

Concept description, A revised Fraser River stock assessment program

A number of issues (some recurring concerns) have caused me to consider a major revision to run-size estimation and stock assessment within the Fraser River. The major issues considered include:

- Recurrences of the "missing sockeye" debate with the related accusations of non-reported catches, blame pointed at the First Nations, and the resulting loss of confidence in the PSC's Mission hydro acoustic program.
- Enumeration errors associated with species mis-identification at Mission and the inability to correct for the error using the in-river test fisheries (inability to randomly sample the return).
- Expectations of a need to deliver specific allocations of salmon to First Nations either due to economic opportunities and/or newly developed FN agreements; and their continued requests to become more involved in an integrated stock assessment program (particularly using fish wheels for harvest/sampling).
- Increasing concern for the impact of climate change on Fraser River conditions and impact that this could have on all salmon species returning to the Fraser.
- Recent positive experiences with radio tagging and the quality of data collected on in-river mortalities and the demonstrated ability to track tagged sockeye through the Fraser drainage; and
- recent interest in re-establishing the Qualark enumeration site under the assumption that we can use that site to verify/calibrate the Mission estimates.

The majority of our recent efforts to improve stock assessment efficiency and accuracy in the Fraser River have focused on changes to escapement enumeration programs, but the majority of our management and science issues are actually in the lower river and canyon. Very few of the advancements made in our current stock assessment programs¹ will address the most serious issues in the list above. However, I would suggest that the current cultural and environmental conditions are "ripe" for consideration of significant change to directly confront these issues and improve the future.

The proposed changes would include:

- 1) Development of a live-capture fishing system in the lower Fraser (must be below Mission) to provide fish for tagging and random sampling; including all species. Initially one or two large fish wheels would be developed to provide "proof of principle" without major construction tasks. The wheels may operate all year.
- 2) Application of radio-tags at the lower river site and installation of shore-based fixed receivers to monitor tags as they pass. Most receivers used recently in the Fraser are not the property of DFO and capital investment would be required.
- 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 (recommend a reward per tag).

¹ DNA technology will continue to provide useful information on population of origin and genomics

- 4) Re-establish the Qualark enumeration site (on both sides of the river) to provide in-river counts of passing salmon and install directional radio receivers in the water to detect tags during the passage of salmon. Didson hydro acoustic equipment would be recommended for both sites and would require site preparation to account for the change in river cross-section during the season.
- 5) Integrate the radio-tagging program with the escapement monitoring programs to maximize use of information and reduce costs of spawner enumerations. This latter point needs further consideration but should certainly provide 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.

Why could this be implemented now?

- the use of fish wheels has been extensively tested in other rivers and can be adapted to the lower Fraser (probably with leads to direct fish into the wheel). This will provide a constant sampling portion to sample and allow application of random sampling protocols, availability to fish for tagging, and protection from seals. Fish wheels and automated counting systems could be jointly developed so that the wheels operate 24 hours a day and enumerate fish without handling.
- The cost of radio-tags is declining and with advanced purchasing of large numbers of tags, their unit cost could be substantially reduced.
- Shore-based digital receivers can now be downloaded remotely so that real-time data can be maintained without visiting each receiver and for immediate use for in-season management (increased costs associated with remote downloading).

What are the benefits, presuming it works?

- This system would be the first fully integrated assessment program in the Fraser River. The system would be similar to the Nass River model but on a larger scale. The system would allow for effective and informative participation of First Nations and DFO; particularly with the incentive of First Nation fisheries being an important recovery tool throughout the Fraser watershed.
- The use of radio-tagging provides direct monitoring of in-river harvest rates, non-fishing mortality rates, and rates of up-stream migration. Theoretically, the issue of missing salmon should be explainable and in particular non-reported catch can be monitored and estimated (locations of loss may also be identified).
- The effect of climate change in the Fraser can be monitored annually and studied in greater detail by use of specialized tags. Direct relationships between river conditions and up-stream passage by stock could be developed.
- The combined information from Qualark, in-river mortality rates, migration rates, and mark-rates in fisheries can be used to estimate the run-size passing Mission site. Initially, this added information could be used to calibrate/correct Mission estimates. (In the future, only one system would need to be operated, and theoretically this new system would be much more informative.)
- While this system was initially considered for sockeye salmon, the fish wheel and tagging system could be applied to any species (initially sockeye only).

Fraser River concept proposal to address

Development of fully integrated assessment frameworks
sockeye first followed by other species. (Who is involved
and what can they do?)

Annual debate about "Missing fish" (in-river
escapement estimation versus in-river mortality
and environmental conditions)

Estimation of in-river harvest rates and sources of
non-catch mortality (estimation of survival rates
during migration)

Reduced costs of spawning escapement
enumeration programs; may also allow for broader
coverage of spawning locations.

Increased potential for research and assessment of
climate impacts (annual monitoring of in-river
mortality and associated environmental condition.

Basics of Mark and Recapture estimation

To be estimated, unknown at
time of marking

N

Number of fish sampled
(marked and unmarked) to
recover R tags

n

M

R

Number of marks applied

Number of marks
Recovered

Basics of Mark and Recapture estimation

To estimate the population size, re-arrange the known values

N

$=$

$\frac{M n}{R}$

Statistical design elements

N can be indexed by time periods, marking locations, and stocks (DNA analysis)

Each index increased the marking numbers to maintain precision/accuracy

Inverse sampling to recovery a target of 'x' tags in a sampling strata.

Fraser sockeye populations:

151 spawning popn.

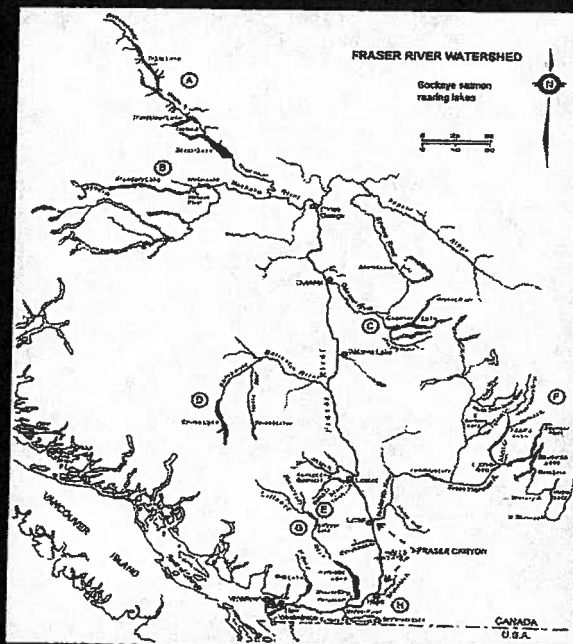
30 PSC production units

4 management run-timing units

~ 40+ CUs (tbd)

Up to 33 annual assessment programs totalling \$1M to \$1.5M in costs!

Recent successes in implementation of Didson enumerations and radio-tagging.

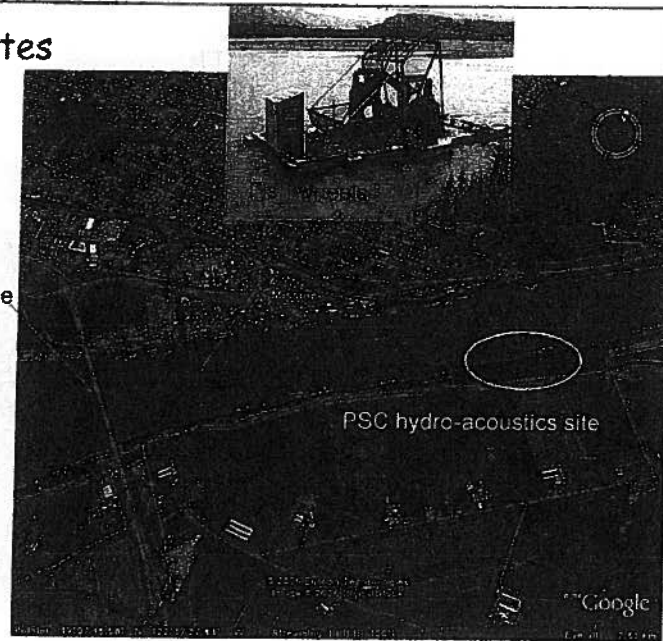


Tagging sites

Mission Bridge

Crescent Island
approx. 10 km
downstream.

PSC hydro-acoustics site



Mission to Qualark

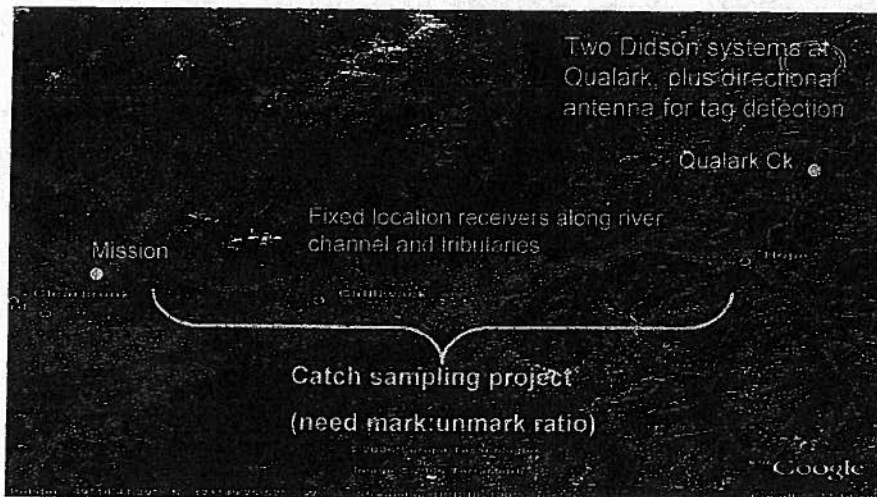
Two Didson systems at
Qualark, plus directional
antenna for tag detection

Qualark Ck

Fixed location receivers along river
channel and tributaries

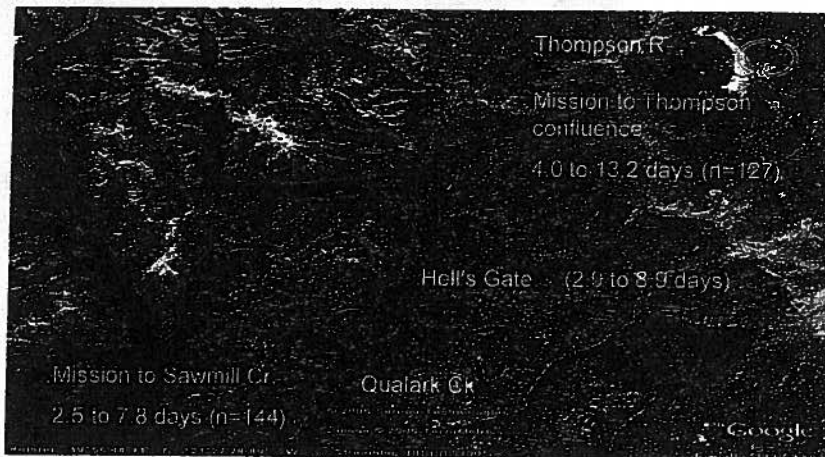
Mission

Catch sampling project
(need mark:unmark ratio)



Qualark –Thompson

2006 radio tagging passage time (range)



Summary of value to DFO:

- Fully integrated assessment program, initially for sockeye
 - Build an in-river migration and management model
 - Need to integrate with ocean tagging and harvest rate estimation
- All sources of mortality can be monitored with estimable accuracy and precision
- Project is now technically feasible and affordable (fine costs depend on partnerships and precision goals)
- Means to directly assess impact of climate change (river flows & temperature) on Fraser R salmon.
- Potential for significant benefits in public accountability in resource management