Count on Salmon

Proceedings from a Workshop held April 20, 2010.

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Prepared for

The Fraser Salmon and Watersheds Program
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Executive summary

The Fraser Salmon and Watersheds Program (FSWP) and Pacific Salmon Foundation (PSF) hosted a workshop to discuss the Count on Salmon (COS) program. The workshop was held at the office of the Pacific Salmon Commission in Vancouver, British Columbia, on April 20, 2010. Its objectives were to: 1) improve the understanding of the history, objectives, applications and experimental design of the Count on Salmon (COS) project; 2) discuss what has been learned over the duration of the project (scientific advances, improved management, changes in project design), and how to maintain ongoing learning; 3) review the project's objectives and experimental design for 2010 and beyond; 4) build collaborative relationships amongst different investigators; 5) explore future options and opportunities for the participation of First Nations and other communities; and 6) recommend questions, analyses and options for further consideration. Workshop participants included experts in the fields of salmon behaviour, physiology, and modelling; DFO scientists monitoring/researching Pacific salmon and the Fraser River; First Nations; senior Pacific Salmon Commission staff involved in in-season management of Fraser River salmon; COS field technicians and management; and PSF and FSWP staff overseeing COS. ESSA Technologies Ltd. facilitated the meeting.

Workshop participants discussed COS in its current form and where they would like to see the program go. They identified program recommendations and items in need of further resolution in three areas: 1) COS objectives; 2) experimental design; and 3) opportunities for collaboration. Items in need of further resolution will require discussions between all stakeholders that have an interest in COS, including future collaborators.

Discussions about the 2010 field season (experimental design) and the future direction of COS were productive and highlighted many of the challenges and opportunities that the program is experiencing. A critical component to the future success of COS is increasing its level of collaboration with First Nations, community groups, and researchers in the watershed, so as to increase both the level of buy in, and overall benefits. A main theme coming from the workshop is the need for a *clearly articulated vision and a set of unified objectives*. Clarity on these things is essential to secure future funding and to ensure that the resulting information is useful to the target audience.

This document summarizes the progress made with respect to the workshop's objectives and relevant discussions on COS.

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1.0 Introduction

On April 20, 2010 the Pacific Salmon Foundation (PSF) and Fraser Salmon and Watershed Program (FSWP) hosted a workshop at the office of the Pacific Salmon Commission (PSC) in Vancouver, British Columbia. The focus of the workshop was to discuss the Count on Salmon (COS) program in its current form and identify areas for improvement moving forwards. Workshop participants included: experts in the fields of salmon behaviour, physiology, and modelling; DFO scientists monitoring/researching Pacific salmon and the Fraser River; First Nations; senior PSC staff involved in in-season management of Fraser River salmon; COS field technicians, project managers, and scientists; and PSF and FSWP staff overseeing COS. All were encouraged to provide insights from their respective fields as it pertained to COS and in-season management of Fraser River salmon. For a list of workshop participants refer to Appendix B.

As described in the agenda (Appendix A), the workshop tackled six objectives over the course of a day:

1. Improve the understanding of the history, objectives, applications and experimental design of the Count on Salmon (COS) project.
2. Discuss what has been learned over the duration of the project (scientific advances, improved management, changes in project design), and how to maintain ongoing learning.
3. Review the project's objectives and experimental design for 2010 and beyond.
4. Build collaborative relationships amongst different investigators.
5. Explore future options and opportunities for the participation of First Nations and other communities.
6. Recommend questions, analyses and options for further consideration.

These objectives were addressed through a combination of presentations (Appendix C) and plenary discussion. Considerable progress was made in addressing all objectives, which will greatly assist COS in developing a forward looking vision that contributes to in-season management of Fraser sockeye. The outcomes from the workshop as they relate to the above objectives are summarised in this document in a manner that will facilitate next steps. To ensure that all content is retained, we have included detailed notes from the workshop in Appendix D.

The purpose of this report is twofold: 1) to provide a record of the workshop; and 2) to provide a series of ideas to help the COS project move forward and continue building on its research while also responding to new opportunities. With respect to the latter, Section 3.0 provides a consolidation of the suggestions put forth by workshop participants. The suggestions do not represent consensus decisions and as such, the report does not contain a list of recommendations that participants unanimously agreed to. The report organises participant comments according to the three areas noted above in workshop objectives 3 to 5: COS project objectives, experimental design, and collaboration.

2.0 COS overview

2.1 History

The impetus for COS was a recognition that improved efficiency and accuracy of existing stock assessment methods could help address reoccurring concerns such as: 1) the missing fish

debate and resulting loss of confidence in the Mission hydro acoustic program; 2) enumeration errors because of species mis-identification; 3) assessment of the timing and location of en-route losses; 4) implementing more selective fishing methods in the lower Fraser River; and 5) allocation of salmon to First Nations. Historically, improvements in stock assessment focused on changes in escapement enumeration programs, however the majority of management and science issues arise in the lower river. Furthermore, technological advances and success with radio tagging opened up several opportunities to pilot new tools that could be used in combination with existing stock assessment methods (English et al. 2005; Robichaud and English 2006; 2007).

In 2006, Brian Riddell[1] identified five programmatic changes worth exploring, with the intention of addressing the concerns listed above.

1. Development of a live-capture fishing system in the lower Fraser (below Mission) to provide salmon (all species) for tagging and random sampling. Utilize one or two large fish wheels to provide "proof of principle" without major construction tasks.
2. Application of radio-tags at the lower river site and installation of shore-based fixed receivers to monitor tags as they pass.
3. Establish a direct sampling program in First Nation fisheries (particularly above Mission) to maximize samples to determine mark-to-unmark ratios and recovery radio tags.
4. Re-establish the Qualark enumeration site (on both sides of the river) to provide in-river counts of passing salmon and install underwater antennas and broadband scanning radio receivers to detect all radio-tags passing through the Qualark hydroacoustic detection zone.
5. Integrate the radio-tagging program with the escapement monitoring programs to maximize use of information and reduce costs of spawner enumerations. Expected benefit is improved information on the distribution of salmon to the smaller populations (i.e., based on the distribution of radio tags) and run timing to all populations.

The project was developed to pilot these programmatic changes and to determine the relative benefit of each element to improving the accuracy and efficiency of stock assessment methods used for Fraser River salmon. Expected benefits included: increased participation of DFO and First Nations; direct monitoring of in-river harvest rates, non-fishing mortality rates, and rates of up-stream migration; monitoring of the effects of climate change in the Fraser (i.e., relationship between in-river conditions and up-stream passage); using information from Qualark and tagging studies to calibrate/correct Mission estimates; and the development of selective live-capture techniques suitable for the lower Fraser River. It should be noted that the major components of the COS project were initiated in 2007, but that this initiative was not referred to as the COS project until 2009.

2.2 Goals and Objectives

The goals and objectives for the fishwheel and telemetry components of the COS program are the product of several Fraser Basin Council and Fraser Basin Assembly meetings that were conducted prior to the establishment for the Fraser Basin Initiative and Fraser Salmon and Watersheds Program (FSWP). The designs for the fishwheel and telemetry studies were reviewed by PSC and FSWP and were viewed as consistent with the priorities for these funds. The main components of the COS program were initiated in 2007 with the following three general goals:

1. Improve the reliability of in-season abundance estimates for Fraser salmon;

[1] At the time Brian was the Division Head, SAFE Division, Science Branch

2. Identify the times and locations of en-route losses for Fraser sockeye; and
3. Assess the relative impact of environmental conditions and fisheries on in-river survival for Fraser sockeye.

The goals were designed to be achievable within a four year time period. Achievement of these goals is expected to provide essential information for the future management of Fraser River salmon stocks. The specific objectives for 2007 were to (Robichaud et al. 2008):

- Test the feasibility of using fishwheels near the Mission Railway Bridge to capture and tag salmon during the June to September period;
- Apply conventional external tags to, and obtain biological samples from, a portion of all salmon species caught using fishwheels; and coordinate with First Nations, commercial and recreational catch monitoring programs to obtain mark-rate information from in-river fisheries;
- Capture, sample and radio-tag all run timing groups of Fraser sockeye;
- Use radio-telemetry to provide a reliable estimate of the in-river survival rate for each sockeye run timing group and to determine the portion of the en-route losses that can be reliably attributed to in-river fisheries and non-fishery related factors;
- Determine whether any discrepancy between the Mission hydroacoustic and spawning area escapement estimates for each sockeye run-timing group can be explained by en-route losses;
- Determine the fate of those radio-tagged sockeye last detected at the Seton Junction;
- Identify potential solutions to the migratory challenges the sockeye face in the Seton Junction to Kelly Creek area; and
- Combine the information from the 2002-07 studies to compare and contrast the migration speeds, behaviour and survival of sockeye for the different river flows and water temperatures observed during the migration period.

The objectives of the COS program have changed over time. In 2008, the objectives were modified. The specific objectives for 2008 defined in Smith et al. (2009) included:

- implement a full-scale live capture and tagging facility at Mission and in the Fraser canyon for each salmon species;
- tag a representative sample of all salmon species, steelhead and sturgeon caught in these fishwheels, and collect DNA samples for sockeye, chinook and steelhead;
- use the mark-recapture data from fisheries and fishwheel samples to compute in-season escapement estimates for each of the target species;
- provide biosampling data needed for species and stock composition estimates; and
- provide an adequate supply of sockeye for future periodic assessments of in-river survival using radio-telemetry techniques.

In 2009, the objectives were changed again to reflect new research priorities (Robichaud et al. 2010). The objectives were:

- Estimate near-shore species and stock composition throughout the Mission hydroacoustic monitoring period;
- Capture, sample and radio-tag all run timing groups of Fraser sockeye and Yale and Harrison Spring-run chinook;
- Estimate in-river survival rate for each sockeye run timing group and determine proportion of en-route losses from in-river fisheries and non-fishery related factors;

- Determine whether discrepancy between the Mission hydroacoustic and spawning area escapement estimates for sockeye run-timing groups can be explained by en-route losses;
- Estimate escapement past Mission using mark-recapture data from radio-tagging and tracking, test-fishing and acoustic surveys at Qualark to;
- Compare and contrast the migration speeds, behaviour and survival of sockeye for the different river flows and water temperatures observed during the study periods.

2.3 Experimental design

Similar to the objectives, the experimental design has changed over time. The tools used to implement the design (i.e., fish wheel, radio tagging) have remained constant over the past three years, but the detailed implementation has varied. Changes include the number of fish wheels used, the location of fishwheel sites, the number of hours per day that the fish wheel is operated[2], tagging sites (marine vs. freshwater), and the number of radio-telemetry tracking sites. Annual changes in the design make it difficult to estimate interannual variability in migration rates, stock composition, en-route mortality, etc.

The basic components of the COS study proposed for 2009 as described in Robichaud et al. (2010) included:

- Capture and radio-tag Spring run chinook near Yale and Harrison;
- Continuous operation of 2 fishwheels (one large and one small) at the Crescent Island site with effort coinciding with operations of hydroacoustic station near Mission;
- Collection of daily species composition data from the fishwheels;
- Collection of adipose and scale samples of sockeye for stock composition and aging analysis;
- Radio tag all run-timing groups of sockeye in proportion to run size and opportunistically radio-tag chinook. Ensure that sufficient numbers of fish are tagged to assess migratory behaviour and spawning success with reasonable certainty;
- Collection of gill tissue samples from a subset of tagged sockeye for a DFO genomics study;
- Tracking of radio tagged fish using mobile and fixed tracking stations strategically deployed throughout the basin;
- Recover the majority of tags caught in recreational, commercial, and First Nations fisheries;
- Monitor pass of radio-tagged fish at Qualark to estimate mark rate; and
- Combine mark-rate data with estimates of fish abundance at Qualark to produce estimates of sockeye escapement that could be compared to estimates derived from data collected at the hydroacoustic station near Mission.

2.4 Existing collaborations

COS has entered into several collaborative arrangements over the course of the last 3 years. This includes both collaborations amongst researchers, and collaborations with First Nations and other communities. With respect to the former, there are three main research

[2] In years with very large pink returns it is not possible to operate the fish wheels 24 hours per day because the wheels are inundated and do not have sufficient capacity to hold the large number of fish.

collaborations[3], two of which are detailed in Appendix E. The extent of collaboration in each of the research initiatives varies, and in some cases consists of information sharing, where data collected by COS are passed to the collaborating researcher who then builds on these data (e.g., scales and tissue samples collected by COS for DFO genomic study, migration estimates collected by COS are input into the migration model being developed by researchers at SFU). The level of collaboration between COS and researchers carrying out tagging for physiological and behavioural studies in the Fraser (Carleton and UBC) is more involved due to the nature of the research (i.e., bidirectional exchange of movement data and information) and the need for shared tagging platforms.

COS has been successful at engaging a few First Nation communities (e.g., Matsqui, Yale, Siska and Nicola First Nations) to help carry out a portion of the COS program (e.g., Matsqui and Siska fishwheel testing, Qualark hydroacoustic operations, catch monitoring and assistance with applying radio-tags to sockeye and chinook). The level of cooperation of First Nation and recreational fishers has been excellent with regard to the reporting any radio-tags recovered in in-river fisheries. This is due to the extensive efforts to make fishers aware of the radio-telemetry studies conducted for the past 8 years and the reward program that LGL has administered on behalf of the PSF and PSC.

2.5 Learning to date and successes

The COS program integrates three forms of information to derive estimates of sockeye, chinook, and pink salmon abundance: data from the Crescent Island fishwheels, data from the Whonnock gillnet test fishery, and hydroacoustic data from Mission and Qualark . Radio-telemetry studies have provided information on migration speeds, and en-route losses have been combined with catch and escapement monitoring data to build in-river fisheries management models (see Appendix E). In brief, COS results to date include:

- *estimates of species composition at Mission,* based on Whonnock gillnet data, fishwheel data, and spatially stratified hydroacoustic counts;
- *in-season estimates of sockeye passage at Mission*, using radio-telemetry and Qualark hydroacoutic data;
- *estimates of en-route losses* as a function of run-timing and water temperatures; and
- *migration rate estimates* for Fraser chinook and *migration success* of catch and release sockeye and coho, both derived from radio-telemetry data.

For more detailed results refer to the Count on Salmon presentation in Appendix C and Robichaud et al. (2010).

In addition, COS has successfully collaborated with several research groups operating out of DFO, SFU, and UBC, as well as First Nations group (i.e,. Matsqui, Yale, Siska and Nicola First Nations). Details of these collaborations are given in Section 2.4.

2.6 2010 objectives and study design

The core objectives and work plan for 2010 remain largely unchanged from the 2009 season, though there are some modifications and one new objective (#3 below). Objectives for 2010 include:

[3] 1) Collaborations with DFO genomic study – COS collects the gill tissue and scale samples. 2) Collaborations with SFU – Migration rates estimated by COS radio-telemetry tagging study inform the migration module of a larger simulation model being used to evaluate in-season management strategies. 3) Collaborations with Carleton and UBC to maximise tagging and data collection efforts to determine movement and migration rates and hook and release mortality.

- Provide in-season estimates of the near-shore composition using fish wheels deployed at the Crescent Island site;
- Provide in-season mark recapture estimates of the number of sockeye passing Mission using mark rate samples from Qualark and the number of radio-tagged sockeye detected at the Mission hydroacoustic site;
- Conduct additional focused monitoring of selected key fishing areas to determine the fate of all radio tagged sockeye entering these fisheries; and
- Estimate in-river survival, migration rates, and the impact of river fisheries.

Thus far, changes to the study design for 2010 are as follows:

- Marine tagging (500 tags) of sockeye (some chinook) to assess river entry timing, in-river survival and migration rates from mission to spawning grounds. Rationale for moving to marine tagging is a reduction in mortality rates as a function of tagging and warm river conditions[4];
- Use of fishwheel for radio-tagging sockeye in the first half of July before water temperature increase (i.e. mostly early Stuart run-timing group);
- Use marine purse seines and Lummi reef nets to radio tag other sockeye timing groups to reduce in-river losses associated with higher water temperatures at tagging; and
- Additional fixed station receivers, mobile tracking, and catch sampling data to assess reasons for en-route losses at key locations.

3.0 Suggestions and items to be resolved

During the second half of the workshop, participants were asked for feedback on three areas of the COS program: 1) program goals and objectives; 2) program experimental design; and 3) opportunities for collaboration. The following sections provide individual participant's feedback and ideas on each of the three areas. The intention of gathering this information is to help COS move forward and continue building on its research while also responding to new opportunities. Current funding for COS comes to an end in 2010, at which point the program will need to have in place new financial support to continue. Articulation of clear objectives, experimental design, and collaborations that align with funder priorities is a necessary step for securing future funding.

3.1 COS objectives

A discussion of COS objectives was a key component of the workshop for two reasons. First, as mentioned above, articulation of objectives that align with potential funder interest will greatly increase the probability of securing future funds. Second, leading into the workshop, participants expressed a lack of clarity regarding the overall vision for COS. The discussion around COS objectives can be categorised into three thematic areas:

1. **Direction** – what is the future vision for the program and what are the objectives to which everyone can agree?;
2. **Governance** – what is the process for making decisions and who should be involved?; and
3. **Objectives** – what concerns exist regarding the current objectives and how do you evaluate whether objectives have been met?

Table 1 lists all the suggestions made by participants.

[4] In 2009, mid-summer tagging mortality was between 50 and 60%. Physiological stress from tagging was exacerbated by high river temperatures.

During the workshop the sentiment of a lack of clarity around COS's future direction was echoed during the workshop. As described in Section 2.1, COS was not initially intended to inform management and a few participants felt that COS should remain research focused. However, a substantial number of workshop participants felt that COS's efforts would be of greater utility if they were more geared towards in-season management priorities. The pull between management and research has led to confusion and a lack of buy in from some community groups. Participants recommended that the future focus of COS, management vs. research, should be resolved before any attempt is made at developing a unified set of objectives.

Participants appeared to agree with the general picture painted by the existing goals. Several minor modifications were proposed (original goals are in Section 2.2) and are shown in italics:

1. *Quantify and* improve reliability of in-season abundance estimates for Fraser sockeye, *chinook and pink salmon*;
2. Identify the times and locations of en-route losses for Fraser sockeye; and
3. Assess *the impact* of environmental conditions, fisheries and the *interaction between environmental conditions and fisheries* on in-river survival for Fraser sockeye.

Participants agreed that the articulation of a unified set of research objectives and complimentary program components (e.g., community and First Nations partnerships that jointly work towards finding solutions), is particularly critical in light of the Cohen Enquiry which will be looking for cohesive and thoughtful recommendations. While developing these objectives, it is important to keep the focus on the contributions that COS can make towards improving Fraser sockeye management and not to get side tracked by the much larger issue of in-river management. Who should be involved in finalizing COS objectives, and the process for doing so, is not clear. That being said, several participants clearly articulated that it is not sufficient to just know what the objectives are and to buy into them; rather, they would like a process for evaluating proposed objectives and determining whether or not they have been met. Workshop discussion also highlighted that as part of this process, COS should select appropriate objective specific benchmarks that strike the right balance between the precision and accuracy required by management (e.g., to make good decisions on in-season harvest) and the cost of collecting the information (i.e., does the increased precision help make better decisions and therefore warrant the additional cost).

Several participants remarked that the current governance structure of COS lacks transparency and appears to be ad hoc. The suggestion to form a steering committee was well received by the majority of participants. The role of the steering committee would be to ensure program continuity, set the direction, articulate the vision, set objectives and targets for evaluating the objectives, and explore issues around long-term resources. Participants suggested candidates for seats on the steering committee, as well as organisations that would be appropriate to include in a COS technical committee (see Appendix F). Moving forward with a steering committee will require a balance between inclusiveness and efficiency.

Table 1 List of issues and suggestions provided by workshop participants regarding COS's goals and objectives. Suggestions are divided into three categories: 1) Direction: questions relating to where the program is going and how they should get there; 2) Governance: questions around the process for making decision; and 3) Objectives: questions relating specifically to the objectives and evaluation of objectives.

Category	Suggestion / issue
Direction	What are the next steps to achieve a unified position on objectives? Does everyone agree on the current objectives? Need to reach agreement and develop a communication strategy for a unified position moving forward. Identify common/major issues to rally support. Communicate this strategy in a 2 pager handout.

Direction	Will COS continue to be science focused or move to applied research?
Direction	What are the most critical inputs to in-season harvest management decisions? Which of these does COS produce?
Governance	Who is in charge? What is the governance for this effort and what should the model look like?
Governance	Establish a steering committee to update the objectives and performance measure, identify the future direction.
Governance	How are the fish managers being engaged? Science cannot operate in a vacuum.
Objectives	Does the sustainability of the fishery depend on the quality of the information/science? Explore trade-offs between precision and quality of information/science vs. management goals/objectives and the tolerance around meeting them.
Objectives	Reduce the impact of in-river fisheries on en-route loss (i.e., more effective and selective gear).
Objectives	Are other salmon species going to be addressed or will focus remain on sockeye? There is not the same in-season management for other species as for sockeye, i.e., do we need to get such detailed data on other species? To extend COS to other species implies that there is in-season management of them, which there is not. Chinook may be moving towards in-season management.
Objectives	How important is live capture for species abundance? Do we need to use the fish wheel?
Objectives	Do the objectives address the need for physiological predictors?
Objectives	Is the objective of COS to understand spatial-temporal estimates of factors contributing to mortality (including PSM) for each species? For single or multiple years? For in-season, post-season, or both? To inform management?

3.2 Experimental design

The COS project has contributed to the state of knowledge on Fraser salmon and participants expressed that they would like to see the research component continue to improve. The majority of participants agreed that improving the science around various in-river related issues is a worthwhile endeavour, and in this respect COS has the potential to play an important role in improving in-season management. The various program components (radio tagging, tracking, and recovery; acoustic monitoring; in-river catch monitoring; species composition; and up-river tracking) have value in addressing the concerns listed in Section 2.1. That being said, workshop participants listed several aspects of the experimental design that are of concern. Concerns and recommendations are listed in Table 2 and are categorized by program area. Mike Lapointe, PSC, captured the sentiment of many concerns listed in Table 2 with the following points:

- Moving to tagging in marine areas is critical because it avoids the potential confounding effects of tagging and handling in-river that could exacerbate the politics. This is more costly, but necessary – the added costs need to be supported to produce defensible science.
- Radio tagging can provide valuable information, but because of the expense of tags, we need to be aware of the scientific limitation of small sample sizes. This is particularly true when trying to get more stock, time or reach specific information.
- Catch monitoring part of the program needs to be strengthened to ensure success and acceptance. In particular, a few reaches of the river need to have intensive sampling for mark rate information (radio tags). In years when direct sampling efforts have not been adequately supported, estimates of radio tag removals in fisheries has relied on harvest rates derived from existing catch estimates and abundances at Mission to partition tag mortality into fishing and other causes. This method has considerable uncertainty associated with estimates of fishery removals, and is unlikely to be accepted given the current political disputes over harvests. Independent estimates are only available through subsampling for the mark rate.
- Support of Qualark, primarily because it provides immediate feedback that can be used to help improve Mission estimates. Mission is nearing the final phase of its development improvements – mid-channel sampling from stationary vessel. Having Qualark during

this period is very helpful (3-5 yrs). Qualark provides ground truthing ability for Mission. We also need something to ground truth Qualark, (i.e. improved monitoring in the upper watershed).

- There are concerns about the size selectivity of lower Fraser fish wheels (wheel biased towards smaller fish relative to mid-river test fishery data). It is difficult to determine the source of this difference – larger fish avoiding capture by the wheels or differences between fish sizes nearshore vs. offshore? Further work is needed to determine the source of this potential size bias if fishwheels are going to continue to be an important sampling platform.
- A spatially stratified approach to collecting information on species composition can improve the ability to partition the acoustic estimates to species and reduce reliance on expert judgment. But fish wheels may not necessarily be the best way to gather near shore data because of concerns about size selectivity. Fishwheels offer some advantages (e.g., 24 hour operation, large sample size, protection from seal predation) but we need to balance those advantages against disadvantages (e.g., size selectivity, nearshore sampling sites, etc.).
- Program improvement depends on learning by doing. This may require changes as we determine what tools can best fulfill program objectives.

Participant discussions highlighted that much of the conflict surrounding in-river issues is driven by politics, rather than by scientific uncertainties. Consequently, it is critical that the science is defensible so that it does not inadvertently exacerbate the politics (e.g., overestimating the number of fish passing Mission can lead to finger pointing and accusations about some groups catching too many fish). Participants agreed that science needs to be supported and trusted within the context of what it is intended to do (i.e. specific and well-scoped questions), while at the same time recognising that it is a learning process and does not have all the answers. Last, transparency and sharing of information are important; however, participants acknowledge that there is a responsibility on the part of everyone who accesses the information to not jump to conclusions and recognise the uncertainty in the data.

Table 2 List of issues and recommendations provided by workshop participants regarding COS's experimental design. Recommendations are divided into 6 categories: Overall, Acoustic, Harvest, Species composition, Tagging and Modelling.

Category	Recommendation / issue
Overall	Start with null hypothesis that there is no difference in species or stocks. Then sequentially add factors that we think may have an impact on salmon survival or migration rates.
Overall	Is it possible to have a multi-year design?
Overall	Concern with sample representation– reference vs. experimental groups, capture locations, capture methods.
Acoustic	Develop a comparison of Mission and Qualark acoustic observations that is independent
Acoustic	Qualark test fishery– who is best qualified to look at alternate data interpretations for species composition in pink return years? PSC has presented an alternate interpretation. Is a technical committee needed? Need agreement on which is best method.
Acoustic and harvest	What level of precision is needed for estimates of run size and harvest to make good management decisions? Do other sources of information satisfy the precision requirements, i.e., is COS needed for estimating abundance from a decision making perspective?
Acoustic and tagging	Compare daily run size estimates and migration for multiple species (chinook, pink, sockeye)
Harvest	Use of approach nets to get: harvest rate by fishery/CU; escapement by CU. These aren't captured by tagging in Georgia Strait
Harvest	Need to continue to improve catch monitoring information to ensure success and acceptance. A few reaches in the river need intensive sampling for mark rate information. Tag returns currently rely on harvest rates

Category	Recommendation / issue
	derived from existing catch estimates and abundance at Mission. Method does not add value and is unlikely to be accepted in current politics. Independent estimates are only available through subsampling for the mark rate.
Species composition	Concern around size selectivity of fish wheel. What is the cause for this bias – sampling method or fish distribution? Is more DIDSON work needed?
Species composition	Spatially stratified approach for species composition useful to partition acoustic estimates to species. Not convinced that fishwheels are the best way to do this because of size selectivity concerns. Need to balance advantages of fishwheel against disadvantages.
Species composition	What options exist that don't occur in freshwater? Can gill nets be used to get stock composition? What selectivity curves and corrections are required?
Species composition	Examine applicability of Mulligan DIDSON research on species ID using tail beat signal
Tagging	Can bias at Mission vs. loss en-route be addressed without tagging and freshwater components of COS (fishwheel), i.e., is a test fishery sufficient?
Tagging	What is the impact of holding time in the fishwheel on stress and survival of tagged fish?
Tagging	Move to marine tagging to avoid high river temperature and provide data for marine areas. Acoustic vs. radio technology? If you use acoustic tags than you can measure mortality in the ocean?
Tagging	Need to have a couple of years of overlap between marine and freshwater tagging to estimate the relationship between them and perform a crosswalk between the two methods.
Tagging	Does the focus on marine tag application eliminate the need for in-river application at Mission?
Tagging	Need to validate tagging impact to provide definitive survival estimates representative of run at large. Are tagged fish surviving to spawn? Likewise need sufficient sample sites of tagged fish within temporal increment to assess physiological prediction of mortality.
Tagging	What are the opportunities to incorporate non-destructive physiological sampling into tagging methods in 2010?
Tagging	Are duplicate acoustic sites necessary and cost effective?
Tagging	What are other options to tag early Stuart sockeye (other than fishwheel)? Are the other options more cost effective?
Tagging	Need for common approaches among research groups (e.g., shared tagging platforms, tagging/biopsy techniques)
Tagging	Radio tagging provides good information, but is costly. Small sample size has limitations, particularly when trying to get more stock, time, or reach specific information. Need sufficient sample size to have defensible results.
Modelling	Use the management simulation model (SFU) to test alternative experimental designs. Design will depend on future shape of stocks and fishery – try to model these.
Modelling	Using the model, identify key unknowns and sensitivities and build these into the future design

3.3 Opportunities for collaboration

Funds from FSWP and PSC (the major funders thus far) are not expected to continue at their current levels, meaning that alternative funding sources must be found if COS is going to continue. Fostering greater collaboration between COS, researchers, government agencies, First Nations, and other community groups is of particular importance because many prospective funders are interested in projects that engage a variety of sectors to address issues that compliment research efforts (e.g., application of research to management and harvest practices). The majority of participants agreed that increased collaboration is a fundamental requirement for securing future funds. The value of increased collaboration in areas other than research is that it provides a means through which COS' research can be easily accessed and applied, thus making the science more visible in the watershed.

COS, with the help of a steering committee, would benefit from identifying advocates for the program and future funders, bring them onto the steering committee to assist with developing a

future vision, and formulate a cohesive set of objectives. Participation in this process can help to achieve a greater level of buy in on the part of funders and foster long-term relationships.

Workshop participants made a number of suggestions regarding opportunities for collaboration (Table 3). Suggestions were categorised into one of four themes:

1. **Communication**;
2. **Governance**;
3. **Science**; and
4. **First Nations and community involvement**.

The first two themes focus on ways that COS can engage a broader audience within the Fraser watershed while the latter two themes refer to the two types of collaboration that COS can engage in. Each type of collaborative relationship has a distinct purpose, however they are complimentary.

Communication

Suggestions around communication fall into one of two sub-categories:

i) Communication with First Nations and communities in the basin (i.e., what is the most effective way to communicate with these groups); and
ii) Data and information sharing.

Historically, COS has been reliant on technical people from different groups to spread the word to senior entities within their organisations, who then in turn want to get involved. This strategy is effective, but lacks the necessary mechanism to communicate with groups not involved with the technical elements. Participants felt that a communication strategy that goes beyond the technical aspects of the program would enable non-technical audiences to be reached. The need for better communication was also highlighted by one participant's comment during the workshop regarding a lack of clarity on whether a conflict of interest exists between assisting COS while employed by a First Nation carrying out its own stock assessment and monitoring. This comment illustrates a disconnect between groups working in the Fraser watershed. Greater attention and resources allocated towards communicating the win-win nature of collaborating with COS would help to address the disconnect.

Governance

On the theme of governance, suggestions fell into one of two areas. The first is to engage First Nations and active community groups in the process. Although not required to deliver on the program's current objectives, someone suggested hosting public consultation in the future to gather community input on an updated set of program objectives. This type of interaction has the potential benefit of attracting collaborators. This second point is around greater clarity around the broader governance of COS. The majority of participants agreed that COS would benefit from the creation of a steering committee with a diverse membership (discussed in Section 3.1).

Science collaboration

Participants expressed opinions on two points with regards to science collaboration. The first is around identifing all the potential researchers working in the Fraser on issues of disease, avoidance, cumulative impacts, etc. Improved communication between groups active in the watershed will help ensure that individual efforts are complementary and mutually beneficial. Second, COS has been successful at connecting with academics (SFU and UBC), but it has not been as effective at regularly engaging with First Nation scientists, nor have First Nations been brought to the table to discuss annual experimental design and potential research synergies.

One of the participants noted that there is an increasing expectation on the part of First Nations to be involved in these decisions and not just involved in implementing COS's vision. Funds may be available through FSWP to engage First Nation scientists in bilateral discussions with COS to improve communication within the watershed.

First Nations and community involvement

Increasing the number of collaborations with First Nations would be facilitated by the identification of key areas where both parties feels collaboration would be valuable. That being said, several participants acknowledged that this exercise needs to be more creative than it has been in the past, and necessitates a hard look at what capacity currently exists amongst First Nations, and leveraging this capacity in novel ways. A key step in establishing collaborative relationships is the identification of key contacts amongst First Nations (i.e., who should COS contact?), and focal points for collaborative processes. This latter point will likely become clear through increased dialogue with First Nations and improved communication between COS and the communities in the watershed.

Table 3 List of collaborative opportunities provided by workshop participants. Opportunities are categorised by collaborators (e.g., government agencies, communities, First Nations (FNs), researchers, etc.) and the nature of the interaction/collaboration (i.e., communication, governance, science & monitoring, community and First Nations engagement)

Nature of collaboration	Targert audience / Collaborators	Details
Engagement	Communities and FNs	More intensive, but localized ratio tag studies to identify locations of tag loss within the watershed. (What are the capital investments required for equipment and training?)
Engagement	Communities and FNs	Need to involve upriver communities. Tag recovery programs may be an option. Habitat monitoring in bottleneck areas (i.e., in areas where we are losing a lot of fish)
Engagement	FNs	Opportunities for FNs to provide technical assistance in-season in middle and upper river data collection, catch monitoring for mark rate studies. Potential to parse out en-route mortality (non-catch) from fishing mortality.
Engagement	FNs	FNs's selective fisheries (food and ceremony and commercial). Look for opportunities to use more effective gear so that COS can be self funding (fish wheel operation is very expensive).
Engagement	All	Build confidence in program goals and results by working with all fisheries
Governance	FNs	Engage FNs up front to assist with the definition of objectives. Move away from exclusive focus on implementation.
Governance	FNs	Develop similar agreements to the one between the Mission hydro-acoustic station and Sumas FN around operations. Agreements between collaborators protect the rights of both parties, particularly those of FNs to fish.
Governance	All	Create a cross-agency design and management team to support and promote the COS initiative. Create a unified program that supports the science, making it easier to find future funding.
Governance	All	Find funding partnerships to fund tagging platforms and tag monitoring.
Governance	FNs & government agencies	What is the vision and governance structure for long-term operation of Qualark? Future training to run the facility?
Communication	Communities and FNs	Improvement of tag recovery. Is current rate of recovery adequate?
Communication	FNs	Outline a process for information gathering and analysis for Fraser FNs
Communication	Communities and FNs	Identify and communicate the information needs for in-season management for in-river user groups
Communication	Communities and FNs	Need someone within COS with the responsibility to identify and foster individuals/groups for collaboration
Communication	All	Need for a common data center, website, and/or share point site for collaboration and

Nature of collaboration	Targert audience / Collaborators	Details
		communication (e.g., tagging data, climate change groups). Who would manage it?
Science and monitoring	Researchers	How can COS leverage other work (e.g. juvenile work by Scott Hinch, out of Fraser Basin studies (a lot of work happening in the US), juvenile tagging studies (POST))/
Science and monitoring	Researchers	Climate change research on Fraser salmon for river conditions and marine approach areas. Potential collaborators: UBC, DFO, UW, ESSA, Rutgers.
Science and monitoring	Researchers	Addition of socio-economic component to migration model. Perform a management strategy evaluation.
Science and monitoring	Government agencies	Collaborations with CAHR-DFO on cumulative effects assessment for en-route and pre-spawn mortality (Dave Patterson, DFO, leading a study on cumulative effects)
Science and monitoring	FNs and researchers	Engagement of collaborators and FNs in the annual experimental design.
Science and monitoring	Researchers	Quantification of indirect fisheries impacts (e.g., avoidance behaviour, cumulative avoidance, unrecorded net/hook encounters, disease)
Science and monitoring	Researchers	Identify and organize all the "tagging" players in the Fraser to optimize results. Can COS piggy back on an existing fish sampling platform?

4.0 Moving forward

Based on the discussions summarized in Section 3.0, workshop participants identified a list of action items and next step for COS to consider. Items are categorized as either 2010 field season considerations or COS community engagement and direction.

2010 field season

- Find a tagging platform for 2010 marine tagging
- Investigate opportunities for buying field gear for future seasons (costs for radio telemetry are declining)
- Work with First Nations to carry out monitoring (catch, habitat, mortality sources), particularly in Thompson, Seton, and Bridge River area.
- Design and implement a mark rate sampling effort study to estimate mortality and catch for key fisheries between Mission and the spawning areas (e.g., Hope-Sawmill, Thompson junction to Kelly Creek, Spence Bridge to Kamloops).

COS community engagement & direction

- Create a steering committee
- Improve communications (e.g., get on agenda for Fraser River First Nations Forum to discuss opportunities for collaboration, improve usability and awareness around daily catch, tag, and migration rate data available on PSC website, broadcast win-win nature of collaboration)
- Create a unified set of objectives
    - Develop a road map of how to achieve goals
    - Create a timeline for when things will happen (e.g., objectives formulated by Sept 2010, road map by November 2010, etc.)
    - Develop a plan for carrying COS through its transitional year
- Present a united front to the Cohen enquiry. Key players to include: individuals/organisations working on salmon management, treaty negations, and climate change issues in the Fraser watershed.

5.0 References

English, K. K., W. R. Koski, C. Sliwinski, A. Blakley, A. Cass, J.C. Woodey. 2005. Migration timing and in-river survival of Late-run Fraser River sockeye using radio-telemetry techniques. Trans. Amer. Fish. Soc. 134:1342-1365.

Robichaud, D., J. Smith, K.English, S. Tyerman. 2010. Application of fishwheels and radio-telemetry for in-season assessment of salmon returns to the Fraser River, 2009. Prepared for Fraser Salmon Watersheds Program by LGL Limited Environmental Research Associates.

Robichaud, D., K. K. English and J. J. Smith. 2008. Feasibility of fishwheel use for escapement estimation and results from the salmon radio-tracking on the lower Fraser River in 2007. Report for the Pacific Salmon Commission, Vancouver. 140 p.

Smith, J.J., Robichaud, D., K. K. English and P. Johnson. 2009. Feasibility of fishwheel use for escapement estimation and results from the salmon radio-tracking on the lower Fraser River in 2008. Report prepared by LGL Limited for the Pacific Salmon Commission, Vancouver. 104 p.

Robichaud, D. and English, K.K. 2007. River entry timing, survival and migration behaviour of Fraser River sockeye salmon in 2006. Report prepared for Fisheries and Oceans, Canada, Pacific Biological Station, Nanaimo, B.C., August 2007. 113 p.

Robichaud, D. and English, K. K. 2006. Assessing in-river migration behaviour and survival of Summer-run sockeye salmon caught and released in the Lower Fraser River in 2005. Report prepared for Fisheries and Oceans, Canada, Pacific Biological Station, Nanaimo, B.C. 66 p.

Appendix A – Workshop agenda

Pacific Salmon Foundation – Count on Salmon Workshop

Date & Time: April 20, 2010 (9 am to 4:30 pm)

Location: Pacific Salmon Commission
600 – 1155 Robson Street
Vancouver, B.C.

Dial-in number: 604-899-4310, Conference ID: 4071261#

Web link to see files during meeting:
https://www2.gotomeeting.com/join/495843155

Workshop Objectives

1. Improve the understanding of the history, objectives, applications and experimental design of the Count on Salmon (COS) project.
2. Discuss what has been learned over the duration of the project (scientific advances, improved management, changes in project design), and how to maintain ongoing learning.
3. Review the project's objectives and experimental design for 2010 and beyond.
4. Build collaborative relationships amongst different investigators.
5. Explore future options and opportunities for the participation of First Nations and other communities.
6. Recommend questions, analyses and options for further consideration.

The pre-workshop materials and workshop structure are intended to maximize time for structured and informed dialogue.

Limited Scope

This is a technical workshop focused on the design and application of the COS project. We will not have time to discuss issues related to the overall management of Fraser fisheries or the COS project. Detailed technical issues (e.g. # tags, methods of analysis) can be raised for post-workshop consideration, but will not be able to be resolved at the meeting.

Pre-Workshop Package

(emailed to participants the week before the workshop)

1-2 page written summaries of the history, objectives, experimental design, and key applications/results for the following:

- Fishwheel and Radio telemetry summary (Karl English)
- Hook and release mortality (Andrew Steggeman)
- Migration modeling (Aaron Springford)
- Physiology and migration studies (Scott Hinch, Tony Farrell);

Background Material available on www.thinksalmon.com

(if difficulty is experienced downloading any reports from this website contact Tiffany Pither at 6044 664-7664 ext119 to obtain a copy)

- Feasibility of Fishwheel Use for Escapement Estimation and Results from the Salmon Radio-Tagging on the Lower Fraser River in 2007

- Feasibility of Fishwheel Use for Escapement Estimation and Results from the Salmon Radio-Tagging on the Lower Fraser River in 2008

- Feasibility of Fishwheel Use for Escapement Estimation and Results from the Salmon Radio-Tagging on the Lower Fraser River in 2009

- 2008 Lower Fraser River Sockeye Recreational Hook and Release Mortality Study

- 2008 Lower Fraser River Sockeye Recreational Hook and Release Mortality Study

Workshop Agenda

8:45 am Arrive and mingle

A. Introduction and Overview presentations

9:00 am. Why We're Here / Introductions (Cam West)

9:20 am Workshop objectives & agenda, process, guidelines (Dave Marmorek)

9:30 am Overview of COS (Karl English, Mike Lapointe & Mark Saunders):

10:20 am Clarification Questions

10:30 am BREAK *{note down issues that you would like to have discussed later}*

10:45 am High Level Context for COS Project (Brian Riddell)

10:55 Overview of Migration Physiology Studies link to COS (Scott Hinch, Tony Farrell)
(brief - emphasize key links to COS)

11:05 Overview of Migration Modeling link to COS (Aaron Springford)
(brief - emphasize key links to COS)

11:15 am Clarification Questions

B. Elicitation of issues to be discussed in afternoon (David Marmorek)

11:25 am Silent Generation

- participants silently write down issues they'd like to have discussed, using the following categories:

    1. COS Objectives and Applications
    2. Experimental Design
        a. for 2010 and beyond
    3. Opportunities for Collaboration
        a. amongst researchers
        b. amongst communities throughout the watershed
    4. Other Issues

11:35 am Record issues from participants (including those on the phone)

- Go through the four categories, soliciting issues from participants
- Summarize issues succinctly, avoiding issues already raised
- Cluster issues as they are raised

12 noon LUNCH *{provided}*

- Facilitation team and FSWP personnel further cluster issues

C. Discussion of Issues

12:45 pm COS Objectives and Applications

- what needs to be resolved in the short term (pre 2010 monitoring)?
- what can be resolved later?

1:30 pm Experimental Design
- what needs to be resolved in the short term (pre 2010 monitoring)?
- what can be resolved later?

2:30 pm Opportunities for Collaboration
- what needs to be resolved in the short term (pre 2010 monitoring)?
- what can be resolved later?

3:15 pm Other Issues

3:30 pm BREAK

D. Wrap Up

3:45-4:30 Next steps; how will follow-through occur for each category? (David Marmorek)
- COS Objectives
- Experimental Design
- Opportunities for Collaboration among Researchers
- Opportunities for Collaboration w Communities

Post-workshop activities:
- Workshop report (mid-May)
- Meetings to discuss responses to workshop recommendations
- In-season information

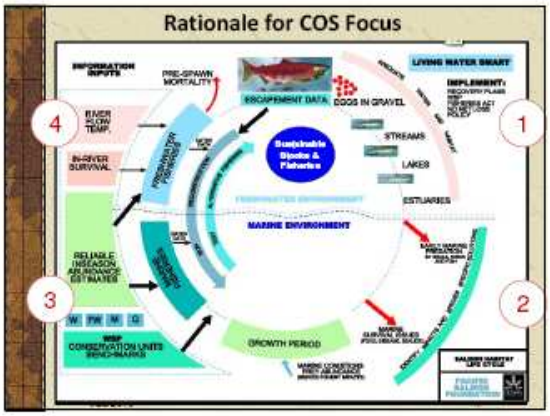
4:30 Meeting adjourns

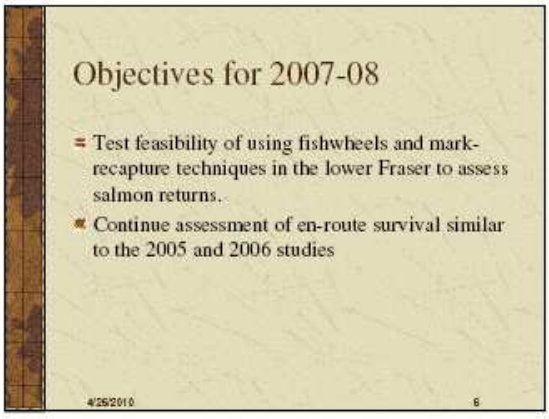
Appendix B – Workshop participant list

Name	Affiliation	Email
Aaron Springford	SFU	aspringf@sfu.ca
Angus MacKay	Salmon Endowment Fund	
Brenda Morgan	Matsqui FN	brenda.morgan@shaw.ca
Brian Riddell	PSF	briddell@psf.ca
Cam West	FSWP	cwest@psf.ca
Dave Marmorek	ESSA	dmarmorek@essa.com
Dave Patterson	DFO	David.Patterson@dfo-mpo.gc.ca
George Cronkite	DFO	George.Cronkite@dfo-mpo.gc.ca
Gord Sterritt	NSTC	g.sterritt@nstq.org
Hermann Enzenhofer	DFO	Hermann.Enzenhofer@dfo-mpo.gc.ca
Howie Wright	FNFC	Howie_Wright@syilx.org
Jason Smith	LGL	jsmith@lgl.com
Jim Thomas	J.O.Thomas	information@jothomas.com
Karl English	LGL	kenglish@lgl.com
Katherine Wieckowski	ESSA	kwieckowski@essa.com
Ken Wilson	MCC	wilsonkh@telus.net
Kristy Miller-Saunders	DFO	Kristi.Miller@dfo-mpo.gc.ca
Mark Saunders	DFO	Mark.Saunders@dfo-mpo.gc.ca
Michelle Tung	FSWP	mtung@psf.ca
Mike Lapointe	PSC	Lapointe@psc.org
Mike Staley	M. Staley	mstaley@mstaley.com
Murray Ned	Sto:lo TC	murray.ned@stolotribalcouncil.ca
Pete Nicklin	UFFCA	indiseaent@shaw.ca
Richard Basanich	FNFC	
Scott Hinch	UBC	shinch@interchange.ubc.ca
Stan Morgan	Matsqui FN	
Timber Whitehouse	DFO	Timber.Whitehouse@dfo-mpo.gc.ca
Victor Keong	Salmon Endowment Fund	

Appendix C – Workshop presentations

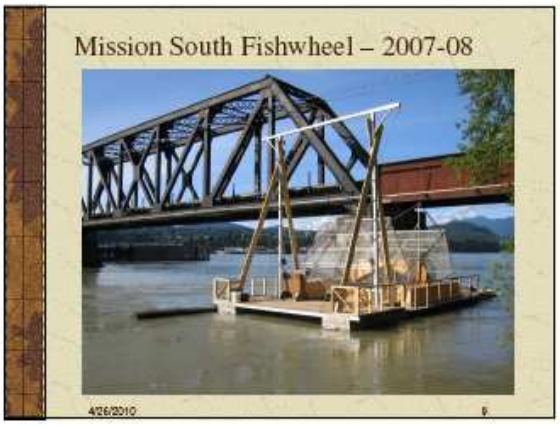
Count on Salmon (Karl English, LGL)





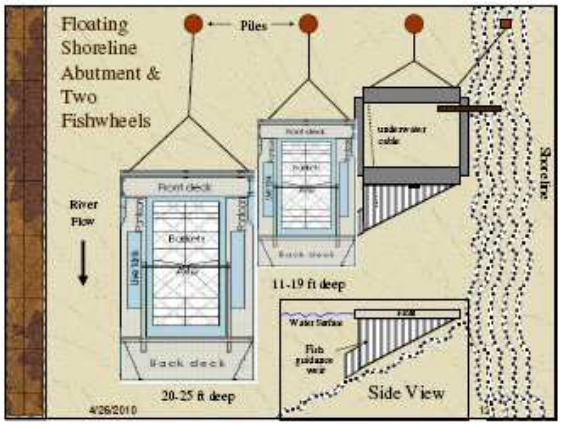

Proposed Fishwheel Sites
Mission Railway Bridge
Proposed Fishwheel Sites
Highway 11 Bridge
flow
Google
4/26/2010
7

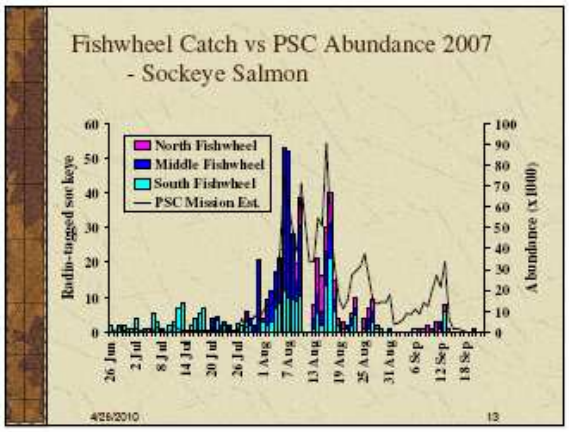

Proposed Fishwheel Sites
flow
400 m
Site 3
Site 2
Site 1
Google
4/26/2010
8

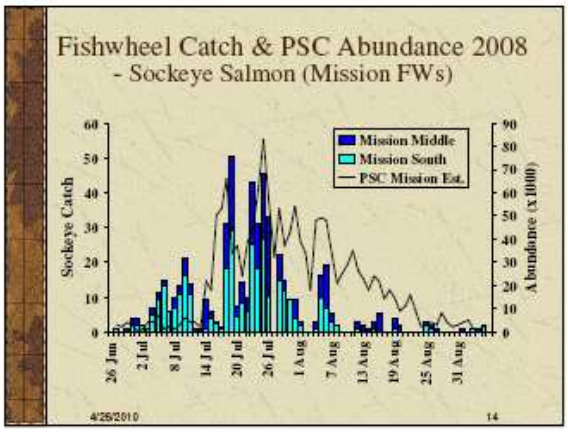

Mission South Fishwheel – 2007-08
4/26/2010
9

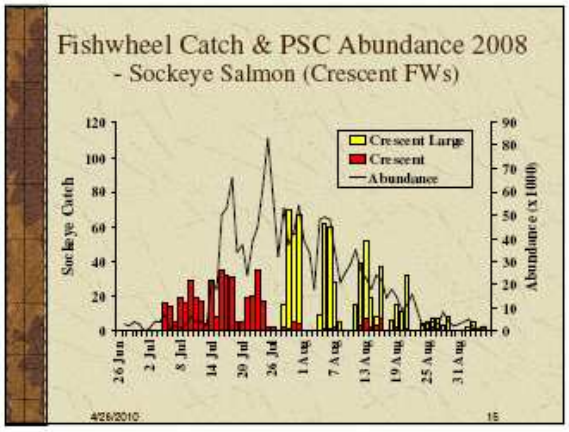

"Crescent" Site - (9 km below Mission)
4/26/2010
10

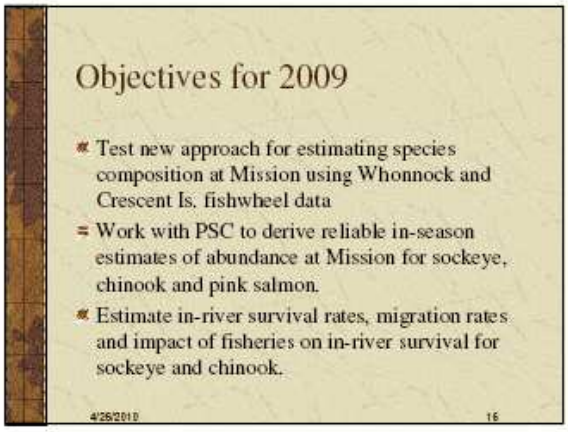

Large FW at Crescent Site – 2008-09
4/26/2010
11

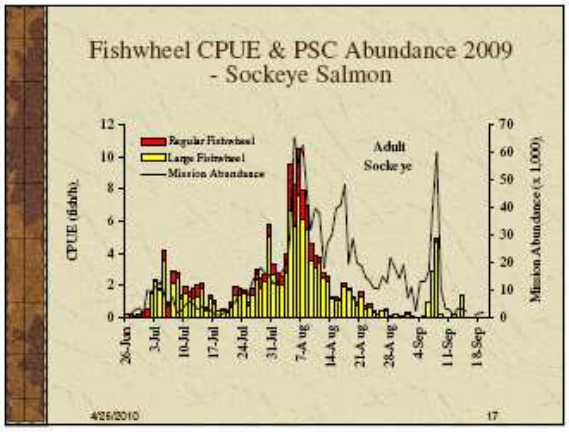

Floating Shoreline Abutment & Two Fishwheels
Piles
River Flow
Front deck
Back deck
11-19 ft deep
20-25 ft deep
Shoreline
Side View
4/26/2010

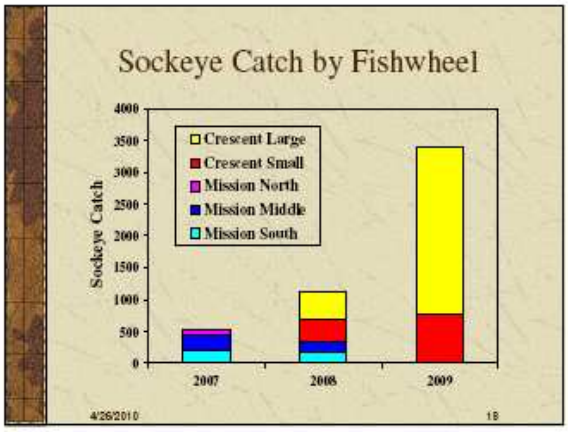

Fishwheel Catch vs PSC Abundance 2007
- Sockeye Salmon
North Fishwheel
Middle Fishwheel
South Fishwheel
PSC Mission Est.
Radio-tagged sockeye
Abundance (x1000)
26 Jun
2 Jul
8 Jul
14 Jul
20 Jul
26 Jul
1 Aug
7 Aug
13 Aug
19 Aug
25 Aug
31 Aug
6 Sep
12 Sep
18 Sep
4/26/2010
13

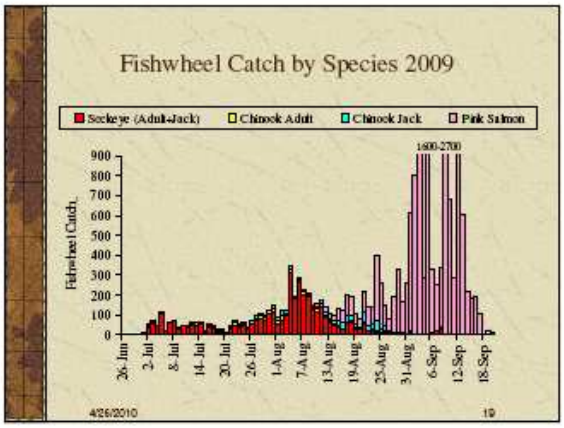

Fishwheel Catch & PSC Abundance 2008
- Sockeye Salmon (Mission FWs)
Mission Middle
Mission South
PSC Mission Est.
Sockeye Catch
Abundance (x1000)
26 Jun
2 Jul
8 Jul
14 Jul
20 Jul
26 Jul
1 Aug
7 Aug
13 Aug
19 Aug
25 Aug
31 Aug
4/26/2010
14

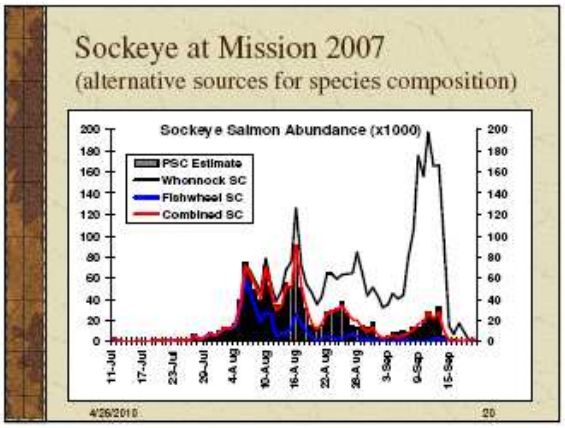

Fishwheel Catch & PSC Abundance 2008
- Sockeye Salmon (Crescent FWs)
Crescent Large
Crescent
Abundance
Sockeye Catch
Abundance (x1000)
26 Jun
2 Jul
8 Jul
14 Jul
20 Jul
26 Jul
1 Aug
7 Aug
13 Aug
19 Aug
25 Aug
31 Aug
4/26/2010
15

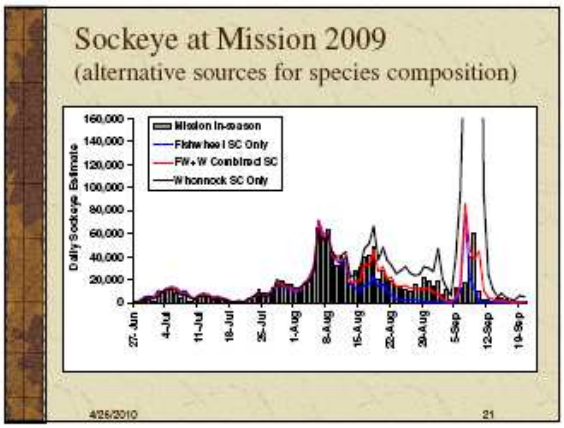

Objectives for 2009
Test new approach for estimating species composition at Mission using Whonnock and Crescent Is. fishwheel data
Work with PSC to derive reliable in-season estimates of abundance at Mission for sockeye, chinook and pink salmon.
Estimate in-river survival rates, migration rates and impact of fisheries on in-river survival for sockeye and chinook.
4/26/2010
16

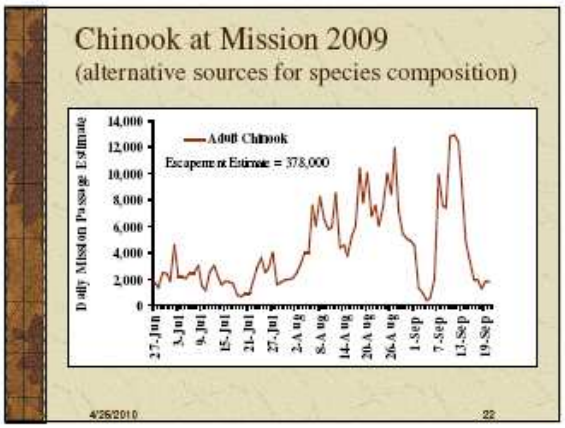

Fishwheel CPUE & PSC Abundance 2009
- Sockeye Salmon
Regular Fishwheel
Large Fishwheel
Mission Abundance
Adult Sockeye
CPUE (fish/hr)
Mission Abundance (x 1,000)
26-Jun
3-Jul
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
4/26/2010
17

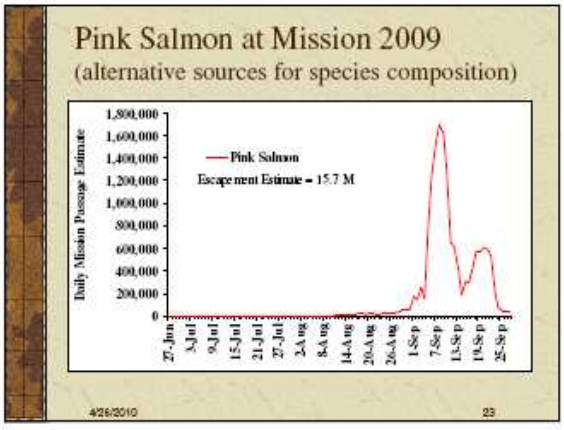

Sockeye Catch by Fishwheel
Crescent Large
Crescent Small
Mission North
Mission Middle
Mission South
Sockeye Catch
2007
2008
2009
4/26/2010
18

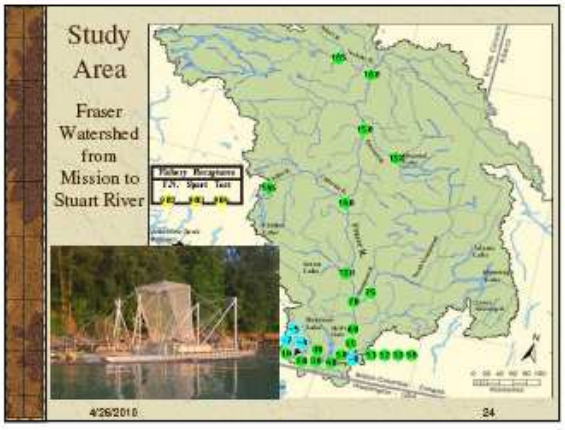

Fishwheel Catch by Species 2009
Sockeye (Adult+Jack)
Chinook Adult
Chinook Jack
Pink Salmon
1600-2700
Fishwheel Catch
26-Jun
2-Jul
8-Jul
14-Jul
20-Jul
26-Jul
1-Aug
7-Aug
13-Aug
19-Aug
25-Aug
31-Aug
6-Sep
12-Sep
18-Sep
4/26/2010
19

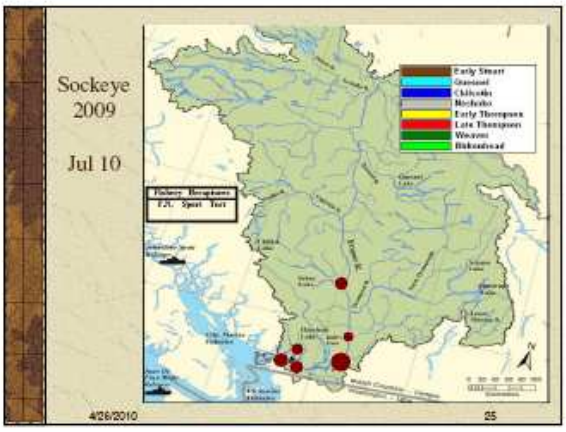

Sockeye at Mission 2007
(alternative sources for species composition)
Sockeye Salmon Abundance (x1000)
PSC Estimate
Whonnock SC
Fishwheel SC
Combined SC
11-Jul
17-Jul
23-Jul
29-Jul
4-Aug
10-Aug
16-Aug
22-Aug
28-Aug
3-Sep
9-Sep
15-Sep
4/26/2010
20

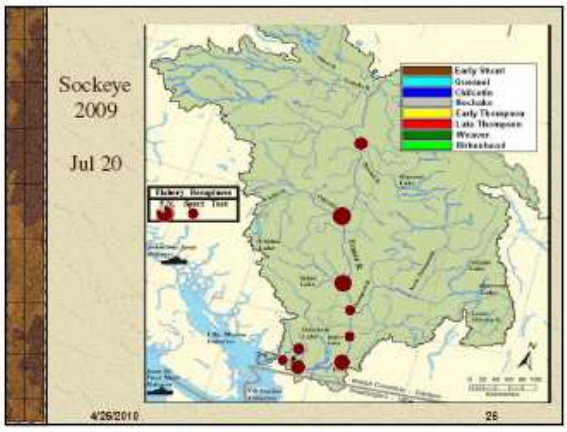

Sockeye at Mission 2009
(alternative sources for species composition)
Mission In-season
Fishwheel SC Only
FW+W Combined SC
Whonnock SC Only
Daily Sockeye Estimate
27-Jun
4-Jul
11-Jul
18-Jul
25-Jul
1-Aug
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
12-Sep
19-Sep
4/26/2010
21

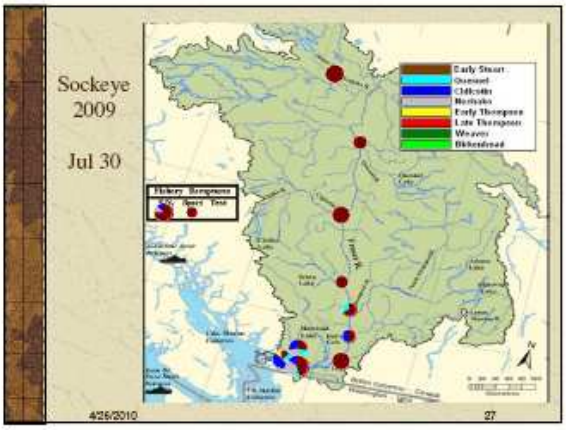

Chinook at Mission 2009
(alternative sources for species composition)
Adult Chinook
Escapement Estimate = 378,000
Daily Mission Passage Estimate
27-Jun
3-Jul
9-Jul
15-Jul
21-Jul
27-Jul
2-Aug
8-Aug
14-Aug
20-Aug
26-Aug
1-Sep
7-Sep
13-Sep
19-Sep
4/26/2010
22

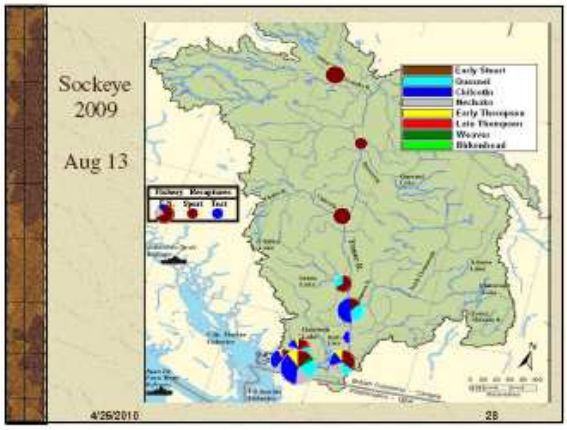

Pink Salmon at Mission 2009
(alternative sources for species composition)
Pink Salmon
Escapement Estimate = 15.7 M
Daily Mission Passage Estimate
27-Jun
3-Jul
9-Jul
15-Jul
21-Jul
27-Jul
2-Aug
8-Aug
14-Aug
20-Aug
26-Aug
1-Sep
7-Sep
13-Sep
19-Sep
25-Sep
4/26/2010
23

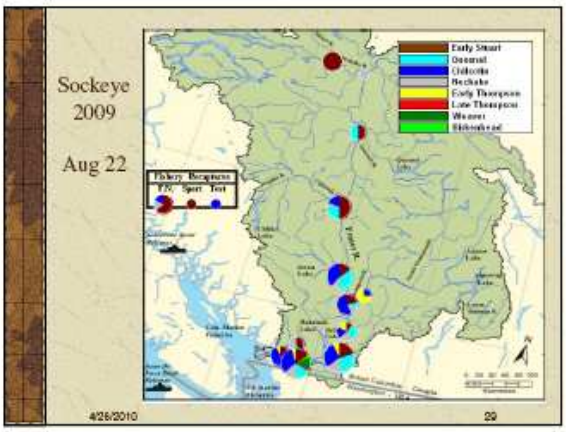

Study Area
Fraser Watershed from Mission to Stuart River
4/26/2010
24

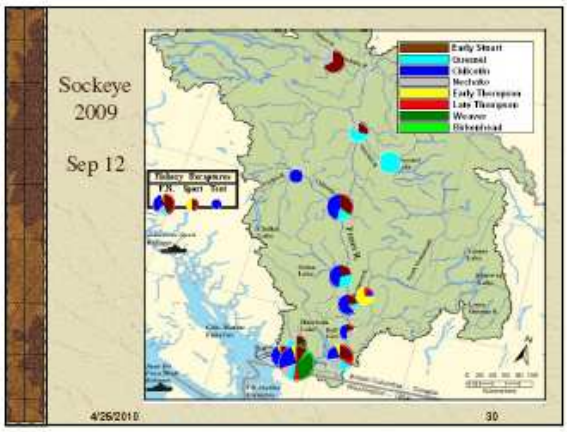

Sockeye
2009
Jul 10
4/26/2010
25

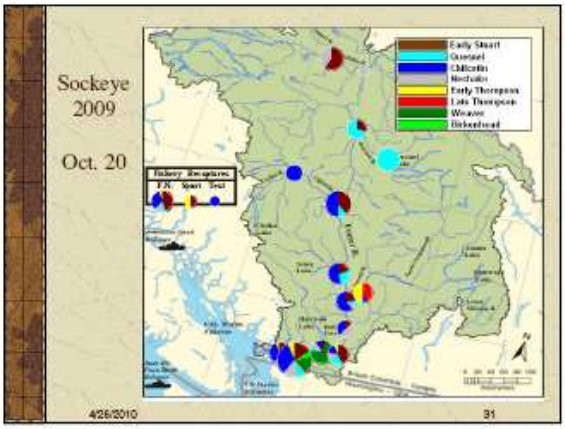

Sockeye
2009
Jul 20
4/26/2010
26

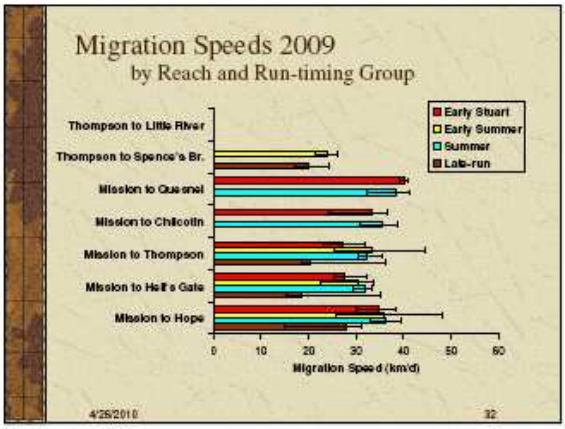

Sockeye
2009
Jul 30
4/26/2010
27

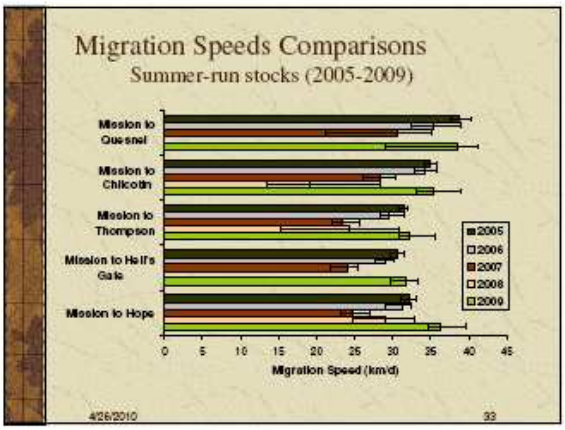

Sockeye
2009
Aug 13
4/26/2010
28

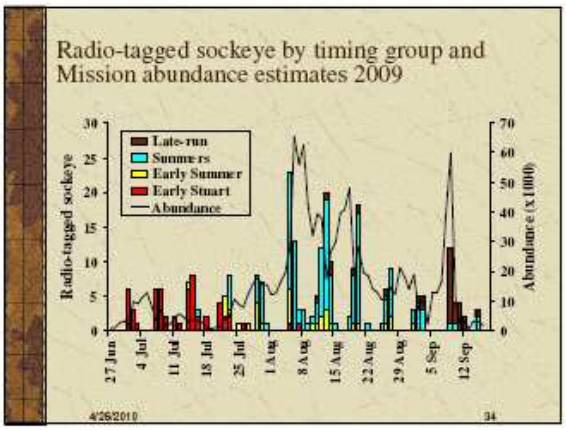

Sockeye
2009
Aug 22
4/26/2010
29

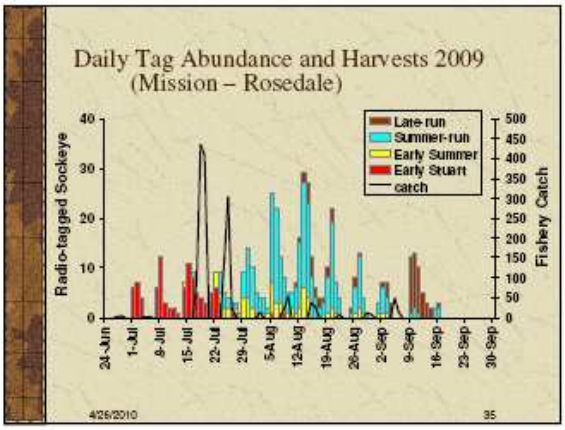

Sockeye
2009
Sep 12
4/26/2010
30

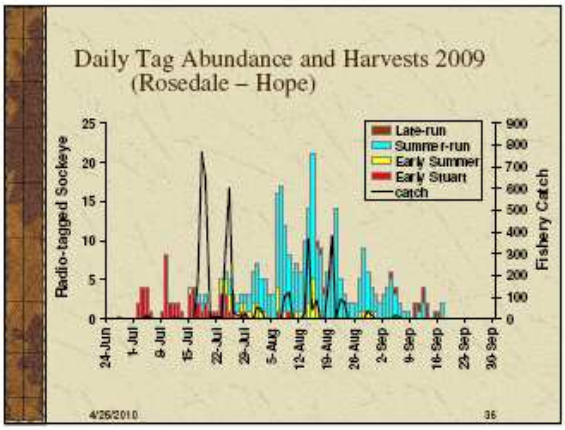

Sockeye
2009
Oct. 20
Early Stuart
Quesnel
Chilcotin
Nechako
Early Thompson
Late Thompson
Weaver
Birkenhead
Fishery Escapement
FN
Sport
Seal
4/26/2010
31

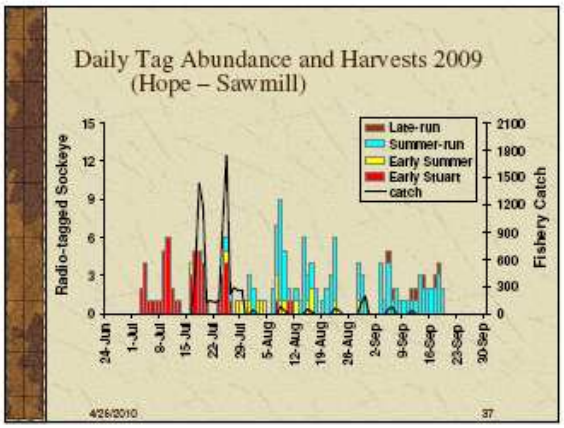

Migration Speeds 2009
by Reach and Run-timing Group
Thompson to Little River
Thompson to Spence's Br.
Mission to Quesnel
Mission to Chilcotin
Mission to Thompson
Mission to Hell's Gate
Mission to Hope
Early Stuart
Early Summer
Summer
Late-run
0
10
20
30
40
50
60
Migration Speed (km/d)
4/26/2010
32

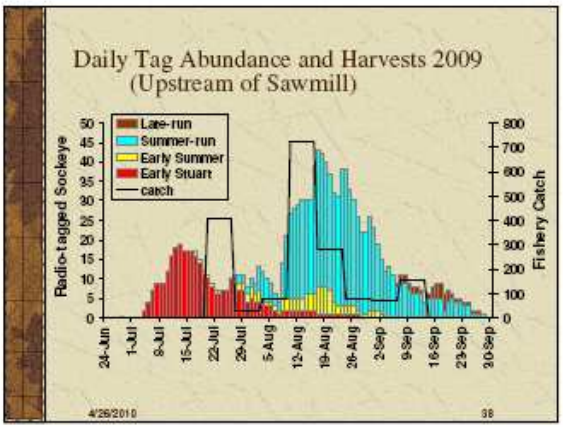

Migration Speeds Comparisons
Summer-run stocks (2005-2009)
Mission to Quesnel
Mission to Chilcotin
Mission to Thompson
Mission to Hell's Gate
Mission to Hope
2005
2006
2007
2008
2009
0
5
10
15
20
25
30
35
40
45
Migration Speed (km/d)
4/26/2010
33

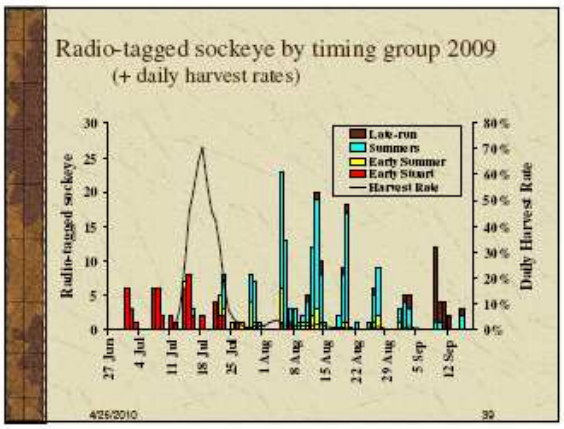

Radio-tagged sockeye by timing group and
Mission abundance estimates 2009
Late-run
Summers
Early Summer
Early Stuart
Abundance
Radio-tagged sockeye
Abundance (x1000)
27 Jun
4 Jul
11 Jul
18 Jul
25 Jul
1 Aug
8 Aug
15 Aug
22 Aug
29 Aug
5 Sep
12 Sep
4/26/2010
34

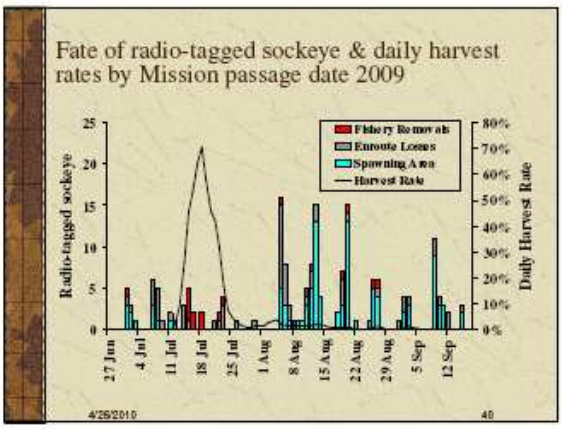

Daily Tag Abundance and Harvests 2009
(Mission – Rosedale)
Late-run
Summer-run
Early Summer
Early Stuart
catch
Radio-tagged Sockeye
Fishery Catch
24-Jun
1-Jul
8-Jul
15-Jul
22-Jul
29-Jul
5-Aug
12-Aug
19-Aug
26-Aug
2-Sep
9-Sep
16-Sep
23-Sep
30-Sep
4/26/2010
35

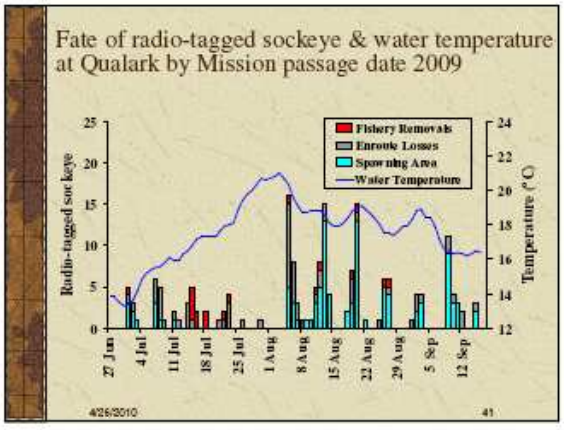

Daily Tag Abundance and Harvests 2009
(Rosedale – Hope)
Late-run
Summer-run
Early Summer
Early Stuart
catch
Radio-tagged Sockeye
Fishery Catch
24-Jun
1-Jul
8-Jul
15-Jul
22-Jul
29-Jul
5-Aug
12-Aug
19-Aug
26-Aug
2-Sep
9-Sep
16-Sep
23-Sep
30-Sep
4/26/2010
36

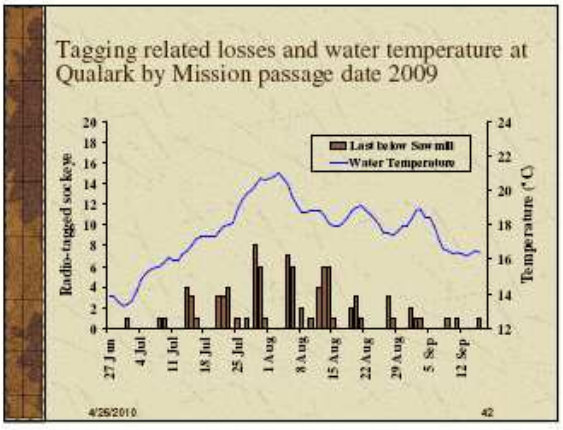

Daily Tag Abundance and Harvests 2009
(Hope – Sawmill)
Late-run
Summer-run
Early Summer
Early Stuart
catch
Radio-tagged Sockeye
Fishery Catch
4/26/2010
37

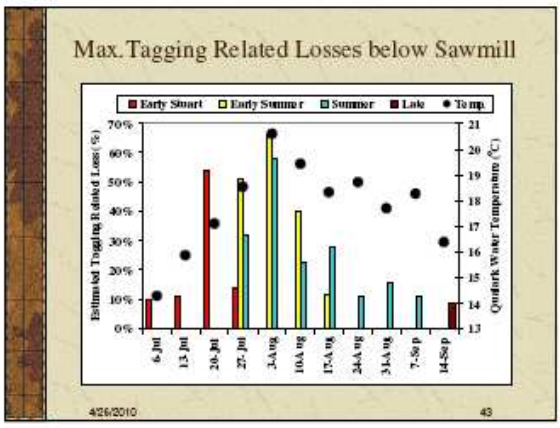

Daily Tag Abundance and Harvests 2009
(Upstream of Sawmill)
Late-run
Summer-run
Early Summer
Early Stuart
catch
Radio-tagged Sockeye
Fishery Catch
4/26/2010
38

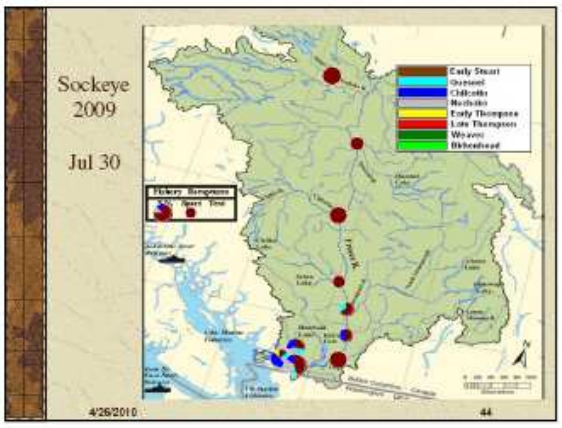

Radio-tagged sockeye by timing group 2009
(+ daily harvest rates)
Late-run
Summers
Early Summer
Early Stuart
Harvest Rate
Radio-tagged sockeye
Daily Harvest Rate
4/26/2010
39

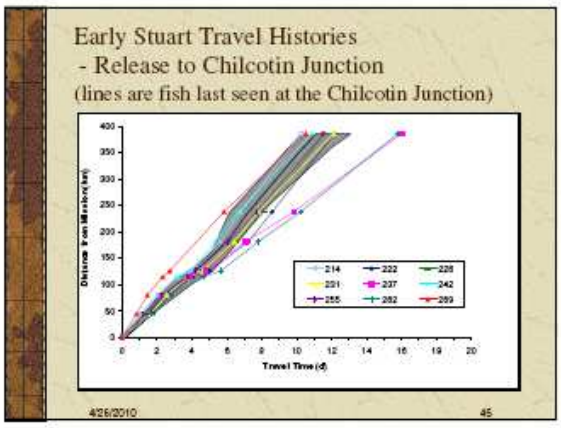

Fate of radio-tagged sockeye & daily harvest rates by Mission passage date 2009
Fishery Removals
Enroute Losses
Spawning Area
Harvest Rate
Radio-tagged sockeye
Daily Harvest Rate
4/26/2010
40

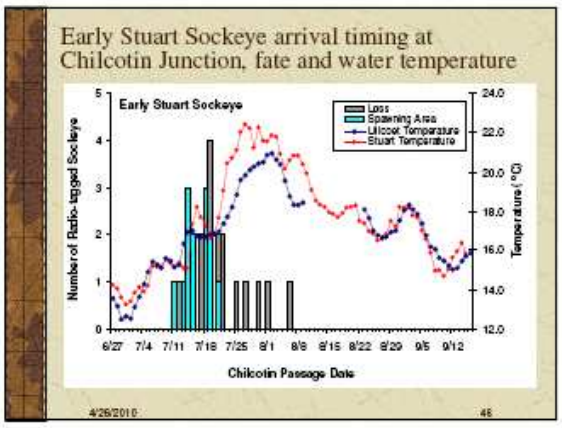

Fate of radio-tagged sockeye & water temperature at Qualark by Mission passage date 2009
Fishery Removals
Enroute Losses
Spawning Area
Water Temperature
Radio-tagged sockeye
Temperature (°C)
4/26/2010
41

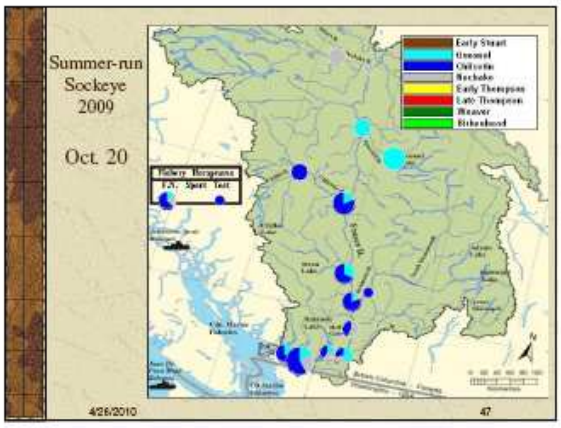

Tagging related losses and water temperature at Qualark by Mission passage date 2009
Lost below Sawmill
Water Temperature
Radio-tagged sockeye
Temperature (°C)
4/26/2010
42

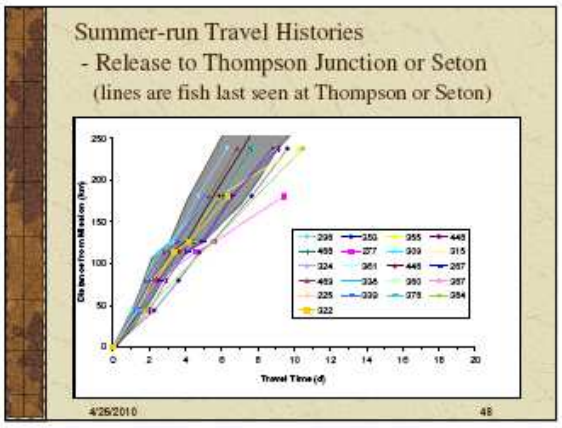

Max. Tagging Related Losses below Sawmill
Early Stuart
Early Summer
Summer
Late
Temp
Estimated Tagging Related Loss (%)
Quesnel River Water Temperature (°C)
6-Jul
13-Jul
20-Jul
27-Jul
3-Aug
10-Aug
17-Aug
24-Aug
31-Aug
7-Sep
14-Sep
4/26/2010
43


Sockeye
2009
Jul 30
Early Stuart
Quesnel
Chilcotin
Bowron
Early Thompson
Late Thompson
Weaver
Birkenhead
4/26/2010
44

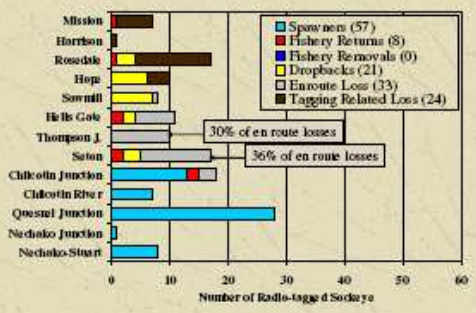

Early Stuart Travel Histories
- Release to Chilcotin Junction
(lines are fish last seen at the Chilcotin Junction)
Travel Time (d)
4/26/2010
45


Early Stuart Sockeye arrival timing at
Chilcotin Junction, fate and water temperature
Early Stuart Sockeye
Loss
Spawning Area
Lillooet Temperature
Stuart Temperature
Number of Radio-tagged Sockeye
Temperature (°C)
6/27
7/4
7/11
7/18
7/25
8/1
8/8
8/15
8/22
8/29
9/5
9/12
Chilcotin Passage Date
4/26/2010
46


Summer-run
Sockeye
2009
Oct. 20
Early Stuart
Quesnel
Chilcotin
Bowron
Early Thompson
Late Thompson
Weaver
Birkenhead
4/26/2010
47


Summer-run Travel Histories
- Release to Thompson Junction or Seton
(lines are fish last seen at Thompson or Seton)
Distance from Mission (km)
Travel Time (d)
4/26/2010
48

Final Distribution of 143 Summer-run Sockeye 2009



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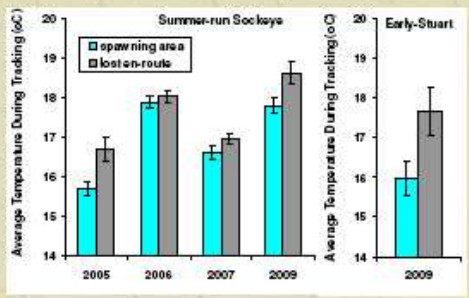
Average Daily Temperature Exposure (Mission-Chilcotin junction)



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Sockeye Run Reconstruction Analysis

- Years: 2002-2007
- Stocks: 5 run-timing groups, 25 CUs
- In-river Fisheries
  - First Nations (21), commercial (2), sport (1)
- Migration Parameters (year-stock specific)
  - run timing from Mission
  - fishery residence times from radio-telemetry
  - en-route losses from radio-telemetry

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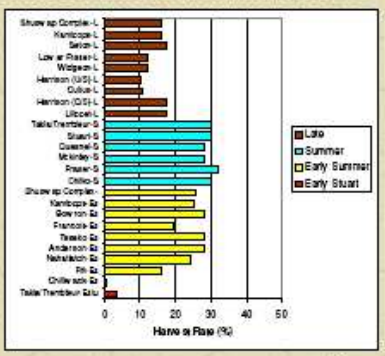
Sample Run Reconstruction Results for 2006

Harvest Rate by CU for Fraser River Fisheries



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Conclusions from 2009

- Fishwheels at the Crescent site
  - caught more fish of all species
  - very high catch rates during the pink migration
  - good sample of near-shore species composition
- Use Whonnock, fishwheel data and spatially stratified Mission hydroacoustic counts.
- Use Qualark hydroacoustic data to verify Mission estimates for sockeye.

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Conclusions from 2009 (continued)

- En-route losses related to higher water temperatures during migration
  - lowest en-route losses in early July and September
  - highest en-route losses during warm period in late July
  - en-route losses – product of significantly higher temperatures and other stresses
  - similar results observed for summer-runs 2005-07
- Integrate all available data into run reconstruction analysis for Fraser sockeye CUs

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Plans for 2010

- Use Crescent Island fishwheels for:
  - daily near-shore species composition
  - weekly DNA and biological samples
  - radio-tagging Early Stuart sockeye
- Use marine purse seines and Lummi reef nets to radio-tag other sockeye timing groups;

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Plans for 2010 (continued)

- Use radio-tagged sockeye to identify the times and locations for en-route losses
- Use additional fixed-station receivers, mobile tracking, and catch sampling data to assess reasons for en-route losses at key locations;
- continue work with First Nations, DFO, PSC and universities on sockeye run reconstruction analyses

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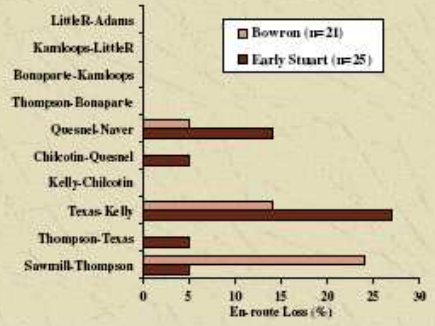
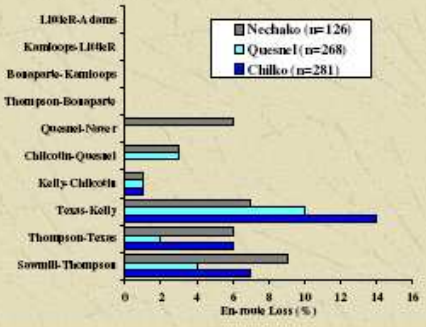
Average distribution of en-route losses

-Early Stuart (2006-07), Bowron (2002,03,05,06)



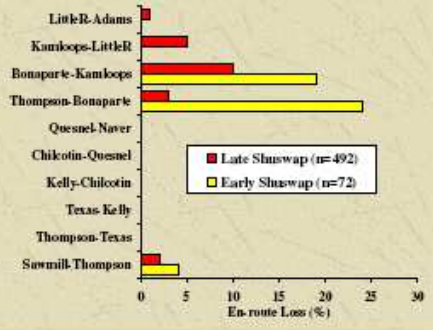
Average distribution of en-route losses

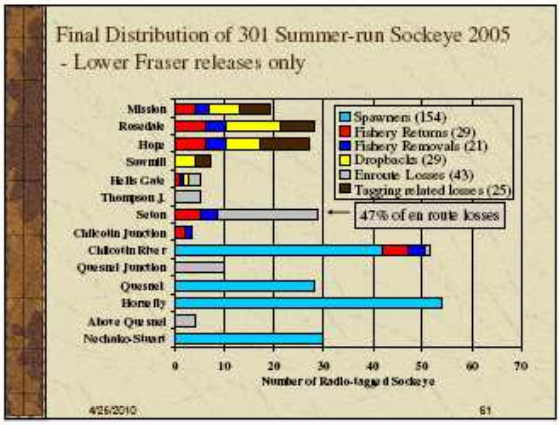
-Summer-run stocks based on 2002-07 data

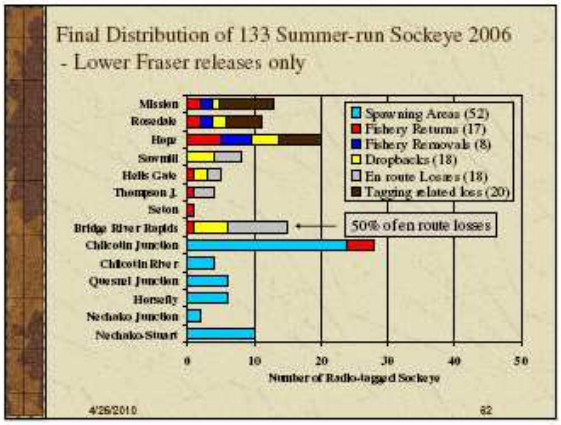


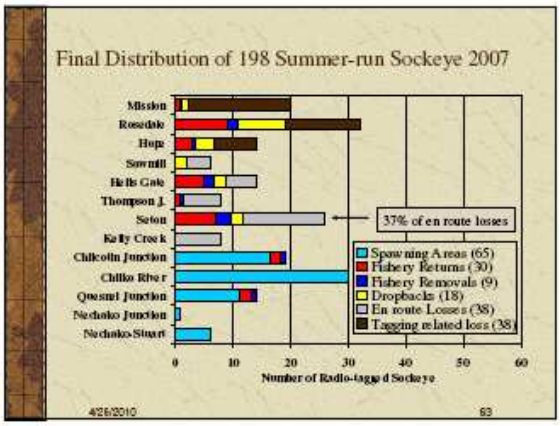
Average distribution of en-route losses

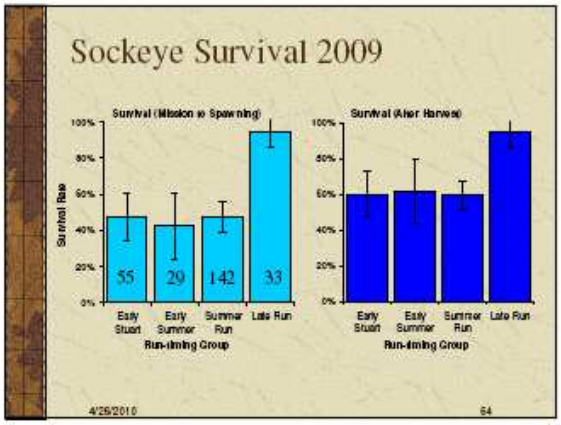
- Early & Late Shuswap stocks based on 2002,03,06 data




Final Distribution of 301 Summer-run Sockeye 2005
- Lower Fraser releases only
Mission
Rosedale
Hope
Sawmill
Hells Gate
Thompson J.
Seton
Chilcotin Junction
Chilcotin River
Quesnel Junction
Quesnel
Horsefly
Above Quesnel
Nechako-Stuart
Spawners (154)
Fishery Returns (29)
Fishery Removals (21)
Dropbacks (29)
Enroute Losses (43)
Tagging related losses (25)
47% of en route losses
0
10
20
30
40
50
60
70
Number of Radio-tagged Sockeye
4/26/2010
61


Final Distribution of 133 Summer-run Sockeye 2006
- Lower Fraser releases only
Mission
Rosedale
Hope
Sawmill
Hells Gate
Thompson J.
Seton
Bridge River Rapids
Chilcotin Junction
Chilcotin River
Quesnel Junction
Horsefly
Nechako Junction
Nechako-Stuart
Spawning Areas (52)
Fishery Returns (17)
Fishery Removals (8)
Dropbacks (18)
En route Losses (18)
Tagging related loss (20)
50% of en route losses
0
10
20
30
40
50
Number of Radio-tagged Sockeye
4/26/2010
62


Final Distribution of 198 Summer-run Sockeye 2007
Mission
Rosedale
Hope
Sawmill
Hells Gate
Thompson J.
Seton
Kelly Creek
Chilcotin Junction
Chilko River
Quesnel Junction
Nechako Junction
Nechako-Stuart
37% of en route losses
Spawning Areas (65)
Fishery Returns (30)
Fishery Removals (9)
Dropbacks (18)
En route Losses (38)
Tagging related loss (38)
0
10
20
30
40
50
60
Number of Radio-tagged Sockeye
4/26/2010
63


Sockeye Survival 2009
Survival (Mission to Spawning)
Survival (After Harvest)
Survival Rate
100%
80%
60%
40%
20%
0%
55
29
142
33
Early Stuart
Early Summer
Summer Run
Late Run
Run-timing Group
4/26/2010
64

In-river Fraser sockeye simulator: Overview and data inputs (Aaron Springford, Simon Fraser University)

Simon Fraser University
Fisheries Research
Resource & Environmental Management

In-river Fraser sockeye simulator

Overview and data inputs

Aaron Springford
Sean Cox
Cam Noble
Brett Zuehlke
contact: aspringf@sfu.ca

Project goals (April 2007 workshop)

- Management based on Conservation Units (CUs)
  - Wild salmon policy
- Evaluate ability to meet new in-river fisheries obligations
  - Treaty process
- Examine tradeoffs
  - Between fisheries, escapement goals
- Examine effects of uncertainties
  - Run size and timing
  - Migration rates, en-route mortality

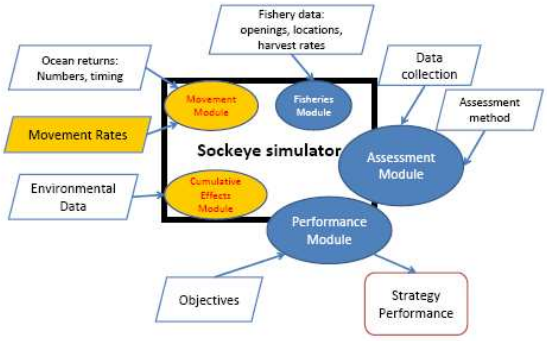
Project approach (April 2007 workshop)

- A simulation model capable of evaluating:
  - broad fishery management strategies
    - e.g. effort vs. quota limitation
  - how specific uncertainties may affect the performance of these strategies
    - e.g. migration patterns, measurement errors, en-route mortality, …

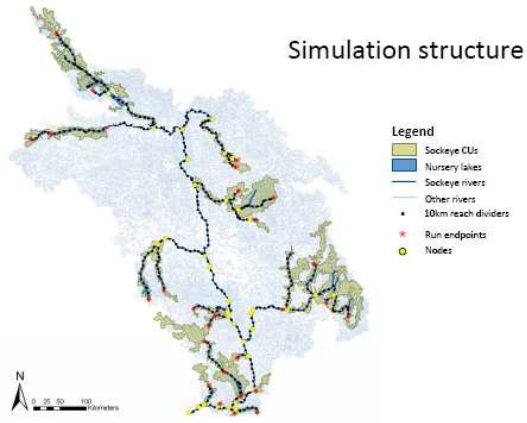
Why simulation?

- In-river Fraser sockeye fisheries are complex
  - Management is challenging
- Current system is uncertain, and may change in the future
  - Environment
  - Biology
  - Management strategy
- Real-world management testing is expensive
  - Time to results, value of fishery
  - Simulations are inexpensive

Simulation structure



Simulation structure

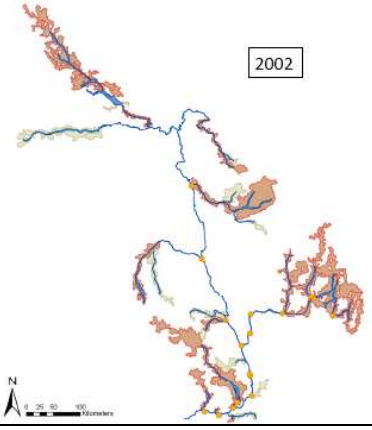


Current simulation inputs

- Ocean returns: Numbers, timing → From LGL run reconstruction
- Movement Rates → From LGL data interpretation
- Environmental Data → From DFO temperature loggers
- Fishery data: openings, locations, harvest rates → From LGL run reconstruction

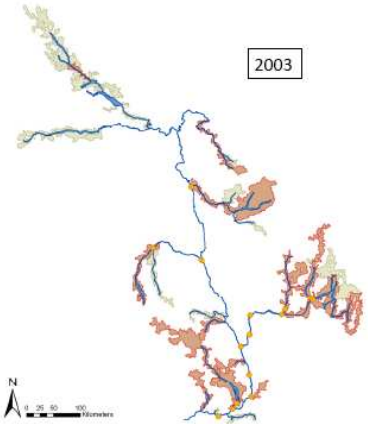
Data analysis challenges

2002



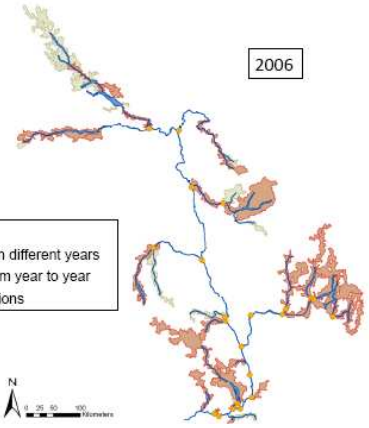
Data analysis challenges

2003



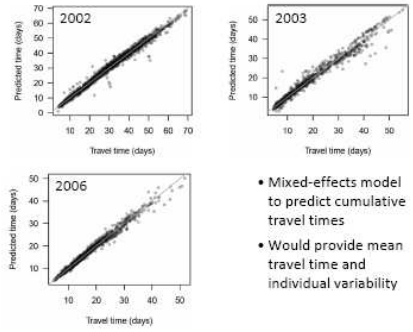
Data analysis challenges

2006



- Not all CUs have data
- Different CUs have data in different years
- Receiver stations vary from year to year
- Missing detections at stations

Analysis of tagging data



- Mixed-effects model to predict cumulative travel times
- Would provide mean travel time and individual variability

Analysis of tagging data

- Fits looked hopeful
- Not adequate to use in simulation
  - Imbalanced data
  - Lack of coverage

  } Poor estimates for some CU/reach combinations
- We currently use LGL's mean travel times
  - Fishery-scale
  - Variability?
- Analysis would benefit from more balanced design in space and time

Increasing the sustainability of multi-sector Pacific salmon fisheries in coastal rivers in British Columbia by quantifying and reducing mortality of released fish (Scott Hinch, University of British Columbia)

Increasing the Sustainability of Multi-Sector Pacific Salmon Fisheries in Coastal Rivers of British Columbia by Quantifying and Reducing Mortality of Released Fish

2009-2011

Steven Cooke - Carleton
Tony Farrell - UBC
Scott Hinch - UBC
Bill Willmore - Carleton
Murray Rudd - Memorial
(now Univ. York in UK)

NSERC Strategic Grant Supplemental Program
Targeted towards Capture Fisheries and Aquaculture

Partners

DFO Resource Management
- Timber Whitehouse, Marla Maxwell
Joe Tadey, Barry Rosenberger, Diana Trager, Deb Sneddon

Fisheries and Oceans Canada

Pacific Salmon Commission
Chehalis First Nation
Area E Gillnetters Association
Trout Unlimited
Watershed Watch Salmon Society

Trout Unlimited Canada

Watershed Watch Salmon Society

Release Mortality

Fish are released for a variety of reasons…

- Management response - catch was prohibited species or gear
- Conservation ethic (catch-and-release)
- High grading
- Quotas/limits reached
- Fish can also escape from fishing gear

Fate of released fish

- Releasing fish is predicated on the assumption that the true release mortality is known and at a sustainable level
- However, little information on the fate of released Pacific salmon in freshwater fisheries
- Some unknown proportion of released fish die as a result of interaction with fishing gear even though they were released (<1% to >90%)

Objectives of the Strategic Grant (2009-2011)

1. To provide information to fisheries managers and fishers on mortality of freshwater migrating adult Pacific salmon after capture using different fishing gears and practices
2. To identify and test potential strategies for improving recovery of fish released from different fishing gears in order to recommend potential best practices for minimizing delayed mortality
3. To determine perceptions of potential threats or benefits that our results may have on the different fishing sectors to refine the delivery and implementation of management actions and educational initiatives

Objective 1. Quantify mortality and the factors that contribute to mortality

Graham Raby (MSc student)

Validation of reflex impairments (on all fish) to develop rapid and simple predictors of mortality potential for use by fishers

Objective 1. Quantify mortality and the factors that contribute to mortality

Mike Donaldson (PhD student)

Development of stress and recovery profiles for pink, coho, sockeye, chum and chinook salmon (Weaver Creek and Chehalis Hatchery)

Objective 1. Quantify mortality and the factors that contribute to mortality

Mike Donaldson (PhD student)
Marika Gale (MSc student)

Evaluating the condition, behaviour and post-release survival of sockeye after exposure to experimental fishing **simulations**

Objective 1. Quantify mortality and the factors that contribute to mortality

Graham Raby (MSc student)

Evaluating the condition, behaviour and post-release survival of endangered interior Fraser coho captured incidentally in pink beach seine fishery (DFO and LGL)

Objective 1. Quantify mortality and the factors that contribute to mortality

Mike Donaldson (PhD student)

Evaluating the condition, behaviour and post-release survival of sockeye salmon captured as part of the J.O. Thomas angling study (J.O. Thomas, DFO, PSF, LGL)

Objective 2. Evaluate strategies for reducing mortality and facilitating recovery

Mike Donaldson (PhD student)

Comparison of the performance of different "fisher-friendly" (inexpensive, simple to carry) recovery bags or recovery approaches

Objective 3. Human dimensions evaluation

Vivian Nguyen (MSc student)

- Identify the barriers that would for fishers adopting different handling, release, or recovery strategies and tradeoffs that they would be willing to make
- Would benefit targeted education and awareness campaigns to promote conservation-oriented behaviour

- **Field interviews**
- **Surveys**
- **Intended to complement biological studies**

Plans for 2010

- Recently met with DFO management to help target research
- Continue the partnership with J.O. Thomas Study and LGL Study (will provide 200-300 tags)
- Companion tagging study at a 'lower' tagging site (200-300 tags) – compare beach seine / drift gill between sites
- Continue examination of coho beach seine by-catch (FN chum fishery)
- Initiation of human dimension studies
- 2011 opportunities exist...

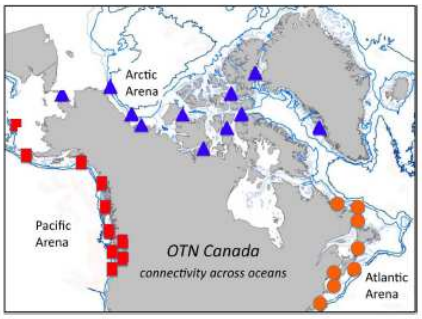
OCEAN TRACKING NETWORK

OTN - Headquartered at Dalhousie University, 2010-2017

- Canadian-led global research consortium
- multi-disciplinary, multi-national research program
- large-scale monitoring system using Canadian archival tag and acoustic curtain technology implemented across five oceans and seven continents
- core focus is on North America (Canada, USA, Mexico, Greenland, Cuba) with partnerships in place for key demonstration curtains on all continents
- provides large-scale arrays at areas of particular biological and physical interest

NSERC Strategic Network

29 Primary Investigators (Academia and DFO)



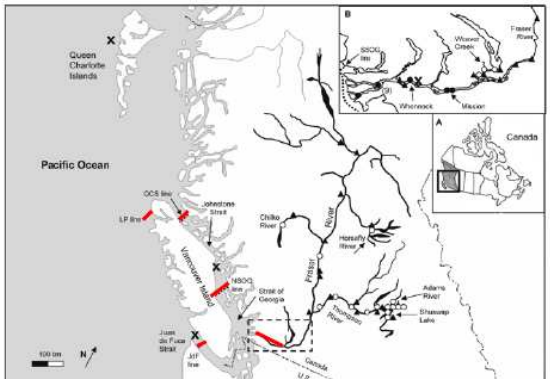
Canada Ocean Tracking Network – Pacific Arena

UBC - Scott Hinch, Tony Farrell
Carleton – Steve Cooke
UNBC – Mark Shrimpton

DFO – Dave Patterson, Rick Thomson, Kristi Miller, John Ford
PSC – Mike Lapointe

PSF – Brian Riddell
Kintama – Dave Welch

POST acoustic lines (—) ○▲= previous location of UBC or partner receivers
X = fish capture locales



Study animals and systems for Pacific OTN research

- research focused on anadromous Pacific salmon (*Oncorhynchus spp.*), their physical and biological environments, and their management
- a key focus is on salmon which originate in southern BC, and primarily on those from or interacting with the Fraser River, as this is Canada's most productive salmon system, and home of a multi-sector, multi-species fishery

Research Approaches:

- Use of interdisciplinary and experimental biological approaches in testing hypotheses about fish behaviour and associations between behaviour, survival and physical environments using telemetry as the core tool
- All questions and hypothesis tests should have application to fisheries management in some way

Objectives:

- Test hypotheses that could account for high juvenile mortality patterns including starvation, predation, parasites and physiological stress.
- Test hypotheses to explain high mortality patterns in some species and stocks of adults including oceanographic conditions, disease, physiological stress, advanced senescence, altered homing cues, marine mammals.
- Test hypotheses about adult salmon migration rates, routes and survival after capture and release from ocean fisheries in relation to organismal physiology, oceanographic conditions and fishing 'stressors.

Plans for 2010

• Chilko sockeye out-migrating tracking study (200 tags)

• adult Fraser sockeye ocean tagging with links to coastal oceanography and physiology (400 tags)

  • will collaborate and share tagging platforms and approaches with Karl

Appendix D – Workshop minutes

Pacific Salmon Foundation – Count on Salmon Workshop

April 20th, 2010

Session	Presenter	Comments
Introduction and Overview	Karl English -	
	• Rationale: - working in the 3 and 4 region (slide 4)	
	• 3 goals: 1) improve reliability of in season abundance estimates (multiple species); 2) identify on route losses (time and place); 3) assess impact of environment	
	• Objectives have changes slightly from year to year.	
	• Fish wheels on Mission CP rail bridge (3 sites, was a 4th one year)	
	• 2007/2008 – insufficient catch off the CP bridge so added another site for 2008/2009 (8 km below Mission)	
	• Pinks migrate at same time as sockeye in every 2nd year, and get lots of chinook Jacks at same time – made switching focus to species composition logical (2009)	
	• As season moves along (August) catch fewer fish (sockeye) in fish wheel because fish are moving offshore (don't overlap with where fish wheels are)	
	• In 2009 had tonnes of pinks coming through and couldn't run the wheels more than 5-6 hours per day	
	• When use fish wheel for near shore composition and Whonnock species composition you get a pretty good fit (don't get this if only use one or the other. With Whonnock get over estimate	
	• Sockeye at Mission: combined species composition get pretty good fit	
	• Don't have other species composition estimates to compare the combined to for pink and chinook	
	• For acoustic – putting in more receivers for 2010	
	o Provides migration rates – slower migration rates for late run than early ones (fastest to slowest: early stuart, summer, late summer/fall)	
	• Radio Tag – timing of fishery dictates whether you get these tags returned,	
	o In 2009, when had fishery going, escapement was zero, particularly when take into account in-river mortality	
	• In 2009, mid summer tagging mortality was between 50 and 60% - aggravated by high temperature	
	• In Thompson and Seton see high en-route losses of sockeye (30% or more)	
	• Temperature isn't the only factor at play in en-route mortality. There are also fishing pressures etc. (slide 50 – fish are making it through in 2008 and 2009 at higher temperatures than back in 2007 and 2006)	
	• Run reconstruction – can see harvest rates by CU (work Aaron is doing with Sean)	
	• Plan for 2010 – daily near shore species composition; weekly DNA and bio samples; radio tagging of Early Stuart; move to marine tagging; add some radio tags; used additional receivers, mobile tracking, and catch sampling data to assess en-route; continue collaborations	

Session	Presenter	Comments
		Marc and Mike – How data are used in-season management • Think there is room for improvement in in-river science and that it is worthwhile • Four major components of count on salmon provide good information • FN involvement is critical – without broad support this effort will fail • A lot of issues in-river are not driven by lack of science but the politics around "missing fish" As a result: • Science needs to be very defensible, therefore science cannot be exacerbates the politics (e.g., overestimates feed into the idea of missing fish) • Science needs to be transparent and provide information; at the same time because we are still learning and can't jump to conclusions • We need to support and believe the science – don't use it for finger pointing • Don't expect too much from the science but at the same time can't decrease support of it. Recommendations • Need to tag in the marine environment. If tagging in river has greater mortality than you are overestimating the mortality and feeding the finger pointing in-river • Marine costs more, but has huge advantages • Tail beat can be used for species composition (Marc S.) • Catch monitoring – need to strengthen it. With tagging still using harvest rates based on catch estimates at Mission. • Support Qualark because helps provide feedback – don't have to wait three months till get the spawning ground counts • Where do we go from here – how do we secure long term funding? Do we operationalise Qualark? How do we manage these species in real time(Marc) Concerns: • Still concerned about size selectivity of the fish wheel. If we are going to lean on this as a sampling platform we need to ensure that it is random • Need a stratified random approach to sampling for species composition • Not convinced the fish wheel is the best way because of size selectivity • Fish wheel has advantages (doesn't kill fish, samples 24 hours), but from a science perspective it has a draw back • Need to find the best tool to meet the objective, and not find objectives to fit the tool. • Who's really in charge? What is the governance for the effort and what does the model look like? (Marc) Need to continue with collaborative model because this is key for success.
Clarification questions		Brian – what did we see around mortality in freshwater vs marine in 2006, i.e., what is evidence for moving to marine tagging? Karl – moved to FW because we were loosing so many in the marine. But in we are going to go back to marine because the losses in the lower river (mission to sawmill) are mostly associated with tagging. Marine tagged fish in the lower part of the river had much higher survival. Temperature stress in the lower part is exacerbates tagging stress

Session	Presenter	Comments
		Scott – Post doc confirmed that tagging in-river led to more mortality than tagging in the ocean (15-25% survival temperature between 15 and 20 degrees C, above 20 the survival just drops Brian – don't want mortality in-river confounded by the tagging, i.e., don't want to handle them in-river Karl – first year of in-river tagging was in 2005 and it worked really well because migration was really late and river temp was low, in 2006 did both and this is the year we can compare the mortality, Timber – science form perspective of supporting and investing some of the issues is very important. The political realm always wants the quick fix and pressures the science. When look across the species, conditions, etc. it is very complex and won't be able to find a single solution that supports all of it. Link physiology to the environment and find signals that are independent of fishing or survival in one stretch of the river. Questions need to be scoped so that they are useful for management
High Level Context (Brian Riddell)		• COS was a research program and wasn't intended to inform management right away • **Perturbed that simulation model is not using the in-river data, need to have more discussions about this** • In 2006, started discussions about the Fraser concept proposal: Six objectives we wanted to address o Missing sockeye? Is it real and what are the explanations? We have the ability to address this. o Issues of species mis-classification at mission and we can improve this o Expectation of increasing number of treaty agreements and not prepared for any in-river management o Concern about climate change – should be prepared to address this o Radio tagging and POST, fish wheels all good tools that are available • COS was designed and meant to address these objectives. • COS has really been a learning process, and each year has changed in response to what we learn. • Having a unified position about what we need to do in the future is the most important thing for moving forward and securing funding. •
Migratory physiology studies (Scott Hinch)		• Highly collaborative research project. Study 1 - Uses radio tags • Release mortality – what is the fate of the fish once they are released. We have no idea what the mortality is? • Objective: what is the mortality? How can we minimise mortality? What are social implications • Reflexology – determining what characteristics help a fish survive post release. • Want to expand to additional sites. Study 2 – uses acoustic tags (just started) • Trying to link biological and physical aspects of oceanography • Want to supplement POST sties • Want to match acoustic with radio so can double the coverage • Focus in on Pacific salmon, and in particular Fraser system • All questions have to have application to management • 2010 plans – look at what is happening to the smolts, etc.

Session	Presenter	Comments
Migration Modelling (Aaron Springford)		• Management based on CUs; need a way to evaluate new in-river fisheries obligations; examine tradeoffs; • Recommendation was to build a simulation model to address the new concerns • What we need for the simulation model – Movement rates which feed into the movement module and cumulative effects module (this is where COS comes in to informing the model) • Current inputs – ocean returns; number….etc. • Data analysis challenges: need movement rates by CU, but because they LGL study wasn't designed to inform the model it is fairly unbalanced design; don't know what the interannual variation is and don't have CU movement rates for all years; some CUs don't have any data; missing detections. • Fits for some CUs look hopeful, but they aren't adequate for simulation. Currently use LGL mean travel time. But have concerns about the variability (not getting it and really need) • Analysis would benefit from more balanced design across both time and space. Karl – reason for imbalance is because in first couple of years of COS we focused on the late run, then in 2005/2006 we looked a summer, and only since 2007 are we trying to focus on all runs. Should be able to get better estimates of variability in years to come
Clarification questions		• Marc – If we did have a joint way forward makes our position that much stronger. Is there any thinking going on simulating the marine environment in the Strait of Georgia? Brian – there is a whole piece in the report that talks to this. Aaron – physically it does, the model starts from where the fish enter the straits. In answer to Brian's questions, we are using LGL's data. Karl – Now they are using the mean; but there is an estimate of variation for each of the means which could be incorporate into the model.
Issues raised by participants		1) COS objectives and applications (green) • Do the objectives address the need for physiological predictors? • Explore tradeoffs • Outline a communications strategy for moving forward and for everyone to rally around • How important is live capture for getting species composition and acoustics? One of the objectives Brian read was live capture. • Do we all agree on the objectives and can we develop some long term objectives that everyone can rally around to form a unified base for research support • What are the most critical inputs to in-season management and which of these does COS provide • Building confidence in program goals and results by bringing in all fisheries. • Will COS continue to be a research driven effort or will it shift to answer applied question? 2) Experimental Design (yellow) • Harvest by CU,

Session	Presenter	Comments

- Getting buy in from stakeholder groups to increase catch monitoring
- Sample representation concerns in the study – dealing with complex systems for a complex species
- Develop comparisons of Mission and Qualark observations that are independent of each other.
- Impact of holding time on fish in the fish wheel? How does this stress the fish?
- Who are the players when it comes to tagging? Do we need a common approach amongst groups? Tagging platforms?
- Agreement around multi-year designs instead of switching from year to year.
- Qualark test fishery? Who is most qualified to interpret the data? Do we need a technical committee to analyse this data and say how it should be used?
-
- How do the tagged fish fare on the spawning grounds? Do they reproduce?
- Precision estimates?
- Future design will be dependent on the future condition of the stocks, not the current condition
- Examine Pete Mulligan's work using tail beats for species composition.
    - What are other methods for species composition?
- What
- Validate the impact of tagging at whatever level we use?
- Marine tagging – should we just use one tag type instead of two tag types
- Need to do more comparisons between COS data and that collected by other test fisheries.
- Are two acoustic sites necessary and can we fund this in the long term?
- What are the indirect consequences of fisheries impacts? Migration corridors
- In-river tagging studies need to have a companion tagging study in the marine environment

3) Opportunities for Collaboration

- Need a committee to lead the hunt for future funds.
-

a) amongst researchers

- Dave Patterson doing a project looking at cumulative effects that may fit nicely with COS
- There is a lot of work in the US that we can leverage
- Who is going to pay for the tagging platforms for marine tagging? We don't have any money to do this. There is one small funder that could be used to leverage other funds.
- Management strategy evaluation to be coupled with the simulation of migration

b) amongst communities

- Mission acoustic site and Sumas FN – agreements in general between collaborators to make sure that the rights are of FN to fish aren't compromised?

Session	Presenter	Comments
		• Non-catch fishing mortality from sorting and drop outs? How do we get a handle on this? (ken Wilson) • Opportunities for technical support by FN • How can up river communities be involved in this (e.g., tag recovery) • Looking for opportunities to use more effective gear so that this program can be self funding. • Need to involve FN in the design not just in implementation • Could involved communities to carry out much more intensive monitoring (e.g., of habitat) 4) Other Issues • Qualark? What is the long-term operational plan for this facility? Future training of people to run the facility • Data center to get people involved? But who manages this and who funds it? • Where is management? Can't do science in a vacuum
Discussion		
COS Objectives and applications		**Unified objective:** • What do we want to define as the objectives for COS. COS was never intended to feed management and the question is should it? • The larger picture of objectives is beyond the scope of COS and current funders would step out of the picture as it moves into the management discussion. • The fundamental objectives have never changed but the methods have. If we want to expand it into a management framework with a communication strategy then it is the logical next step, but it wasn't the initial intention of COS. • Some of the criticisms of COS is that it doesn't address all the management objectives, but it was never intended. Objectives for 2010: 1) Provide in-season estimates of the near-shore composition using fish wheels deployed at the crescent Island site. 2) Provide in-season mark recapture estimates of the number of sockeye passing mission using mark rate samples from Qualark and the number of radio-tagged sockeye detected at the Mission hydroacoustic site 3) Conduct additional focused monitoring of selected key fishing areas to determine to fate for all radio tagged sockeye entering these fisheries. 4) Estimate in-river survival, migration rates, and impact of river fisheries • How does COS in its existing form support management? Project Goals: 1) Improve reliability of in-season abundance estimates for Fraser salmon 2) Indentify the times and locations of en-route losses for Fraser salmon 3) Assess the relative impact of environmental conditions and fisheries on in-river survival for Fraser sockeye

Session	Presenter	Comments

		• How do we know when we got there, i.e., when goals are met? What are the benchmarks we are shooting for? The level of precision on any one of these will determine if you can do the others.
		• Need to know what your management system is going to be if you want to model this?
		• Not enough to just know if you are meeting your management objectives, you also need to evaluate them.
		• To extend COS to the other species, implies that there is in-season management for the other species, but the reality is that there is not.
		  • This is a relevant comment for Goal 1, but not for 2 and 3 given the current system
		  • Chinook is close to be there for in-season management
		• For Goal 3 – change it to include the interaction between them: "Assess the impact of environmental conditions and fisheries on in-river survival for Fraser sockeye"
		• For Goal 1 – it's not just improve because we don't even know how reliable the estimates are. We need to first quantify the reliability of the estimates. It's also not just in-season but it's post-season because spawning escapement is what forecasts are based on.
		  • Can't drop out the other salmon, because you need to look at the interaction. Need to look at sockeye, chinook, and pinks,
		  • Modify goal to be: "Quantify and Improve reliability of in-season abundance estimates for Fraser salmon
		  •
		• What is the level of precision you need to be down to the smallest CU? Do you even need to be down at the level of the smallest CU? You probably won't even get there? Just focus on a couple of key CUs
		• Temporal resolution: daily
		• One of the primary things that COS was supposed to do was to verify Mission

Experimental design		• One thing we've focused on is the number of tags we needed to get a certain level of precision. We couldn't get the desired level of precision using passive tags with current catch rates, for this reason went to the active tags. This informed the current design
		• Goal of COS was never to do the estimation to finest CU scale
		• In 2010, will be able to see whether the loss rate of tagged fish is the same that you would expect from those in the fishery.
		• With Qualark and the tags, we've been able to see that Mission is pretty credible.
		• Are we saying that we want some sort of monitoring in-season design in the Fraser and that COS was supposed to inform what this design?
		  o It wasn't the main purpose, but certainly is a possibility.
		• If didn't have COS, are other sources of information sufficient?
		  o It wasn't that hot in the past which is why started doing COS to see what could be done better. COS is a backup to Mission.
		• Do Mission and Qualark need to be independently cross referenced? Are they both needed?
		  o As an in-season diagnostic it is very useful to have both
		  o If there isn't an independent system above Mission how do you know if something went wrong at Mission?
		  o All of this is (COS) is an attempt to capture the bias and inter-annual variability OR it is a something that will be

Session	Presenter	Comments
		transformational to in-season management. o It isn't the latter. The primary role of COS is to help us do better book keeping so that the number seen at the spawning ground matches what was seen down at mission minus all the in-river mortality. • Selective removal of tags is a problem in the sport fishery • If get more tags back form FN than expect you need to know why. Are they catching more than they should? For this reason you need to have upstream monitoring where you know how many fish went in at A and how many you saw at B. The difference is how many were lost. Need to do a mark rate study to figure out how much removal is from catch and how much from natural mortality. • Species composition: fish wheel has advantages. Gill net is theoretically possible, but hasn't been demonstrated. With the live capture know it is a sustainable test fishery. Decisions for late run are made in August. • Size selectivity, the ocean test fishery catch fish that are just a little bit bigger than those caught in the fish wheel. The fish wheels are sampling where the larger fish are migrating through. o Sampling near shore gives you a better estimate of total salmon, o Mission is pretty good for the lower river, but don't have anything for the river above the canyon. Could use radio tags, acoustic, another hydro acoustic site (e.g., Boston bar). • Marine tagging does not give you a good enough sample to determine species composition? • Stress wise would rather stay away from tangle nets. Probably better to just have one site that you are using to tag (for early stuart in particular) and species composition. Early Stuart not abundant enough to do marine tagging. • The benefit of continuing with in-river is that you can use the last four years of data. You need to have some overlap between the two to not loose the last four years of data. • Tag induced mortality – If using acoustic tags you can measure mortality in the ocean. Hypothesis is that the handling effect is less in the ocean than that in freshwater.
Opportunities for collaboration		• Four themes: 1) communications; 2) governance; 3) science; 4) FN involvement • 1) communication – 2 categories – i) communication for communities in the basin (what is the most effective way) and ii) data and information sharing • 2) science – individual research groups (avoidance, impact, disease)– how do we identify all the potential researchers? Generally well developed within research community except for tapping into the FN science – collaborate on the design and implementation • 3) governance – i) FN – greater opportunity to bring them into the process and ii) broader governance of COS – program continuity. Who sets the objectives; what is long term resourcing? • 4) FN involvement – i) what are the key items we can collaborate on? Tagging? Need to be more creative at looking at the capacity that is there and leveraging it.(this is something that is important to FSWP) ii) Who do we contact? What are the key focal points to set up the collaborative processes? What are the critical priorities for 2010? • Tagging platform for marine? Can we piggy back on an existing platform? Platform = test fishery • Anyone can participate in the steering committee meeting: conference calls, internet

Session	Presenter	Comments
		• Two places where have seen consistent losses are in Thompson and Seton/Bridge River • Need a mark rate estimate study carried out downstream of Qualark • Are there some easy things that we can do to improve communication? Have been trying to get onto the Stolo agenda for quite a while now. • Data is on the PSC website, but there is no interpretation of the data on the site. • FN want to be part of the science. It's not just about the communication? • FN - Receivers in our backyard that we don't know anything about. We could use these for our projects and we have projects that could feed into COS. • Removing the bias – defensible, unbiased representative samples so that eliminate some of the finger pointing. • Engage the press – helps spread the word about what the program is trying to do from a science and social perspective (was successful for the hook and mortality study). • Future funding will be scarce (PSF and PSC funding will be lower). • If we really want to look long term may want to form an organising body. • Straight of Georgia program may be another source of collaboration • Good prospects for buying less expensive gear in the future.

Next steps		1) COS objectives and applications
		• Brian to email the 2005 objectives to Cam
		• See a road map and timeline of where we are trying to go and how goal's will be achieved (need to appoint someone to do this)
		• Create organising committee (Brian Riddell, Terri Tebb, Mike Lapointe, Timber, Andrew Wilson, Cam West, Kristi Miller, Scott Hinch, Dave Patterson, Mike Staley, Sean Cox) – need to get FN on there (Sto:lo, Tsawwassen, Musquem, etc.)
		  • Two types of committees – need a 1) steering committee (high level objectives and funding) – Marc Saunders, Barry Rosenberger, Brian Riddell, Mike Lapointe, FN (? – Murray Ned (STC), Pat Matthews or Saul Terry (Shuswap), Robert Hope (Yale), Mike Jimmy (Sto:lo nation)), and a 2) technical committee (experimental design and implementation.
		  • From Steering group want to get a consensus 2 pager that provides mandate for moving forward. Maybe the technical people should write the first draft and send it to the Steering committee.
		  • For 2010 suggest going back to the 2006 model (Karl), because we have a bigger group that needs to be coordinated this year.
		  • Going to have to change because the funders are going to change
		• To get the word out COS largely dependent on technical people spreading the word to their senior people who then in turn want to get involved.
		• Need to balance size of steering committee with ability to do things.
		• Need to identify future funders and believers in the project and bring them into the steering committee and have them buy in to the vision so that they are willing to provide financial support.
		• Develop cohesive front for the Cohen enquiry.

Session	Presenter	Comments
		• The overall vision is for COS is still missing – how does it all fit together to support management. • More consultation to make objectives relevant to a larger audience. 2) Experimental Design 3) Opportunities for Collaboration a) amongst researchers b) amongst communities What happens now? • Are going to have to go back to Core funders to see if there are opportunities to modify and/or add to the program? • Get back to the participants with any resulting actions. • See if FSWP can use the legacy communication fund to see how COS communication can be improved.

Appendix E – Research collaborations with COS

Evaluating in-season management strategies for Fraser River sockeye salmon fisheries

School of Resource and Environmental Management, Simon Fraser University

The long-term objective of this project is to develop a simulation model of the Fraser River sockeye salmon management system that can be used to evaluate different approaches for in-season assessment and allocation of harvest given realistic levels of uncertainty in biology (e.g., sockeye run timing, migration rates, natural mortality during migration) and fishery dynamics. Full background details, objectives, approaches, and stakeholder inputs are described in the working paper by Cox and Holt (2007)15.

A key requirement for management strategy evaluation is a simulation modelling framework capable of representing a range of realistic scenarios of Fraser River sockeye migration, survival, and fishery processes. Development of the operating model structure is closely tied to the ultimate intended use, which is to evaluate the alternative in-season stock assessment and fishery management approaches identified in Cox and Holt (2007) (e.g., area-time openings, transferable quotas, transferable effort, etc.). Therefore, the model must be able to track abundance (and physiological state) and catch of individual sockeye stocks from ocean areas to spawning grounds. Furthermore, the model must include capability to simulate potential fisheries (e.g., test, FSC, commercial, etc.) along similar paths.

Our working model (written using open-source **R** software, http://www.r-project.org/ , and C) simulates migration dynamics of 30+ sockeye stocks over 12 h discrete time intervals and 10 km migration track sections ranging from Johnstone and Juan de Fuca Straits to individual spawning grounds (total migration track length is stock-specific). The model can use stock-specific rates of sockeye movement and survival as functions of their current environment (e.g., stock, river location, flow, temperature, etc.), and of cumulative effects of environments they've migrated through (e.g., accounting for accumulated temperature and physical stress), provided such information is available. Representing such a high level of complexity, while minimizing the computational burden has been our primary technical challenge. For example, in order to simulate cumulative effects, we have developed a hybrid area/individual-based formulation that simultaneously tracks a small number of individual fish in addition to total stock numbers by area. This allows us to apply cumulative effects based on individual exposures.

Stock-specific migration and survival information is needed to inform the simulation, as are stock-specific responses to physical stress. Attempts to parameterize the model using raw tagging data have been hindered by lack of contrast due to yearly changes in survey design – our current parameterization relies on LGL's interpretation of the tagging data.

Currently, we are using the simulation model to test run reconstruction methods, as these methods form the basis of in-river management strategies. We will also be using the software to explore key management uncertainties soon. Application of the software is inherently time consuming and situation-specific. Thus, we are hoping to train other qualified researchers in the use of the software to increase its value as a management tool.

[5] Cox and Holt (2007) "A conceptual model for evaluating in-season management strategies for Fraser River sockeye salmon fisheries" is available upon request.

Increasing the sustainability of multi-sector Pacific salmon fisheries in coastal rivers of British Columbia by quantifying and reducing mortality of released fish

NSERC Strategic Grant – Special Fisheries Competition (2009-2012).

Project Summary: Abundant and sustainable Pacific salmon (*Oncorhynchus* spp.) stocks are important economically, ecologically, culturally and politically to Canada. These six species of Pacific salmon (i.e, coho, chinook, sockeye, pink, chum and steelhead) represent some of Canada's last remaining large fisheries on wild fish. New federal fisheries policy and management strategies have shifted large amounts of salmon harvesting from marine to coastal river locations where First Nations, recreational, and commercial fisheries all occur. Despite the use of different gear (e.g. gillnets, beach seines, angling), all sectors involved in freshwater Pacific salmon fisheries will capture non-targeted or non-desirable fish. Being able to release these fish and ensure their survivability is paramount to achieve harvest allocations, stock conservation, and the sustainability of these fisheries. Using lower Fraser River fisheries as the model, we propose studies to: 1) quantify sub-lethal disturbances (injury, stress, reflex impairments) in salmon caught by different fishing gear; 2) assess mortality rates of different species relative to gear type; and 3) identify and test potential strategies for improving recovery of fish released from different gear. Specifically, we will evaluate the use of a flow-through box, in-river holding pen, and soft-mesh sack to facilitate recovery of fish by coupling physiological approaches with field-based telemetry studies. Another goal of our research is to provide fishers with tools for assessing fish condition easily and reliably. We will do so by validating and refining the use of reflex impairment indicators (e.g., loss of equilibrium, loss of gag response) as predictors of mortality. Such information would help fishers to decide when to release and when to hold onto fish for recovery, and would also enable them to revise their fishing behaviour in real time to reduce mortality rates. Because all resource management issues must include a thorough understanding and management of human (i.e. fisher) behaviour and fisher-fish interactions, we will also study the factors that would influence fisher adoption and use of different recovery tools and the tradeoffs that they would be willing to make with respect to different legislated or voluntary actions. The current management process does not have and therefore cannot use scientifically defensible estimates for post-release mortality for different species caught in the multi-sector fisheries. This situation has created acrimonious relationships among the users groups with each group being suspicious of the incidental harm or mortality being inflicted by the other fishing groups. Collectively, the proposed research will provide information to management agencies to reduce uncertainty in current management approaches and provide fishers with increased fishing opportunities and associated harvest. Although the work will be restricted to the lower Fraser River, the findings will apply to other coastal river fisheries for Pacific salmon across BC and indeed throughout the Pacific northwest.

Progress to Date: Our team has been working on Pacific salmon migration with a focus on sockeye salmon for the past ten years. From 2005 to 2009 with support from NSERC we have been evaluating the effects of climate change (warming river temperatures) on adult sockeye. In addition, we have examined the interacting effects of climate change and fisheries stressors using a combination of field and laboratory assessments. This work on climate change and fisheries interactions has transitioned into the new program of work described above. In 2009 we worked with the Chehalis Band to experimentally study different fisheries stressors on sockeye physiology, behaviour and mortality in the Harrison system. We also worked with the "Fraser Hooking Mortality Study" where we applied radio tags to study the behaviour and survival of sockeye released following capture via rod and reel or beach seine. We also worked

with several FN groups to radio tag endangered interior coho salmon that were captured as part of the pink salmon fish.

Proposed Research for 2010: Our team will be radio tagging appox. 600 fish in 2010 as part of the NSERC discard mortality study. Our research efforts will like focus on sockeye and coho. We will continue to participate in the FSWP-funded J.O. Thomas study to quantify the hooking mortality of sockeye. 2010 presents a unique opportunity to use ocean-tagged fish (by the LGL team) as controls for fish tagged in river which will generate a robust and defensible in-river mortality estimate for recreational fishing. In addition, we will compare several techniques that may facilitate recovery. An additional component that we will add in 2010 is to apply tags to sockeye using the same gear type at several locations in the lower Fraser ranging from river entry to approx 120 km upstream of river entry. It is likely that these fish will be beach seined and then exposed to experimental stressors (low and high) and injury (low and high) to tease determine how capture location mediates mortality arising from stress and injury. The final telemetry project for 2010 will be focused on coho salmon incidentally captured in the FN chum salmon beach seine fishery. This project is in the preliminary planning phases and we are about to begin consultation with the FN community.

NSERC-Funded Team: Steven Cooke, Carleton Univ.; Scott Hinch, UBC; Tony Farrell, UBC; Murray Rudd, Memorial Univ.; Bill Willmore, Carleton Univ.; David Patterson, DFO Fraser E-Watch and Michael Davis, US NOAA

Primary Partner: DFO Resource Management

Secondary Partners: Trout Unlimited, Area E Gillnetters, Fraser Watershed Watch Salmon Society, Chehalis Indian Band, Pacific Salmon Commission

Collaborators: Jim Thomas (J.O. Thomas and Associates), Karl English (LGL Ltd.), Pacific Salmon Foundation

Funding: NSERC, DFO, PSF, Canadian Wildlife Federation

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Appendix F – Steering and technical committee suggestions

Table 4 Suggestions for steering committee

Name	Affiliation
Marc Saunders	DFO
Barry Rosenberger	DFO
Al Cass	DFO
Mike Lapointe	PSC
Brian Riddell	PSC
Rick Hansen (or someone else)	PSEFC
Murray Ned	Sto:lo Tribal Council
Robert Hope	Yale FN
Pat Matthews (or Saul Terry)	Shuswap FN
Mike Jimmy	Sto:lo FN

Table 5 Suggested organisations that should be on a COS technical committee

Organisations
PSC
PSF
DFO
SFU
UBE
LGL
Matsqui FN
Sumas FN
Sto:lo FN
Nicolo FN
Shushwap FN