rivers and streams,
- Biochemical Oxygen Demand assays,

- nutrient enrichment programs for lakes, reservoirs, rivers and streams,
- seasonal N and P co-limitation and nutrient limitation,
- nutrient application techniques for solid and liquid fertilizer in rivers, streams, lakes and reservoirs,
- nutrient loading models for eutrophication risk assessment,
- the heat budget of lakes and reservoirs.

Evaluation

Weekly quizzes	15%
Presentation	5%
Lab assignments	20%
Midterm	25%
Final exam	35%
Total	100 %

Comments: The student must achieve a minimum 50% passing grade on the final exam in order to pass this course.

Text(s) and Equipment:

Required: Student Resource Manual (provided)

Course Record:

Developed by: Ken Ashley (Authoring Instructor) Date: December 20th, 2013

SFU SIMON FRASER UNIVERSITY
THINKING OF THE WORLD

Course Outline

Faculty of Environment

Program: Ecological Restoration

ECO 621

Graduate Seminars in Research Methods

Prerequisites:		**Course is a prerequisite for:**	
ECOR 9100	Concepts of ER & the Physical Environment	ECOR 9300/9400	Applied Research Project 1 & 2
ECO 611	Concepts of ER & the Biological Environment		
ECOR 9110	Planning and Monitoring for Ecological Restoration		

Hours/Week:	**Lecture:**	**Seminars**	3	**Total Hours:**	45	**Level:**	M.Sc.
				Total Weeks:	15	**s:**	3

Course Description:

This course examines general philosophical foundations of science, the nature of scientific disputes, and the relevance of these to ecology. We will discuss some fundamental concepts including: science, the scientific method, reliable knowledge, poor science, hypothetical-deductive approach, hypothesis testing, and experimental design. This course is designed to strengthen critical thinking skills when reviewing current information and when formulating new activities in ecological restoration. This is a seminar-based course in which students present assigned readings, and then lead class discussions to help students develop their professional philosophy and critical thinking skills.

Course Learning Outcomes

Upon completion of this course, successful graduate students will be able to:

- Distinguish ecology from other endeavors and better identify "good" science,
- Develop reliable inquiries to generate reliable knowledge in ER,
- Critically review scientific literature and assess the scientific defensibility of the research,
- Generate your own scientifically-defensible research plan,
- Formulate and deliver higher quality verbal and written arguments,
- Demonstrate an ability to learn from other fields,
- Interact effectively as a part of a team exploring important issues.

Evaluation

Seminar presentation	25%
Assignments	50%
Class participation	25%
Total	100 %

Comments: Class participation is based upon class attendance and full participation in discussion and seminars. Punctuality with assignment deadlines is also evaluated.

Text(s) and Equipment:

Required: Course handouts

Recommended:

Course Record:

Developed by:	Leah Bendell	Date:	January 3rd, 2014
	Authoring Instructor		

SFU SIMON FRASER UNIVERSITY
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Course Outline

School of Construction and the Environment

Program: Ecological Restoration

ECO 622

Project Management & Policy for ER

Prerequisites:		**Course is a prerequisite for:**	
ECOR 9100	Concepts of ER & the Physical Environment	ECOR 9300/9400	Applied Research Project 1 & 2
ECO 611	Concepts of ER & the Biological Environment	ECO 641	First Nation & Social Perspectives
ECOR 9110	Planning and Monitoring for Ecological Restoration		

Hours/Week:	3	**Lecture:**	3	**Seminars**	x	**Total Hours:**	45	**Level:**	M.Sc.
						Total Weeks:	15	**s:**	3

Course Description:

The first half of the course will start off with project management, including how to manage uncertainty in designing a project, decision-making tools, risk assessment, and communication. You will use quantitative methods of risk assessment and decision analysis to explicitly take uncertainty into account when making decisions in management of natural resources. Examples from management of forests, wildlife, fisheries, and water resources will be used to exemplify the processes. You will develop a communication approach to provide project partners information about uncertainties and resulting risks to project goals. Second half of the course will provide a practical introduction to the legal system that governs the use and protection of natural resources and the environment in Canada, including an overview of the law relevant to land use planning in British Columbia. We will examine several aspects of environmental and resource law, including the Environmental Protection Act, fisheries and forestry regulation, SARA, the BC Wildlife Act, and native rights. Overall, this course will provide you with knowledge and approaches to manage full ecological restoration programs, while meeting federal and provincial laws and policies.

Course Learning Outcomes

At the end of this course the student will be able to:

- Assess the fundamental role that uncertainties play in the observation and management of ecological restoration projects.
- Evaluate the nature, sources, and management implications of those uncertainties.
- Evaluate and interpret uncertainties using Bayesian statistics.
- Select methods for environmental risk assessment and risk management, using quantitative decision analysis.
- Evaluate future research priorities through estimating the value of research information.
- Design a communication plan to inform about uncertainties and risks to environmental managers, scientists, stakeholders, other members of the public.

- Evaluate a restoration plan that minimizes the risk of uncertainty, while adhering to provincial and federal policies and regulations.
- Assess when certain policies and regulations are relevant to a restoration activity.
- Develop a permit application for a specific restoration activity suitable for submission to BC's Permit and Authorization Service Bureau.

Course Handouts Evaluation

Weekly quizzes	20%	**Comments:**
Lab assignments	20%	
Midterm	25%	
Final exam	35%	
Total	100 %	

Text(s) and Equipment:

Required:

Recommended:

Course Record:

Developed by: Doug Ransome (Authoring Instructor) Date: December 15th, 2013

SFU SIMON FRASER UNIVERSITY
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Course Outline

Faculty of Environment

ECO 641

Program: Ecological Restoration

First Nations & Social Perspectives of ER

Prerequisites:		**Course is a prerequisite for:**
ECO 622	Project Management & Policy for ER	
ECER 9110	Planning and Monitoring for Ecological Restoration	

Hours/Week:	3	**Lecture:**	2	**Seminars**	1	**Total Hours:**	45	**Level:**	M.Sc.
						Total Weeks:	15	**s:**	3

Course Description:

This course examines the human-nature relationship in terms of the practice of ecological restoration. This course explores multiple perspectives on ecological restoration, with an emphasis on working with First Nations and incorporating community values and preferences into restoration project processes and goals. The course integrates lectures, group discussions, and case studies to guide students to expand the scope of ecological restoration and consider how to develop plans that incorporate diverse perspectives and protocols. The course will review practices of ethical conduct and protocols for working within First Nations communities and other communities.

Course Learning Outcomes

At the end of this course the student will be able to:

- Analyze the multiple aspects/perspectives of ecological restoration, such as social value, aesthetics, economic factors, psychological/spiritual aspects.
- Examine the roles that communities of place, especially First Nations, may play in developing, initiating, and completing restoration activities.
- Assess issues affecting First Nations communities in BC and Canada.
- Adapt a restoration plan to balance various aspects/perspectives of ecological restoration.
- Develop a communication plan to engage effectively with communities and First Nations.

Evaluation

Lab assignments	20%	**Comments:**
Midterm	25%	
Final exam	35%	
Seminars/Presentations	25%	
Total	100 %	

Text(s) and Equipment:

Required: Class handouts

Recommended:

Course Record:

Developed by:	Sean Markey, Dana Lepofsky Authoring Instructor	Date:	January 10th, 2014

BRITISH COLUMBIA INSTITUTE OF TECHNOLOGY

Course Outline

School of Construction and the Environment

ECOR 9300; 9400

Program: Ecological Restoration

Applied Research Projects 1 & II

Prerequisites:	**Course is a prerequisite for:**
Level one and two of the program	

Hours/Week:	3 + 3	**Lecture:**	**Lab**	3 + 3	**Total Hours:**	45 + 45	**Level:**	M.Sc.
					Total Weeks:	15 + 15	**s:**	3 + 3

Course Description:

The purpose of the Applied Research Project is to enable you to pursue a restoration plan or research topic in depth while developing certain skills that will be useful in your future employment in the various areas of ecological restoration. These skills range from general to specific. General skills include the abilities to: 1) conceptualize and formulate a manageable restoration project or research question, 2) organize the required steps, 3) integrate and synthesize concepts and findings of other researchers, 4) collect and analyze data, 5) evaluate the strength of evidence or conclusions, 6) integrate all this information into detailed, effective, and well-organized restoration plan, or similar deliverable, and 7) communicate effectively both in writing and orally. You will also improve your abilities in specific skills such as pre- and post-restoration monitoring, interacting with and communicating complex approaches to clients and project partners, proposal writing, and designing restoration plans, decision analysis, statistics, risk assessment, conflict resolution, strategic planning, and others.

In ECOR 9300 students will develop the foundation for the formal restoration plan, or similar final product. During ECOR 9400, students will develop a restoration plan (or similar deliverable) specific to the client's needs. Students will identify the stressors that need to be addressed for their specific site, and design a plan that is scientifically defensible by drawing on the best current knowledge available. They will identify the uncertainties present with the specific site, and include an approach to minimize the risk associated with these uncertainties. When possible, students will detail a research design that will reduce these uncertainties, should the restoration plan be implemented.

Course Learning Outcomes

At the end of this course the student will be able to:

- Work directly with an industry sponsor on an applied research project,
- Solicit and obtain an industry sponsor,
- Liaise and communicate effectively with the industry sponsor,
- Identify a topic area of mutual interest to the sponsor and the student,
- Develop a preliminary discussion document for submission to the industry sponsor,
- Research the topic area of interest,
- Assess current practices and standards employed by industry,

- Perform a literature review to determine state of the art and future trends in this field,
- Submit a formal proposal,
- Develop a project proposal following standard proposal format guidelines,
- Apply technical writing skills to ensure clarity, good grammar, correct punctuation, proper mechanics, and accurate documentation,
- Perform proposal revisions as specified by industry and/or faculty,
- Prepare an interim progress report,
- Communicate with industry and faculty on a regular basis,
- Review overall current project progress,
- Submit an interim progress report and carry out necessary project modifications as required,
- Submit a formal industry sponsored technical report,
- Develop a final report following standard report format guidelines,
- Apply technical writing skills to ensure clarity, good grammar, correct punctuation, proper mechanics, and accurate documentation,
- Document project methodology to enable independent repetition and verification of research,
- Record project observations/results in a logical and concise manner,
- Evaluate/discuss results and information collected,
- Draw effective and meaningful conclusions from the research conducted,
- Provide feasible recommendations/solutions to improve, correct, mitigate, or revise current industry practices.

Evaluation

Progress reports	45%	**Comments:**
Final Report	30%	
Presentation	25%	
Total	100 %	

Text(s) and Equipment:

Required:

Recommended:

Course Record:

Developed by: Eric Anderson (Authoring Instructor) Date: December 12th, 2013

Appendix 11B: Electives

The following courses will be available as electives for the proposed program. Additional electives will be added as new courses have been developed, or as the Applied Research Committee deems appropriate.

Table 1. Courses available as electives from SFU.

Aquatic Cluster	Terrestrial Cluster
BISC 829 Conservation Ecology	BISC 829 Conservation Ecology
REM 625 Risk Assessment of Natural Resources	BISC 838 Population Ecology
STAT 650 Statistics for Resource Management	REM 611 Applied Population and Community Ecology
EASC 601 Advanced Groundwater Geochemistry	GEOG 617 Soil Science
GEOG 611 Hydrology	REM 625 Risk Assessment of Natural Resources
GEOG 613 Fluvial Geomorphology	REM 610 Applied Environmental Toxicology & Environmental Management of Contaminants
GEOG 619 Ecogeomorphology and Hydrology	STAT 650 Statistics for Resource Management
EASC 70X Special Topics in Hydrology	REM 670 Introduction to Forestry: Field Class in Forest Management
REM 670 Introduction to Forestry: Field Class in Forest Management	

SFU SIMON FRASER UNIVERSITY
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Course Outline

Faculty of Biological Sciences

BISC 829

Conservation Ecology

Prerequisites:	**Course is a prerequisite for:**
Course # Acceptance into the M.Sc. Program	

Hours/Week:	4	**Lecture:**	2	**Labs**	2	**Total Hours:**	60	**Level:**	M.Sc.
						Total Weeks:	15	**s:**	3

Course Description:

BISC 829 – Conservation Ecology will illustrate the value of applying ecological theory, particularly concerning life history and demography, to issues of management and conservation. Examination of life history characteristics and variability of individuals will demonstrate how knowledge of demography and population parameters is essential for effective conservation. Emphasis will be on vertebrate species. This course will focus on studies directed at identifying ecological and evolutionary processes that contribute to the persistence of populations and structure of communities, and examine how this information may be used to direct conservation strategies that mitigate human impacts on biodiversity. The class will be organized around lectures and discussions of classic and recent papers (1 classic, 2 recent per week) that have used molecular, population and landscape level approaches to address conservation.

Course Learning Outcomes

At the end of this course students will have a strong understanding behind both how to quantify current patterns of biodiversity and the biological and anthropogenic processes that underpin and threaten those patterns in order to aid conservation efforts. Students will have an understanding of the following topics:

1. Loss of genetic variation and fitness;
2. Allee effects on productivity;
3. Habitat loss and fragmentation, and edge effects;
4. Metapopulations – path effects and incidence function models
5. Dispersal behaviour and corridors;
6. Population viability analysis and conservation decision making;
7. Biological invasions and genetic integrity;
8. Reintroductions;
9. Biodiversity assessment, surrogacy, reverse design and optimal decision making in conservation biology.

Evaluation

Class participation	15%	**Comments:**
Written tutorial plan	15%	Class participation is based upon class attendance, participation
Tutorial plan presentation	15%	in discussions, and contribution to group projects

Tutorial plan reading list	15%
Paper	40%
Total	100 %

Text(s) and Equipment:

Required: Class handouts

Recommended: n/a

Course Record:

Developed by: Currently offered at SFU Authoring Instructor Date: Date

SFU SIMON FRASER UNIVERSITY
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Course Outline

Faculty of Environment

School of Resource and Environmental Management (REM)

REM 625

Risk Assessment of Natural Resources

Prerequisites:

Course # Acceptance into the M.Sc. Program

Course is a prerequisite for:

Note: This course requires that students already have reasonably good quantitative skills in terms of using Excel spreadsheets proficiently to develop and apply relatively simple formulas and graphs. However, due to the high demand to take this course and due to limited computer-lab space, ALL students who are interested in taking this course should contact the Professor in November or December prior to the start of the course. To encourage everyone to take this course and to ensure that everyone is able to handle the material, registration for this course is NOT open to any

Hours/Week:	3	**Lecture:**	3	**Labs**	**Total Hours:**	45	**Level:** M.Sc.
					Total Weeks:	15	**s:** 3

Course Description:

REM 625 – Risk Assessment of Natural Resources will use quantitative methods or risk assessment and decision analysis to explicitly take uncertainty into account when making decisions in the management of natural resources. Methods of quantifying uncertainty and the resulting risks will be investigated. Examples will be drawn from the management of forests, wildlife, fisheries, water resources, energy, and toxic chemicals. The communication of information regarding uncertainties and the resulting risks to resource managers, the public, and scientists will be broached. Advantages and limitations of various quantitative methods will be discussed. Computer laboratories will form part of the pedagogy.

Course Learning Outcomes

To learn:

1. The fundamental role that uncertainties play in the observation and management of environmental systems;
2. The nature, sources, and management implications of those uncertainties;
3. How to describe and quantify those uncertainties using Bayesian statistics;
4. Methods for environmental risk assessment and risk management;
5. Quantitative decision analysis to help rank alternative management actions while taking uncertainties into account;
6. The importance of sensitivity analysis for making robust decisions;
7. How to set future research priorities through estimating the value of research information
8. How to communicate information about uncertainties and risks to environmental managers, scientists, stakeholders, other members of the public;
9. The advantages and limitations of quantitative methods that account for uncertainty.

Evaluation

Computer Assignments	75%	**Comments:** Class participation is based upon class attendance, participation in discussions and field trips, and contribution to group projects.
Class Participation	15%	
Presentation	10%	
Total	100 %	

Text(s) and Equipment:

Required:

Course Record:

Developed by: Currently offered at SFU Authoring Instructor Date: Date

SFU SIMON FRASER UNIVERSITY
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Course Outline

Faculty of Science

STAT 650

Department of Statistics and Actuarial Science

Quantitative Analysis in Resource Management and Field Biology

Prerequisites:		**Course is a prerequisite for:**
Course #	Acceptance into the M.Sc. Program A course in parametric and non-parametric statistics.	Course #

Note: STAT 650 is a course in parametric and non-parametric statistics. This course may not be used for the satisfaction of degree requirement in the Department of Statistics and Actuarial Science.

Hours/Week:	4	**Lecture:** 3	**Seminars: 1**	**Total Hours:**	60	**Level:**	M.Sc.
				Total Weeks:	15	**s:**	5

Course Description:

STAT 650 investigates the use of statistical techniques and mathematical models in resource management with special emphasis on experimentation, survey techniques, and statistical model construction. Emphasis will be placed on applications to resource and environmental management, field biology, and other fields.

Course Learning Outcomes

At the end of this course students will have an understanding behind the methods of sampling and experimental designs, including associated statistical analyses, employed in resource and environmental management and field biology. Practical methods and underlying concepts will be stressed.

Evaluation

Exercises	20%	**Comments:**
Written Project	15%	Grading is subject to change.
Term Test #1	15%	
Term Test #2	15%	
Final Exam	35%	
Total	100 %	

Text(s) and Equipment:

Required: There is no formal text assigned for this course.

Course Record:

Developed by:	Dr. Carl Schwarz Authoring Instructor	Date:	Spring 2014

SFU SIMON FRASER UNIVERSITY
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Course Outline

Faculty of Science

Department of Earth Sciences

EASC 601

Advanced Groundwater Geochemistry

Prerequisites:		**Course is a prerequisite for:**	
Course #	Acceptance into the M.Sc. Program Undergraduate course in hydrogeology recommended (or permission of the instructor)	Course #	Course name

Hours/Week:	5	**Lecture:** 2	**Labs** 3	**Total Hours:**	75	**Level:**	M.Sc.
				Total Weeks:	15	**s:**	3

Course Description:

EASC – Advanced Groundwater Geochemistry investigates advanced topics in understanding water-rock interactions and the geochemistry during processes such as weathering and recharge, acid mine drainage, diagenesis and hydrothermal ore deposit formation. The course focuses on the physical and chemical principles that govern the geochemistry of groundwater with emphasis on water sample collection and analysis, chemical thermodynamics, gas-water-rock interactions and geochemical modeling. Assignments for the course are based on the theory part of the course, and these will be distributed during lab time. A 20 minute presentation relating to the term research paper will also be required as a component of the research paper.

Course Learning Outcomes

At the end of this course students will be familiar with, be able to conceptualize, and be able to situate the following ten topics relative to groundwater geochemistry:

1. Water Quality, Water Sampling and Water Analysis
2. Solutions, Minerals and Equilibria
3. From Rainwater to Groundwater
4. Biological, Physical and Chemical Processes
5. Carbon Dioxide, Acidity, Alkalinity and Carbonate Reactions
6. Silicate Weathering
7. Ion Exchange and Adsorption
8. Reduction Oxidation
9. Isotopes
10. Geochemical Modelling

Evaluation

Lab Assignments	20%	**Comments:**
Mid-term Exam	20%	n/a
Final Exam	30%	

Research Paper and Presentation	30%
Total	100 %

Text(s) and Equipment:

Required:

Course Record:

Developed by: D.M. Kirste Date: Date

Authoring Instructor

SFU SIMON FRASER UNIVERSITY
THINKING OF THE WORLD

Course Outline

Faculty of Environment

Department of Geography

GEOG 611

Hydrology

Prerequisites:	**Course is a prerequisite for:**
Course # Acceptance into the M.Sc. Program	

Hours/Week:	4	**Lecture:** 2	**Labs** 2	**Total Hours:**	60	**Level:**	M.Sc.
				Total Weeks:	15	**s:**	4

Course Description:

GEOG 611 – Hydrology II is a second introduction to physical hydrology and focuses on hyrdrological processes at the soil core, plot, hillslope and catchment scales. The emphasis will be on understanding the hydrological processes at each scale and how these processes can be measured.

Course Learning Outcomes

At the end of this course students will have a strong understanding of the hydrological processes at multiple scales and be able to measure these processes at each scale. Students will also be able to understand the effects of land use change (i.e. deforestation/afforestation, urbanization) and climate change on water flow pathways, streamflow amount and timing, and related water quality. Finally, students will also acquire a working understanding of hydrological modeling.

Evaluation

Participation	5%	**Comments:**
Assignments	20%	Lab attendance and participation is mandatory.
Graduate project	15%	
Mid-term exam	25%	
Final exam	35%	
Total	100 %	

Text(s) and Equipment:

Required:

Course Record:

Developed by: _____ Date: Fall 2007

Authoring Instructor

SFU SIMON FRASER UNIVERSITY
THINKING OF THE WORLD

Course Outline

Faculty of Environment

Department of Geography

GEOG 613

Rivers: Fluvial Geomorphology

Prerequisites:	**Course is a prerequisite for:**
Course # Acceptance into the M.Sc. Program and permission of the instructor.	

Hours/Week:	60	**Lecture:**	4	**Labs**	**Total Hours:** 240	**Level:**	M.Sc.
					Total Weeks: 15	**s:**	4

Course Description:

GEOG 613 – Fluvial Geomorphology is an examination of past and current conceptual and methodological issues in fluvial geomorphology based on analyses of the primary research literature. Topics will be based on papers on the dynamics of channel migration, bend-flow, channel-planform environmental domains, fluvial sedimentology, measurement of sediment transport in rivers, long-term sediment yield, river/estuarine processes and issues relating to channel energetic and equilibrium. This course attempts to put a human face on the research enterprise and will address the role of the personal histories and experiences of authors in determining what research his pursued and how it is done. The structure of the course will be as follows: a weekly seminar based on a structure reading list selected largely (but not exclusively) from journal papers based on research completed by the SFU River Research Group over the last four decades. A brief written assignment will be required as a response to a set of questions based on the assigned readings. Students will be expected to discuss their answers during the weekly seminar.

Course Learning Outcomes

At the end of this course students will have a solid foundation into past and current conceptual and methodological issues in fluvial geomorphology. Students will have an understanding of the following topics: dynamics of channel migration, bend flow, channel-planform environmental domains, fluvial sedimentology, measurement of sediment transport in rivers, long-term sediment yield, river/estuarine processes and issues relating to channel energetic and equilibrium.

Evaluation

Weekly class assignments	20%	**Comments:**
In-term examinations (2)	80%	n/a
Total	100 %	

Text(s) and Equipment:

Required:

Recommended:

Course Record:

Developed by:	Currently offered at SFU	Date:	Spring 2007
	Authoring Instructor		

SFU SIMON FRASER UNIVERSITY
THINKING OF THE WORLD

Course Outline

Faculty of Environment
Department of Geography

GEOG 619
Ecogeomorphology and Hydrology

Prerequisites:	**Course is a prerequisite for:**
Course # Acceptance into the M.Sc. Program Some undergraduate training in calculus, physics, and ecology would be helpful.	

Hours/Week:	4	**Lecture:**	2	**Seminar:** 2	**Total Hours:**	60	**Level:** M.Sc.
					Total Weeks:	15	**s:** 3

Course Description:

GEOG 619 – Ecogeomorphology and Hydrology is focused on understanding the interactions between water, Earth surface dynamics and ecosystems. In particular, the course examines the physical dynamics of rivers and the biological dynamics of these freshwater ecosystems. This course is not intended to replace a full course on stream ecology, river geomorphology or physical hydrology, but rather to create some bridges that will give students access to these bodies of knowledge. Students should consider taking this course if they are interested in physical hydrology or geomorphology as this course will introduce students to the role that biological processes play in Earth surface dynamics. The course will consist of a project to be completed by the end of the semester and reading seminars. Students who are beyond the first year of their graduate degrees will be encouraged to link their project to thesis work. Students will compile one or two reading lists on topics of their choosing and lead discussions on those readings. There are no exams in this course. There will be several guest lecturers throughout the course on various topics.

Course Learning Outcomes

At the end of this course students will be able to conceptualize and integrate the water and sediment movement in riverine ecological systems, giving students access to the scientific literature on geomorphology and hydrology. Students will be able to apply the tools they learn in this course to freshwater ecology, terrestrial fisheries, environmental Earth science, geomorphology, hydrology and stream restoration. Students will have a strong foundation in the dynamics of rivers and the biological dynamics of freshwater ecosystems.

Evaluation

Project proposal	10%	**Comments:**
Project	40%	n/a
Reading lists/discussion	30%	
Participation in discussions	20%	

Total	100 %

Text(s) and Equipment:

Required:

Recommended:

Course Record:

Developed by: Jeremy G. Venditti (Authoring Instructor) Date: Spring 2013

SFU SIMON FRASER UNIVERSITY
THINKING OF THE WORLD

Course Outline

Faculty of Science
Department of Earth Sciences

EASC 70x
Special Topics in Hydrogeology

Prerequisites:	**Course is a prerequisite for:**
Acceptance into the M.Sc. Program EASC 101 and PHYS 102 or 121 or 126 or 141; and 12 additional units in Earth Sciences, Physical Geography or Environmental Science	n/a

Hours/Week:	5	**Lecture:**	2	**Labs**	3	**Total Hours:**	75	**Level:** M.Sc.
						Total Weeks:	15	**s:** 3

Course Description:

EASC 70x – Special Topics in Hydrogeology is an introductory course to hydrogeology and thus a foundational course in fluids in geological media. As such, it is relevant to the oil and gas and mining industries as well as to environmental and engineering applications. The course will introduce students to the basic concepts and principles governing the flow of water in the subsurface environment (i.e. groundwater), and to use these to develop an understanding of aquifers or oil reservoirs and their physical properties. The required assignments are based on the theory component of the course, and these will be distributed during lab time. There is also a laboratory project that will be distributed and worked on during lab time over the course of four weeks. Finally, there will also be a mandatory field trip at some point during the semester.

Course Learning Outcomes

At the end of this course the student will be able to:

- Describe the water and hydrologic cycles,
- Assess groundwater flow to wells,
- Interpret the recharge and interaction of surface water with ground-based and atmospheric water,
- Analyze groundwater as a resource using field methods, management-tools and modelling.
- Assess a regional groundwater flow regime.

Students will also understand the following:

- Principles of groundwater flow,
- Properties of aquifers, and the
- Geology of groundwater occurrence.

Evaluation

Laboratory Assignments	25%	**Comments:**
Laboratory Project	20%	n/a
Mid-Term Exam	20%	
Final Exam	35%	
Total	100 %	

Text(s) and Equipment:

Required:

Recommended:

Course Record:

Developed by: Dr Diana Allen (Authoring Instructor) Date: Fall 2013

SFU SIMON FRASER UNIVERSITY
THINKING OF THE WORLD

Course Outline

Faculty of Biological Sciences

BISC 838

Population Ecology

Prerequisites:	**Course is a prerequisite for:**
Course # Acceptance into the M.Sc. Program	

Hours/Week:	2	**Seminar:**	1	**Labs**	**Total Hours:** 45	**Level:**	M.Sc.
					Total Weeks: 15	**s:**	3

Course Description:

This course is designed to give graduate students, early in their studies, an introduction to different types of population dynamics models, their assumptions, and an understanding of how you might collect data to parameterize them. We do not expect that students will have extensive backgrounds in modeling or theory at the start of this course, but we do expect that students will be active participants in the course though hands-on assignments, discussions, and computer exercises outside of class.

Student evaluation will be based on a final written project (an NSERC style research proposal using one of the modeling approaches), a presentation of a model from the literature, regular participation in discussions, and good citizenship. This course is designed to provide students with a framework for introduction to population dynamics models and their application, but is not intended to be a comprehensive treatment of any particular model type. As a result, students will get out of this course exactly what they put into it in terms of reading, contributing to discussions, and completing the quantitative exercises. We expect that the course content and direction may change based on the discussions from week to week and the specific research interests of the participants.

Course Learning Outcomes

At the end of this course students will have a strong understanding behind:

- Big picture overview of models
- R modeling tutorial (F Simon)
- Single species models (BR)
- Two species models: competition
- Single species structured models
- Matrix models & elasticity analysis
- Stochastic matrix models
- Estimating parameters (CMR)
- SDP/Disease models

Evaluation

Term Paper	40%	**Comments:** n/a
Seminars	10%	
Lab Exercises	20%	
Field / Lab Project	20%	
Lab Exam	10%	
Total	100 %	

Text(s):

Course Record:

Developed by: Wendy Palen Date:

Authoring Instructor

SFU SIMON FRASER UNIVERSITY
THINKING OF THE WORLD

Course Outline

Faculty of Environment

School of Resource and Environmental Management (REM)

REM 611

Applied Population and Community Ecology

Prerequisites:	**Course is a prerequisite for:**
Course # Acceptance into the M.Sc. Program	

Hours/Week:	4 + field trips	**Lecture:**	4	**Labs**	**Total Hours:** 60+	**Level:**	M.Sc.
					Total Weeks: 15	**s:**	4

Course Description:

This course explores the scientific foundations of applied ecology and highlights contemporary conservation strategies designed to balance the needs of people and nature. We will explore topics such as social-ecological-system dynamics and resilience, reserve design and metapopulation theory, ecosystem services and poverty alleviation, climate change and food security, and ecosystem-based management. Course readings will include textbook chapters to provide students with the foundations of applied ecology, and cutting-edge, peer-reviewed literature to expose students to the latest innovations in the field of conservation science. Students will also have the opportunity to apply field and modelling approaches to real-world conservation issues. Half and full day field trips to local conservancies and parks will allow students to develop practical field research skills. Finally, classroom sessions will engage students in lively group discussions and will include lectures, hands-on analysis, guest speakers, and group work on current and contentious topics in conservation science.

Course Learning Outcomes:

By the end of this course, students will be able to:

1. Identify and synthesize the core principles of ecology that should be considered while addressing an environmental issue
2. Understand the key processes that drive ecosystem dynamics and their associated uncertainties
3. Communicate complex and/or contentious ecological information clearly and effectively to a target audience
4. Work independently and collaboratively on contemporary environmental problems to formulate and implement solutions

Evaluation:

Individual In-Class Assignments	30%	**Comments:**
Group Projects	60%	Class participation is based upon class attendance, participation
Class Participation	10%	in discussions and field trips, and contribution to group projects

Total	100 %

Text(s) and Equipment:

Required:

Course Record:

Developed by: Currently offered at SFU Authoring Instructor Date: Date

SFU SIMON FRASER UNIVERSITY
THINKING OF THE WORLD

Course Outline

Faculty of Environment
Department of Geography

GEOG 617
Soil Science

Prerequisites:				**Course is a prerequisite for:**			
Course #	Acceptance into the M.Sc. Program						
Hours/Week:	5	**Lecture:** 2	**Labs** 3	**Total Hours:**	75	**Level:**	M.Sc.
				Total Weeks:	15	**s:**	4

Course Description:

GEOG 617 – Soil Science will focus on forest soils: soil properties and processes, and forest soils in relation to resource management. The term project will allow students to explore a particular area of interest in forest soil science. Although labs are scheduled for three hours they will typically only be two hours long. There will be no labs in the first week of classes. There will be two off-campus field trips.

Course Learning Outcomes

At the end of this course students will be able to conceptualize and have a solid comprehension on the dynamics of forest soils including their properties and processes. Students will also have a strong foundation on the relation of forest soils to resource management.

Evaluation

Assignments	30%	**Comments:**
Mid-term exam	15%	n/a
Term project – paper	25%	
Term project – presentation	10%	
Final examination	20%	
Total	100 %	

Text(s) and Equipment:

Required: Readings and supplemental material will be distributed throughout the term.

Recommended: Fisher, R.F., and D. Binkley. 2000. *Ecology and management of forest soils*. Third edition. Wiley, New York.

Course Record:

Developed by: Margaret G. Schmidt (Authoring Instructor) Date: Spring 2008

SFU SIMON FRASER UNIVERSITY
THINKING OF THE WORLD

Course Outline

Faculty of Environment

School of Resource and Environmental Management (REM)

REM 610

Applied Environmental Toxicology and Environmental Management of Contaminants

Prerequisites:	**Course is a prerequisite for:**
Course # Acceptance into the M.Sc. Program	

Hours/Week:	5	**Lecture:**	5	**Labs**	**Total Hours:** 60	**Level:**	M.Sc.
					Total Weeks: 15	**s:**	5

Course Description:

This course will investigate the environmental behaviour and toxic effects of chemical substances in the environment and the application of methodologies for their assessment and management. The content of the course will be divided into five categories:
1. Environmental pathways of chemicals and contaminants – environmental partitioning, dynamics of environmental distribution, mass-balance, mechanisms of transport and transformation, fugacity, environmental modelling;
2. Exposure assessment – mechanisms of chemical uptake and elimination in biological organisms, toxicokinetics, bioaccumulation, trophodynamics, structure-activity relationships;
3. Hazard assessment – toxicity of chemical pollutants in biological organisms, dose-response relationships, toxicity of single and mixtures of chemicals, ecotoxicity, carcinogenesis;
4. Ecological and human health risk assessment of contaminants – methods for ecological risk and human health assessment, cancer potency factors, reference dose, quantitative risk assessment;
5. Legislation and management – students examine the application of scientific principles in current environmental management practices and regulations in Canada. This includes a discussion of the various legislative frameworks applying to pollutants, the development of standards and human consumption guidelines and environmental quality criteria, contaminated sites assessment, monitoring, risk assessment, effluent regulations and others.

Course Learning Outcomes

By the end of this course students should be able to have a strong foundation in understanding the theory and practical application of environmental chemistry and toxicology for the purpose of assessing the environmental behaviour, toxicity and human health risks of chemical contaminants in the environment. Students will learn how the various topics/subdisciplines in environmental toxicology are interconnected and integrated. Students will understand the application of theories discussed in the course to management problems. Finally, students will gain an awareness of the legislative framework in which environmental toxicology is conducted.

Evaluation:

Assignment #1	25%	**Comments:**
Assignment #2	30%	Class participation is based upon class attendance and
Student paper and oral presentation	35%	participation in discussions
Class contributions	10%	
Total	100 %	

Text(s) and Equipment:

Required:

Course Record:

Developed by: Currently offered at SFU Date: Date

Authoring Instructor

SFU SIMON FRASER UNIVERSITY
THINKING OF THE WORLD

Course Outline

Faculty of Environment

REM 670

School of Resource and Environmental Management (REM)

Introduction to Forestry: Field Class in Forest Management

Prerequisites:	**Course is a prerequisite for:**
Course # Acceptance into the M.Sc. Program REM 611 (Applied Population and Community Ecology) or permission of instructor.	

Hours/Week:	25	**Lecture:**	See below	**Labs**	See below	**Total Hours:**	75	**Level:**	M.Sc.
						Total Weeks:	3	**s:**	5

Course Description:

REM 670 – Introduction to Forestry, examines the theory and practice of forest management based on an understanding of the linkages between forest ecosystem dynamics, economics, policy and social management. Principles are illustrated with reference to contemporary forestry issues. The course content is represented by 15 days of a mixture of lectures, field trips, discussions, and projects. The course will involve working with a case area to put together a curriculum that covers a very broad range of activities and issues related to forestry, and which involve a broad range of people, institutions, and interests. The first week will be about half lectures by Professor Lertzman and half field time or lectures by community members. The second week will be with community members in the field or inside the whole week. The last week will focus on group projects, finishing with a public presentation. All groups must produce a final product, which will usually be in the form of a written report; however, with permission of the instructor students can produce final products in alternative formats. All course related business should be completed by the end of June.

Course Learning Outcomes

At the end of this course the student will be able to:

- Understand the objectives of forestry and how the basic tools of forestry are used to achieve those objectives,
- Develop a functional knowledge of the structure and dynamics of forest ecosystems, and to appreciate the constraints and opportunities for forestry posed by ecological processes at the individual, stand, ecosystem, and landscape levels,
- Become familiar with the history and objectives of forestry policy in BC, and to be able to analyze current issues in forest management in that context,
- Use the understanding referred to above to analyze and understand a variety of current issues of debate in forest management,
- Become familiar with how these various issues are manifest in a diverse range of real management situations in the case region,

- Become aware of the special challenges and opportunities associated with forestry at different scales of operation, with different management objectives, and in different cultural contexts (e.g. First Nations),
- Become familiar with the central role of planning at different scales in forest management,
- Develop an appreciation for the complexities of developing sustainability in forest-dependent communities.

Evaluation

Participation in classroom sessions	20%	**Comments:**
Preparation and participation in fieldtrips	25%	Class participation is based upon class attendance,
Presentation of group projects	15%	participation in discussions, and contribution to
Completed final project product	40%	group projects
Total	100 %	

Text(s) and Equipment:

Required:

Recommended:

Course Record:

Developed by:	Dr. Ken Lertzman	Date:	Spring/Summer 2011

Appendix 9: Related BCIT & SFU Policies

This proposal references the following BCIT policies:

This proposal references the following BCIT policies:

Policies 5601 Faculty Qualifications

Policy FSA 0710ca Faculty and Staff Association Collective Agreement

Policy 6601 Faculty and Staff Association Performance Development System

Policy 6600 Integrity in Research

Policy 6601 BCIT Intellectual Property Policy

Policy 5402 Program Review

Procedure 5402-PR1 Program Review Processes

Policy 5401 Program Development and Change

Procedure 5401-PR1 Program Development and Change Processes

Policy 6500 Research Ethics for Human Subjects

Policy 5101 Student Regulations

Policy 5103 Student Evaluation

Policy 5003 Admissions

Procedure 5003-PR1 Admission Procedure

Policy 5404 Program Advisory Committees

Procedure 5404-PR1 Program Advisory Committee Processes

This proposal references the following SFU Policies:

Policy 10-6 Position Evaluation and Salary Administration

Policy ad9-06 Salary Administration

Policy A 11.01 Tenure Track Appointments

Policy A 11.02 Promotions

Policy A 11.03 Renewal, Tenure and Promotion

Policy A 11.04 Committees

Policy A 11.05 Criteria for Appointment, Contract Renewal, Tenure, Promotion and Salary Review

Policy A 11.06 Tenure and Promotion Appeals

Policy A 11.07 Joint Appointments

Policy A 11.08 Part-Time Faculty

Policy A 11.10 Teaching Professor

Policy A 20.01 Faculty Salaries

Policy r30.03 Intellectual Property Rights

Policy R 20.01 Ethics Review of Research Involving Human Participants

Policy r60.01 Integrity in Research and Misconduct in Research (http://www.sfu.ca/policies/gazette/research/r60-01.html)

Policy r20.03 Treatment of Animals in Research and Teaching

Policy T20.01 Grading Practices and Grading Appeals

Appendix 10: Budget

Notes:

- Draft budget – final budget will be determined by SFU's Graduate Tuition Oversight Committee. $500 per unit is an informed estimate for proposal purposes.
- MSc ER students will not be eligible for awards funded by the SFU operating budget

Draft Budget
Master's of Science - Ecological Restoration

	Year One *	Year Two ** Steady State	Steady State - 20 students	Steady State - 15 students
	Year One*	Year Two*		
Revenue				
15 Students in first year, 20/year thereafter @ $500 per credit - 36 credits total	$157,500.00	$322,500.00	$360,000.00	$270,000.00
Total Program Revenue	**$157,500.00**	**$322,500.00**	**$360,000.00**	**$270,000.00**
Instructional Costs				
Core Program - semesters 1 & 2 (6 x 3 credit coures @ $7,500/crs)	$45,000.00	$45,000.00	$45,000.00	$45,000.00
Field Applications - semester 2 (3 credits) - will need two instructors	$15,000.00	$15,000.00	$15,000.00	$15,000.00
Aquatic Concentration - semester 3 (3 credit, existing courses)	$0.00	$7,500.00	$7,500.00	$7,500.00
Terrestrial Concentration - semester 3 (3 credit, existing courses)	$0.00	$7,500.00	$7,500.00	$7,500.00
FN and Social Perspectives - semester 4 (3 credits)	$0.00	$7,500.00	$7,500.00	$7,500.00
Applied Project - semesters 3-4 (2 x 3 credit based on SFU Sessional rate)	$0.00	$15,000.00	$15,000.00	$15,000.00
Guest Lecturer Stipend	$2,500.00	$5,000.00	$5,000.00	$5,000.00
Total Instructional Costs	**$62,500.00**	**$102,500.00**	**$102,500.00**	**$102,500.00**
Administrative Support				
Program Director Course Release	$15,000.00	$15,000.00	$15,000.00	$15,000.00
Program Director Salary Stipend ($5K plus 18% benefits)	$5,900.00	$5,900.00	$5,900.00	$5,900.00
Program Assistant	$30,000.00	$30,000.00	$30,000.00	$30,000.00
Administration overhead (SFU)	$7,875.00	$16,125.00	$18,000.00	$13,500.00
Collaborative Cohort Conference		$1,000.00	$1,000.00	$1,000.00
Field Expenses - students to pay for accommodation + food		$7,500.00	$7,500.00	$7,500.00
Publicity	$3,000.00	$3,000.00	$1,500.00	$1,500.00
Misc and field supplies	$10,000.00	$10,000.00	$10,000.00	$10,000.00
Curriculum Development	$16,000.00	$5,000.00		
Total Administrative Support	**$87,775.00**	**$93,525.00**	**$88,900.00**	**$84,400.00**
Total Expenses	**$150,275.00**	**$196,025.00**	**$191,400.00**	**$186,900.00**
VPA tuition fee revenue cut (both institutions)	50,400.00	103,200.00	115,200.00	86,400.00
TOTAL PROGRAM REVENUE GENERATION/LOSS	**($43,175.00)**	**$23,275.00**	**$53,400.00**	**($3,300.00)**

Appendix 11: Calendar Entry

Master of Science (MSc) in Ecological Restoration

Proposed Calendar Entry

Simon Fraser University and the British Columbia Institute of Technology collaborate on the Master of Science (M.Sc.) in Ecological Restoration, a full-time professional graduate program offering a combined emphasis on applied technical experience and advanced theoretical foundations of ecological restoration. This joint BCIT-SFU credential requires students to satisfactorily complete coursework at BCIT and SFU. For further information visit http://www.fenv.sfu.ca/eco-r.

Admission Requirements

The MSc in Ecological Restoration is administered by SFU and BCIT. To qualify for admission to the program, a student must satisfy the university admission requirements for a Master's Program as stated in Section 1.3.3 of the Graduation Admission section of the SFU calendar. The student must hold a four-year bachelor's degree in ecology, plant science, animal science, soil science, environmental science, resource science (land, water, fish and wildlife, forestry), physical geography, environmental engineering, or a related program from a recognized post-secondary institution.

In addition, students must have completed:

- one introductory course each in ecology and statistics
- two upper level courses in: biology, ecology (plant, fish, wildlife, restoration/reclamation, etc.), statistics, plants science, soil science, physical geography (hydrology, geomorphology, limnology, etc.), forest science, natural resource management, environmental science, or related courses

See Graduate General Regulations for English Language and reference requirements.

Program Requirements

The program consists of ten courses (including three courses, one core and two electives, in the student's area of specialization) and an Applied Research Project. These courses can be completed over four academic semesters in the full-time program.

The program is composed of three main areas: core program, area of specialization, and applied research project.

Core Program (required for all students):

- Concepts of Ecological Restoration and the Physical Environment, ECOR 9100
- Concepts of Ecological Restoration and the Biological Environment, ECO 611
- Planning and Monitoring for Ecological Restoration, ECOR 9110
- Field Applications of Restoration Principles, ECOR 9200
- Restoration of Terrestrial Ecosystems, ECOR 9210; *or* Restoration of Aquatic Ecosystems, ECOR 9220
- Graduate Seminars in Research Methods, ECO 621
- Project Management & Policy for Ecological Restoration, ECO 622
- First Nations & Social Perspectives of Ecological Restoration, ECO 641

Area of Specialization

Students select three courses, one core course and two electives, in their area of specialization. The courses are:

- Restoration of Terrestrial Ecosystems Concepts, or Restoration of Aquatic Ecosystems (as above)
- Two elective courses from area of specialization table below (Table 1)

Applied Research Project

In their Applied Research Project, students will conduct extensive fieldwork, normally in collaboration with industry partners and academic supervisors.

Academic Requirements within the Graduate General Regulations

All graduate students must satisfy the academic requirements that are specified in the graduate general regulations (residence, course work, academic progress, supervision, research competence requirement, completion time, and degree completion), as well as the specific requirements for the program in which they are enrolled, as shown above.

Table 1. Elective Area of Specialization courses available from SFU

Aquatic Cluster	Terrestrial Cluster
BISC 829 Conservation Ecology	BISC 829 Conservation Ecology
REM 625 Risk Assessment of Natural Resources	BISC 838 Population Ecology
STAT 650 Statistics for Resource Management	REM 611 Applied Population and Community Ecology[11]
EASC 601 Advanced Groundwater Geochemistry	GEOG 617 Soil Science
GEOG 611 Hydrology	REM 625 Risk Assessment of Natural Resources
GEOG 613 Fluvial Geomorphology	REM 610 Applied Environmental Toxicology & Environmental Management of Contaminants
GEOG 619 Ecogeomorphology and Hydrology	STAT 650 Statistics for Resource Management
EASC 70X Special Topics in Hydrology[10]	REM 670 Introduction to Forestry: Field Class in Forest Management
REM 670 Introduction to Forestry: Field Class in Forest Management	

[10] Please note that there are a variety of EASC courses of potential relevance to the program.

[11] Noted as a core REM course that may require a second offering.

Appendix 12: Program Approval Process and NOI

Approval Dates:

NOI:

- Faculty of Environment GPC, April 22, 2013
- Senate Graduate Studies Committee (SGSC), May 6, 2013
- Senate Committee on University Priorities (SCUP), June 19, 2013

Full Program Proposal:

- Faculty of Environment GPC, March 17, 2014
- Senate Graduate Studies Committee (SGSC), May 5, 2014
- Senate Committee on University Priorities (SCUP), July 16, 2014
- Senate
- Board of Governors

Notice of Intent: Master of Science in Ecological Restoration

Faculty of Environment NOI Preamble

June 7, 2013

Summary:

The Master of Science in Ecological Restoration (MScER) will be a professional, premium fee program offered jointly through the Faculty of Environment, Simon Fraser University and the School of Construction and the Environment, British Columbia Institute of Technology. There are two main features of the program that will distinguish it from competitors and make it an excellent foundation for graduates interested in ecological restoration work:

1. The program will combine the scientific knowledge of SFU with the applied technical capacity of BCIT (both critical to ecological restoration work); and,
2. The program will provide training in both biological *and* physical processes related to ecological restoration.

A third feature of the program enables its fit within the Faculty of Environment: the MScER premium fee status ensures that the program will generate the financial resources necessary to sustain itself while contributing resources back to the University.

History:

SFU and BCIT have been discussing the MSc in Ecological Restoration program since Spring 2011. In February 2012, SFU hosted a forum of 36 government, private sector, NGO, First Nations, and academic participants to discuss the relevance and guiding principles for the program. The strong statements of support for the proposed program during this session provided the impetus to begin program development. The program steering committee (members listed below) has been meeting since that time to develop the concept and gain institutional support to proceed to full program development.

Program Development Steering Committee:

SFU	BCIT
Leah Bendell, Biology Dan Burns, Dean's Office Sean Markey, Associate Dean/REM Jonathan Moore, REM/Biology Rudy Reimer, Archaeology/First Nations St. Jeremy Venditti, Geography Duncan Knowler, REM (ex)	Ken Ashley, Faculty Doug Ransome, Faculty Rob Stevens, Associate Dean All within: Natural Resources, School of Construction and the Environment

Notice of Intent:

Master of Science in Ecological Restoration

A professional, premium fee program to be offered jointly through the Faculty of Environment, Simon Fraser University and the School of Construction and the Environment, British Columbia Institute of Technology

June 7, 2013

1.Credential to be awarded

Master of Science (M.Sc.) in Ecological Restoration

2.Location

Simon Fraser University: Burnaby (administration & classroom)
Simon Fraser University/British Columbia Institute of Technology (BCIT):
(classroom/field components)

3.Faculty or School offering the new program

Faculty of Environment, SFU & School of Construction and the Environment, BCIT

4.Anticipated program start date

2015

5.Description of the proposed program

a.Aims, goals and/or objectives
Ecosystem services and natural habitats have been severely impacted due to the cumulative impacts of past and current anthropogenic influences, such as: urban sprawl, industrial expansion, invasive species, and contamination of soils and water resources. These factors and the resultant need to improve habitat for threatened and endangered species, have led to the need for ecosystem restoration work across the province, Canada, and internationally.

In 1992 E.O. Wilson noted; *"Here is the means to end the great extinction spasm. The next century will, I believe, be the era of restoration in ecology"*. It is now well into the "next" century and restoration ecology has become a key discipline in need of rapid advancement. We need to restore our degraded ecosystems such that ecosystem integrity is re-established and the goods and services they once provided can again be realized. The MSc in Ecological Restoration will be a professional degree program, offered at a premium fee to students, that will provide the appropriate methods, tools and training to implement and achieve such restoration goals.

The core strengths of the program, realized through program design and the innovative potential of the partnership between SFU and BCIT, are twofold:

1. The program will combine the scientific knowledge of SFU with the applied technical capacity of BCIT (both critical to ecological restoration work); and,

2. The program will provide training in both biological *and* physical processes related to ecological restoration.

These two characteristics of the program will ensure that the MSc in Ecological Restoration is highly innovative, academically rigorous, and practically relevant.

b. Anticipated contribution to the mandate and strategic plan of the institution

Ecological Restoration is a scientific discipline that has emerged due to the increasing need to restore damaged ecosystems. It is intentional activity that initiates or accelerates recovery of an ecosystem with respect to its health, integrity and sustainability (Society for Ecological Restoration (SER), 2004). This focus on sustainability provides a strong bond between the MSc ER proposal and the academic, institutional, and community strategic priorities for the University and, specifically, for the Faculty of Environment.

SFU is committed to sustainability as an institutional priority for all university activities, providing a foundation on which SFU may establish itself as a leading institution in the transition to a sustainable society. In order to make its commitment to sustainability real and tangible, SFU became a signatory of Talloires Declaration[12], and also adopted a General Policy (#38)[13] on sustainability. In its General Policy #38 on sustainability, the university provides a framework within which other policies and procedures may be developed that demonstrate responsibility and due diligence on the part of the University and that educate and assist members of the University community to understand and fulfill their responsibilities to practice sustainability. Some specific elements directly relevant to MSc ER include the following:

> *SFU will bring vision, intellect and high ethical standards to achieving and maintaining institutional leadership in sustainable operations, research, teaching, performance evaluation and community outreach. (3.0.1)*
>
> *SFU will strive to be in the forefront of sustainability research and education and will use its institutional capability to promote sustainability within and beyond the University. (3.2.1)*
>
> *SFU will seek and develop opportunities to collaborate on sustainability among academic and administrative units across*

[12] Composed in 1990 at an international conference in Talloires, France, this is the first official statement made by university administrators of a commitment to environmental sustainability in higher education. The Talloires Declaration is a ten-point action plan for incorporating sustainability and environmental literacy in teaching, research, operations and outreach at colleges and universities. It has been signed by over 350 university presidents and chancellors in over 40 countries.

[13] http://www.sfu.ca/sustainability/pdf/GP38.pdf

> *the University and, beyond the University, with its alumni and the surrounding communities. (3.4.1)*

SFU's commitment is also reflected in the *SFU Academic Vision, Outcomes and VPA Goals for 2013*[14], which positions SFU as "a top international choice for students, staff and faculty who believe that research and education are central to a healthy, socially responsible society."

The proposed MSc in Ecological Restoration is also in direct alignment with the Faculty of Environment strategic priorities:

i. Scholarly activities in the Faculty are intellectually inspired to address environment issues, broadly defined. In its areas of expertise, future programming will emphasize core areas of basic research as well as applied and problem-solving studies.

ii. Community service learning and the application of scientific knowledge to the resolution of environmental problems become accepted parts of knowledge dissemination and outreach.

iii. Partnerships including student exchanges with other research institutions, within and outside BC, are to be encouraged.

c. Target audience

The intended target audiences are graduates from SFU's Faculty of Environment, Faculty of Science, (and related programs), BCIT's Bachelor's degree in Ecological Restoration, and graduates from other institutions with related degree programs. We anticipate considerable interest from employees of resource companies, as well as representatives from First Nations communities and various government agencies. Being the first of its kind in Canada, the proposed M.Sc. degree in Ecological Restoration may draw baccalaureate -holding students who are keen to apply their fundamental biological and physical science skills to the applied science of ecological restoration from across Canada. We also anticipate that the program will be highly desirable for international students.

d. Delivery methods: Proposed courses

A professional graduate degree will be offered over 4 semesters, including a project to be completed in the third semester. A common core set of courses will be completed in the first two semesters that cover theoretical and applied aspects of ecological restoration as well as providing a common background in both biological and physical sciences. A series of elective courses will provide specialist training in either aquatic or terrestrial restoration, while maintaining balanced training in physical and biological sciences. We will also include core courses with content focused on project management, policy and regulatory

[14] http://www.sfu.ca/vpacademic/files/FINAL__AcadVisOC_VPAGoals_June22009.pdf

issues, and First Nations perspectives. The Steering Committee will consider use of flexible delivery (e.g. condensed course delivery) for core courses and separate elective offerings.

Core program requirements (18 s):

RENR 7003-3 Principles of Restoring Disturbed Landscapes
RENR XXXX-3 Project Management and Policy for Restoration*
RENR XXXX-3 Field applications*
ENV XXX-3 First Nations Perspectives and Natural Resource Management**
ENV XXX-3 Physical restoration**
ENV XXX-3 Biological restoration**

Project: Cohort-based field class under the supervision of the program director. Students may also choose to substitute this course for a suitable practicum placement.

NOTE: The program will be delivered using a cohort model. The Director will select non-core courses from the following list as elective options available for the specific cohort year. The following course list provides a sample of the offerings available at SFU and BCIT to cover the elective courses for the program. We will refine and finalize the list during the Full Program Proposal development stage. Particular attention will be given to considerations of pre-requisites and program completion. Program completion will be based upon a set number of courses within a specific credit range (to accommodate different programs with course credit variations).

Aquatic Concentration (minimum of 12 s)

Select 2 courses from:

RENR 8102 Restoration of Freshwater Aquatic Systems
RENR 8106 Wetland and Estuary Restoration
BISC 814-3 Aquatic Ecology
BISC 829-3 Conservation Biology
REM 612-5 Simulation Modeling in Natural Resource Management
REM 613-5 Methods in Fisheries Assessment
REM 614-5 Advanced Methods in Fisheries Assessment
REM 624 Risk Assessment of Natural Resources
STAT 650 Statistics for Resource Management

Select 2 courses from:

RENR 8201 Terrain and Stream Channel Assessment for Ecological Restoration
EASC 703-3 Special Topics in Hydrogeology
EASC 601-3 Advanced Groundwater Geochemistry
GEOG 611-4 Hydrology
GEOG 613-4 Fluvial Geomorphology
GEOG 619-3 Ecogeomorphology
GEOG 650-5 Research Methods in Spatial Information Science
GEOG 651-4 Advanced Spatial Analysis and modeling

GEOG 653-4 Remote Sensing of Environment
GEOG 655-4 Advanced Principles of GIS

Terrestrial Concentration (minimum of 12 s)

Select 2 courses from:
RENR 8101-3 Terrestrial Ecosystem Restoration
RENR XXXX Wildlife Restoration*
RENR XXXX Invasive Species management*
BISC 829-3 Conservation Biology
GEOG XXX-4 Biogeography
REM 611-5 Population and Community Ecology
REM 624 Risk Assessment of Natural Resources
GEOG 617-4 Soil Science
REM 671-5 Forest Ecology
REM 610 - Applied Environmental Toxicology and Environmental Management of Contaminants

Select 2 courses from:
GEOG 650-5 Research Methods in Spatial Information Science
GEOG 651-4 Advanced Spatial Analysis and modeling
GEOG 653-4 Remote Sensing of Environment
GEOG 655-4 Advanced Principles of GIS
STAT 650 Statistics for Resource Management

* New course under development at BCIT.
** Will be created in the Faculty of Environment to service the program at SFU

e. Distinctive characteristics

In spite of the increasing needs in the private sector, government and conservation organizations, opportunities to gain expertise in ecological restoration are limited in North America (NA). Nelson et al. (2008)[15] surveyed 300+ academic institutions in NA with a focus on identifying the number of academic institutions offering a specialization in ecological restoration. They concluded that opportunities to graduate with a degree specifically in ER were extremely limited. They noted that only 11 institutions (4%) offered undergraduate degrees and only four (1%) offered graduate degrees. In other countries, even fewer educational opportunities exist. The SFU-BCIT joint Master's Degree will become the first academic institutions to offer a Master's Degree in Ecological Restoration in Canada and one of only a few institutions to do so in North America.

[15] Nelson C.R., T. Schoennagel, & E.R. Gregory. 2008. Opportunities for academic training in the science and practice of restoration within the United States and Canada. Restoration Ecology Vol. 16, No. 2, pp. 225–230

As noted above, the program offers two distinctive strengths: 1) The program will combine the scientific knowledge of SFU with the applied technical capacity of BCIT; and, 2) The program will provide training in both biological *and* physical processes related to ecological restoration. This unique combination is made possible by the close proximity of BCIT to SFU, enabling ready access to both institutions and the expertise in biological and physical science within the Faculty of Environment (Geography, Resource and Environmental Management) and Faculty of Science (Biological Sciences and Earth Sciences). Few other institutions have such an opportunity available to them.

f. Anticipated completion time

Students will require 4 semesters to complete the degree requirements.

g.Enrolment plan for the length of the program

It is estimated that 15-20 students will enter the program each year.

h. Policies on student evaluation

The instructor will grade courses. The program will also require a project to be completed under the supervision of the program director.

i. Policies on faculty appointments (minimum qualifications)

No faculty appointments are anticipated.

j. Policies on program assessment

The program will have a joint steering committee comprised of representatives from BCIT and SFU Faculty of Environment. We will also form an external Advisory Committee. There will be on-going dialogue as to the success of meeting the program aims and objectives with feedback being incorporated into the design of the program as necessary.

The administrative structure for the program will adapt the model used by the Master of Digital Media (MDM) program, which includes a Program Director and a Steering Committee comprised of Faculty from contributing institutions. The experience of the MDM program will also help to inform the registration and budget model for the MSc in Ecological Restoration.

k. Level of support and recognition from other post-secondary institutions and relevant regulatory or professional bodies **and**

l. Evidence of student interest and labour market demand

In anticipation of the development of a joint program in Ecological Restoration, SFU and BCIT held a workshop, February 10th 2012. Thirty-six representatives from key sectors (government, private sector, NGO's, First Nations and

academia) were asked to present their ideas with respect to relevant skills and knowledge that a graduating student would require. It was unanimously recognized by all sectors that Ecological Restoration is a rapidly growing field and such a program is well timed and needed. This solid support has been reinforced by undergraduate students polled in first year classes at SFU (EVSC 100), and in third and fourth year courses at BCIT. A major outcome of the sector workshop was a prioritization of the key aspects of an ER program with this list of priorities then guiding the development of the SFU/BCIT collaborative professional graduate program in Ecological Restoration.

At a national level, a recent Profile of Canadian Environmental Employment published by ECO (Environmental Careers Organization) Canada in 2010 further demonstrates the need for a graduate degree in Ecological Restoration. Based on a survey of 2,204 organizations across all major industry groups in Canada, it was concluded that "…*trends since the 2007 ECO Canada Survey of Environmental Employment demonstrate that environmental skills are quickly becoming more important across the workforce and within every industry*…and that…*All skilled environmental occupational categories were in demand with some percentage of employers planning to hire in each category. More employers have plans to hire workers in site assessment and reclamation, waste management, environmental safety and health, and water quality than in other categories.*

Graduates from this proposed master's program would be competitive for employment in:

- Private sector: graduates could work with native plant nurseries, consultancy firms, independent restoration contractors, and developers; or as, utility company biologists, oil/gas/mine reclamation biologists, private land biologists and managers.
- Government (Federal, Provincial, Regional, & Municipal): graduates could work in a variety of government departments, including: parks, forestry, resource management, water management, agricultural land management; or as, habitat biologists, natural heritage specialists, species-at-risk biologists, fisheries biologists, invasive species management specialists, environmental biologists and managers.
- Conservation organizations: graduates could work in a variety of conservation organizations, including: the Nature Conservancy of Canada, Audubon Society, Ducks Unlimited, British Columbia Wildlife Federation's Wetland Institute, Habitat Conservation Trust Fund, watershed stewardship groups, land trusts and conservancy organizations.

m. Related programs in your own or other BC post-secondary institutions

As noted in section f) the proposed MSc in Ecological Restoration is a unique combination of the applied courses offered through BCIT with the fundamental sciences provided by SFU. As such, it fills its own niche. Currently, in BC, only the University of Victoria offers a program in Ecological Restoration that is social science based. The program at University Victoria is non-degree and offers a certificate or diploma in Ecological Restoration (and the opportunity for a specialization in their School of Environmental Studies). We have

engaged in consultations with the University of Victoria and they are supportive of this initiative and see potential for future collaboration.

6.Contact information for the institutional contact person

Sean Markey, PhD spmarkey@sfu.ca Associate Dean, Faculty of Environment Associate Professor, Resource and Environmental Management Simon Fraser University Ph: 778.782.9606	**Rob Stevens, PhD** Robert_Stevens@bcit.ca 604-432-8323 Associate Dean, School of Construction and the Environment, British Columbia Institute of Technology

Appendix 13: Program Benchmarking

There currently are only two Canadian post-secondary institutions that offer a master's program in ecological restoration, or similar area of expertise. The University of Alberta has a comprehensive program in land reclamation and rehabilitation, and the University of Victoria has both a thesis-based M.Sc. and professional-based MA in Environmental Studies with an option in Ecological Restoration. Both institutions' programs are two years with only one course specific to ecological restoration. In the United States, there are six institutions that offer an M.Sc. in Ecological Restoration, or similar program. In general, these six institutions offer a thesis-based M.Sc., professional M.Sc. (courses + capstone project), or both. Programs are typically two years, with most programs requiring 30 credits of coursework, including a thesis, capstone project, or research paper. Similarly, most programs have a minimum entry requirement of a B.Sc. in a related resource management discipline and a GPA of 3.0 or better. Half of the programs only had one course specific to ecological restoration, with the rest having two or three courses specific to ecological restoration.

Benchmarking has supported the finding of Nelson et al. (2008) [16]. They surveyed 300+ academic institutions in North America with a focus on identifying the number of academic institutions offering a specialization in ecological restoration (ER). They concluded that opportunities to graduate with a degree specifically in ER were extremely limited. They noted that only 11 institutions (4%) offered undergraduate degrees and only four (1%) offered graduate degrees. Fewer educational opportunities exist in other countries. The BCIT-SFU joint master's degree will become the first master's degree specifically in ecological restoration offered in Canada, and BCIT and SFU are jointly one of only a few institutions to do so in North America.

Similarly, benchmarking supports the results noted by Bakker and Howell[17] (2011). These authors reviewed academic programs with an ecological restoration focus in North America. One of their conclusions was that, once Society for Ecological Restoration's Practitioners Certification Program (PCP) is initiated, certification in academic programs with an ecological restoration focus be based on the whole program rather than a single course. Half of the programs examined had only one course specific to ecological restoration, with the rest having two or three courses specific to ecological restoration. The proposed program will have nine courses specifically designed with an ecological restoration focus.

The proposed program is very similar in name, program length, entry requirements, and total s to other post-secondary programs in ecological restorations shows. Most programs require 30 s for graduation, with two programs requiring 45 s. The proposed program requires 36 s to graduate (Table 2).

[16] Nelson C.R., T. Schoennagel, & E.R. Gregory. 2008. Opportunities for academic training in the science and practice of restoration within the United States and Canada. Restoration Ecology Vol. 16, No. 2, pp. 225–230.

[17] Bakker, J.D., and J. Howell. 2001. An Assessment of Introductory Restoration Courses in the United States and Canada. Restoration Ecology Vol. 19, No. 5, pp. 572 – 577

Table 2. Benchmarking—post-secondary institutions offering a post-graduate degree in ecological restoration

Program Comparison					
Name of Program	Institute	Credential - length	ER-specific Courses	Entry Requirements	Credits
Ecological Restoration	**BCIT/SFU**	**M.Sc. – 2 years**	**10 courses**		36 credits including CapStone Project
Land Reclamation & Remediation	University of Alberta	M.Sc – 2 years	1 course	Bachelor degree + GPA of 3 (B)	Not found
Environmental Studies (with an optional ER focus)	UVIC	M.Sc. – 2 years MA – 2 years	1 seminar course	BSc. (M.Sc.) or BA (MA) in area of specialization Minimum overall average of B+	30 credits including a 15-credit Thesis (M.Sc.)
Restoration Ecology	UC Davis	M.Sc. Ph.D.	1 course	Bachelor's degree in range science, plant science, animal science, soil science, resource science (land, water), or a related biological science, - 3.2 grade point average (A=4.0) for all upper division courses. Degree must include: 2 courses each in introductory biology, introductory chemistry, introductory physics (6 courses); 1 course each in introductory calculus, introductory statistics, introductory ecology (3 courses).	30 credits + Thesis
Restoration Ecology and Environmental Horticulture	University of Washington	- M.Sc. – 2 to 3 years - Master of Environmental Horticulture (MEH) – 1.5 to 3 years	2 courses	Applicants are expected to have a substantial natural resources background. - GRE, GPA >3.0	M.Sc. - 45 credits including a 9-credit Thesis MEH – 45 credits – Non-thesis
Ecological Restoration	Colorado State University; Forest & Range Stewardship	Master of Natural Resource Stewartship (MNRS) – 3 semesters	2 courses	Bachelor's degree in natural resources. If applicant has another specilization, they may have to take prerequisite courses to compensate for any academic deficiencies.	30 credits 300+ level of which 21 credits must at the 500 level. Non-thesis Program
Environmental Restoration Engineering and Science	University of Minnesota	M.Sc.	3 courses	A Bachelor's degree in a field related to ecology, civil engineering, or environmental and earth sciences.	30 credits, including a Capstone Project and Oral Defense.

Program Comparison					
MS Ecological Restoration, Forest Resources and Conservation	University of Florida	M.Sc. – 1 year - Distance Education	3 courses	Bachelor's degree	30 credits + Research Paper + Comprehensive Exam
Restoration Ecology Program	North Carolina State	- M.Sc. in ER - technical option (thesis-based masters) - 2 years - Master of Natural Resources - ER technical option (professional masters) - 2 years	1 course	- an undergraduate degree in one of life sciences (degrees in biology, ecology, environmental science, and forestry), - a very high undergraduate (and if applicable graduate) GPA > 3.2 - very high scores on the GRE (Graduate Record Exam)	• M.Sc. - 30 credits + Thesis and Oral Exam • MNR-ER 30 credits + Written Exam and Oral Exam