STEELHEAD MONITORING

Monitoring Group 2 – Project F

Acoustic tracking of hatchery-reared and wild Cheakamus River steelhead smolts to address residualisation and early ocean survival

POST PACIFIC OCEAN SHELF TRACKING PROJECT

Kintama Research Corp.

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Acoustic tracking of hatchery-reared and wild Cheakamus River steelhead smolts to address residualisation and early ocean survival

As part of the overall assessment of steelhead trout supplementation recovery efforts for the Cheakamus River population, we propose a study that will compare the degree of residualisation, the migratory behaviour, and the early marine survival rates between wild smolts and those reared in hatcheries.

This monitor forms part of Monitor 2 of the **Cheakamus River Steelhead Supplementation Assessment (McCubbing et al 2007 in prep).**

Deliverables/Uncertainties Addressed:

Primary

- Evaluate residualism/out migrant mortality rates of wild and hatchery released smolts.
- Comparative study of residualism/out migrant mortality rates for differing rearing groups and release locations.
- Collection of behavioural information of residuals (in river migrations etc)

Secondary

- Early ocean survival data of hatchery (and wild) smolts
- Migration pathway determination

Project Feedback:

Evaluation in year one may amend smolt release strategy in Year 2, if significant differences in residualism/early marine survival are observed between release groups in year 1. This may be undertaken to reduce competitive and predatory behaviour of residuals on other species and/or to maximize survival in the early ocean phase.

Linkage

All Projects in Monitor 2, Smolt Release Strategy Evaluation.
POST, Keogh LGB
BC Hydro Smolt Monitoring Project.

Introduction:
Recent developments in acoustic tagging technology have yielded individually-coded tags small enough to be surgically implanted into juvenile salmonids. By deploying a series of acoustic receivers in rivers and using the Pacific Ocean Shelf Tracking Project (POST) array of receivers on the ocean seabed (Welch et al. 2003), the migration routes and rates of individual fish can be quantified and survival rates of populations crossing lines of receivers can be estimated.

Residualisation is a key issue in determining the overall success of the hatchery-rearing program. It is possible that hatchery-reared juvenile steelhead could differ in their degree of residualisation (where smolts stop migrating downstream and revert to parr) from wild steelhead and between release groups dependent on rearing conditions and release strategies. This could be assessed by using acoustic telemetry in the Cheakamus River to monitor for the presence of tagged steelhead in the 2-3 months following the downstream migration, i.e., to detect individuals that failed to migrate downstream. Acoustic and radio receivers would be placed at several locations in the Cheakamus River, both upstream and downstream from the release site. If residualised fish moved past these receivers, they would likely be detected. This would allow not only an estimate of how many fish residualise, but also in what areas they are located.

Wild steelhead smolts from the Cheakamus River were tagged with acoustic tags in 2004 and 2005. Their migrations downstream and through the Strait of Georgia system were tracked using the POST array (Melnychuk et al. 2007). A high proportion of tagged fish survived the downstream migration (71%, 84%), and after ocean entry fish migrated rapidly through Howe Sound. Most fish proceeded north through Johnstone and Queen Charlotte Straits, while a few went south through the Strait of Juan de Fuca. In both years the survival rate from release to leaving the Strait of Georgia system was 27%. Such measures of early marine survival, migration rates, or migratory routes could be assessed for hatchery-reared smolts using this method. Since the first few weeks of the smolt migration are likely to be the most important period that determines recruitment of salmonids in general, this early ocean comparison could provide great insight into survival and therefore fitness differences between wild and hatchery-reared steelhead.

Methods:
Acoustic telemetry is the preferred method for quantifying survival and migration rates during both the downstream and early ocean migration because (i) tags transmit well through both freshwater and saltwater, (ii) fixed-station receivers are less expensive than radio telemetry receivers, allowing more receivers to be deployed for the same total cost; the relatively lower detection probabilities of a given fixed-station acoustic receiver relative to a radio receiver can be offset simply by deploying more acoustic receivers. Acoustic telemetry will also help to address the degree of residualisation in steelhead. (

In order to assess the success of the hatchery-rearing program, comparisons should be made between hatchery smolts and wild smolts (in a data analysis sense, “treatment” vs. “control” populations). Whichever key issues are to be compared between them (residualisation, survival rates, migration rates), the ideal comparisons will occur in the same year to avoid effects of interannual variation. We aim for these stronger comparisons, although the abundance of wild smolts in 2007 will likely continue to be depressed, so there may not be adequate numbers of wild smolts caught for tagging until 2008. In this event, hatchery-reared fish could still be tagged in 2007 to establish a baseline dataset for this release. The degree of residualisation would be assessed using acoustic telemetry. Also, the migratory and mortality patterns could be compared to wild steelhead smolts from the Cheakamus River which were tagged and tracked in 2004 and 2005 using similar acoustic methods. In 2008, when more wild smolts are likely to be caught (McCubbing et al 2006), fish from both groups could be tagged to allow a direct comparison of wild and hatchery-reared smolts in the same year.

Previous studies with this Cheakamus River steelhead population have shown that a sample size of 50 acoustic tags is adequate for quantifying the migratory patterns and estimating both downstream and early ocean survival rates. Detecting any differences in these measures between wild and hatchery-reared populations will depend on the extent of those differences and the sample size used. A sample size of 50 in each release group (FVTH and TF) as well as wild smolts is probably a minimal but adequate level to be able to detect differences that are biologically meaningful. If the degree of residualisation is considerable (e.g., >20%), a sample size of 50 should also be sufficient to detect with high probability any remaining tags in the 2-3 months following their release. Sampling effort will be intensive and will consist of both fixed-station receivers and manual tracking.

If the abundance of wild smolts in 2007 and 2008 turns out to be sufficiently high to allow fish to be tagged, then we propose sample sizes of 50 fish in each group for each year (total over 2 years, 300 acoustic tags, Table 1). If the abundance of wild smolts is too low in 2007 for tagging, then only hatchery fish would be tagged in 2007 and all groups would be tagged in 2008. Increased tag application rates would then be proposed for wild fish in 2008 (n=100) as only one set of within year comparative data would be collected.

Coded acoustic tags (VEMCO V9-SC) will be programmed to transmit a signal every 30s, on average. This will provide a good balance in the trade-off between detection probability and battery life. With tags pinging on average every 60s in the 2004-2005 studies on wild Cheakamus steelhead smolts, detection rates averaged about 43% on river receivers and >90% on lines of ocean receivers. The in-river detection rates will likely suffice to detect smolts that may residualise over the following 2-3 months after release provided that either they move within the river and pass stationary receivers or are detected with a mobile sampling program. Decreasing the emission interval to 30s will further increase detection probabilities. Even with this 30s interval, battery life will be sufficient to address residualisation for $2\text{-}3^{+}$ months after release and early ocean survival. Steelhead smolts migrated rapidly out of the inshore Strait of Georgia system in 2004 and 2005, with average number of days between release and detection on the receiver line across Queen Charlotte Strait being 26.5 and 23.5 days in 2004 and 2005, respectively (Melnychuk et al. 2007). The last fish was heard at that line 43 (2004) and 28 (2005) days after release, so battery lives of 2-3 months should suffice for quantifying early ocean survival rates even if smolts migrate slower in 2007 or 2008.

Stationary receivers will be placed both upstream and downstream of release sites to monitor for residualisation in the Cheakamus River. A total of 8 stations will be deployed between the confluences at Culliton Creek and Cheekeye River in long, quiet runs or pools to ensure high detection probabilities (Example: Figure 1). Locations of receivers will vary accordingly with release locations, if those differ within or between years. Further, another 6 stationary receivers (previously purchased, and used "in-kind" for this proposed study) will be deployed in the Squamish River and in the Squamish estuary (Figure 2) to detect migrating fish as they leave freshwater in order to differentiate between freshwater and early ocean survival. Fish migrating through Howe Sound or the Strait of Georgia, or leaving the inshore system through either Queen Charlotte Strait or the Strait of Juan de Fuca (Figure 3), will be detected by the POST receiver lines, typically with detection rates of 90-95% (Welch et al. 2003). This will provide the data for estimating early ocean survival rates and comparing these between wild and hatchery-reared steelhead smolts.

Mobile sampling effort on the Cheakamus River will improve the ability to detect residualised fish that do not move much within the river system past stationary receivers (and would thus not be detected). We propose 2 sampling trips by raft each year, at approximately 1 and 2 months after release of smolts to monitor for the presence of residualised fish. Sampling trips will use a mobile receiver with hydrophone lowered into the river, and will run from just downstream of the Culliton Creek confluence to the Cheekeye River confluence.

References

Melnychuk, M.C., Welch, D.W., Walters, C.J. and Christensen, V. 2007. Riverine and early ocean migration and mortality patterns of juvenile steelhead trout (*Oncorhynchus mykiss*) from the Cheakamus River, British Columbia. Hydrobiologia. In press.

Welch, D.W., G.W. Boehlert, and B.R. Ward. 2003. POST–the Pacific Ocean salmon tracking project. Oceanologica Acta, 25: 243-253.

Table 1 Proposed Tagging strategy 2007-2008 for residual monitoring

Table 1.	Tag application Residual Acoustic Tag Study		
	2007	***2008***	***Total***
FVTH upstream release	50	50	100
TH mid river release	50	50	100
Wild option A	50	50	100
Wild option B*	0	100	100
		Total all	300 max

*Option B for wild tagging will be undertaken if Option A is not completed due to low number of steelhead smolts expected in 2007 (i.e. conservation concern over-ride).

Figures

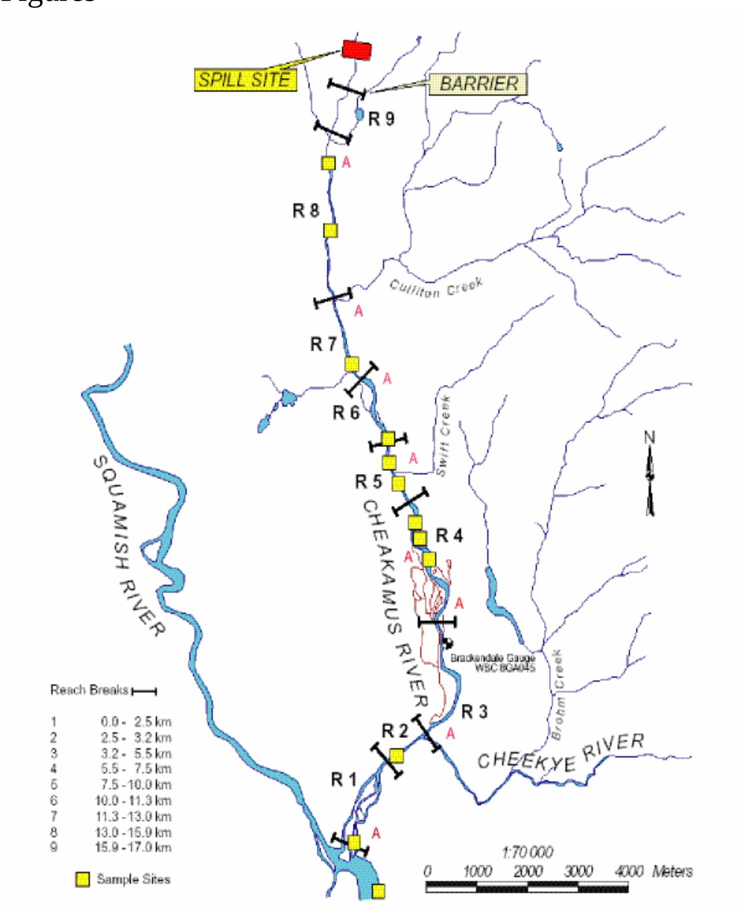

Figure 1. Proposed placement of in River Acoustic receivers

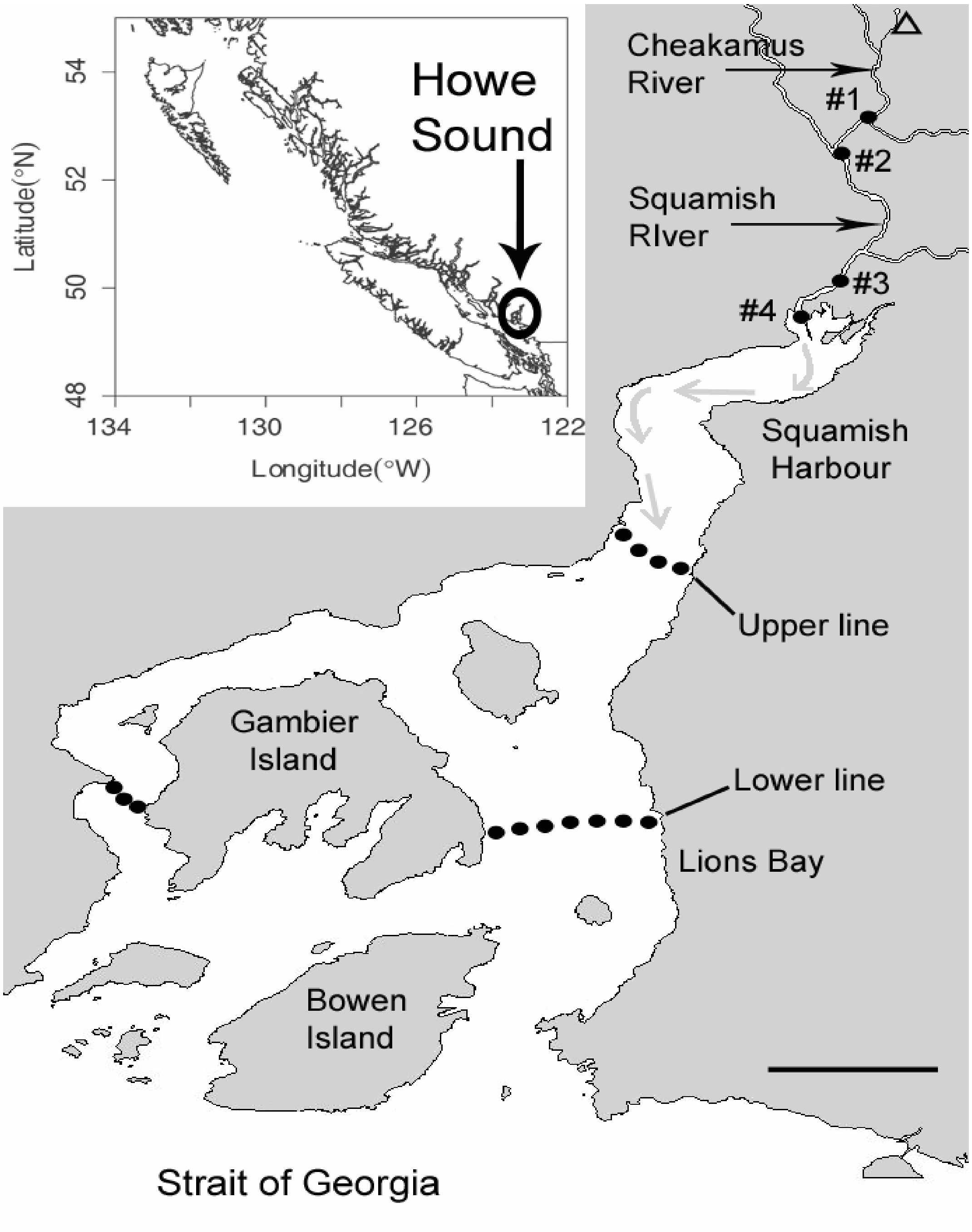

Figure 2 Map Indicating Sensors In Squamish River and Howe Sound for Acoustic Tracking Project

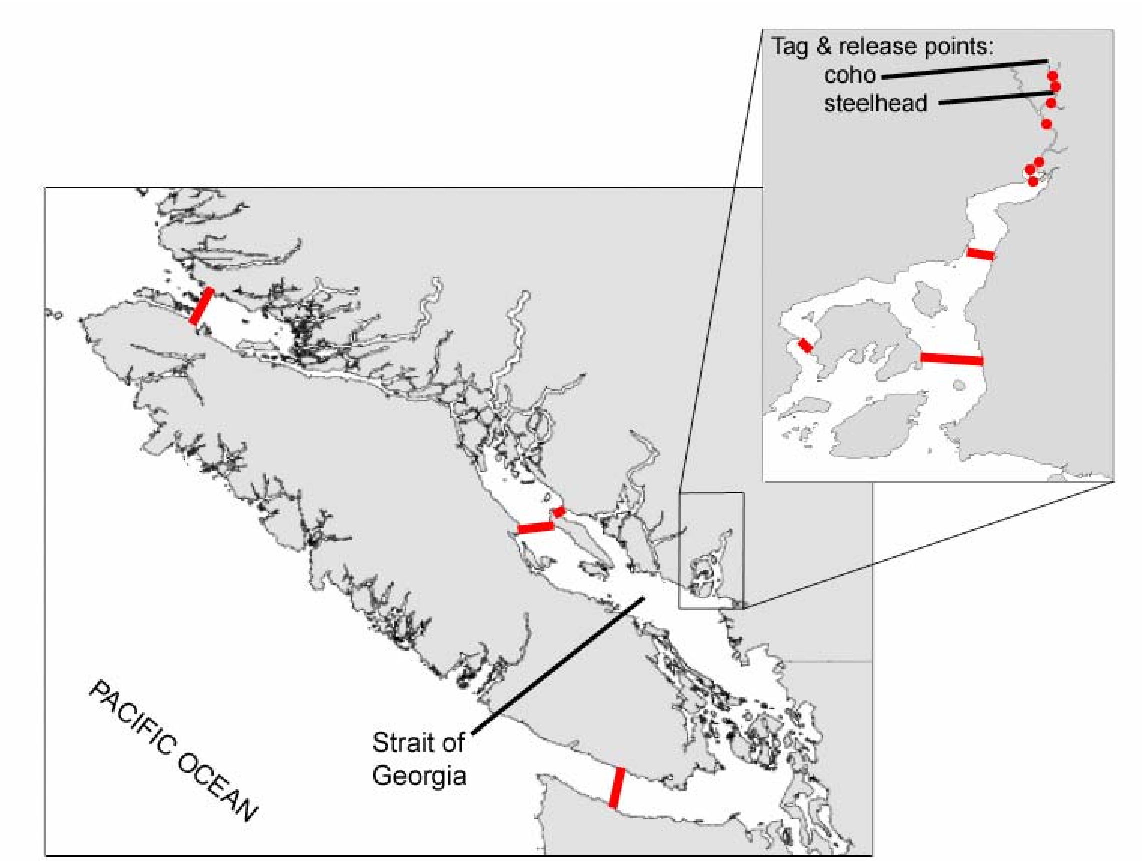

Figure 3 Map Indicating Sensors in Howe Sound and POST Ocean arrays for Acoustic Tracking Project