Individual Proposal by Participants in the September 22 – 27 NSF-IGERT MCCE Transboundary Course (CFR 590E)

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Summary: Two faculty, two graduate student instructors and 8 graduate students spent five days in an intensive course examining the interaction between salmon recovery, farming and water where transboundary cooperation, differences, interests, and issues were involved. Rather than the traditional method of inviting speakers to a class on the University of Washington campus, we went to each person's work or research place and used the site and each expert's knowledge of their "site" to convey information. We visited with the research scientist responsible for coordinating all salmon recovery in the Puget Sound, we visited with two commercial fishermen and spent time either on their boat or at their home, we learned from two restoration ecologists, one a tribal scientist involved in the restoration of an estuary on tribal lands, another interested in restoring habitat in southern British Columbia for the Salish sucker and the Nooksack Dace: two species listed as endangered on the Species at Risk Act (SARA, similar to ESA in the United States); we learned from a wildlife area manager about the tradeoffs and risks to upland and migratory species with the proposed removal of dikes in an effort to restore a former estuary; we spent almost six hours with two dairy farmers, both interested in sustainable and wise use of their animals and lands, one organic, the other not; we heard frank talk from members of the Lummi Tribe regarding how their strong mixture of scientific and traditional knowledge regarding the salmon was largely ignored in public discussions about salmon recovery; we heard from a Ph.D. candidate from the University of British Columbia about the different layers of institutions on both sides of the border involved in water and watershed management and their ability to be and to be perceived as agents of change and cooperation; and finally, we spent an entire afternoon examining a small watershed emerging from the US and flowing into the Fraser River in southern British Columbia with a professor from the University of British Columbia who, with his colleagues and students, had spent thirty years collecting data about land use, land changes and their combined impact on water quantity and quality.

Course Project Reports from Hagen, Holland, Lutz, Nguyen, Parikh, Schmidt, Sheldon, Taylor

Contents:

Course Background

I. **Introduction ;** We will spend almost five days exploring the nature of salmon, farms and water in the Puget Sound - Georgia Basin region. As preparation, we have selected a series of articles that address elements of the transboundary exploration, as well as our IGERT itself.

The IGERT Program itself: What does "Multinational Collaborations on Problems to the Environment" really mean?

1. **Interdisciplinary Nature of IGERT in general and this IGERT in particular (Rhoten and Parker 2004; Schlosberg and Sisk 2000, Sung et al. 2003).**

These three articles, while brief, provide a general outline as to the major directions people see interdisciplinary research heading. More and more, we as grad students hear encomiums to interdisciplinary research, and how, in a competitive job market, intellectual breadth is both attractive and necessary. However, articulating an interdisciplinary research program can be fiendishly difficult. These articles should help clarify some of this.

2. **Elements of Nature and the Environment as they apply to this IGERT (White 1999; Willems-Braun 1997).**

The difficulty of teasing apart Nature from humans, culture, or the term of your choice, is now an

academic truism. We hear it—"You know, you're implicated in the systems you study"—and roll our eyes. As we all acknowledge, nature is a politicized construct, the pristine is a myth, and the "natural" dichotomies that we all know and love are artificial at best, sinister at worst. But what are some ways in which a cultural diet of nature is constructed? The two articles examine analogous situations where uses of nature, and constructions of nature, can be wildly different depending on who is doing the using and constructing.

3. **Elements of Multinationality that apply to both this IGERT and the Transboundary Course (BC Version I and 2; Dodge 2004; Kamb 2004; Williams 2000).**

This is perhaps the most attractive component to this IGERT—the opportunity to do work overseas for a year. It's also where Interdisciplinary and Environment will be brought together in the service of your project. To be multinational is to be eminently political—you will enter another sovereign nation and ask to play around there—yet scientists seldom think about the political implications of their work, or how knowledge construction, even that which is supposedly objective, can be a political act. We may argue that certain natural phenomena don't pay attention to national boundaries. That's certainly true, but the people making decisions about those phenomena most definitely care about which side of the border they're standing on. The Williams article and the Boldt decision articles look at ways in which sovereign nations and peoples view the same resource, the conflicts that can arise, and the widely variable ways that people can view the same physical space.

4. **Salmon Stuff:**

   a. **Salmon Science. (Mantua and Francis 2004; Ruckelshaus et al. 2002)**
   b. **Salmon Social (Dodge 2004; Kamb 2004; Shared Strategy for Puget Sound).**

Salmon recovery is as much a social challenge as a scientific one, if not more so. The Boldt decision essentially shaped much of the conflicts that the US faces today between tribal fishermen and everyone else. The Shared Salmon executive summary is a product of a bottom-up management strategy, and represents one of the first recovery efforts that both farmers and fisherman are tepidly enthusiastic about.

Transboundary Studies (Norman and Melious 2004)

Via three mechanisms, we will learn about transboundary issues around salmon and salmon recovery. Salmon as both individual fish and as populations see "no boundaries or borders" and spend a significant part of their life cycle in the open ocean.

The Course

Each of you comes to this course and the first year of your IGERT experience with a wide range of backgrounds, interests, experiences, and perspectives. We hope to build on these strengths and use the diversity of the group to learn about the environment, about different countries, about individual, group and cultural sensitivity, etc. This transboundary course was developed as an immersion experience.

Course Philosophy: Acclimation, inquiry, respect and feedback are integral elements of this course.

Assignment: During the course, we expect you to keep a personal journal with notes about the readings and the various sites and people we meet. We will have you work in groups each evening to discuss what you have seen and learned. As we progress through the various days, you, as an individual, should have prepared an articulated statement about one issue that you have learned about during this course. We will spend a day with an expert in group activities from the College of Engineering to help us produced a refined statement, in the form of a proposal or a white-paper, or an op-ed piece. Our goal is for you to monitor this piece of work over the rest of the year and both reflect on it and refine it.

Course Schedule

Date & Time	**Activity**	**Person**
September 22: Afternoon & Evening	Discuss the documentary on Fisherman's Terminal, Tour & dinner at Fisherman's Terminal	Peter Knutson
September 23: Morning	Presentation on Puget Sound Salmon Recovery	Mary Ruckelshaus
Early Afternoon	Tour of Estuarine restoration on Swinomish Tribal Lands	Todd Mitchell
Late Afternoon	Tour of Skagit Wildlife Area and discussion of dike removal	John Garrett
Evening	Discussion of Skagit Valley salmon and salmon recovery issues	Arn & Fran Thoreen
September 24 Morning	Further discussions	Arn Thoreen
Noon	Tour of a Whatcom County dairy farm	John & Karen Steensma
Afternoon	Tour of small stream restoration for two SARA listed species	Mike Pearson
Evening	Cultus Lake	
September 25 Morning	Hike to Teapot Dome	
Afternoon	Tour of Sumas Watershed	Hans Schreier
Evening	Cultus Lake	
September 26 Morning	Tour of a Whatcom County organic dairy farm	Hans & Colleen Wolfisberg
Early afternoon	Discussion of transboundary studies	Emma Norman
Late afternoon/evening	Discussion by Lummi Tribe and special dinner – Northwest Indian College	Jimmy Wilson, Lenny Dixon, Dick Poole, Randy Kinley
September 27: Morning/ early afternoon	Group Activities	Jim Borgford-Parnell Dick Olmstead

Course Readings

British Columbia - Washington Environmental Council – Version 1
British Columbia – Washington Environmental Council – Version 2 (2003)
Dodge, J. 2004 (Feb. 9). Echoes of landmark case linger. The Olympian.
Kamb, L. 2004 (Feb 12). Boldt Decision 'very much alive' 30 years later. Seattle PI.
Kolbert, E. 2005 (May 9). Annals of Science: The Climate of Man – III. The New Yorker, p. 52.
Mantua, N. and Francis, R. 2004. Natural Climate Insurance for Pacific Northwest Salmon and Salmon Fisheries: Finding Our Way Through the Entangled Bank. *American Fisheries Society Symposium* 43: 121-134.
Norman, E.S. and J. O. Melious. 2004. Transboundary environmental management: A study of the Abbotsford-Sumas aquifer in British Columbia and Western Washington. *J. of Borderlands Studies* 19(2): 101- 119.
Noss, R. 1989. Who Will Speak for Biodiversity? *Conservation Biology* 3(2): 202-203.
Proctor, J. 1995. Whose Nature? The Contested Terrains of Ancient Forests. In *Uncommon Ground: Toward Reinventing Nature,* William Cronon, ed. New York: W.W. Norton.
Rhoten, D. and Parker, A. 2004. Risks and Rewards of an Interdisciplinary Research Path. *Science* 306: 2046.
Ruckelshaus M.H., et al. 2002. The Pacific Salmon Wars: What Science Brings to the Challenge of Recovering Species. *Annual Review of Ecology and Systematics* 33:665-706.
Schlosberg, D. and Sisk T. 2000. The Environmental Science/Policy Interface: Crossing Interdisciplinary Boundaries with a Team-Teaching Approach. *PS: Political Science and Politics* 33(1): 75-79.
Shared Strategy for Puget Sound 2005. Executive Summary
Sung, N.S., et al. 2003. Educating Future Scientists. *Science* 301:1485.
Vitousek, P., et al. 1997. Human Domination of Earth's Ecosystems. *Science* 297:494-499.
White, R. 1999. The Nationalization of Nature. *The Journal of American History* 86(3): 976-986.
Willems-Braun, B. 1997. Buried Epistemologies: The Politics of Nature in (Post)colonial British Columbia. *Annals of the Association of American Geographers* 87(1): 3-31.
Williams, D.M. 2000. Representations of Nature on the Mongolian Steppe: An Investigation of Scientific Knowledge Construction. *American Anthropologist* 102(3): 503-519.

Course Project Reports

Erin Hagen: Farming in southern BC: An ecological perspective

New international markets for chicken and pork continue to grow, prompting land use shifts from traditional crop agriculture to high yield animal protein production. These production shifts have very different inputs and outputs causing changes for soil, water, air, wildlife and humans.

I propose to explore farming from an ecological perspective within the Abbotsford aquifer (or maybe the Sumas watershed??), where there has been an intensification of high yield animal protein agriculture within recent years. An examination of the presence, size and location of landscape features within the area (e.g. roads, forest, streams, hedgerows) will characterize the fragmentation of the system. This data can then be coupled with information about farm type (e.g. crop, chicken, pig, dairy; organic, conventional, sustainable) to better understand

distinctions between types of farms, and possibly implications on land use. The landscape information could be used with other information (e.g. soil and water quality, methane release) in the development of an organic scorecard, which could take into account wildlife habitat, soil condition, chemical inputs and outputs, and many other categories, to rate farms not just for the end product, but for the farm system (perhaps a measure of sustainability). The scorecard could also incorporate a type of bonus for incorporating solutions to diminish negative environmental impacts of farming. This scorecard could be refined and used by farmers, scientists, citizens and policy makers.

Alex Holland: Ecological Impacts of the Switch from Crop-Based Agriculture to Intensive Animal Protein-Based Agriculture.

The growing animal density in the Washington state – British Columbia region has resulted in excess manure production, which can no longer be taken up by the land as fertilizer, and results in high nitrate concentration in the aquifers. In addition, the widespread footbath practice in the dairy industry introduces high levels of formaldehyde and cupper sulfate into the manure, which contaminates the soil and interferes with biological nitrogen cycling.

I would like to look at industrial biological treatment processes, compare the widespread nitrification/denitrification process to the novel anammox process, developed at the University of Nijmegen, in the Netherlands. With Nam, I would like to look at methane recovery processes, and Nam will look at processes to efficiently make electricity from the recovered methane. With Rhonda, I would like to assess soil contamination with formaldehyde and cupper. I will look at bacterial strains that degrade formaldehyde (my lab is expert in methylotrophy, and can give me insights), while Rhonda will look at phytoremediation as a way to stabilize cupper in the soil. We will look at 'cow boots' as a sustainable alternative to the footbath practice.

Preliminary work will assess ecological impact of unsustainable nitrogen cycle (Erin), as well as how these issues are perceived by the farming and wildlife conservation communities (Emma).

As a group, we will assess various 'scientific solutions' depending on their ease of application and cost, the way they are welcome by the farming community, and the expected ecological outcomes. We will share our results with the 'Ag-Ed' community (Rhonda), and established businesses.

Finally, this study will help us determine key notions to define sustainable farming, which we will contrast to conventional and organic farming. We will support our analyses will long-term economic analyses. These results will be shared with the consumers and the agricultural businesses.

This study could be later extended to look at pesticide use and resilience in the soil, or cultivation of genetically modified vs. classically bred crops.
The methane recovery question could be extended to look at biodiesel as a potential fuel source in the farming industry. Algal and plant production of fatty acids could be compared to obtain the main raw component for the biodiesel. Methanol, which constitutes 20% of the biodiesel,

could be produced renewably from decaying forest wood (pine-beetle in Canada, forest fire in California or Washington etc.), using the syngas process.

http://www.anoxkaldnes.com/
http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/N/NitrogenCycle.html
http://www.anammox.com/
http://www.davismanufacturing.com/products/cow_boot.html
http://www.pbsanimalhealth.com/cgi-local/SoftCart.exe/hoofcare/technovithoof.html?E+scstore

Jim Lutz: Title: Several future scenarios for the Georgia Basin/Puget Sound Region given possible trends in climate change and human activities

Who is the audience? Ours is a research proposal, and the audience is the community of funding organizations. However, the result of the research will be a set of future scenarios of actions and their consequences that can be presented to or discussed with a variety of stakeholders. Thus, our audience is those funding agencies concerned with disseminating scientific results to the citizenry at large.

How is the issue framed to reach the audience?

As a scientific proposal to explore environmental scenarios for Georgia Basin/Puget Sound basin, our work will be built on existing science (*sensu* Rucklehaus). However, as a result of the extreme social and political polarization surrounding the issues of water quality, land use, and salmon preservation, much of the existing science is restricted to dealing with data in the recent historical record. Although less precise, other data about past conditions, and extrapolations about future climate can help explore hypothetical future conditions. We propose that examining, and through models, modifying hypothetical conditions will allow a wider audience to examine how various scenarios would impact their own lifestyles. We hope to show what actions might be useful (or useless) in promoting healthy ecosystems for farming, fishing, habitation and water use. Our research will not be framed as one of predicting the future, but rather of illustrating consistent consequences of following several climatic and land use trajectories.

Possible Team Members: Jim Lutz, Tapan Parikh, Kimberly Sheldon, James Taylor

Nam Nguyen: Recovery of Methane Gas from animal manure

From the Transboundary course's field trip, I discovered an idea that sparks my interest -- the recovery of methane gas from the animal manure and its use to produce electricity locally. This idea appears to offer possible solutions for two currently environmental problems: one is the problem with too much animal manure and the other is the energy shortage.

The immediate and obvious benefit from methane production is the energy value of the gas itself. In addition, its use would reduce the need for fossil fuels, thus decreasing the carbon dioxide pollution that comes from their combustion as well as the carbon dioxide produced in association with drilling, mining, processing and transporting them. In addition, on farms where manure is

stored in lagoons, methane is usually generated, released into the atmosphere to become a strong greenhouse gas. Thus, by capturing and burning the methane produced from the manure, the rate of global warming can be reduced because both the inputs of fossil carbon dioxide and methane into the atmosphere are greatly reduced. Furthermore, using methane to generate electricity can lower energy costs and create some local autonomy from large, multi-national energy companies or suppliers. It's also a way to handle the increased pressure on livestock operations to control odors, improved manure handling, and reduced ground and surface water contamination.

The project that I would like to pursue under this IGERT is to explore the recovery of methane from the farms' animal waste. As an engineer, the first thing that I need to do is to learn how methane is produced from the manure. Secondly, I need to investigate more efficient methods of energy conversion and methods of concentrating the energy in methane gas to eliminate storage difficulties. Finally, I need to design or modify current equipment to improve the methane production and its conversion to electricity.

Tapan Parikh: Analysis and Presentation Toolkit for Bridging Different Visions

Audience: Stakeholders associated with salmon in the Puget Sound – Georgia Basin (e.g., farmers, fishermen, natives, government, residents, etc.)

Proposal: What we would like to do is develop an analysis and presentation toolkit that a) documents the effects of human action, climate change, etc. on salmon populations on specific river systems, and b) allows us to present these results in a way that helps all stakeholders (farmers, fishermen, natives, government, etc.) agree on a common vision for the future leading to coordinated direct action. The presentation method should be closely tied to concrete things people care about - farms, fish, water, land, the past and the future. By bridging the gap between abstract scientific results and concrete human values, science can be used as a multi-partisan estimate of truth that various stakeholders can agree to. Some examples of presentation methods include: rich data visualization and scenario depiction (future and past). Issues of appropriate scale (geographic and temporal) will be emphasized.

Rhonda Schmidt: Ecological Impacts of Agriculture

I am planning on working with a group of IGERT fellows on the ecological impacts of agriculture. From what we learned from Hans Schreier, John Steensma and Hans Wolfisberg, agricultural practices are changing and intensifying on the Sumas aquifer. These changes are causing large amounts of wastes such as manure to be generated, and work needs to be done to address how it will be utilized. Also, there are farmers practicing many different "styles" of farming. We visited a "sustainable" dairy and an "organic" dairy. This brought up the question of the differences between the two practices.

One potential project could be to look at the quantity and composition of manure streams from large-scale meat farms. This project would allow individual students to pursue research in their particular fields, while still providing authentic opportunities for interdisciplinary collaboration. For example, I am interested in how the use of copper sulfate hoof baths is impacting copper concentrations in soils that are treated with cow manure. Nam is interested in

generating methane from manure. Erin is interested in the ecological impacts of manure on streams. Alex is interested in control of nitrogen in manure. Our audience would be the farming community.

Another potential project would be to investigate the differences between conventional, sustainable and organic farming practices. We would look at the literature on the topic through our own disciplinary lenses to compare and contrast the practices. We could produce a poster illustrating what we find, and write some "op-eds" to inform the general public. We could also work with undergrads and high school agriculture students and teachers to develop an instructional unit or event to get them thinking about the issue.

Kimberly Sheldon: Back to the Future: using data from the recent past to protect future Northwest salmon habitat

Goal: The goal of this project is to use historical data and future climate scenarios to create a model that determines future water temperatures along river systems in the Skagit Valley. Because salmon spawning activity and egg development are sensitive to water temperature, we will use the data of future water temperatures to identify river systems with the greatest potential for future use by salmon. The information provided by the model will be helpful in guiding habitat restoration and management policies.

Audience: This study is designed to identify river systems that may be important as future salmon runs, therefore, any party interested or involved in salmon recovery and the policies governing salmon habitat protection would benefit from this research. Groups such as native Indian tribes, government agencies, NGOs, sport fishers and concerned citizens could use this knowledge to support efforts that protect areas important for future generations of salmon.

Contribution: As a biologist I hope to use my knowledge of climate change research to create a model for the Skagit Valley that is applicable to other river systems. I would also like to use my skills in experimental design to look at the effects of other anthropogenic disturbances, such as dams and invasive species, on the river systems identified in our study. Finally, I hope to combine my background in ecology with my teaching experience to communicate our findings to the various stakeholders, both scientists and laypeople.

James Taylor: Spatiotemporal Trends in Salmon Ecological Trajectories: Climate, Environment, and Human Impacts

The goal of this project is to expand current knowledge of salmon population histories, environmental, and climatic requirements beyond the Industrial Era. Current policy planners and salmon ecology stakeholders rely heavily upon near-term trends in salmon populations when making decisions about potential habitat restoration programs. Mid-term variation in salmon ecology since the Pleistocene-Holocene transition can provide valuable information for establishing natural and anthropogenic conditions relevant to the construction of expected background fluctuations in salmon populations, while also providing stakeholders with analogous and semi-analogous expectations for salmon habitat under conditions of global climatic change. Once established, such information will be presented in simplified, interactive digital media accessible to the

public and policy makers in an attempt to facilitate greater cooperation and understanding between disparate stakeholders. The project seeks to establish a climatic (sea-surface and fresh water temperatures), environmental (near-shore upwelling, riparian habitat), demographic (salmon), and anthropogenic record for one specific riverine system as a model for future regional research in other related systems.

As an archaeologist specializing in paleoclimate and paleoenvironmental studies I hope to establish centennial scale trends in SST and upwelling regimens from archaeofauna found in association with human cultural material. Such information can serve to establish correlations between changing environments and human subsistence practices, as well as anthropogenic impacts on the marine environment. Other areas in which this project should focus could be salmon life-histories and demographics, such as fish ecology and proxy population data, riverine temperature, and nutrient bases. Likewise, this project will require interactive public outreach information systems, such as web based data sets and GIS mapping.