Deployment of ocean surface current trackers in upper Johnstone Strait for the collection of local tide and current data to explain variability in marine catch data and improve daily abundance and run size estimates of Fraser River Sockeye & Pink salmon.

2016 Annual Report to the Southern Fund Committee

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Introduction

Fraser River sockeye *Oncorhynchus nerka* and pink salmon *Oncorhynchus gorbuscha* are managed by the Fraser River Panel to meet spawning escapement and harvest goals (Pacific Salmon Commission 2004). Test fishing data in combination with hydroacoustics (Chen et al. 2004; Xie et al. 2005), are used for in-season assessment of Fraser River sockeye and pink salmon stocks (Woodey 1987). Marine test fishing catches are used as early indicators of relative abundances in coastal marine areas, but need to be extrapolated using an expansion line (1/catchability) to derive abundance estimates. Because of the high variability in marine test fishing catchability and uncertainty in expansion lines, the resulting abundance estimates vary widely and are not very precise.

Marine test fisheries, used to assess the migration timing and abundance of Fraser sockeye and pink salmon, are located in both Juan de Fuca Strait and Johnstone Strait migratory approaches (Figure 1). Marine gillnet test fisheries are typically used to assess the marine abundance of earlier timed Fraser sockeye (Early Stuart and Early Summer-run stocks) while purse seines test fisheries are used to assess the marine abundance of summer-run and late-run Fraser River sockeye and Fraser River pink salmon. Purse seine test fisheries typically begin in late July and end sometime in August or early September depending on the cycle year, timing and abundance and management requirements. Purse seine test fisheries operate daily, during daylight hours, and weather permitting make 6 systematic sets per day at 6 different locations. Juan de Fuca Strait purse seine test fisheries take place at varying depths, perpendicular to shore, near the 'Blue Line' (in the vicinity of Carmanah Point) while the majority of upper Johnstone Strait test fishing sets are made nearshore, at designated shore tie-off locations, along the east coast of Vancouver Island between the Blinkhorn peninsula and Fine Beach (Figure 2). Additionally, there are a few test fishing locations along the northwest shore of Cracroft Island as well as in open water in mid Johnstone Strait. While it is commonly accepted that tides and currents impact salmon migration (Olson and Quinn 1993, Bourque et al. 1999), thus far it has not been possible to explain the variability in test fishing catchability data using published tide and current information. This could be due to the fact that published tide and current information do not take into account the effects of weather and physical geography on local real-time currents. Weather, geography and tides influence the local currents, salmon behaviour and distribution and test fishing catchability.

In 2015 the PSC and DFO submitted a joint three year project proposal to the PSC Southern Endowment and Enhancement Fund (SEF) Committee to track ocean surface currents in upper Johnstone Strait for the collection of local real-time tide and current data in an attempt to explain the variability in marine test fishing catch data and improve the run size estimates of Fraser River Sockeye and Pink salmon. The first year of the project has been focused on Research and Development, with the **main objectives** being:

1) Develop a technical protocol to set-up the SPOT Trace devices used to track surface currents,
2) Experiment with the deployment of the surface current tracking buoys within the field,
3) Explore the resulting GPS current tracking data,
4) And develop a deployment strategy for 2017.

In the second and third year of the project (2017 and 2018), the number of surface current trackers will be increased and linked with upper Johnstone Strait test fishing data and the proposed SEF tagging study data.

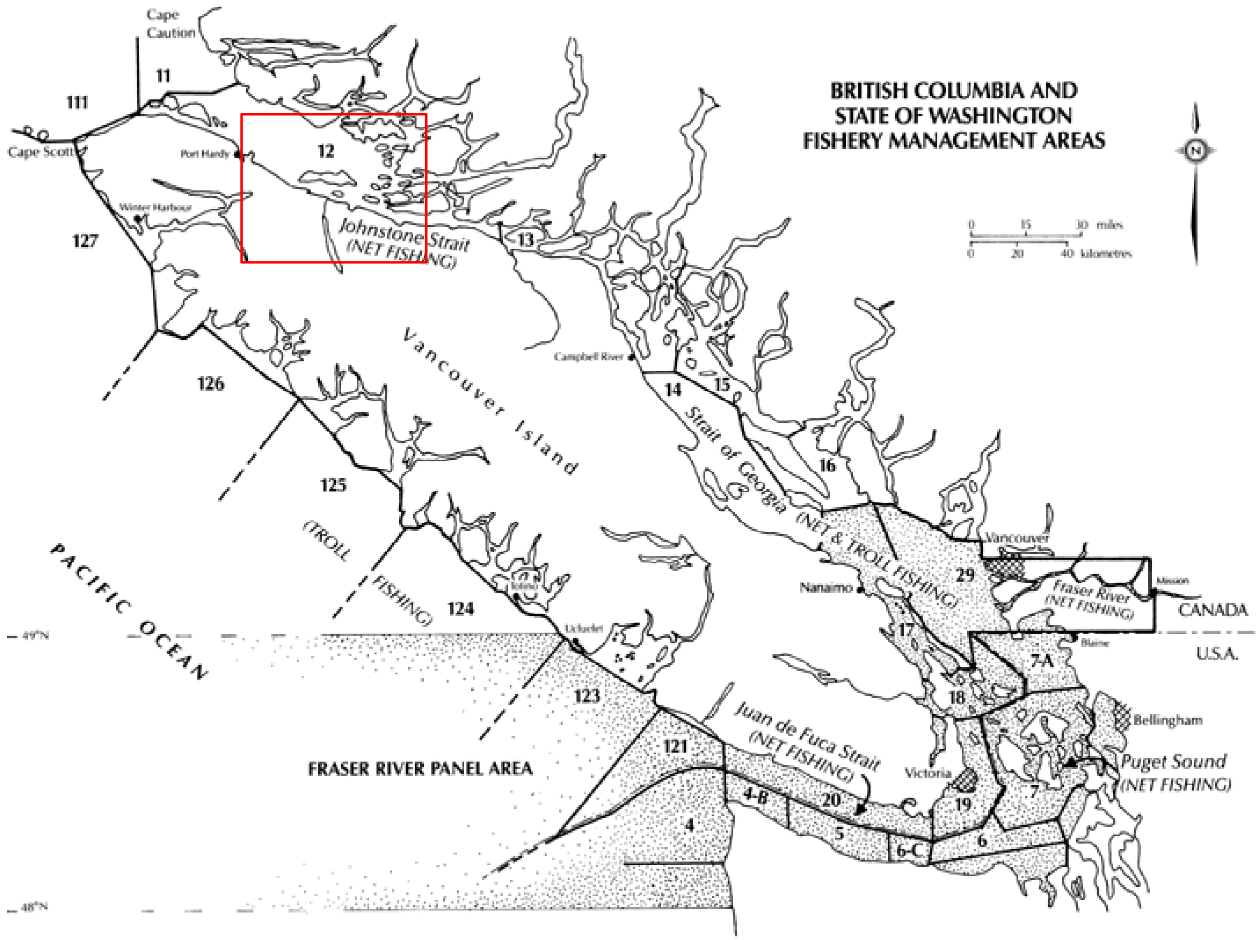

Figure 1. Northern and southern marine migration routes and SEF Project study area.

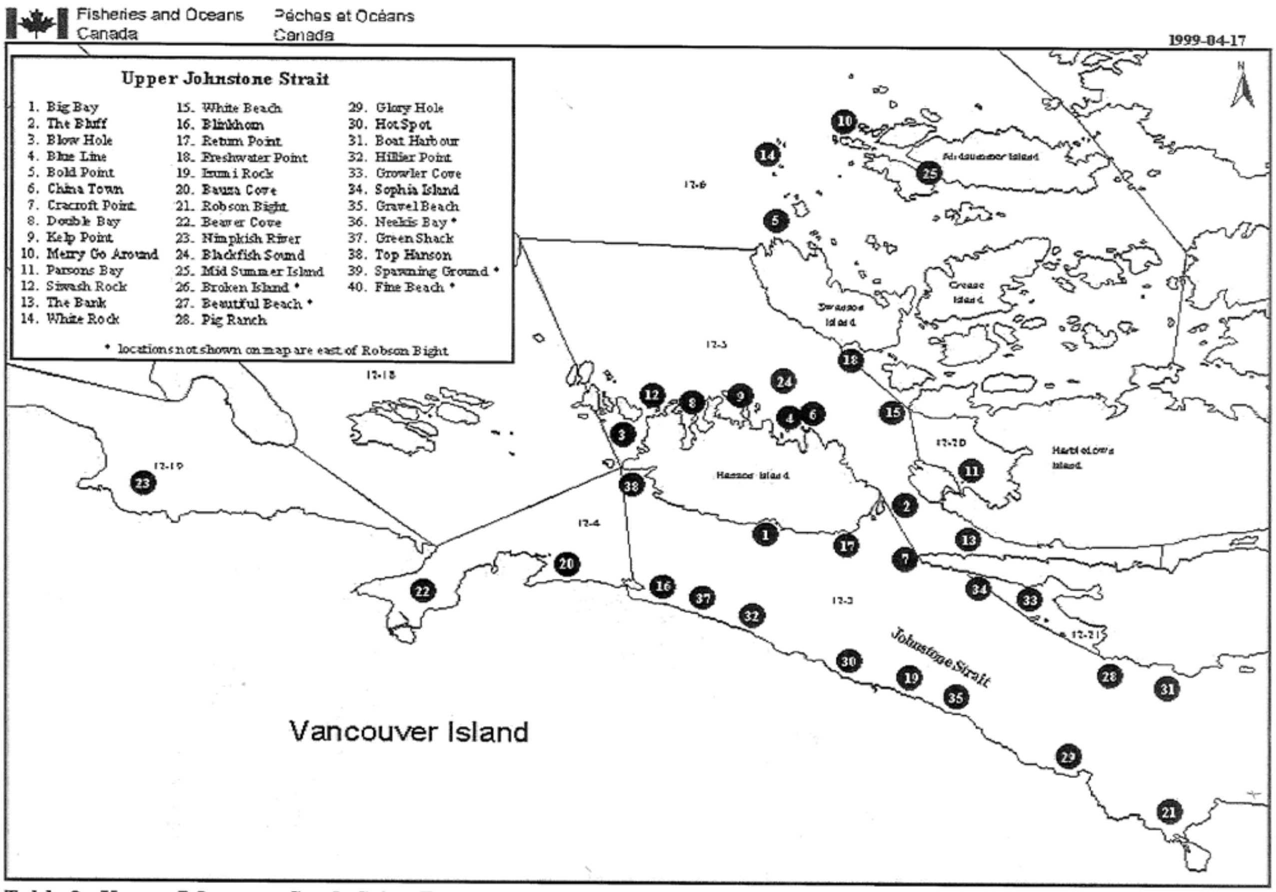

Table 2. Upper Johnstone Strait Seine Test Fishing Locations (Area 12)

Figure 2. Map of upper Johnstone Strait study area and test fishing locations.

Methods

The Institute of Ocean Sciences (IOS) in Sydney, B.C. has developed ocean surface current tracking technology (SCT) using SPOT Trace ® hardware (Figure 3). SPOT Trace devices utilize Global Positioning Satellite (GPS) technology. We collaborated with oceanographer and research scientists Dr. Richard Thomson and Tamás Juhász at IOS to use their tracking technology to collect ocean current data from upper Johnstone Strait. Their SCT units are constructed from readily available biodegradable building materials. To minimize the direct effects of weather on the buoy, each buoy has a drogue and most of the buoy floats below the water surface, with only approximately 5 cm above the water surface (Figure 4). As proposed for 2016, 25 SPOT Traces were purchased. Unfortunately, IOS could only provide 20 SCT buoys instead of 25, but those were provided free of charge, in return for access to the surface current data collected. Twenty SPOT Trace units were serviced as recommended by Tamás Juhász (re-labeled, checked for battery charge, internal tags containing ESN and authorization code were removed, SPOT Trace firmware was updated). Each SPOT Trace device was registered and Global Star tracking parameters (Table 1) were setup using the interactive www.findmespot.com webpage as recommended by Tamás Juhász. We did not require additional licencing or permits to deploy or track the SCT and they were not considered navigation or environmental hazards. Each SCT buoy was clearly labeled 'Harmless Oceanographic Instrument' and 'Pacific Salmon Commission Research Buoy' along with contact information if found by the public. Each SCT was stored in a plastic bucket to prevent damage during transportation. On July 27, 2016 each SPOT Trace was activated just prior to deployment, the buoys were deployed in numerical order, and the time and start location were noted (Table 2). Fisheries and Oceans Canada provided a deployment vessel.

Figure 3. Surface current tracker shortly before deployment. To minimize the direct effects of weather on the SCT movement, the majority of the SCT floats below the surface with only the SPOT Trace above the water surface.

Figure 4. GPS surface current tracking buoy developed by the Institute of Ocean Sciences.

Table 1. SPOT Trace tracking device settings.

Name:	SEF1
Tracking:	5 minutes
Movement Alerts:	Enabled
Dock Mode:	Disabled
Status Message:	Disabled
Power Off Message:	Enabled
Low battery Message:	Enabled
Third Party GPS Forwarding:	Disabled

Table 2. Date, time and location of SCT deployment in upper Johnstone Strait.

SEF Code	deployment date	time of deployment	geographic location	latitude	longitude
SEF1	27-Jul-16	10:09	set ~ 0.5 m off Fine Beach	50.4859	-126.47
SEF2	27-Jul-16	10:14	set equally spaced in a NW 322 diagonal from Fine Beach	50.4969	-126.479
SEF3	27-Jul-16	10:19	set equally spaced in a NW 322 diagonal from Fine Beach	50.5087	-126.486
SEF4	27-Jul-16	10:30	set mid channel SW of SEF3. between Fine Beach and Robson Bight	50.5009	-126.535
SEF5	27-Jul-16	10:36	set ~ 0.5 mile off Robson Bight	50.4965	-126.577
SEF6	27-Jul-16	10:40	set equally spaced in a NW 305 diagonal from Robson Bight	50.5087	-126.593
SEF7	27-Jul-16	10:44	set equally spaced in a NW 305 diagonal from Robson Bight	50.5184	-126.603
SEF8	27-Jul-16	10:51	set ~ 0.5 mile off the Glory Hole	50.5143	-126.66
SEF9	27-Jul-16	10:56	set equally spaced in a NW 324 diagonal from the Glory Hole towards Blackney Passage	50.5285	-126.668
SEF10	27-Jul-16	10:59	set equally spaced in a NW 324 diagonal from the Glory Hole towards Blackney Passage	50.5403	-126.675
SEF11	27-Jul-16	11:03	set in Blackney Passage	50.552	-126.683
SEF12	27-Jul-16	11:07	set equally spcaed heading WSW 243 towards Blinkhorn	50.5528	-126.705
SEF13	27-Jul-16	11:10	set equally spaced heading WSW 243 towards Blinkhorn	50.5502	-126.728
SEF14	27-Jul-16	11:14	set equally spcaed heading WSW 243 towards Blinkhorn	50.5481	-126.752
SEF15	27-Jul-16	11:18	set off Blinkhorn	50.5455	-126.773
SEF16	27-Jul-16	12:16	set ~ 1 mile north of Hanson Island	50.5854	-126.71
SEF17	27-Jul-16	12:21	set ~ 1 mile north of Hanson Island	50.6007	-126.737
SEF18	27-Jul-16	12:28	set north of Hanson Island / Malcolm Island with orange flagging tape	50.6212	-126.776
SEF19	27-Jul-16	12:37	set north of Malcolm Island with orange flagging tape	50.6437	-126.804
SEF20	27-Jul-16	12:48	set north of Malcolm Island with orange flagging tape	50.6689	-126.842

Results

All 20 SCT buoys were deployed on July 27, 2016 between 10:09 a.m. and 12:48 p.m. during an ebb tide in upper Johnstone Strait at various predetermined locations (Figure 5). Each SPOT Trace device was checked to ensure it was sending out a GPS signal before deployment. Each SPOT Trace continued to send a signal every 5 minutes thereafter until it either stopped moving or the batteries died. The findmespot.com website allowed access to all of the recorded and stored all of the SPOT Trace GPS coordinates. The website provided filtering capabilities to sort and download the tracking data in a variety of different formats including GPX, CSV and KML.

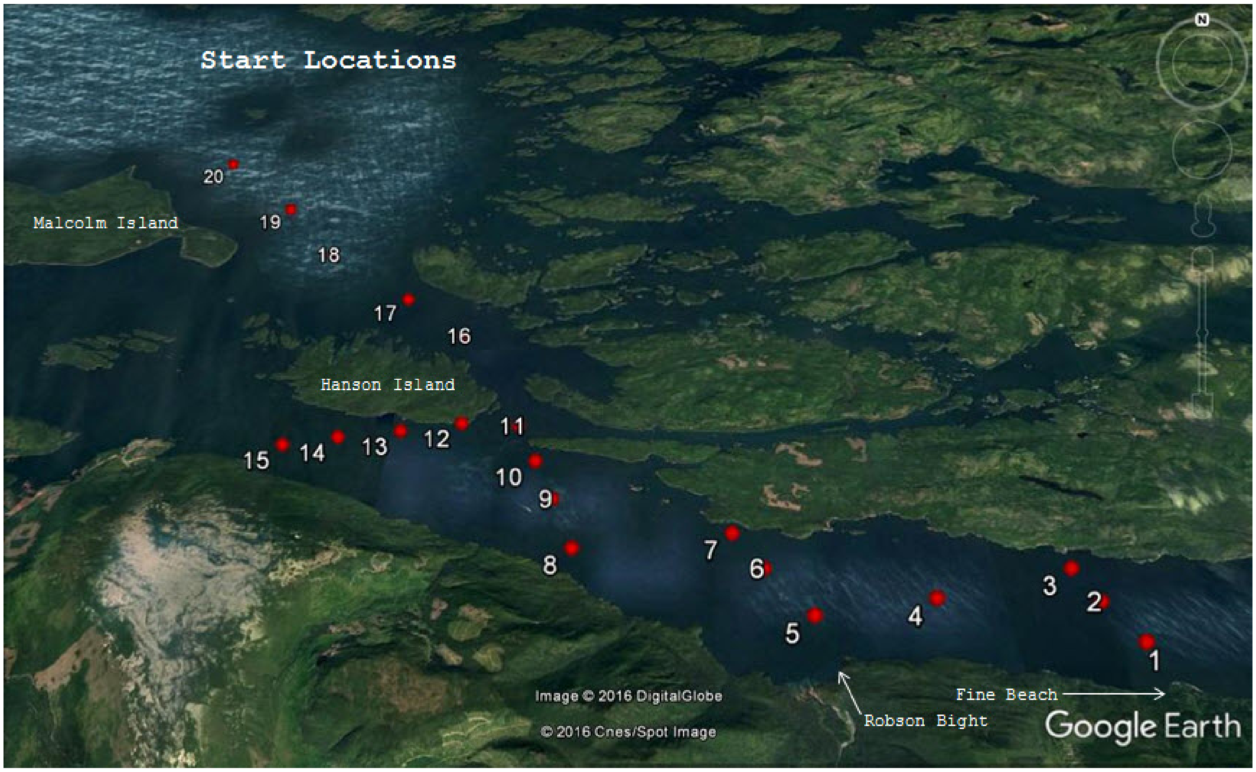

Figure 5. Map of deployed SCT start locations in upper Johnstone Strait.

Some of the SCT's were beached or tangled in kelp near-shore within a few days after deployment, however several of the remaining buoys drifted for a number of days, and / or over a relatively long distance before they eventually beached or became tangled in kelp and stopped sending a signal (Figures 6 & 7). Eighteen of the twenty buoys were recovered, three of which were missing the SPOT Trace GPS device. Fourteen buoys were recovered by DFO staff and three were recovered by the public. One buoy was recovered but not returned immediately, and was later recovered by DFO Staff. The majority of the recovered buoys were severely damaged and required substantial work to refurbish them. Twelve of the recovered buoys were refurbished and redeployed by DFO Staff on September 21, 2016 during the Chum salmon test fishery. The refurbished and redeployed SCT devices tracked upper Johnstone Strait surface currents during the Chum test fishery. To-date only two of those SCT's have been reported as recovered from the public, and no in kind effort has been made to recover the SCT's from the September deployment.

Only the data collected from the July 27 deployment has been analyzed graphically using Google Earth Map and summarized in this report. Figure 6 shows the results for the first buoy released on July 27, 0.5 km east of Fine Beach, one of the major test fishing locations where catches can be quite large in comparison to other test fishing sites. The SCT first traveled northwest and later southeast for several days before returning northwest. The signal for this SCT ended on August 3, only 7 km northwest from the initial deployment location at Fine Beach. Figure 7 shows additional tracks from other buoys deployed on July 27.

Because of the exploratory nature of the first year deployments and the limited number of SCT deployed, no further analyses were conducted. Further analyses involving linking the local current information with published tide and current information and test fishery are scheduled to take place during the second and third year of the project.

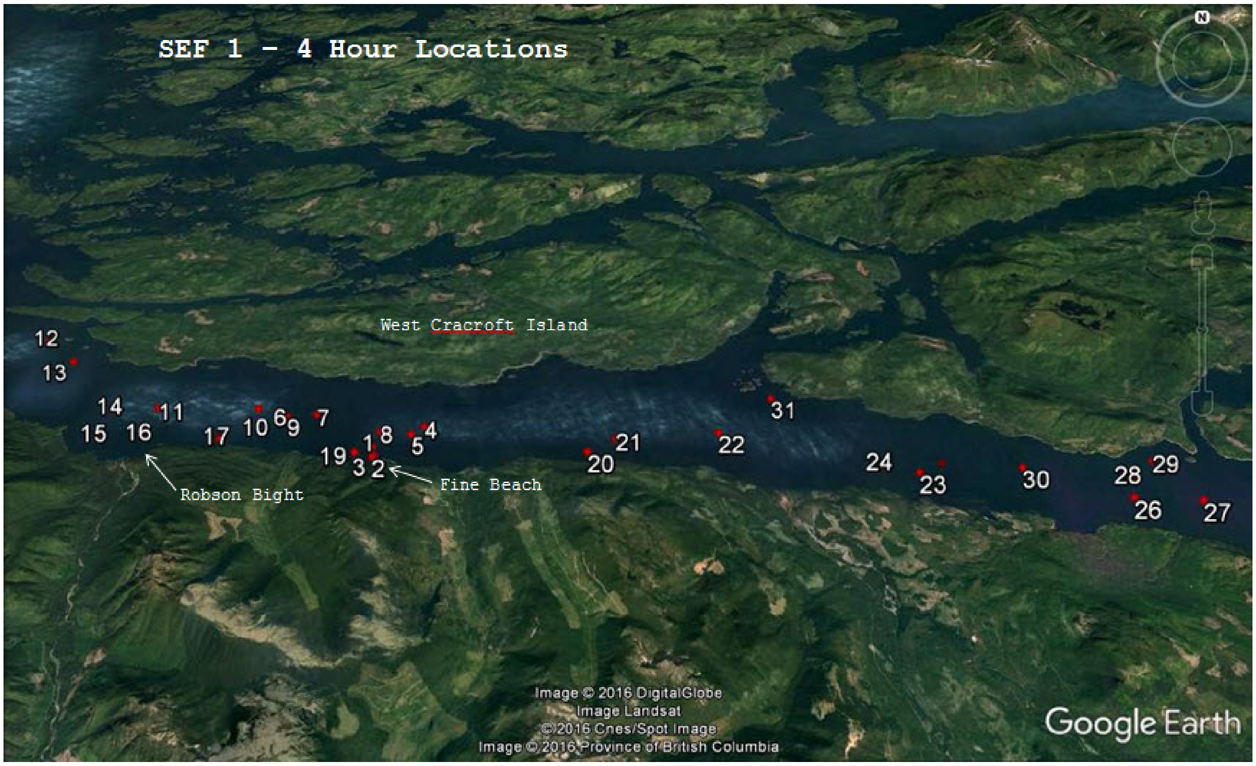

Figure 6. Illustration of the tracking data obtained by the surface current tracking technology (SCT) developed by IOS. This particular buoy was deployed 0.5 km east of Fine Beach on July 27 and stopped sending a signal 7 km northwest of Fine Beach on August 3.

Figure 7. Multiple SCT tracks from buoys that were released at different locations on July 27, 2016.

Discussion

In upper Johnstone Strait, tidal currents flood eastward and ebb westward (Thomson and Huggett, 1980); however, not all of the buoys moved east and west likely due to smaller scale eddies and local currents caused by weather, tides and the physical geography. Buoys released on July 27, 2016 at various locations tended to cluster in particular areas after a few days of drifting. High winds on July 29-30 may have contributed to some of the SCT movement and possibly caused some to beach or become tangled in kelp beds. The deployment strategies for 2017 and 2018 are based on the 2016 results and will consider the number of available SCT, the number of deployment locations, dates of deployment, and tidal cycles in combination with the proposed SEF tagging of Fraser River pink salmon in 2017 and Fraser River sockeye in 2018. To maximize tagging success, tagging sessions will occur near the peak of abundance.

For 2017 we propose the deployment of 30 SCT's, at 5 locations in upper Johnstone Strait (Figure 9). SCT deployment would over several days, beginning near the peak abundance of Fraser River pink salmon. Our preference will be to deploy SCT's at four different aspects of the tidal cycle (ebbing tide, bottom of the ebb tide, flooding tide and top of the flood tide; see Figure

8). SCT deployment will coincide with the Johnstone Strait with the proposed SEF project tagging sessions. The collection of data should also coincide with peak Johnstone Strait purse seine test fishing catch per effort. Because substantial winds are likely to impact the surface current and the SCT to a greater extent than the salmon migrating deeper in the water column, deployment of STC units during strong winds should be avoided whenever possible. In 2018 we have proposed 50 SCT buoys and more tagging sessions near the Johnstone Strait peak abundance of late-run Fraser sockeye.

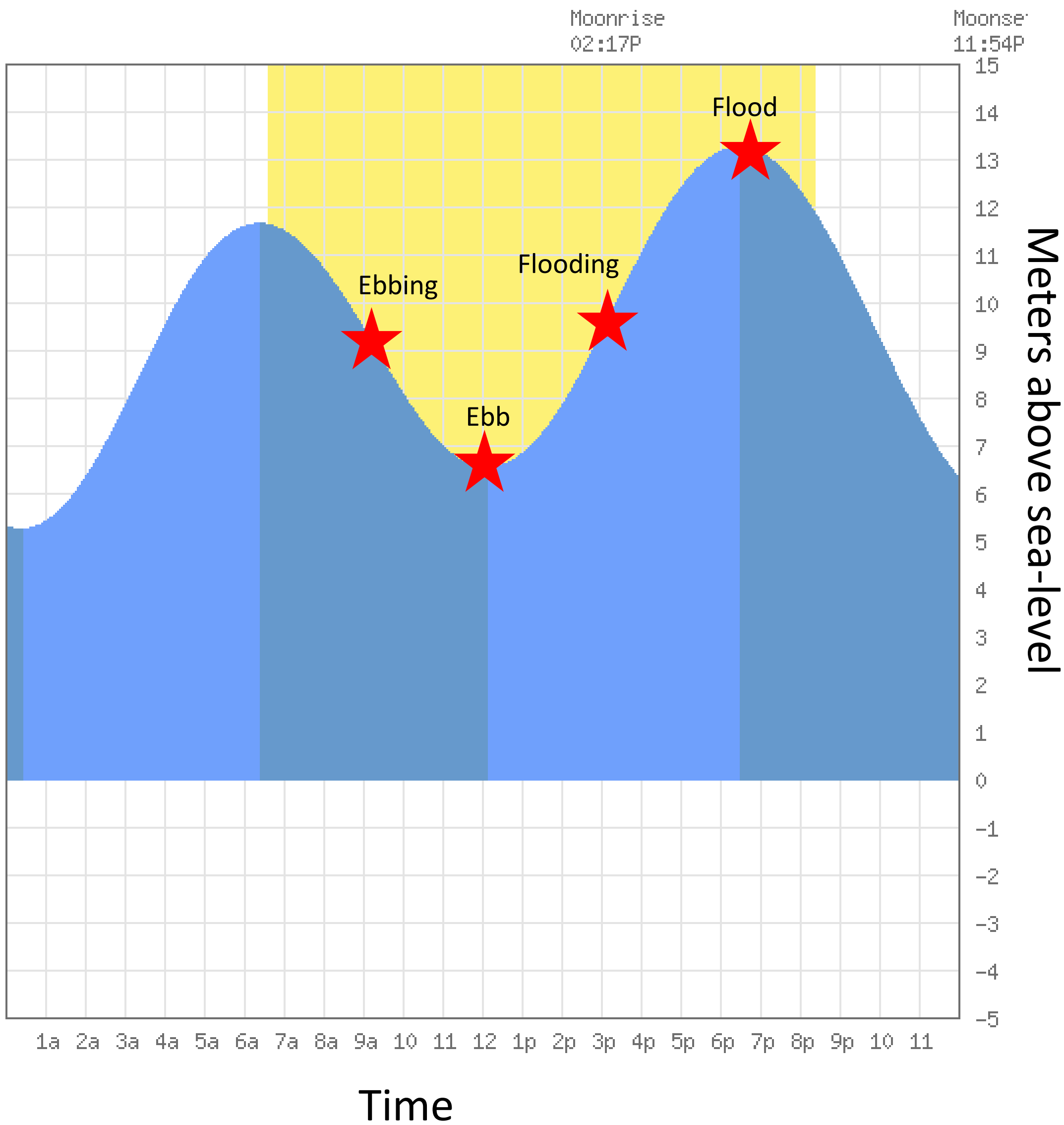

Figure 8. August 28, 2017 Port Hardy, BC tide graph showing different parts of the tidal cycle for SCT deployment.

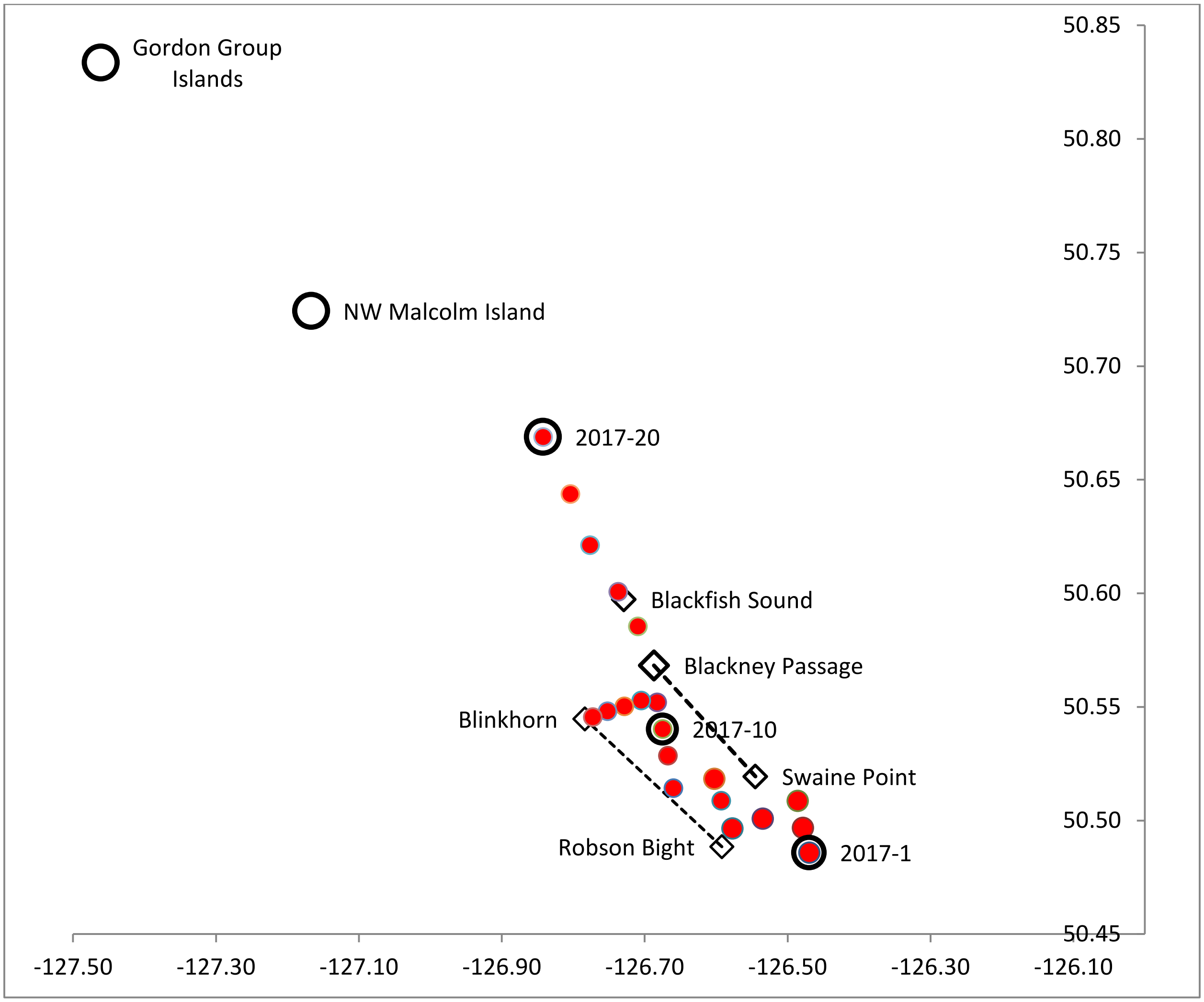

Figure 9. Location of the proposed SCT deployment sites for 2017 in upper Johnstone Strait (open circles), 2017-1, 2017-10, 2017-20, NW Malcolm Island and Gordon Group Islands in relation to the deployment locations of 2016 (red circles).

Budget

The 2016 project costs were less than budgeted (see the attached Project Budget Variance Form for details). This is due to the fact that 25 surface tracking buoys, 25 SPOT Trace devices and 25 Global Star tracking packages were anticipated to be purchased. IOS however could only provide us with 20 surface tracking buoys instead of 25, but offered those free of charge in exchange for access to the collected data. Actual project expenses for 2016 were approximately $2,600 below budget due to fewer SCT units being operational, and no financial cost to purchase the buoys in 2016. We also have five SPOT Trace units that were not used in 2016 which will be carried over for use in 2017. We request the SEF allow the carry-over of approximately $2,600 CDN and 5 SPOT Trace (valued at $550 CDN) from 2016 to 2017.

Conclusion

The work done in 2016 for this SEF project has been very exploratory given the limited knowledge and experience with SCT units to measure local currents. The first year of the project was successful in terms of developing a technical protocol for the set-up and service of the SPOT Trace devices, experimenting with the deployment of these devices, and extracting local surface current information from the findmespot.com website. Based on this experience a spatial and temporal deployment strategy has been developed for 2017 to coincide with the migration of Fraser River pink salmon.

Acknowledgements

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