

Graduate Student Conference on
Fisheries And Marine Ecosystems:
Integrating Science and Management
April 30 to May 2, 2004
Camp Alexandra, Crescent Beach
British Columbia, Canada

Conference Proceedings

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Introduction

Our aquatic ecosystems are experiencing devastation on a global scale, largely due to human influence. Recent research by Boris Worm and Ransom Myers, published in *Nature* (15 May, 2003) shows that marine commercial fisheries have stripped many of our economically and ecologically valuable species by 90% of their former abundances. Habitat degradation and pollutants have caused further declines and may be preventing the recovery of some species

These impacts extend beyond the species of interest to entire aquatic ecosystems, and commercial and recreational fishing economies. Fisheries collapses often have devastating results, not only for predatory species that feed on the harvested species, but also for local fishing communities. Scientific understanding of these declines has so far not resulted in sound management and sustainable fishing practices.

Can science better inform management of the human threats to human fisheries and potential solutions?

The Graduate Student Conference on “Fisheries and Marine Ecosystems: Integrating Science and Management” will tackle this question from the perspectives of young researchers.

First, the conference will address what is currently being done to achieve sustainable fisheries in both freshwater and marine environments. Second, we will assess our role in achieving this as young researchers.

As graduate students in the early part of our careers, we offer fresh perspectives on fisheries science and management, and a breadth of view that comes from our diverse backgrounds. This conference will provide a unique opportunity for graduate students to explore interdisciplinary issues regarding the science and management of marine and freshwater resources. Specifically, this conference will offer an opportunity to present research and proposals with similar interests, discuss the current state of fisheries, and explore different ideas about the future of our field. The format will be a mix of oral presentations, poster sessions, small-group discussion, and a large-group synthesis of ideas.

- Conference Co-chair, Carrie Holt



Organizing Committee

The First Annual FAME Graduate Fisheries Conference is brought to you by “The Fish Chicks” in the Fisheries Research Group in the School of Resource Management at Simon Fraser University:

Conference Co-Chairs

Carrie Holt Stacy Webb

Organizing Committee

Nina Barton
Ashleen Benson
Jaclyn Cleary
Merran Hague
Carrie Holt
Kendra Holt
Sylvia Humble
Ann-Marie Huang
Joanna McGarvie
Karen Skibo
Stacy Webb



Funding Sources

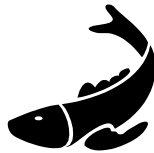
A very special thank-you to our funding sources who helped make this event possible.

- Department of Fisheries and Oceans – Simon Fraser University Contribution Agreement
- Simon Fraser Student Society

Guest Speakers

Alida Bundy

Alida is a 3-yr veteran Research Scientist with Fisheries and Oceans, Canada at the Bedford Institute of Oceanography, Nova Scotia. Alida began her career in fisheries in the NW coast of Scotland where she crewed on a trawler. She subsequently pursued a M.Sc. in Fisheries Biology and Management (U. N. Wales, UK), then a Ph.D. in Resource and Environmental Studies at the Fisheries Centre, U. British Columbia. She has been working for DFO on the east coast of Canada in one capacity or another since 1998. Her foremost interest is in the conservation of the biodiversity of our oceans. To this end, her research interests include the impact of fishing on marine ecosystems, the structure and functioning of ecosystems, ecosystem-based management and ecosystem based indicators of fishing impacts, development of assessment methods for data-poor fisheries, adaptive management of fisheries and interdisciplinary approaches to fisheries science.



Josie Osborne

Josie Osborne is a Tofino-based marine biologist with a background in the biology and ecology of marine plants and invertebrates. She completed a B.Sc. in marine biology at the University of British Columbia, and a Masters of Resource Management at Simon Fraser University. Her Masters research focused on the management implications of variable recruitment, stock assessment sampling design, and data collection by user groups in BC's intertidal clam fisheries. She also has research experience in marine plant enzyme kinetics, northern abalone (*Haliotis kamschatkana*) physiology, and decision analysis applications for timber supply analysis in BC's forest industry. Since 1998 she has been a staff biologist for the Nuu-chah-nulth Tribal Council on the west coast of Vancouver Island (WCVI), working in various fisheries and aquaculture initiatives with First Nations. She is currently involved in the development of the WCVI goose barnacle (*Pollicipes polymerus*) fishery, shellfish aquaculture, environmental monitoring of finfish aquaculture, and stock assessment and education/awareness initiatives for species at risk such as the northern abalone and the sea otter (*Enhydra lutris*). Josie's main interest is integrating local knowledge (both First Nations and non-First Nations) with scientific principles of fishery management to design fisheries that are both biologically and socioeconomically sustainable. Josie also volunteers for several WCVI organizations giving interpretive talks and walks about intertidal life.

Conference Proceedings

FRIDAY APRIL 30th, 2004

6:00pm – onward	Check-in Poster Session & Social Mixer (posters will remain on display for the entire weekend)
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SATURDAY MAY 1st, 2004

7:30am – 8:30am	BREAKFAST	
8:30am – 8:45am	Introduction and Welcome Carrie Holt & Stacy Webb	
SESSION 1	FLOUNDERING in the DEEP END: STRATEGIES for FISHERIES MANAGEMENT & CONSERVATION Session leaders: Joanna McGarvie & Merran Hague	
8:45am – 10:00am	Natalie Ban (UBC)	Selecting Ecologically Viable MPAs: A Research Proposal
	Trevor A. Branch (U of Washington)	Would Individual Transferable Quotas Solve the Problems of the U.S. West Coast Groundfish Fishery? Lessons from British Columbia.
	Ashleen Benson & Carrie Holt (SFU)	Simulations of a Management Procedure for Patagonian Toothfish (<i>Dissostichus eleginoides</i>)
	Elizabeth Fetherston (Duke University)	Comparative Fishery Management Successes and Failures in the North Pacific and North Atlantic Fisheries of America: The Atlantic Cod and Pacific Halibut Fisheries.
	Sian Morgan (UBC)	Gold Rush: the Rise and Fall of a Sea Cucumber Fishery in the Central Philippines.
10:00am – 10:15am	COFFEE BREAK	
10:15am – 10:30am	Stacy Webb (SFU)	Fishing or Catching: Assessing the Vulnerability of BC Wild Rainbow Trout Stocks to Overfishing (a work in progress)

<p>SESSION 2 ONE FISH, TWO FISH, RED FISH, BLUE FISH: ASSESSMENT & MONITORING of FISH POPULATIONS Session leaders: Kendra Holt & Karen Skibo</p>		
10:30am – 11:15am	<p>Mary Cashman (UBC)</p> <p>Merran Hague (SFU)</p> <p>Michael Melnychuk (UBC)</p>	<p>Ecological Impacts of Small-scale Fishers’ Decisions on the Danajon Bank, Philippines: A Research Proposal.</p> <p>The Use of Genetic Tagging to Estimate Abundance of B.C. Inshore Rockfish (<i>Sebastes</i> spp) in Rockfish Conservation Areas: A Work in Progress</p> <p>Juvenile Marine Mortality in Pacific Salmon: Patterns Before Causes Before Management</p>
11:15am – 11:45am	Break-out session	
11:45am – 12:00pm	Group discussion of break-out questions	
12:00pm – 1:00pm	LUNCH	
<p>SESSION 3 UNTANGLING the RED TAPE: INCORPORATING DIVERSE PERSPECTIVES in FISHERIES MANAGEMENT Session leader: Jaclyn Cleary</p>		
1:00pm – 2:30pm	<p>Sylvia Humble (SFU)</p> <p>Heather D’Agnes (U of Washington)</p> <p>Robert Arlinghaus (Leibniz)</p> <p>Frances B. Van Cleve (U of Washington)</p> <p>Fernandes, Damian (U of Manitoba)</p>	<p>Industry Involvement in Research and Management: The B.C. Sea Cucumber Fishery.</p> <p>The Role of Participation in Community Based Coastal Resource Management in the Philippines.</p> <p>Understanding the Human Dimension as a Prerequisite for the Development of Ecosystem- Based Management Actions in Recreational Fisheries</p> <p>The Role of Natural Science in Decision-making within Regional-scale Restoration Projects in European Countries and the United States.</p> <p>Community-based Conservation of <i>Arapaima</i> <i>gigas</i> in Central Guyana</p>

	Manjunatha R. Ranga (U of Manitoba)	Shifting from Integrated Rice-Shrimp System to Intensive Aquaculture: Impacts on the Sustainability of Rural Livelihoods in Kerala, India.
2:30pm – 2:45pm	COFFEE BREAK	
SESSION 4 COLD WET CASH: ECONOMIC VALUES of FISHERIES MANAGEMENT & CONSERVATION Session leader: Sylvia Humble		
2:45pm – 4:00pm	Cameron Ainsworth (UBC) Dale Marsden (UBC) Sarah Nathan (SFU) Heather Keith (UBC) Apurba Deb (U of Manitoba)	Cost Benefit Analysis of Ecosystem Restoration in British Columbia. Canada’s International Fisheries Trade Since 1950: Volume, Value and Implications for Conservation. Bioeconomic Models in Fisheries Management: Indirect Valuation of Wetlands A Bioeconomic Analysis of the Purse Seine and Longline Tuna Fisheries. Impact of Globalisation of the Shrimp Sector of Bangladesh: Linked political economy and environmental impacts with focus on coastal resources and livelihoods
4:00pm – 4:30 pm	Break-out session	
4:30pm – 5:00pm	Group discussion of break-out questions	
5:00pm – 6:00pm	Free time (beach etc.)	
6:00pm – 7:00pm	DINNER	
EVENING SEMINAR SESSION		

7:30pm	<i>Panel discussion:</i> Integrating scientific, traditional, and commercial fishing knowledge in fisheries management.	
	Josie Osborne	Integrating Local Knowledge with Scientific Principles of Fishery Management: The Goose Barnacle Fishery on the West Coast of Vancouver Island.
	Alida Bundy	<i>TBA</i>
8:00pm – 8:30pm	Group discussion	
8:30pm – onward	Poster Session & Social Mixer and Bonfire	

SUNDAY MAY 2nd, 2004

7:30am – 8:30am	BREAKFAST	
SESSION 5 A TALE OF TWO FISHIES: ECOLOGY & ENVIRONMENTAL MONITORING Session leaders: Stacy Webb & Nina Barton		
9:00am – 10:15am	Kate Leatherbarrow (UVic)	Management of Recreational Boat Anchoring in the Southern Strait of Georgia: Effects of Physical Disturbance on Benthic Infauna
	Rebecca Asch (U of Rhode Island)	Evaluating the Effects of Bottom Fishing Disturbance on the Sessile Epifauna of Georges Bank
	Corey Peet (UVic)	Interactions Between the Salmon Louse (<i>Lepeoptheirus salmonis</i>) and Outmigrating Juvenile Salmonids in British Columbia.
	Melissa Anderson (U of Washington)	Whale Watching Expectations, Evaluations and Onboard Marine Environmental Education: A Case Study of the San Juan Islands, Washington
	Nathan Taylor (UBC)	Effects of Size Selective Fishing on Estimates of Growth and Mortality Parameters.

10:15am – 10:30am	COFFEE BREAK
10:30am – 11:00am	Break-out session
11:00am – 11:30am	Group discussion of break-out questions Closing Remarks
11:30am – 12:00am	Pack and Clean-up rooms
12:00pm – 1:00pm	LUNCH (FAME network meeting for those interested)
1:00pm	Check-out

Presentation Abstracts

Cost Benefit Analysis of Ecosystem Restoration in British Columbia.

Ainsworth, Cameron

University of British Columbia

The marine ecosystem of northern British Columbia is modeled using Ecopath with Ecosim simulation software. Four historical periods are represented and evaluated as possible restoration goals for the future, from pre-European contact to present (c.1750, c.1900, 1950 and 2000). Using an optimization routine, we determine the fleet-effort configuration that will best allow an idealized, responsible fleet to harvest the restored system under a variety of harvest objectives. Objectives provide a range of policy options that trade-off exploitation with conservation. Policies are verified using replicate optimizations, initialized with random fleet-effort starting points. Using economic, social and ecological indicators, we gauge the merits of each restoration goal, and provide a benchmark of potential value to weigh against the costs of restoration. While the pre-contact system promises the greatest socio-economic and ecological returns, it is the least similar to the present condition and so represents the most ambitious restoration project. A cost-benefit analysis compares each restoration period. The speed of restoration is important in order to maximize cost-effectiveness, while continuing to provide for the needs of resource users. Through our research we hope to present policy options for west coast fisheries that seek restoration, rather than sustainability, as their goal.

Whale Watching Expectations, Evaluations and Onboard Marine Environmental Education: A Case Study of the San Juan Islands, Washington

Anderson, Melissa

University of Washington

The increase of recreational whale watching worldwide has created controversy on the negative impacts of boat traffic in close proximity to whales and the positive impacts of onboard marine environmental education on tourists. It is essential to determine tourists' expectations and evaluations of whale watching trips, and the importance of onboard marine environmental education, in order to best manage the social aspects of the whale watching tourism. 57 social surveys were collected, along with detailed ethnographic field notes, from orca whale watching tourists in the San Juan Islands, Washington, between August 17 and September 10, 2003. The surveys gathered data using open-ended and objective questions on expectations for the trip, evaluations for the trip and the educational component, whale biology and conservation knowledge, demographics and what was found to be disappointing. The surveys were analyzed using SPSS and *Anthropac*. Survey results show that tourists primarily expected to see whales (75.4%), to enjoy the outdoors (66.7%) and to learn about whales (38.6%). Not a single respondent stated expectations pertaining to the proximity of the boat to the whales. Tourists indicated that seeing orcas (39.3%), orca behavior or proximity to the boat (30.4%), seeing wildlife other than orcas (16.1%) and learning about orcas (16.1%) made the trip most memorable. Survey results and ethnographic field notes showed that overall trip enjoyment was increased by the onboard educational component. These findings indicate that while tourists find proximity to whales and charismatic whale behavior memorable, they do not expect it in a trip. Tourists do expect to learn about whales and indicate that education is essential in achieving trip satisfaction. It is therefore crucial to include an educational component on all whale watching trips in order to maintain trip satisfaction for the tourists while maintaining a safe viewing distance from the whales.

Understanding the Human Dimension as a Prerequisite for the Development of Ecosystem-Based Management Actions in Recreational Fisheries

Arlinghaus, Robert

Liebniz University

Recreational fisheries management is as much people management as fish stock management. Unfortunately, our knowledge of predictor variables explaining the support of anglers for various management actions is limited. However, it is exactly this type of knowledge that is crucial to improve angler education and information programs and to develop ecosystem-based recreational fisheries management strategies. By means of a telephone survey and an open-ended question, the management preferences of anglers in Germany were elicited. Management attitudes and management preferences of anglers were both dominated by habitat management and stocking policies. Management strategies potentially restricting anglers' own activity were strongly opposed. A discriminant analysis was conducted to analyse which of 23 independent variables measured explained best whether the anglers supported the more sustainable, ecosystem-based habitat management strategy or the less sustainable stocking approach. Anglers with high pro-ecological and low traditional management beliefs, negative stocking and positive habitat management attitudes, satisfied with the previous angling year, less catch orientated, successful and specialized, fishing most frequently in natural water bodies, and living in more rural areas intended to fund habitat management as opposed to stocking and vice versa. This study suggested that basic human characteristics might be powerful predictors of management support of anglers. In contrast, typical angler variables such as angler commitment, experience or site preferences seem to exhibit less explanatory power. It was concluded that the understanding of the human dimension of anglers is the prerequisite for the development of ecosystem-based management actions in recreational fisheries.

Evaluating the Effects of Bottom Fishing Disturbance on the Sessile Epifauna of Georges Bank

Asch, Rebecca

University of Rhode Island

Sessile epifauna (e.g., sponges, hydroids, bryozoans, and tubiferous polychaetes) are ecologically important, because many taxa generate three-dimensional microhabitats that augment the structural complexity of the benthic environment. These microhabitats may directly benefit invertebrates and demersal fishes by aggregating food sources and providing refuge from visual predators. In 1994, three areas of Georges Bank were closed to bottom fishing. While the initial objective of this management decision was to decrease fishing mortality, the closed areas eventually became one of New England's first de facto experiments with ecosystem-based management. In order to investigate the fishery closure's effect on benthic megafauna, bottom photographs and Naturalist dredge samples were collected from stations inside and outside one of the closed areas between 1994-1998. Closed and open stations exhibited significant differences in epifaunal community structure; however, there was no monotonic increase in the total percent cover of sessile epifauna at closed stations that had previously been subjected to fishery disturbance. In comparison with closed stations located at similar depths, open stations displayed a higher percent cover of encrusting bryozoans, a lower percent cover of bushy bryozoans and sponges, and a reduced abundance of non-colonial organisms. The abundance and percent cover of hydroids and the tubiferous polychaetes *Filograna implexa* and *Protula tubularia* seemed to depend more on depth than fishery disturbance. To explore how frequently Georges Bank megafauna establish microhabitat associations with sessile epifauna, the weighted abundance of 57 species was compared against two multivariate indices of sessile epifaunal abundance developed through principal components analysis (PCA). Results indicated that 17 species were disproportionately abundant in areas characterized by a high percent cover of arborescent epifauna and calcareous tubeworms; 14 species occurred most commonly at stations with a high percent cover of sponges; 11 species were associated with disturbed habitats, and; 15 species exhibited no distinct microhabitat preferences.

Selecting Ecologically Viable MPAs: A Research Proposal

Ban, Natalie

University of British Columbia

The goal of my research is to investigate the relevance of terrestrial park establishment tools to MPAs, and examine the efficacy of two different approaches of MPA designation – science-identified MPAs and stakeholder-identified MPAs. Currently less than one per cent of Canada’s marine waters are protected, while fisheries are declining significantly. MPAs are being hailed as one of the ways to stop this decline, and possibly restore overexploited ecosystems. At the World Summit on Sustainable Development in South Africa in 2002, Canada committed to establishing a representative network of MPAs by 2012. My Ph.D. research will critically examine some of the methods and tools used to select sets of MPAs, and make recommendations on effective and efficient MPA establishment tools.

Simulations of a Management Procedure for Patagonian toothfish (*Dissostichus eleginoides*)

Benson, Ashleen and Holt, Carrie

Simon Fraser University

Despite extensive efforts to reduce uncertainties in fisheries and the development of complex models to predict the effects of fishing, sustainably managed fisheries are the exception rather than the rule. Many researchers have concluded that traditional methods of assessment and management of fish stocks do not work because of (1) conflicting management objectives, (2) inadequate communication between fisheries scientists and managers that results in ambiguous management objectives and scientific advice, and (3) an inability to account for uncertainty in data and management procedures. The latter factor has been emphasized in recent years. Measuring the risk fishing poses to a population is assumed to facilitate decision making, but it is rare that the consequences of alternative actions are examined.

A novel approach to fisheries management was recently proposed. The management oriented paradigm (de la Mare 1998) is a feedback management system with four main components: (1) measurable objectives, (2) a management procedure based on decision rules, (3) assessments based on specific data, and (4) prospective evaluation of management procedures using computer simulations. This approach has been used to evaluate precautionary catch limits for some species, however the value of incorporating new survey data dynamically into management procedures has not yet been assessed.

Our objectives are twofold: (1) to explore the properties of a generalized feedback management system within a management oriented paradigm, and (2) to assess the value of scientific learning through annual survey data. Using Patagonian toothfish (*Dissostichus eleginoides*) as a case study, we evaluate the performance of management strategies that account for dynamic learning compared to those that do not. We evaluate how well the management system detects and adjusts to changes in the underlying biological system, such as variations in carrying capacity that might result from climate change.

Would Individual Transferable Quotas Solve the Problems of the U.S. West Coast Groundfish Fishery? Lessons from British Columbia

Branch, Trevor A.

University of Washington

The U.S. west coast groundfish fishery and the British Columbia groundfish fishery are twins bordering on each other. Both fleets catch a similar suite of species occupying similar habitats, and up until 1996 were heading towards disaster under trip limit management. After 1996 their paths diverged: the U.S. fishery is now a federal disaster with nine overfished species, whereas the B.C. fishery is economically efficient due largely to the introduction of Individual Transferable Quotas (ITQs) and 100% observer coverage in 1997. One of the most troubling issues in the U.S. fishery is that catches of many species are required to be discarded (discards are usually dead), an outcome which is economically and biologically undesirable. This outcome is avoided in the B.C. fishery where ITQs provide incentives to avoid catching overfished species, reducing wastage. I examined fishing behavior in individual vessels to show that B.C. fishermen avoided fishing opportunities where low-quota species might be caught. In particular, catches of rougheye rockfish, yelloweye rockfish and shortraker rockfish have been dramatically reduced in B.C., without any concurrent reduction in catches of other target species.

Ecological Impacts of Small-Scale Fishers' Decisions on the Danajon Bank, Philippines: A Research Proposal

Cashman, Mary

University of British Columbia

There is growing concern that small-scale fisheries and the increasing fishing intensity exerted by those fisheries pose a threat to the ecological health and biodiversity of coral reefs. The Danajon Bank, a double barrier reef in northwest Bohol, is a significant area for reef fisheries in the central Philippines and is also of great conservation concern. One of the small-scale fisheries using and potentially impacting this area is the lantern fishery. Lantern fishers are known to move among different target species and even change gears throughout the year. Yet, little is known about what causes these temporal and spatial shifts or the resultant effect on the fish populations and marine environment. I propose to examine the ecological impacts of lantern fishers' decisions on the Danajon Bank, Philippines. To this end, I will 1) characterize the lantern fishery, 2) document shifts in the fishery, 3) construct an ecosystem model of the area and model effects of these shifts, and 4) identify and test management strategies for fishery sustainability.

The Role of Participation in Community Based Coastal Resource Management in the Philippines

D'Agnes, Heather

University of Washington

The current trend towards including coastal residents in the management of their marine resources has been touted by international aid agencies, non-governmental organizations (NGOs) and multilateral agencies as an answer to sustaining project activities when funding ends. This presentation will discuss the forms of participation most prevalent in these project and explore the mechanisms for encouraging local residents to engage in the coastal management process. One of these forms of participation is the formation of a key group of local leaders in a committee responsible for designing, implementing and enforcing Marine Protected Areas (MPAs) within their villages. Using this as an example, the presentation will discuss research methodologies for better understanding if this form of participation is actually ensuring sustainability of the MPA and its enforcement efforts.

Impact of Globalization on the Shrimp Sector of Bangladesh: Linked Political Economy and Environmental Impacts with Focus on Coastal Resources and Livelihoods

Deb, Apurba

University of Manitoba

Through economic liberalization and structural adjustment programs, Bangladesh has sought to obtain the economic benefits of globalization and some significant steps have been undertaken for globalizing the economy. The interplay and dynamics between the human ecology and the patterns of economic development remained overlooked, and it is now being speculated that the ecological dynamics are being altered swiftly by the changing nature of human economic behavior. The country is often characterized by scanty natural resources, high population density, low per capita income and frequent natural calamities. Mangrove forests that developed under the peculiar hydrodynamic and sedimentation conditions of the coastal areas of Bangladesh are enormously important for the livelihoods of the underprivileged coastal communities and their protection from natural calamities. In the face of an increased global demand for shrimp, several thousands hectares of ecologically important mangrove forests were clear cut for shrimp culture with the noble ‘objectives’ of boosting economy, employment generation and local development through patronization of international agencies. An unregulated horizontal expansion of shrimp farms had serious repercussion on the coastal and marine biodiversity as billions of finfish and shell-fish larvae are being destroyed at their planktonic stages in course of collecting wild fry required for the grow-out farms. An inquest into the political economy and influence of the global market show that the local reviled musclemen and the behind-the-screen powerful elites have benefited tremendously, thus further provoking social inequity. A close examination into this disastrous transformation of the mangroves forests from the ‘common resource use’ to ‘private property’ of a few revealed that the demise of mangrove forests impacted many net-negative transfers on the deprived coastal communities who depended directly on the forest resources primarily for livelihoods. The immediate livelihoods and ‘traditional economic safety net’ of the poor, built historically centering the mangrove forests, have been disrupted pushing them to a process of rapid pauperization. Consequent spiral effects of such a conversion of the precious natural resource are, just to name a few, increase in unemployment and underemployment, escalation in social tension, vulnerability to natural calamities, disruption of traditional social bondage, displacement and increase in landlessness, rural-urban migration, deprivation from traditional use rights, humiliation and harsh civic disorder.

Comparative Management Successes and Failures in the North Pacific and North Atlantic Fisheries of America: The Atlantic Cod and Pacific Halibut Fisheries

Fetherston, Elizabeth

Duke University

It is widely known in scientific communities that the world's fish stocks are not the limitless resource that our ancestors once took them for. Numerous studies have demonstrated that the majority of the world's fish stocks are overexploited and under managed. Management mechanisms such as trip limits, seasonal closures, and gear restrictions, in and of themselves, have not delivered the right combination of remedies for fisheries management. To that end, some managers are looking toward Individual Fishing Quotas (IFQs) for a remedy to this escalating problem. The Pacific halibut fishery can claim numerous reasons for the success of its management. The assignment of property rights and the implementation of IFQs are credited with a large portion of that success. Yet, there are more factors inherent to a successful fishery than merely policy and management mechanisms. To prescribe IFQs as an answer to the nation's and the world's over harvesting problems is to miss key biologic, economic, social, and historical information which are specific to each fishery.

On the northeast coast of the United States, there is mounting evidence of fishery policy failure to curtail the growing trend towards over harvest. The history-rich Atlantic cod fishery has faced plummeting catch rates over the past thirty years, and heightened restriction on gear types and fishing days has done little to slow the decline. The biological data and harvest information that has been collected in the Pacific halibut fishery for nearly a hundred years is clearly missing from the management strategies of New England. Only the responsible use of statistically viable catch data paired with an accurate knowledge of the stock will promote the kind of resource stewardship that has been evidenced in the North Pacific, and only with a base of responsible harvest can IFQs be implemented with any hope of success.

The Use of Genetic Tagging to Estimate Abundance of B.C. Inshore Rockfish (*Sebastes* spp) in Rockfish Conservation Areas: A Work in Progress

Hague, Merran

Simon Fraser University

Despite tightening management restrictions, rockfish stocks within the Strait of Georgia continue to demonstrate declining population trends. DFO has recently adapted a spatial management strategy for rockfish protection through the formation of Rockfish Conservation Areas (RCAs) along the coast of British Columbia. However, habitat preferences and physiological characteristics of inshore rockfish inhibit the use of traditional monitoring methods (e.g. long-line, trawl and external tag mark-recapture surveys) for assessing the RCAs. In this study, we examine the use of *in situ* genetic tagging (GENETAG) of inshore rockfish as an alternative marking strategy and complete the first GENETAG field trials on quillback and copper rockfish, *Sebastes maliger* and *caurinus*. Preliminary sampling within the Trincomali Channel RCA in the Strait of Georgia during the summer and fall of 2003 suggests that GENETAG may be a possible alternative to traditional tagging methods for collecting abundance, distribution and movement data on inshore rockfish. Such information may be useful for determining the suitability of currently established RCAs in terms of offering protection to rockfish stocks and for monitoring the effectiveness of these reserves over time.

**Industry Involvement in Research and Management:
The B.C. Sea Cucumber Fishery**

Humble, Sylvia

Simon Fraser University

In recent decades there has been an increasing trend of industry participation in fishery research and management in British Columbia. The giant red sea cucumber fishery provides an example. Since 75% of the coast was closed to commercial fishing in 1997 due to conservation concerns arising from record landings and a lack of scientific data, the Pacific Sea Cucumber Harvesters Association (PSCHA) has been responsible for funding and conducting scientific research to determine an appropriate harvest strategy for the fishery. PSCHA also participates in the management process. The extent of their involvement contrasts favourably with industry participation in the research and management of other fisheries in BC. Through collaborating with the PSCHA on my research involving a rotational harvest strategy, I have learned that harvesters' experience and knowledge of the fishery enable them to provide valuable input to research and management planning.

Industry collaboration in research benefits fisheries by improving the cost-efficiency of field research, providing an alternative funding source, and suggesting appropriate indicators of population health and harvest strategies that may meet conservation goals. Industry collaboration in management improves the feasibility of, and co-operation with management plans. Collaboration in the sea cucumber fishery is facilitated by its relatively small size, the potential for fishery expansion, trust between fishery scientists and industry leaders, and industry commitment to sustainability of the resource.

A Bioeconomic Analysis of the Purse Seine and Longline Tuna Fisheries

Keith, Heather

University of British Columbia

This study will look at the economic performance of the tropical Pacific tuna fishery. Longline and purse seine fisheries from Taiwan, Japan, Korea, the US and the Pacific Island Nations primarily fish in the Pacific Island EEZs along the equator. Over the last two decades, the purse seine fishery catch and effort has been steadily increasing while the longline catch and effort has decreased significantly. Purse seine nets catch juvenile tuna while longlines catch adult tuna. The first part of the study will look at the tuna fishery, including all gears, species and fleets, in various scenarios of changing market prices, fishing costs and fishing effort to look at the bioeconomic interaction between gear types. The purse seine fishery catches more tonnage than the longline fishery but the larger tuna caught from longlines receive higher market prices than juvenile tuna. The tradeoff between a larger quantity of tuna and a higher unit value could be important for long-term measures of profits. The second part of the study will look at the spatial distribution and interaction between the longline and purse seine fisheries through a cost/benefit analysis of each gear and the biological distribution of tuna. Since tuna are vulnerable to both gears, the decision to fish in certain areas could be due to competition avoidance or age class distribution of tuna. The third part of the study will look specifically at yellowfin tuna caught by both purse seines and longlines. The optimal harvest ratio between the two fisheries, with respect to stock sustainability, economic and social benefits, is important to achieve maximum revenue. Cooperative vs. non-cooperative harvest ratios can be simulated to determine the maximum economic performance. From the three analyses, possible policy implications can be obtained to manage the tuna fishery more efficiently from an economic and sustainable perspective.

Management of Recreational Boat Anchoring in the Southern Strait of Georgia: Effects of Physical Disturbance on Benthic Infauna

Leatherbarrow, Kate

University of Victoria

Although the new Gulf Islands National Park Reserve is primarily a terrestrial park, the jurisdiction of the park does extend 200m into the water in anticipation of the proposed National Marine Conservation Area for this region. Therefore, recreational boating activity in these waters must be managed such that ecological integrity of the park is maintained. The physical damage caused to benthic habitats by boat anchors is of particular interest, but there is a lack of adequate literature for the park to make a well-informed management decision. This paper will review literature associated with the environmental impacts of recreational boating and the effects of physical disturbance to benthic communities.

The purpose of this study is to examine changes in benthic infaunal community structure in response to physical disturbance caused by recreational boat anchoring. Habitats of specific interest are eelgrass meadows (*Zostera marina* L.) and soft sediment. Objectives of this project include: 1) Using air photos to understand the historic distribution of eelgrass at anchoring sites; 2) Mapping current benthic habitat distribution at anchoring sites; 3) Building an inventory of anchoring intensity for each site; and 4) Monitoring benthic community infauna and environmental conditions at anchoring sites. Proposed methods and data analysis will be discussed in further detail.

We predict that physical damage caused by anchoring represents a frequent disturbance regime that will result in decreased abundance, species richness and biodiversity at sites experiencing heavy anchoring activity. Results of this study will form the basis for a set of recommendations to the Gulf Islands National Park Reserve management team for minimizing the damage caused by recreational boat anchoring within park boundaries. Management measures could include increasing the number of permanent mooring buoys or restricting the number of boats that are allowed to anchor each night.

Canada's International Fisheries Trade Since 1950: Volume, Value and Implications for Conservation

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About 40% of the volume of world fisheries landings is traded internationally. This trade and the rules that govern it have a critical influence on which fisheries are exploited and the intensity of this exploitation. This will in turn partly determine the health and sustainability of the fishery and its associated ecosystems. We have constructed a database of Canada's landings, imports and exports of fisheries products from 1950 to 2001 using government landings and customs data. We describe how these flows of products have changed over time: through increases in overall value and volume, and changing relative importance of trading partners. We examine how these changes in flows relate to the General Agreement on Tariffs and Trade (GATT), the UN Convention on the Law of the Sea (UNCLOS), Canada's free trade agreements with the United States and Mexico, and World Trade Organization (WTO) agreements. Finally, we discuss how international trade and trade agreements are can both help and hinder the reconciliation of Canadian fisheries with conservation.

Juvenile Marine Mortality in Pacific Salmon: Patterns Before Causes Before Management

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High early marine mortality in coho salmon (*Oncorhynchus kisutch*) may occur during the downstream migration rather than immediately after ocean entry as has been widely assumed. Using acoustic tags, we tracked the movements of 15 hatchery-reared smolts down the Cheakamus and Squamish Rivers, into the estuary and through Howe Sound, a fjord adjacent to the Strait of Georgia. Smolts took from 1.3-15.1 days to reach the mouth of the Squamish River while travelling at average ground speeds of 0.1-1.0 body lengths per second (mean=0.5 BL/s \pm 0.3 SD). Eight smolts died during the downstream migration, including three that were likely eaten by harbour seals (*Phoca vitulina*) in the lower river or upper estuary. After ocean entry, seven smolts took from 1.2-10.5 days to arrive in mid-Howe Sound, travelling at average net speeds of 0.1-3.0 BL/s (mean=1.0 \pm 1.0 SD). No smolts died during the migration through Howe Sound.

Gold Rush: the Rise and Fall of a Sea Cucumber Fishery in the Central Philippines

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In heavily over-fished reef systems, such as those found in many parts of South-East Asia, artisanal fishers are rapidly and effectively exploiting a large number of non food-fish fisheries for income. These fisheries are characteristically short-lived, new idea/technology driven, and pervaded by a gold rush mentality that focuses on immediate gains over long-term sustainable income. This paper aims to present the rise and fall of sea cucumber (*Bohadschia* sp.?) collection (compressor/hookah diving) in the depleted Danajon Bank reef system of the central Philippine as an example of a “gold rush” fishery. Information pertaining to the structure, shifting market values, social consequences and conservation perspectives of participants were collected through spoken interviews in May and June of 2003. Results showed that the fishery had a strict social structure, that dramatic shifts in supply and demand resulted in marked shifts in market value and that the fishery provided income far above subsistence needs. Participants knowingly overexploited populations, convinced of the inevitability of depletion and determined to obtain their share of income in a tragedy of the commons. The potential for co-operative, voluntary fishing unions is discussed as a possible method for managing gold rush fisheries for the purposes of both conserving reef species and maintaining sustainable incomes for artisanal fishers.

Bioeconomic models in fisheries management: Indirect valuation of wetlands

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Wetlands provide a number of ecological services which are important to fisheries. Nutrient cycling and the provision of habitat for aquatic species are among these important services. Many studies have found a positive correlation between wetland area and catch in adjacent fisheries. Quantifying the indirect impact of wetlands on fishery profit can help characterize the incentive for wetland preservation and restoration. Using two examples, I will discuss the role of dynamic bioeconomic models in analysing the impact of wetland area on fishery profit. First, I will present a model of the potential impacts of wetland restoration on profit in the Black Sea Sprat fishery. Nutrient enrichment has been a major cause of decline in the Black Sea Sprat fishery, and wetland restoration is expected to mediate the problem by enhancing filtration. Second, I will describe a proposed study of the impact of changes in mangrove forest area on wild shrimp fishery profit in the Bay of Bengal, India. In the Indian example, wetlands are valued as habitat for shrimp fry.

Interactions Between the Salmon Louse (*Lepeophtheirus salmonis*) and Outmigrating Juvenile Salmonids in British Columbia

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Sea lice (*Lepeophtheirus salmonis*) are a common parasite of salmonids and have been implicated in the decline of wild salmon in Canada and Europe. The placement of salmon farms along migration routes of wild salmon introduces a new host population to this host-parasite system, and it is generally accepted that these two hosts interact to affect louse population dynamics. Studies in Europe and more recently in British Columbia strongly suggest that salmon farms are enhancing the densities of sea lice resulting in increased lice levels observed on wild smolts. Much controversy surrounds the validity of these findings as they do not demonstrate cause/effect due to the lack of baseline data on sea lice densities previous to salmon farming. The consequences of increased lice densities have been documented for post-smolt Atlantic and some Pacific species, but no studies have examined the effects of high sea lice densities on the early juvenile stages. Some species of Pacific salmon migrate out at very small sizes (e.g. pink and chum salmon <5cm) and it is likely that any potential negative effects would be more detrimental at smaller sizes. We address these questions by comparing louse abundance on juvenile Pacific Salmon between areas with and without salmon farms and by laboratory experiments to determine relative susceptibility and lethal infection levels for juvenile Pacific salmonids.

Shifting from Integrated Rice-Shrimp System to Intensive Aquaculture: Impacts on the Sustainability of Rural Livelihoods in Kerala, India

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Estuaries and coastal wetlands of tropical India are known for high biodiversity and productive ecosystems. Sustainable use of coastal resources is crucial for coastal economies and livelihoods of rural communities, and hence unsustainable practices adversely affect rural livelihoods and survival strategies. Traditionally, the people of the Cochin estuary and lagoon (locally known as “backwaters”) in central Kerala practiced a low intensity rice-shrimp culture that consisted of brackish water tolerant rice, rotated with shrimp grown in the same agricultural fields. The fields were naturally seeded with shrimp by opening sluice gates that allowed juvenile shrimp to enter the fields by tidal action. The growth of globalized markets for high value large shrimp species, such as *Macrobrachium rosenbergii*, has resulted in pressures on this age-old traditional system. Many landowners have either converted to an intensive shrimp aquaculture system, or are considering converting to one.

The short-term economic returns from intensive shrimp systems are very high. However, experiences elsewhere in south India and Sri Lanka indicate a number of ecological and social impacts. Possible ecological impacts include wetland degradation and the spread of shrimp disease. Social impacts include the loss of rural livelihoods among the people of poor communities who are employed in the traditional rice-shrimp culture and who have collecting rights over small shrimp. In an intensive system, these people (many of whom are women), lose their farming jobs as well as the food and income from shrimp collecting.

Based on a project sponsored by the Shastri Indo-Canadian Institute, and carried out in cooperation with the Cochin University of Science and Technology, my project attempts to examine the impact of the shift from traditional rice-shrimp integrated farming to intensive monoculture, on the rural socio-economics and the local environment. I examine the hypothesis that the shift has negative impacts on integrated ecosystem management and on rural livelihoods and local institutions.

Effects of Size Selective Fishing on Estimates of Growth and Mortality Parameters

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Gear selectivity and cumulative effects of size-selective fishing bias length-at-age samples used to estimate the von Bertalanffy growth parameters. In fished populations, fast growing young fish and slow growing old fish are over represented in size-age samples. To account for such effects, we treat size-at-age observations as multinomial samples, with expected catches in each size-age category dependent on growth parameters, growth variation, size selectivity, abundance at age, and the history of exploitation. Using simulated data sets, estimated growth parameters using the multinomial likelihood were unbiased if fishing mortality is not too high and the shape of the vulnerability function is correct. In contrast, estimated growth parameters using a least squares approach over-estimates the metabolic growth coefficient (K) and under-estimates mean asymptotic length (L_{∞}). Models that do not explicitly account for the effects of fishing and size-selectivity underestimate L_{∞} and overestimate K .

The Role of Natural Science in Decision-Making Within Regional-Scale Restoration Projects in European Countries and the United States

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A growing number of initiatives for large, ecosystem-scale restoration around the world have incorporated a variety of strategies for utilizing natural science, with equally differing degrees of success. The available literature is populated with information both on topics of restoration ecology and on the role of science in ecosystem-based management; however, literature reporting successful strategies for incorporating science into large-scale restoration projects is lacking.

My hypothesis is that a restoration program that effectively uses science as a foundation for making decisions will be, in the long run, more successful in minimizing uncertainty and maximizing program performance. Therefore, the organizational structure of the program may dictate the efficacy of science in the near-term. In this study, I examine the placement and use of science within the organization of five American and four Western European programs, and the specific attributes of their employment of such science.

I used content analysis and an original grading system based on attributes of the role of science to accomplish this analysis. Sources include elite, semi-structured, organizational interviews, site visits, peer-reviewed literature, agency and program documents, and websites.

Initial results suggest that these programs took on a variety of forms and demonstrated numerous strategies for integrating science into the programs. Science was most effective when a formal pathway existed for communication between policy and scientific aspects of the program. Peer review and regular dissemination of scientific results to the public were important for maintaining credibility and legitimacy. Programs that established a distinct science team early had more effective strategies for producing science and more efficiently translating science to other aspects of the program.

Fishing or Catching: Assessing the Vulnerability of BC Wild Rainbow Trout Stocks to Overfishing (a work in progress)

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British Columbia's southern interior is famous for its rainbow trout (*Oncorhynchus mykiss*) lake fishing. Anglers come to experience the sensation of having a powerful "Kamloops" trout on the end of their line on one of the region's 1200 rainbow trout lakes. Anglers are an important predator of rainbow trout and their effect on the density of fish in a lake can be great. Previous research shows density effects the growth, survival and reproductive rate of trout (Post et al. 1999; Myers et al. 1999). Fisheries managers are challenged to find the balance between providing a range of angling opportunities and maintaining the "expectation" of the catch while conserving wild fish stocks. The tools available to managers to limit angling effort include control over fishing regulations and stocking rates (on the region's 450 stocked lakes), with limited control over angler access. The goal of my project is to identify wild stocks of rainbow trout in BC's southern interior that are vulnerable to overfishing. I will build a model that combines current knowledge of rainbow trout biology, angler effort responses, and environmental variation to assess the effects of management decisions on stocking, regulations, and access/development on trout density. The purpose of the final model is to aid managers in choosing which tools to use to provide a variety of angling experiences on southern interior lakes, while conserving wild fish populations.

Poster Abstracts

Community-based conservation of *Arapaima gigas* in Central Guyana

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Makushi Amerindians in Guyana's North Rupununi region make their living from their local resources, including fisheries. Over-harvesting has led to a community-based conservation project for a valued fish species. The paper examines lessons learned from this initiative involving the Arapaima (*Arapaima gigas*), an endangered species in Guyana. The results are based on a series of interviews and focus group sessions conducted between July and November, 2003.

The Arapaima is associated with many beliefs and taboos in traditional Makushi culture. It still features prominently in local folklore, although taboos have broken down. Guyanese law currently forbids harvesting of the species but is rarely enforced. A joint Brazilian-Guyanese initiative led to the development of a community-based Arapaima management plan. This initiative involved a community-imposed harvesting ban; the formation of fisher groups at village and regional levels; a local monitoring program with check points; and a community education and awareness campaign. The management plan aims to bring back the species and to implement a harvest quota system in the long term.

Between 2001 and 2004, surveyed adult and juvenile Arapaima populations increased three-fold, suggesting that the aforementioned measures are contributing to conservation, even though legal approval of the management plan has stalled. There has been no economic incentive for community conservation because planned harvesting has yet to occur. Thus, the education and awareness campaign appears to have influenced conservation through social enforcement of the ban. Such enforcement appears to have been more effective than formal mechanisms, such as fisher groups and check points, many of which are non-functional. An assessment of these formal structures will only be possible after harvesting re-opens. The initiative highlights that culturally sensitive environmental education, capacity building and associated changes in social norms can play critical roles in conservation. This is important in situations where formal institutions are culturally inappropriate, non-functional, or slow to develop.

Fisheries and Conservation in New South Wales, Australia: An Ecosystem Modelling Approach

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Many fisheries in New South Wales are multi-species and tend to be regulated according to geographic location. Despite this, many of the targeted species are migratory and spend different stages of their life-history in different habitats. Historically, as throughout the world, there has been little consideration of the impacts of management decisions on other fisheries or non-target species, despite the potential for trophic and other linkages among them. Recently, both the New South Wales and Australian Commonwealth governments have undertaken to consider ecosystem issues in managing their fisheries. This project aims to support the implementation of ecosystem-based fishery management in New South Wales, through the development of spatial whole-ecosystem simulations of its marine fisheries, using the Ecopath with Ecosim and Ecospace suite of trophodynamic modelling tools. The dynamic simulations aim to determine the conservation potential of spatial closures and other management measures, such as reductions in commercial fishing and gear restrictions, with explicit consideration of the associated trade-offs with fisheries, including the large recreational sector. The model incorporates all major habitat-zones off the NSW coast, from estuaries to the edge of the EEZ. This broad-brush approach will be augmented by smaller-scale, more detailed models, which will be presented elsewhere.

Seasonal Distribution, Abundance and Habitat Characteristics of Pelagic Fish in Kodiak Island Embayments

Loewen, Mary Beth

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In 1996, the U.S. Congress passed the Sustainable Fisheries Act (Public Law 104-297) which amended the Magnusen-Stevens Act to protect habitat essential to commercially important fish stocks. This Essential Fish Habitat (EFH) is defined as waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity. Utilized habitat may fluctuate both seasonally and annually, making investigation into seasonal distribution and abundance of commercially important fish a crucial aspect of fisheries management.

This study aims to understand broad-scale temporal and spatial patterns of distribution and abundance of nearshore pelagic fish, and examine relationships between these and oceanographic and/or biological factors. Surveys were conducted to define essential fish habitat, as well as determine the availability of prey for upper trophic levels such as Stellar sea lions (*Eumetopias jubatus*) or seabirds that have impacted the management of commercial fish species. Collected fish species included walleye pollock (*Theragra chalcogramma*), Pacific herring (*Clupea pallasii*), eulachon (*Thaleichthys pacificus*), capelin (*Mallotus villosus*), and Pacific grey cod (*Gadus macrocephalus*).

Poverty Alleviation and Biodiversity Conservation in Rural Brazil: A Case Study of the Cananeia Oyster Producers Cooperative

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Our world is losing biodiversity at an alarming rate, threatening the sustainability of our planet. To maintain sustainability, conservation goals need to be reconciled with development goals. However, intense demand for short-term economic gain constrains sustainable alternatives, which are more beneficial in the long-term but less lucrative for immediate needs. Nevertheless, some communities have succeeded in overcoming these constraints and progressed towards economic and environmental sustainability. Communities that have made significant strides towards sustainability have recently been recognized by the United Nations Development Programme - Equator Prize. A 2002 Equator Prize was awarded to the Cananéia Oyster Producers Cooperative of Brazil. Engagement of the Cooperative in environmental and social education, along with the creation of an extractive reserve, intensification of oyster aquaculture methods, and value adding to the oyster product, have helped ensure the sustainability of the mangrove oyster while conserving the region's valuable mangrove estuary. However, despite numerous achievements, the cooperative still faces several economic and technical difficulties. Nevertheless, strong involvement of cooperative members with the project suggests that cooperative members are committed to the process. Such strong commitment may be partially attributed to official, international recognition granted by the Equator Prize, which helped instill pride within the cooperative members, encouraging them to commit to conservation and development goals. Thus, while recognizing communities which have made strides towards sustainability, the Equator Prize itself may also help encourage communities to continue to strive towards sustainability. All lessons learned from this case study are being compared to other Equator Prize case studies to further our understanding on complex, and often conflicting, conservation and socio-economic goals. By furthering our understanding on community-based natural resource management, this study allows for better management decisions to be made by the Cooperative, and other communities around the world, thereby helping maintain the sustainability of our planet.

Development of Methods to Generate Recovery Objectives and to Evaluate Management Options for Endangered Salmon Stocks

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Some Pacific salmon stocks have dramatically decreased in abundance in recent years, and there is a growing need for actions to conserve these stocks and allow them to recover. Insufficient research has been done to determine optimal management actions for allowing stocks to recover, let alone develop methods for determining desirable recovery goals and objectives. However, recovery teams set up under Canada's new Species at Risk Act will need to develop such recovery objectives and recovery plans for species listed under this act. Using Bayesian decision analysis, we determine the rank order of various harvest rules for the seriously depleted Cultus Lake, British Columbia, sockeye salmon population. We seek harvest rules that ensure a reasonably high probability of the long-term survival of the Cultus sockeye stock, and then, under this condition, maximize economic yield from the harvest of late-run Fraser sockeye. We develop a stochastic simulation model of the Cultus Lake sockeye population's dynamics and management for estimating risks associated with various levels of harvesting at different stages during the recovery of the stock. We perform extensive sensitivity analyses in order to identify the harvest strategies that best meet management objectives while also being robust to various uncertainties and assumptions. Optimal actions vary, depending on the desired long-term goals for the stock and the acceptable probability of attaining those goals. The model structure and decision analysis framework developed in this project are applicable to other recovering salmon stocks, as well as other species groups.

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