BC Pacific Salmon Forum

2008 Broughton Research Program

An Overview of the 2008 Research Projects

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1 Introduction

The 2008 research season represents the second year of a coordinated research program the Broughton Archipelago funded by the BC Pacific Salmon Forum in collaboration with other partners. The program has the following objectives:

1. To determine whether salmon farms in the Broughton impact sea lice loads on wild salmon and if so how;

2. To determine whether the survival of individual wild fish is compromised due to increased lice loads; and

3. To determine if any reduced survival of individual salmon has consequences on salmon populations, and if so, are there management techniques that can be put in place to mitigate any risk to wild salmon?

Three broad categories of research were identified in 2007 and the projects that were undertaken to meet the above objectives were categorized accordingly:

A. The out-migration period: quantification of fish and lice dynamics

B. Impacts of lice on individual salmon

C. Pink and chum salmon dynamics

Each category was further refined by several specific key research projects developed to meet the individual objectives.

Two further categories have been included for research in 2008:

D. Biological impacts of SLICE®

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The following report outlines the proposed research program for the second year of the Broughton Archipelago Research Program, some logistical considerations, and the budget developed to meet the objectives of each of the proposed projects as best as is possible with the remaining available funding. As in the 2007 program, where matching funds and in kind support are available from other sources, this information has been included to indicate how BCPSF funds are being used to leverage additional support.

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E.1 Model Development

A. The out-migration period: quantification of fish and lice dynamics

Proposals have been received (or are in progress) for nine research subcomponents relating to the out-migration period. These proposals encompass the following:

1. Characterization of water movements in order to assess potential population mixing of Broughton pink salmon populations and more importantly to assess potential movement of sea lice
2. Quantification of otolith microchemistry to identify populations emanating from each of the five main Broughton Archipelago rivers
3. Continuation of DFO out migrating salmon surveys to quantify lengths and weights, lice abundances, energetic measurements
4. Continuation of Krkosek's surveys in Knight Inlet and Tribune Channel to estimate rates of sea lice transmission from farms to wild salmon, evaluate sea lice management, and to evaluate wild salmon survival
5. Data analysis and mathematical modeling of sea lice and salmon population dynamics
6. Quantification of abundances of free-swimming sea lice in the water column at various distances from the farms and at many of the locations where fish are sampled
7. Studies of vertical migration of sea lice infective stages in the water column.
8. A Centre for sea lice identification to support all of the projects requiring laboratory identification of sea lice species and stage of development
9. Investigations into the sources and processes of winter infections of sea lice on farmed salmon

A.1 Oceanography

Rationale: Predicting the circulation patterns of the near surface waters which are occupied by planktonic sea lice larvae and their hosts coupled with a realistic sea louse larval behaviour and development model would provide valuable information on the spatial and temporal distribution of the infective copepodid stage of this parasite. Particle tracking simulations based on current patterns predicted using local winds and river inputs together with a larval behaviour sub-model may provide estimates of likelihood of transport and dispersion of sea lice larvae from known sources (e.g. untreated farms) to other farms and areas where juvenile salmon are found. Numerical circulation models of the surface water movements together with the observations of circulation, water properties, winds and freshwater runoff will aid in the interpretation of the juvenile salmon monitoring data and the observations of sea lice abundances in the water column.

Methods: Planned are a continuation of the gauging of the flow for the Kingcome and Wakeman Rivers, the continuation of the operation and maintenance of the Broughton weather station network deployed in 2007, deployment of 3 current meter moorings, GPS drifter releases and synoptic surveys of water property profiles in the area. Measurements will be commence during the current winter season rather than focusing solely on the spring out migration period providing important data to support project A.9 (Winter sources of sea lice).

There is a requirement for major repairs to, and replacement and relocation of some of the weather stations requiring IOS personnel to make special servicing trips which will include the chartering of a vessel for several days at a time.

Development and testing of the circulation model FVCOM for the region will continue and will involve interpolation and extrapolation of the weather station winds to the entire model domain. The establishment of estuarine flows at the Johnstone and Queen Charlotte Strait boundaries will also be undertaken. Simulations will include specific time periods using observed winds, river discharges and tides and the results will be evaluated against the corresponding observed currents and GPS drifter tracks. The dispersion and advection of the planktonic larval stages of sea lice depend not only on the circulation but also on the larval behaviour and development. Consequently, an important component of the model development will be the implementation of a biological sub-model of larval behaviour and development similar to that recently developed by Gillibrand and Willis (2007). Particle tracking simulations will be run in which the particles will behave and develop in manner that is consistent with our understanding of the biology of the planktonic sea louse *L. Salmonis*.

Investigators: Dr. M. Foreman, Dr. D. Stucchi (Fisheries and Oceans, Institute of Ocean Sciences)

A.2 Determination of Natal Origins of Pink and Chum Salmon in the Broughton Archipelago

Rationale: Otolith analysis could provide identifying markers for determining natal systems from which fry originate and could potentially. This information will help characterize origins and migration pathways and will be necessary to determine potential source sites of infecting lice on surveyed fish.

Methods: Otolith (ear bone) microchemistry is being used to determine natal origins of Broughton Archipelago salmon. Trace elemental signatures in otoliths reflect chemical differences in river and seawater inhabited by fish. It is hypothesized that site specific elemental fingerprints will be determined for otoliths collected from salmon smolts exiting natal rivers in the Broughton system and elemental fingerprints from larval regions of otoliths taken from juvenile fish will be used to determine origins of salmon caught in fish surveys.

This research is a carry-over from the 2007 period and has not yet been completed due to unforeseen complications.

Funding for work in 2008 is pending completion of the review of 2007 results.

Investigator: Dr. C. DiBacco (The Bedford Institute – Dartmouth, N.S.)

A.3 Marine Monitoring of juvenile pink and chum salmon and sea lice in the Broughton and Knight Inlet, B.C. in 2008-09.

Rationale: There are two objectives of this project:

1. To continue the annual monitoring of sea lice infection of juvenile pink and chum salmon in the Broughton and Knight Inlet
2. To conduct intensive sampling of juvenile pink and chum salmon in the area near the junction of Tribune Channel and Knight Inlet and obtain more detailed information on the patterns of sea lice infection of wild salmon in this region.

Methods: Wild juvenile pink and chum salmon will be sampled by both beach and purse seines at approximately 150 locations throughout the Broughton and Knight Inlet, once each month from March to June, 2008 to cover the period when wild juvenile pink and chum salmon enter the ocean, then pass in close proximity to salmon farms in the Broughton and Knight Inlet, and also during a portion of their subsequent migration further seawards. The geographic area sampled in 2008 will be the same as in 2006 and 2007. The results will provide data on relative abundance (CPUE; catch-per-unit effort), distribution, migration routes, and sea lice infections of wild juvenile pink and chum salmon, three-spine stickleback

and many other fish species, obtained over a very broad area in the Broughton and Knight Inlet. The sampling will include locations far away from the salmon farms, and locations in very close proximity (100-200 meters distant) to the salmon farms.

In 2008 Dr. Hargreaves intends to focus on analyses and publication of the results obtained in previous years, and he does not plan to skipper a research vessel. Instead, a commercial vessel large enough to conduct all the purse seine and beach seine sampling required for the DFO marine monitoring program in 2008 will be contracted to do the fish sampling in both the Broughton and Knight Inlet. There will be accommodation space available aboard this charter vessel for up to three additional people that are involved in other research projects funded or supported by the PSF. Dr. Hargreaves will continue to be the DFO scientific authority and he will also be responsible for planning and overseeing all aspects of the DFO marine monitoring program conducted in 2008.

As in previous years, samples of up to 30 of each fish species captured at each location in the field will be individually frozen and later analyzed in the laboratory at the DFO Pacific Biological Station in Nanaimo, B.C. The analyses will include confirmation of the species identification of each fish, measurement of the weight and length of each fish, and assessment of the prevalence and intensity of infection by all development stages of the sea lice species *Lepeophtheirus salmonis* and *Caligus clemensi.*

Investigator: Dr. Brent Hargreaves (Fisheries and Oceans)

A.4 Sea lice management, transmission, and wild salmon survival

Rationale: This project intends to build on previous work from 2003 to 2007 that combines field data with mathematical models of sea lice infecting juvenile salmon migrating past salmon farms. The objective is to model and estimate both the magnitude and spatial extent of transmission, thereby creating a spatial picture of sea lice population dynamics over the course of the juvenile salmon migration period.

Methods: This project intends to implement field surveys that will involve counting lice on 50 juvenile pink and 50 juvenile chum salmon at 1-3 km intervals from the Glendale estuary down Knight Inlet and around Tribune Channel and Fife Sound. The fish will be examined on site using an established non-lethal assay, that has recently been validated for fish species identification by PSF supported collaboration with Brent Hargreaves' field crew in 2007. The fieldwork is to be based at the Salmon Coast Field Station, located in Echo Bay, which is situated in the centre of the study area. For sampling in more remote reaches the investigators plan to utilize a tugboat. The investigators intend to collect three replicate datasets in April and May of 2008 and to complete data analysis and modeling by Dec 2008. An additional proposal has been submitted to the PSF to fund an analyst to assist with the data analysis and modeling.

Investigators: Mr. Martin Krkosek (University of Alberta), Dr. John Volpe (University of Victoria)

A.5 Abundance of planktonic sea lice in Knight Inlet/Tribune Channel

Rationale: The objective of this study is to map the distribution of planktonic sea lice in the Broughton Archipelago region (specifically along Knight Inlet/Tribune Channel during the spring season out-migration of wild pink and chum stocks). Data on how the abundance of these planktonic stages varies with season and location will provide useful information about when, where, and how severely the lice infect out-migrating wild populations of juvenile salmon.

Methods: Sampling to determine the abundance of lice in the water column and the spatial distribution of planktonic stages will extend from Glendale Cove along both sides of Knight Inlet to the junction with Tribune Channel, and then along both sides of Tribune Channel to Broughton Island. The intent is to include sampling locations far from all active farms, locations near the Sargeaunts/Humphries/Doctor

cluster of farms, and (if possible) locations near other farms with a contrasting intensity/history of stocking or parasite treatment. Weather and vessel availability permitting, these investigators plan to sample this grid at approximately biweekly intervals from mid February to early May 2008. Based on experience in 2007, it is expected that each complete survey to take 3.5-4 days.

At each along-inlet location, a mid-channel CTD profile will be collected and surface layer plankton tows and salinity samples will be taken close to the shoreline.

Batches of frozen samples (one batch for each survey) will be passed to the genetics laboratory of Dr. Ben Koop for DNA extraction and amplification. The intended output is a binary presence-absence matrix for sample location vs. survey date and it is anticipated that this work will lead to a rapid screening for presence/absence of larval sea lice in the frozen subsample.

Investigators: Dr. David Mackas and Dr. Moira Galbraith (Fisheries and Oceans Canada)

A.6 The vertical distribution of Lepeophtheirus salmonis planktonic larvae – The 2008 field experiment

Rationale: To examine the depth distribution of *Lepeophtheirus salmonis* planktonic larvae at a natural setting in the Broughton Archipelago. There are three primary objectives that aim to provide information on the direction and extent of dispersal and the population potential of lice larvae from source populations and address the question of whether infection is purely coincidental or benefited by the vertical migration of copepodids.

1. Determine the vertical distribution of nauplii and copepodids over the diel cycle, including dawn and dusk which often elicit strong changes in vertical distribution not seen in day or night
2. Determine if lice nauplii and copepodids spend time in the upper layers of lower salinity water or if this is a factor inhibiting vertical distribution
3. Determine if lice copepodids undergo diel migration

Methods: The column will be deployed at one or more sites in the Broughton Archipelago. The deployment times and durations will depend on existing facilities although there will be at least 3 deployments during day and night as well as potential additional deployments during dawn and dusk as well as possible deployments with both salmon fry and lice larvae. Statistical analysis will be used to test the effects of environmental (explanatory) variables on the depth distribution and relative abundance of nauplii and copepodid stages of development. Explanatory variables will include diel cycle (i.e., light intensity), salinity, temperature, depth, larval development stage (copepodids vs. nauplii), and sampling date.

Although not discussed in the proposal, it is presumed that this data could also be included in model development.

Investigators: Dr. Al Lewis (University of British Columbia) and Dr. Claudio DiBacco (Bedford Institute, Dartmouth, N.S.)

A.7 Centre for Sea Lice Identification

Rationale: The objective of this proposal is to provide a common analytical resource for researchers in BC requiring sea lice identification. The Centre for Sea lice Identification (CSI) would principally be shared among all applicable researchers funded through the BC Pacific Salmon Forum.

Methods: The CSI will provide analytical services in support of sea lice identification. Specifically, the CSI will continue to use common protocols that are consistent with those published by the BCPSF. The protocols include methods for sample acquisition and storage, sample analysis, sea lice archiving, data collation and data reporting. Given limited on-site sample storage capacity each project conducted by the CSI will be based on prior discussion between the CSI and the researcher concerning the number and condition of samples and expected delivery dates. Unless agreed to with the researcher, the CSI will not retain copies of electronic files and confidentiality will be ensured.

Investigators: Dr. Simon Jones (Fisheries and Oceans Canada)

A.8 Fish Health

This project was encompassed within project B1-4 in 2007 and is now covered in project B6.

A.9 Sources and Processes of Winter Infections of Sea Lice on Farmed Salmon

Rationale: Sea lice research has focused on the spring sampling period to date and has not included an investigation of the dynamics of the lice populations geographically and spatially in the winter period. There are three hypotheses for sources of sea lice:

Internal : 1) Nauplii/copepodids are not free-floating particles and are retained at the farms through a mechanism that is yet to be determined

External: 2) There exists a large source of sea lice carriers at the head of Knight Inlet or 3) Nauplii/ copepods are being transported in deeper water currents from other farms and are infecting salmon farms in the study during the winter

This project aims to identify sources of winter infections and determine whether or not sea lice nauplii and copepodites may be free swimming particles or are retained at farms during the winter months causing winter infections that further develop in the spring or if they are derived from an external source that remains, as yet, unidentified. Information from this study could assist industry in reducing early infections.

Methods: Through a series of substrate sampling, plankton tows in and around net pen sites and the shoreline, sentinel cage studies and stickleback sampling, data will be collected to identify potential sources of sea lice larvae. To determine if a potential reservoir of lice exists at the head of Knight Inlet, sentinel cages, containing sticklebacks, will be secured at the mouth of the Glendale River. Sticklebacks will also be placed in sentinel cages at various points and depths around the Sargeaunts Pass and Doctor Islet fish farms. Every 2 weeks the sticklebacks will be examined for presence or absence of sea lice as well as stage of lice development.

Nauplii collectors will be built using minnow traps with porous substrate tied into them in an attempt to determine if nauplii are being transported in deeper water currents from other farms and are infecting the farms in our proposed study during the winter

Investigators: Dr. Dick Beamish (Fisheries and Oceans Canada), Ms. Joy Wade (Fisheries and Oceans Canada), Dr. Bill Pennell (Malaspina University College)

B. The impacts of lice on individual pink and chum salmon smolts

The second major objective of the research program is to determine whether increased lice loads (if picked up from farms) compromise individual survival. The following studies address this issue.

B.1-4 Effects of sea lice on the physiology and health of pink salmon

Rationale: This project aims to characterize the sub-lethal disturbances associated with different levels of sea lice density in pink salmon in laboratory and field experiments, and use these data to develop a model that will be applied to wild fish to address the effect of sea lice on pink salmon populations. The overall goal is to be able to determine at what sea lice density pink salmon appear to be negatively affected and to what degree. This will allow better interpretation of field observations on lice densities. There are four objectives to meet this goal:

1. Conduct base-line studies to determine "normal" physiological parameters for juvenile pink salmon as a function of age/stage. Very little information is currently available and it is crucial to understand the baseline conditions of these animals before we can determine the impact of sea lice on the individuals.

2. Conduct controlled experiments in the laboratory to investigate the relationship between sea lice density and fitness of juvenile pink salmon.

3. "Ground truth" the laboratory experiments with a limited array of field experiments relating lice density and fitness. It is critical to compare the results of laboratory-based infection studies with natural infections in the field.

4. Calibrate fish health/survival monitoring efforts with predictors of fitness. It is critical to integrate the collective results of the laboratory and field studies in some biologically relevant manner.

Methods:

Objective 1. - Pink salmon fry will be either caught migrating down the Glendale River and Knight Inlet (field), or obtained from Quinsam River hatchery (lab). Biweekly testing will take place over a period of up to three months. Physiological fitness will be assessed using a number of tests (ionic status of plasma and whole body and gill Na^+,K^+-ATPase activity; development of SW tolerance while fish are still in freshwater; drinking rate; and whole animal indicators of fish performance including maximal sustained swimming performance, and standard and maximal oxygen consumption rates). The experimental matrix will be a 3 x 4 x 2 design, considering three different fish ages and four different sea lice densities and examining effects after acute (2 day) and chronic (2 week) exposure periods.

Objective 2. **-** Fish representing three ages (corresponding to body masses of approximately 0.5, 2 and 10 g) will be infected in biologically meaningful numbers (densities of 0, <1, 1 and >1 adult louse per g based on Morton's recommendation that 1 louse per g was a critical loading density in the field). Tests will include: ionic status of plasma and whole body and gill Na^+,K^+-ATPase activity, drinking rate and whole animal indicators of fish performance including maximal sustained swimming performance, and scope for metabolism. This will be predominantly carried out in the field unless naturally infected fish or the ability to infect fish in the field is poor in which case field work will be supplemented with further laboratory studies. To ensure adequate sea lice for laboratory infection studies, these investigators will develop a sea lice culture in their lab. This sea lice culture will start at CAER in January and will involve a collaboration with Dr. Simon Jones.

Objective 3. - Experiments will be conducted in the field to assess the fitness of naturally sea lice-infested fish. Fish captured by Brent's team will be transported to tanks on an as yet to be determined

platform in the field. Drinking rate and indicators of ionoregulatory status will be measured, along with swimming performance and standard and maximal oxygen consumption rates to assess scope for metabolism in fish with a range of natural sea lice densities. If natural densities are low, fish will be infected on site to achieve higher densities. These data will be compared with the laboratory generated data comparing sea lice density with sub-lethal disturbances, and will help to validate the laboratory-based model.

Objective 4. - For most of the physiological measurements that are planned, both the routine (set to a fitness of 1) and maximally disturbed (set to a fitness of 0) values will be obtained from the literature or determined experimentally. Sub-lethal effects of sea lice fitness values will be fit within this range to permit comparisons among the many measured variables. All data will be entered into the model and a principle components analysis will be conducted to determine which parameters are most affected by sea lice. A statistician will be consulted.

Investigators: Dr. Tony Farrell and Dr. Colin Brauner (University of British Columbia and CAER)

B.5 Survival and predation field experiments

No project planned for 2008

B.6 Assessment of fish health in out-migrating juvenile pink salmon 2008

Rationale: There is considerable discrepancy in the interpretation of findings between lab based and field sea lice studies conducted in BC and little is understood regarding the effects of sea lice on wild pink salmon at both the individual and population levels. This proposal is to fund a second year of research assessing the health of wild juvenile pink salmon during their out-migration from the rivers in the southern Broughton Archipelago. The 2008 assessment will examine health in the odd year run of pink salmon – the less abundant run in the region. The data collected during this sampling period will be combined with the data collected in 2007 from the even year run to provide an overview of health status and to determine the extent of association between the measured health parameters and naturally occurring sea lice levels observed in the region. The three objectives of this project are:

1. To assess fish health in the juvenile pink salmon out-migrating through Knights Inlet and Tribune Channel region in 2008 – odd year run
2. To determine if there is an association between the presence and intensity of naturally occurring sea lice and health parameters (i.e. condition factor, gross and microscopic lesions and parasites).
3. To compare findings from 2008 and 2007

Methods: Sampling will be conducted in conjunction with the DFO (Brent Hargreaves) pink salmon survey in the Knight, Tribune and Fife region. Sampling will take place at 5 locations each month. These will be determined in the field based on the presence of a reasonable population size. The population will be assessed four times (monthly, from March – June). Fish will be euthanized, weighed and measured for fork length. In the field, lice will be counted and identified. Lice will be collected and sent to the parasitology laboratory at PBS for confirmatory identification.

Complete histological analyses will be conducted on 15 fish per site. Bacteriology sampling will be performed on fish with gross lesions consistent with septicemia (e.g., reddened fins or abdominal mesenteries). Virology samples will be collected form 20 fish per site, to be analyzed by polymerase chain reaction (PCR) for viral hemorrhagic septicemia virus (VHSV) and infectious hematopoietic necrosis virus (IHNV). The sample population collected for diagnostic testing will be divided to ensure that sea lice

infected fish are represented as equally as possible in the groups submitted for histopathology and viral testing. The total number of fish to be sampled in March and April is 350 and for May and June is 200.

Investigators: Dr. Sonja Saksida (BC Centre for Aquatic Health Sciences), Dr. Simon Jones (Fisheries and Oceans Canada) Dr. Gary Marty (BC Ministry of Agriculture and Lands) and Dr. Sophie St. Hilaire (Idaho State University)

C. Pink and chum population dynamics in the Broughton

The third primary objective of the Broughton Ecosystem Research Program is to capture a better snapshot of the dynamics of natural populations of pink and chum salmon in the Broughton Archipelago and compare population dynamics to those in another system that does not have salmon farming present.

C.1-2 Pink and Chum population Dynamics in the Broughton 2008

Rationale: The primary objective of the Pink and Chum population dynamics program in the Broughton is to determine if reduced survival of individuals due to sea lice (if any) has consequences for the salmon populations in the area, and could be responsible for the decreased escapements observed. The work described below is intended to meet this objective by:

1. Improving river-specific escapement estimates, which permits the estimation of fresh-water survival.
2. Improving estimates of egg-to-smolt survival, which will lead to more accurate estimates of the number of smolts leaving each natal river.

This work would likely improve our understanding of both fresh and marine survival of some key systems within the Mainland Inlets for pink salmon, improve the accuracy of estimates of escapement and provide some calibrations for the expansion of current visual enumerations.

Methods:

1. Continued aerial surveys of key indicator systems (Kingcome, Wakeman, Kakweiken, Anahuati, Glendale, Klinaklini) and continued charter patrol ground surveys will be undertaken. Investigators will calibrate aerial estimates using a DIDSON system on the Glendale and will install a resistivity crump weir on the upstream side of the channel weir to enumerate the adult migration into the channel. A video system will be installed at Embley to improve escapement estimates and stream residence tags will be applied to determine the duration of the stream entry to spawning (death) period. Improved ground-based escapement surveys will be done for the Ahta, Viner, Embley, MacKenzie, Shoal Harbour, Gilford stream escapements. This project will assess how representative our clear stream index sites for pinks are on the Kingcome River and provide more data on other species especially chinook, coho and chum

2. Both river-specific escapement and smolt number estimates are required to estimate marine survival. Estimating juvenile salmon production from Broughton systems requires knowing what the egg to smolt survival rate is. The 'biostandard' presently being used may not be accurate and should be updated. Juvenile traps will be installed on the Glendale River and spawning channel where the escapement information is most accurate. A trap will also be installed on the Viner to assess both pink and chum production.

Investigators: Dr. Brian Riddell and Dr. Pieter Van Will (Fisheries and Oceans Canada)

C.3 Work Plan for Bella Bella Region: Out-group Program of the Broughton Ecosystem Project

Rationale: To better assess the potential impacts of Broughton fish farms on marine survival, it is important to measure smolt numbers and escapement in rivers located in areas away from the Broughton Archipelago that are not in proximity to aquaculture facilities. An integrated sampling program involving spring sea lice sampling linked to fall adult salmon escapement counts will provide a second year of data that will strengthen out-group comparisons with data collected from the Broughton.

Methods: A 3-member crew will capture migrating juveniles with a beach seine in the near-shore waters. Investigators will liaise with Broughton area researchers to ensure that the sampling design is consistent in both locations. Each site will be visited once per week between April and July at sites selected in several primary pink and chum salmon systems. Thirty to fifty juveniles will be collected at each site per visit, live sampled for, measured, and juveniles hosting lice will be euthanized, individually bagged, frozen, and sent to a lab for lice analysis. At the beginning of the sampling season, a sub-sample of juveniles found *not hosting* lice will be retained, and further analysed for lice with dissecting microscope to confirm that lice are not being overlooked by the live sampling technique. Temperature and salinity will also be recorded at each site using a YSI meter.

Between August and October, DFO escapement counts will be supplemented in the same region as the spring sea lice sampling. The small streams that will be added to DFO's large stream counts have excellent visibility, and pilot counts last year showed very high repeatability between observers.

Investigators: Dr. Michael Price (Raincoast Conservation Foundation) and Dr. John Reynolds (Simon Fraser University)

D. Biological Effects of SLICE®

SLICE® (emamectin benzoate) is used as a therapeutant to treat fish for sea lice when numbers reach a threshold at which Provincially mandated treatment occurs. It is important to investigate any chemical treatment which enters the aquatic ecosystem and may have potentially negative impacts and as such it is important to be able to reassure local stakeholders that it is safe.

D.1 Evaluation of the potential uptake of emamectin benzoate and its desmethyl metabolite in non target species following the application of the anti-parasitic chemotherapeutant SLICE®.

Rationale: SLICE® is used as a therapeutant to treat fish for sea lice when numbers reach a threshold at which provincially mandated treatment occurs. The Forum has allocated funding pending finalization of a research initiative that can be implemented in 2008 to assist in establishing thresholds to evaluate the level of uptake of the active compound in this treatment by non-target organisms.

Methods: Refinement of this research initiative is being developed through a collaborative approach with a variety of researchers from both federal and provincial research institutions. Other stakeholders are expected to be engaged in the project development process.

E. Model Development

In line with BCPSF's desire to examine the sea lice/salmon interaction in a broader ecological context, it is desirable to sponsor the development of an integrated framework that would include the various data emerging from the 2007 and 2008 research.

E.1 – Model Development

There are several research projects with modeling components and it would be advantageous to bring key investigators, and other appropriate statistical modelers, together to develop a more complete model to incorporate the findings of all investigators currently working in the region and incorporate the emerging data. It is felt that this would result in a more robust model than those currently being developed in isolation and would provide a foundation for ecosystem based management in the Broughton Archipelago.

Discussions between potential collaborators will begin to take place in early January. An initial meeting is anticipated in April to design the model parameters. A second meeting is suggested in late fall during which field data can be incorporated.

It has been suggested that the recently published Gillibrand model may provide a mechanism for incorporating the biological nature of sea lice into a transmission model.

3 Issues of Importance

Some of the current constraints on research in the region have been (and remain) boat access, access to gravid sea lice, a platform and accommodation to carry out field experiments, and access to data from other researchers and aquaculture companies. It is important to communicate clearly that industry in the region has been very cooperative with Forum researchers during the 2007 period and that this has been appreciated by the BCPSF and the researchers involved.

3.1 Access to Vessels

All researchers undertaking investigations that require field sampling or field experiments require access to remote sites. It is recommended that, wherever possible, researchers should coordinate sampling schedules to ensure the most effective use of vessels and funds. Coordinated sampling will also foster collaboration and sharing of information and techniques.

The BC Pacific Salmon Forum is preparing to support a contract for a vessel with Captain and crew in addition to adequate accommodation for work space facilities through project A3 that would have capacity to accommodate this and other monitoring research through the 2008 field season.

3.2 Access to Gravid Lice

Several projects require lice for various studies. Project B.1-4 requires lice for infection studies and has indicated that techniques are being investigated to culture lice to ensure a constant supply for studies throughout the period.

Project A6 also requires a consistent supply of lice to make use of the equipment constructed in the 2007 season which will allow experimental investigations of vertical migration patterns of lice in the water column. This project requires that lice be cultured in close proximity to the field deployment site to ensure lice are not handled excessively potentially risking them harm and confounding results.

Industry has indicated willingness to cooperate with researchers but that researchers wishing to access lice were advised to ensure that they were prepared well in advance of the research season as adult lice would need to be collected by January. This is imperative since treatment for lice on the farms could begin as early as February.

Marine Harvest and Mainstream encouraged researchers to contact them directly to communicate their needs. These companies have indicated that they will ensure that PI's are informed of the real time lice availability and will direct them to sites where lice are known to be available.

3.3 Research Platform

A field research site is required for several field projects (notably A6 and B1-4). While Echo Bay has been suggested as a potential site for studies, researchers familiar with this site advise this may not be the best location for research due to the activities that take place in the bay. The bay is a small protected harbour that contains a marina and a fishing lodge and, as such, endures a considerable degree of vessel and float plane traffic which has the potential to present considerable stress to animals in containment.

For this reason, other options are being considered. Marine Harvest and Mainstream have both been consulted and there is potential for assistance in provision of a pen structure facility for use. However, the suggestion to use an industry site may pose a potential difficulty for project A.6 which requires a protected area with low current velocities, areas not typically used as farm sites. Possibly the field equipment could be deployed inside the protective nets or on a more protected side of a facility. Researchers are expected to provide their own nets for use as the nets available from industry would not support the containment of juvenile pink salmon.

Whichever platform is utilized, researchers require access to power, running seawater and basic shelter to use as field laboratory facilities for a period from approximately April through to June. Project A.6 also requires a lifting frame to deploy and retrieve the field equipment. A UBC boat may be used for this purpose if a suitable launch site is available. Alternatively, if lifting equipment is available at a farm facility that would be suitable, this could be utilized.

Accommodations are required for all investigators working at the field platform and discussions with industry suggest that there may be a possibility of access to a float home, this has not been confirmed however.

3.4 Industry involvement, potential partnerships and data sharing

Some researchers have requested information on 2008 operational plans for the various farm sites in the Broughton. Industry has cooperated in providing these data to the BCPSF which will be provided to the researchers using the data sharing protocol.

There have been difficulties in the past with access to data from researchers and industry in both directions. Trust is a difficult thing to achieve and to that end, a draft data sharing protocol has been developed by the Forum. It is anticipated that this could smooth the way for future communication and information sharing in a bi-directional manner.

Criticisms of the data available have included a lack of sufficient detail and an insufficient time span. Industry, in many cases, indicates that there is a lack of data that spans back farther than 2003 and that in many cases, this data was not collected in a similar manner or under similar circumstances. There is a genuine concern from the industry standpoint that such inconsistent data could confound results if used inappropriately. Companies seek assurance that data that is provided by them is used in accordance with

certain guidelines and in a transparent manner and that confidentiality remain in place unless otherwise released. Currently, Marine Harvest Canada places data from sea lice sampling, treatment and harvest schedules on its website. This information is available to the public.

It is important to recognize that while several researchers have sought data from companies, companies are equally interested in data generated by researchers for their own production planning. Industry has expressed a genuine desire to have access to data generated by researchers sampling in the area. Provision of such data may allow companies to better understand marine ecosystem dynamics and modify their production plans to reduce their impact on the system.

In an attempt to meet the needs of both sides, a data sharing protocol has been drafted and is being put forward for use. This data sharing protocol will allow researchers to formally communicate their data requirements and both parties will be held accountable for information and how it is used and disseminated.

3.5 Contingency Issues - Unfunded Research Requests

As noted in item 3.3, a contingency is allocated for expenses associated to field platform.

Project A.2 - *Determination of Natal Origins of Pink and Chum Salmon in the Broughton Archipelago* Due to a variety of unforeseen complications, samples were not able to be processed. This was unexpected and unforeseeable. Communications with the principle investigators indicate that future involvement depends on results from the otolith work and whether the Forum and the investigator deem this research avenue worth pursuing. As a result $30,000 is being held in contingency for this research in the 2008 research period.

Project E.1 - *Model Development* funding has been allocated to cover the costs of workshops with researchers to discuss the development of a model. No funding has been allocated for software development or other expenses that may be required to pursue this project. Further expenditures would be determined by the Forum and researchers based on agreed to methodology.

4 Budget

	2007 Funding	2008 Funding
A1 - Oceanography - Foreman/Stucchi	77,000.00	82,000.00
A1b - Winter Monitoring 2007 addendum		14,300.00
A2 - Otolith - DiBacco	29,600.00	*0**
Local support staff	1,620.00	
A3 - Monitoring - Hargreaves	80,000.00	29,500.00
Vessel costs		44,650.00
A4 - Monitor/Estimate Transmission - Krkosek	50,000.00	45,000.00
A5 - Plankton Surveys - Mackas/Galbraith	26,000.00	40,000.00
Local support staff	13,484.75	25,000.00
A6 - Vertical Distribution - Lewis/DiBacco	22,000.00	24,000.00
A7 - Lab Support - Jones	0.00	50,000.00
A9 - Winter sources of lice - Beamish	0.00	80,000.00
B1-4 - Effects of Sea Lice Brauner/Farrell	150,000.00	150,000.00
Transportation/Field costs	10,562.90	*0**
B6 - Fish Health Testing - Saksida	35,038.00	71,900.00
C1-2 - Pink/Chum Dynamics Riddell/Van Will	180,000.00	100,000.00
C3 - Out Group Monitoring Reynolds/Price	48,400.00	49,800.00
D1 - SLICE	0.00	38,500.00
E1 - Model Development	0.00	40,000.00
Other Expenses		
Program Research Meetings	12,534.08	20,000.00
Broughton Coordination	53,370.35	35,000.00
TOTAL MUST FUND INITIATIVES	**789,970.08**	**934,650.00**
Contingency Fund *		75,000.00
Plus 2007 Expenditures		**789,970.08**
TOTAL EXPENDITURE 2007/2008		**1,799,620.08**

* funds to be allocated toward costs to support field research platform and other unfunded research