

## Year 1 Project Funding Summary

### Independent Evaluation of Wild Coho Marine Survival Rates (Black Creek)

Prepared for:

Pacific Salmon Commission

Southern Fund Panel

## **Overview:**

Black Creek (fence) is DFO's only wild coho indicator system for the Strait of Georgia (SOG). Since 1985 an uninterrupted data set has been compiled under the present program and is considered one of the longest time series of coho smolt and adult returns in the Pacific Region. Marine survivals are currently being evaluated using Coded Wire Tags (CWT) on wild, non-adipose marked coho (~20-40% of smolts). Based on lower than expected ratio of CWT fish returning with the current program, A-Tlegay Fisheries Society and DFO are conducting this SEF funded Passive Integrated Transponder (PIT) tag program as a concurrent method to evaluate marine survival, and investigate if there is a difference in survivals based on CWT or PIT tag methodologies. The advantage of using PIT tags is that every returning fish to Black Creek would be autonomously scanned at the enumeration fence for the presence of a PIT tag, while the CWT component relies on handling each fish and scanning by hand. Also, a PIT array will scan all adults, even if the fence is topped, while the current CWT program is unable to scan fish when the fence is topped, as fish bypass the trap box. As an end result, DFO is seeking an improved ability to evaluate wild coho marine survival rates in the SOG.

Since the early 2000's, DFO in partnership with the A-Tlegay Fisheries Society have continued to deliver the juvenile and adult Black Creek programs. The application of PIT tags in juveniles and monitoring of adults in the following year(s) at the fence is a slight augmentation to the current program, without any major labour or infrastructure costs, just tags, antenna arrays, application and reporting.

In future, the expansion to coho survival exploration has high potential and could augment the work already being done at Big Qualicum and Cowichan Rivers including predator monitoring (seal haul out spots, otter dens, heron rookeries, etc.). Also, in future, PIT tags could be used to evaluate the possibility of a fall smolt migrant class leaving Black Creek but would require juvenile tagging in the head waters prior to smolts leaving. Year 2 will again focus on Black Creek and tagging of smolts at the downstream fence in April and May of 2019, and monitoring of adults (2018 smolts) and jacks (2019 smolts) in the fall.

Passive Integrated Transponder (PIT) tags operate on Radio Frequency Identification (RFID) technology and do not have a battery. They can be read at short distances (~ 1 m) with an antenna that both charges the tag with a magnetic field and listens for the response in the form of a unique 16 digit number. (*Figure 1a.*)

A Coded Wire Tag (CWT) is a magnetized piece of stainless steel wire about 1.1 mm long that has etched codes into the wire. CWT's do not transmit a code, and therefore need to be extracted from the fish to be read. CWT presence can be detected with an electronic scanner, but requires fish capture and physical scanning of each fish (*Figure 1b*).

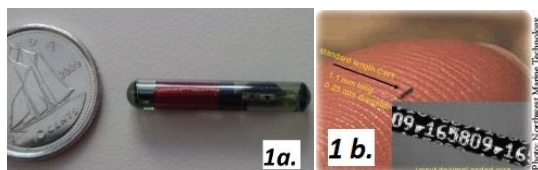
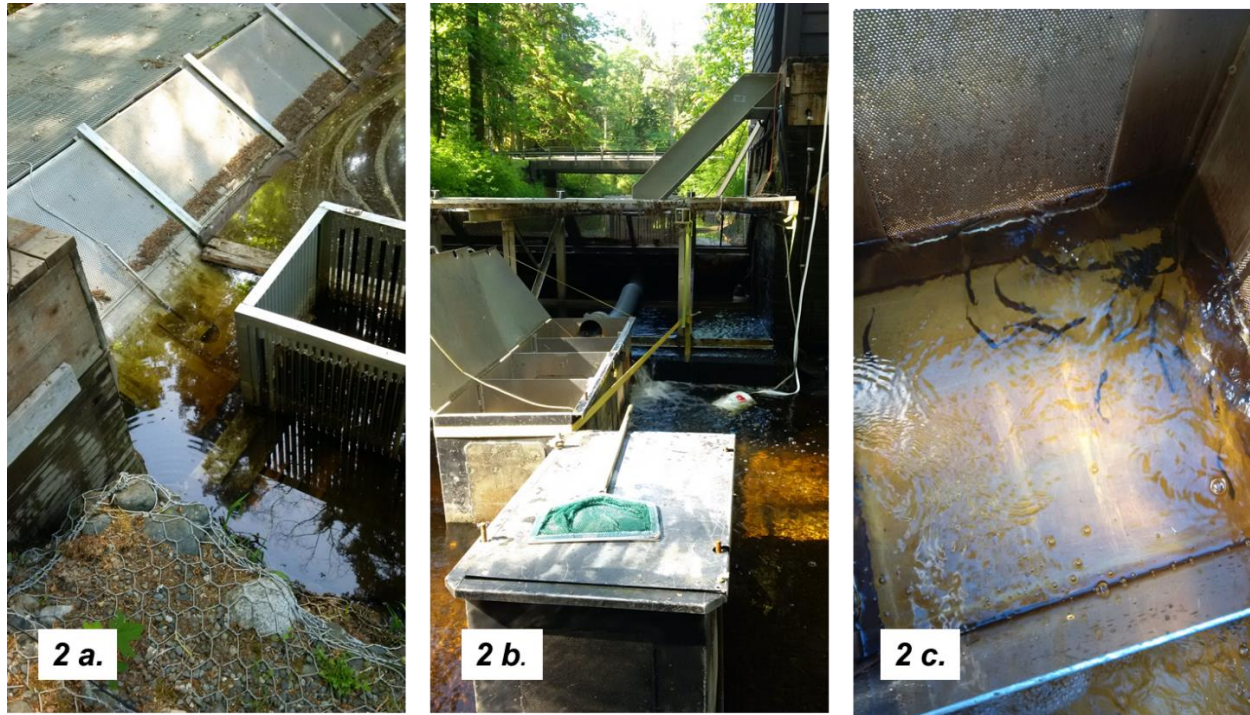


Figure 1. PIT Tag and CWT for Reference

### **2018 Smolt Tagging:**

Each spring at Black Creek, the juvenile panels and trap box are installed in the fence. The panels block the entire stream, forcing smolts down the intake pipe and in to the trap box (*Figure 2*). The fence captures all smolts leaving Black Creek in April and May. Technicians move the fish to the tally shack where biologicals are collected, tags are implanted and smolts counted.



*Figure 2, a. Trap box intake. b. Downstream view of intake pipe and holding box. c. Coho smolts in trap box*

For ease of handling, juveniles that were to be tagged and biosampled were anesthetized using Tricaine mesylate (TMS). A random portion of the catch was selected to be tagged using Biomark pre-loaded 12 mm PIT tags were injected into the coelomic cavity of the Coho smolt (*Figure 3*). The rest of the catch was tagged using CWT's or released untagged. A small portion of captured Coho smolts were measured and weighed for condition factor evaluation. Scales were also taken from various sizes of fish to evaluate smolt age structure.



*Figure 3 a. Anesthetized smolts being PIT tagged. b. PIT tag incision.*

After the smolts were sampled and tagged, they were placed in a recovery tank before being released back into Black Creek. Upon release, technicians typically allowed for a volitional release method versus a “dumping” release method. The volitional release style allows fish to swim out of the holding buckets. Technicians monitored the recovery bucket for morts and shed tags.

The juvenile fence operated from April 10<sup>th</sup> to May 25<sup>th</sup>, 2018. CWT and PIT tagging commenced April 19<sup>th</sup> and 24<sup>th</sup> respectively, and the last tags were applied May 18<sup>th</sup> (PIT) and May 23<sup>rd</sup> (CWT). A total of 40,309 smolts were counted at Black Creek, of which 4,000 were PIT tagged (10%), 28,864 were CWT'd (72%), and 7,445 smolts were counted and released untagged (18%). *Figure 4* illustrates that the 2018 smolt count is below the 1996-2017 average count of 51,810 smolts.

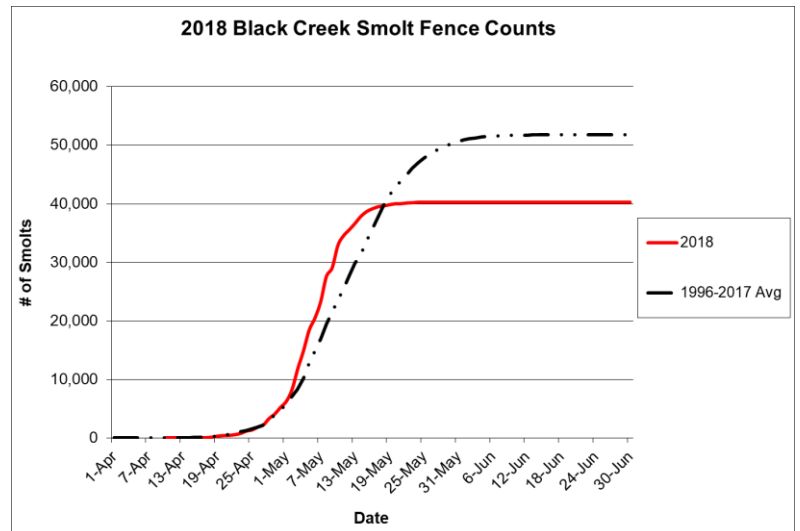


Figure 4. 2018 Black Creek smolt count and 1996-2017 average.

PIT and CWT tagging was conducted based on abundance of fish present for the day, with consideration for migration timing (i.e. early, middle end of migration). *Table 1* & *Figure 5* (below) provide the daily and cumulative smolt count of tagged (PIT & CWT), and untagged smolts.

2018 Black Creek Coho Juvenile Daily Tally					
Date	Untagged	CWT'd	PIT Tagged	Daily Total	Running Total
10-Apr	11	0	0	11	11
11-Apr	3	0	0	3	14
12-Apr	Fence Open - High Water			0	14
13-Apr	Fence Open - High Water			0	14
14-Apr	Fence Open - High Water			0	14
15-Apr	Fence Open - High Water			0	14
16-Apr	Fence Open, panels dropped back in			0	14
17-Apr	10	0	0	10	24
18-Apr	90	0	0	90	114
19-Apr	1	179	0	180	294
20-Apr	1	99	0	100	394
21-Apr	13	0	0	13	407
22-Apr	134	0	0	134	541
23-Apr	1	209	0	210	751
24-Apr	14	0	382	396	1,147
25-Apr	1	181	18	200	1,347
26-Apr	4	473	0	477	1,824
27-Apr	2	288	100	390	2,214
28-Apr	5	1,090	0	1,095	3,309
29-Apr	1	778	0	779	4,088
30-Apr	3	1,132	0	1,135	5,223
1-May	46	666	300	1,012	6,235
2-May	144	1,869	0	2,013	8,248
3-May	39	3,220	300	3,559	11,807
4-May	374	2,515	187	3,076	14,883
5-May	1,351	2,004	200	3,555	18,438
6-May	46	2,010	0	2,056	20,494
7-May	497	1,984	300	2,781	23,275
8-May	1,320	2,532	488	4,340	27,615
9-May	28	1,018	400	1,446	29,061
10-May	2,883	959	0	3,842	32,903
11-May	35	1,340	300	1,675	34,578
12-May	10	919	100	1,029	35,607
13-May	19	1,061	0	1,080	36,687
14-May	33	1,159	0	1,192	37,879
15-May	25	389	400	814	38,693
16-May	7	174	300	481	39,174
17-May	9	221	125	355	39,529
18-May	8	37	100	145	39,674
19-May	2	204	0	206	39,880
20-May	166	0	0	166	40,046
21-May	15	0	0	15	40,061
22-May	5	110	0	115	40,176
23-May	4	44	0	48	40,224
24-May	82	0	0	82	40,306
25-May	3	0	0	3	40,309
Totals	7,445	28,864	4,000	40,309	
Tagging Percentages	18%	72%	10%		
Total Tagged %	82%				

Table 1. Daily fence counts and daily tag applications at Black Creek in spring of 2018.

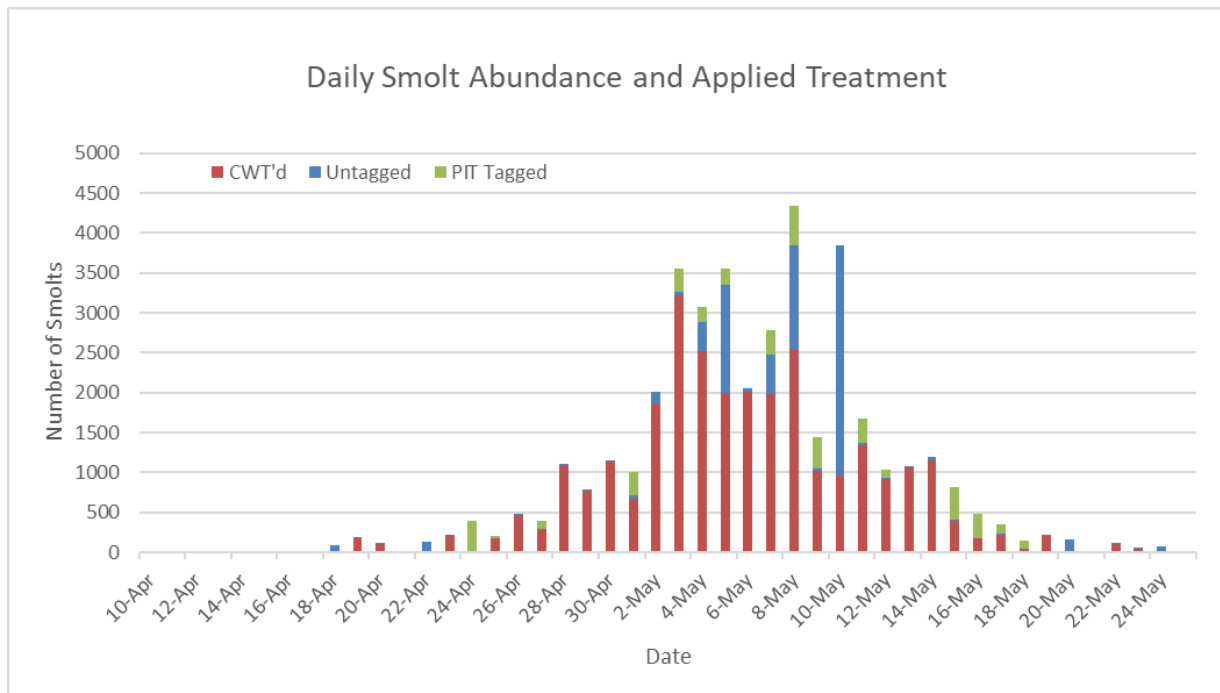


Figure 5. Daily Smolt Abundance and Applied Treatment.

All 4,000 PIT tag fish were measured (fork length). The length was paired to the unique 16 digit tag number. The average length of the PIT tagged coho was 114.28 mm, maximum length was 176 mm and the minimum was 86 mm.

PIT tag retention evaluation was conducted only once. The purpose of the retention was to evaluate if there was any initial PIT tag loss or mortality, similar to CWT retention evaluation. On May 4<sup>th</sup>, 200 PIT tagged coho were put in the retention box and checked after 48 hours (no morts or fungus at that point). At 72 hours these fish were released, no PIT tags were lost, but 13 fish died. The mortality encountered during this evaluation was more likely an effect of holding stress and fungus build up on fish (*Saprolegnia*). On May 8<sup>th</sup> an additional 12 PIT tagging related mortalities occurred. PIT tags from morts were removed, sterilized, and reapplied at a later date. It is believed that mortalities truly associated to tagging is very low. Vidalife water conditioner will be used in 2019 tagging operations to help protect fish mucus layer and reduce fungus on smolts and a smaller number of fish will be held for the tag retention test.



### **PIT Antenna Installs:**

Two antennas were installed as part of this project. The first antenna was installed in the adult trap box and was designed to capture and record all fish that entered or passed through the trap box. The 2.5' x 4' antenna was a home built antenna that was powered by a Biomark IS 1001 reader board on a 24 volt power supply. The Antenna was built out of PVC pipe with 5 wraps of 10 gage wire. The antenna was made water tight to ensure high efficiency. Wood 2x4's were used to mount the antenna to the trap box (*Figure 6*).



*Figure 6. PIT antenna installed at entrance of trap box.*

The second antenna, a full stream loop antenna was installed approximately 50 meters upstream of the fence and trap box. The intention of this antenna was to capture and record all PIT tagged fish migrating up Black Creek, regardless of water level. Trexx deck boards were anchored every 4 feet to the stream substrate using duckbill anchors and ready rod. The Trexx boards provided a solid substrate to anchor the antenna cord to at 1 foot intervals. The antenna loop was spaced at 34 inches as specified by Biomark (antenna supplier) for optimal efficiency (*Figure 7 a,b,c*) The antenna is powered by 2 -24 volt battery banks and a Biomark IS 1001 reader board.



*Figure 7. a. Trexx deck boards anchored to stream substrate. b. Antenna attached to Trexx board at 1 foot intervals. c. Biomark full stream loop antenna in place, anchored to Trexx board.*

A PIT tag hand scanner was purchased by DFO to decode PIT tags as they were injected into juveniles, and also scan jacks returning in the fall of 2018. Crews in the fall of 2019 will use the hand scanner to check for the presence of a PIT tag in jacks and adults (Figure 8).



Figure 8. Biomark PIT Hand Scanner

There were a few un-anticipated issues with the PIT antennas in the fall of 2018. Electrical interference noise on site interfered with antenna read range, tuning capability and efficiency. This effectively left the full stream antenna out of service for the fall, but the trap box antenna was operational, with fewer issues or effects from the electrical noise on site. From October 27<sup>th</sup> to 29<sup>th</sup>, the trap box antenna was not functioning. This was a time of high fish movement, in which the crew manually hand scanned 3 PIT tagged jacks through the trap box. The noise issue was linked to florescent light ballasts and electronic power supplies. This will be addressed by replacing ballasts with a “no noise” alternative and using isolated/shielded power supplies. The antenna’s will be noise tested prior to 2019 adult returns.

### **Environmental Conditions during Coho Outmigration and Tag Application:**

In 2016 DFO installed a hydromet station at Black Creek fence. The hydromet is designed to capture creek water level, water temperature and air temperature. Also, in the Black Creek watershed there is a second data source (level logger) for water level and temperature. Figure 9 (below) displays the environmental parameters during the smolt window at Black Creek for both the level logger and hydromet. Daily smolt abundances increased substantially starting May 2<sup>nd</sup>, when the water temperatures hit 10 C<sup>0</sup>. Over the past years monitoring the fence, it has been observed that 10 C<sup>0</sup> appears to be the magic temperature that triggers an increase in smolt outmigration.

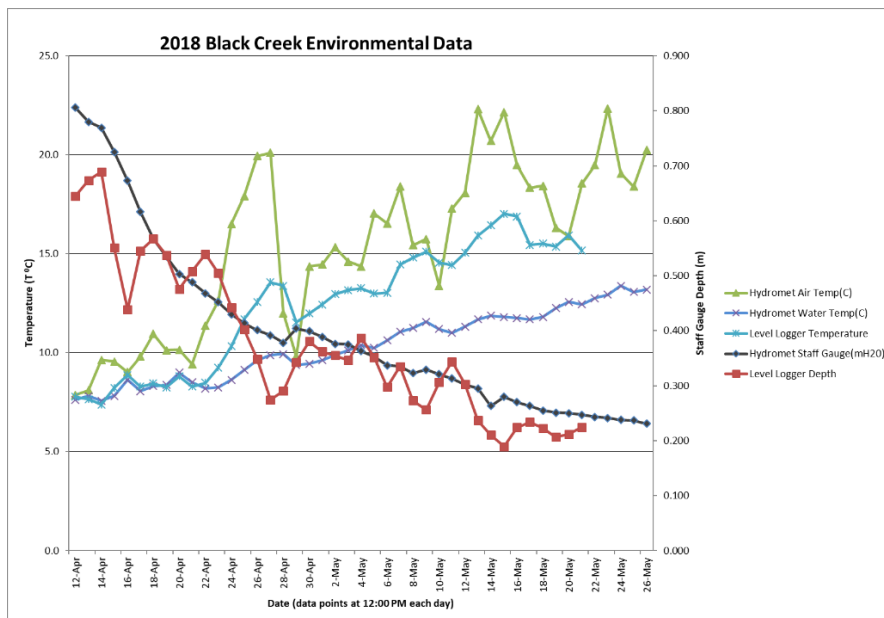


Figure 9. Environmental figures captured during the 2018 smolt window at Black Creek.

## **2018 Adult Monitoring**

The adult fence panels and trap box were installed on September 11<sup>th</sup>, with first fish arriving on September 22<sup>nd</sup>. PIT tag arrays were installed on September 21<sup>st</sup> and 25<sup>th</sup>. Fall crews monitored the fence daily processing fish as they entered the trap box from September 22<sup>nd</sup> until November 10<sup>th</sup>. After November 10<sup>th</sup> the trap box was left open in the event late fish moved through. Each adult that entered the trap box was sampled, visually marked and scanned for presence of a CWT. Jacks were measured and then scanned for the presence of either a CWT or PIT tag. There were periods when the trap box was left open to allow fish to migrate upstream un-sampled or marked. During these occasions PIT tagged jacks were still detected and recorded at the trap box PIT array. Dead pitch, or carcass recovery efforts began November 10<sup>th</sup>, and was completed on December 11<sup>th</sup>.

## **2018 Escapement Estimates:**

A total of 2,702 (preliminary) adult coho were estimated to have returned to Black Creek in the fall of 2018 using a standard single-census Peterson Mark recapture estimate. It is estimated that 1873 jack coho returned based on sampled jack PIT tag rates. A total of 2,371 coho adults and 509 jacks were physically counted through the trap box, but there were times when the trap was left open and fish were allowed to pass without being sampled but were still scanned for PIT tags. The adult escapement estimate is slightly below the historical average (*Figure 10*).

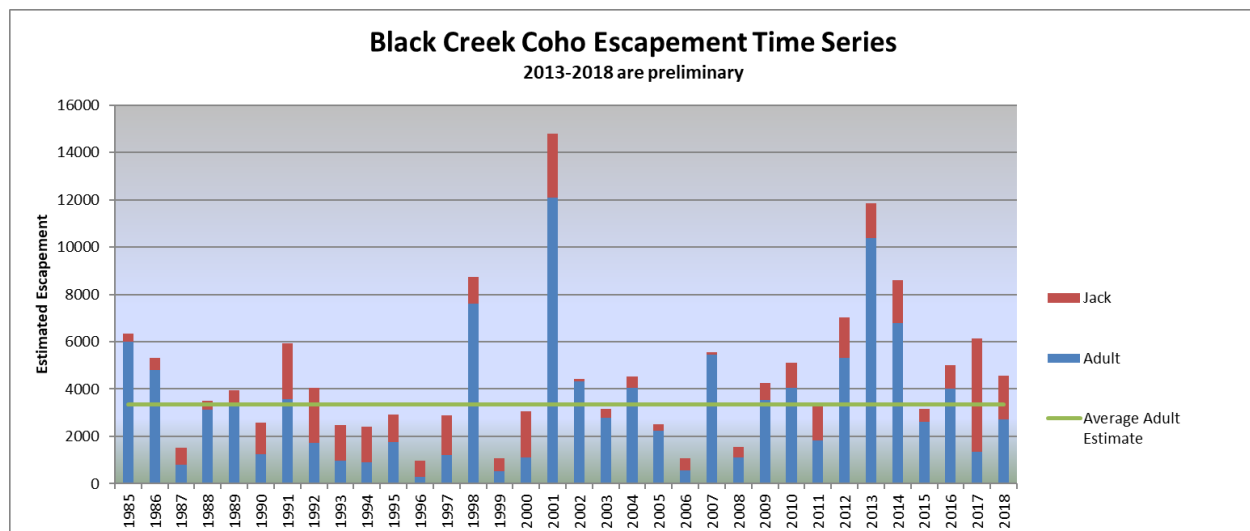


Figure 10. Historical Escapements to Black Creek, Adults and Jacks (1985-2018)

## **Jack PIT Tag Recoveries 2018:**

Due to the life history of Coho, we anticipated encountering our first tagged fish as jacks in the first year of the program. Jacks are precocious male coho (2 year olds) that return the same year they out-migrated. The majority of Coho return as adults the following year as 3 year olds and will not be encountered until the fall of 2019. The first PIT tag jack recovery was September 22<sup>nd</sup>, and the last recording past the fence was Oct 28<sup>th</sup>. A total of 509 jacks were physically sampled

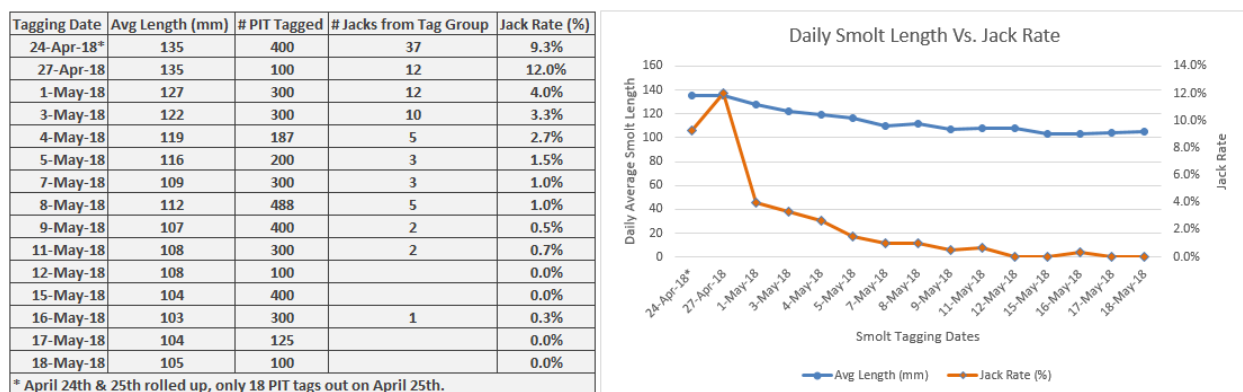


at the fence and hand scanned for PIT tags, of which 25 were PIT tagged, yielding a mark rate of 1 PIT tag per 20.36 jack coho. A total of 92 PIT tags were detected at the fence, producing an expansion of 1873 jacks.

PIT tags were applied to approximately 10% of juveniles leaving Black Creek in the spring of 2018 (4,000 tags/40,309 smolts). Based on tag out percentages it was expected that 10% of jacks returning would be PIT tagged, but that was not the case, only 5% (25/509) were tagged. Similar results were founded based on CWT ratios as well. Of the 509 jacks, 474 were evaluated for CWT presence. 271, or 57% tested positive for a CWT, yet 72% of smolts leaving were tagged. Both PIT tag and CWT evaluations produced lower than expected proportions in returning jacks.

In the past, DFO has not been able to create a jack estimate for coho at Black Creek as too few carcasses are ever recovered in the dead pitch program (5 in 2018). Prior to this year DFO had no way of expanding or estimating jack returns, and the physical fence count was posted. By using PIT tags there is sufficient data to support the creation of a jack estimate, rather than relying only on the fence count which is an underestimate. The ability to estimate total jack escapement will also help with coho marine survival work in terms of giving a better idea of what percentage of the smolt class jacked, and were therefore removed from the adult marine survival estimate calculation.

Smolt timing and size have a direct role in jack rates. Through this PIT tag work, it was observed that smolts leaving earlier were larger and had higher rates of jacking. *Table 2/Figure 11* below demonstrates a significantly larger smolt size earlier in the run timing, which also corresponds with a higher jacking rate. April 24<sup>th</sup> and 27<sup>th</sup> were the first days of PIT Tagging in 2018. On those days alone 9% and 12% of the smolts jacked respectively and had the highest daily average length (135 mm). After May 5<sup>th</sup> the jack rate dropped substantially which supported the original hypothesis that larger and early migrating fish have significantly higher jacking rates. The low PIT tag rate in returning jacks may be a reflection of missing, or not tagging the very early portion of the smolt outmigration, which appears to contribute significantly to the jack return.



*Table 2 / Figure 11. Daily PIT tag application summary with average length and associated Jacking rate.*

When plotting jack rate against the daily average size of smolt, the curved correlation coefficient value of 0.98, and linear of 0.84 (*Figure 12*) strongly supports that earlier and larger fish have a significantly higher jacking rate. In future, based on this work it may be possible to predict which smolts based on size and migration timing will become jacks and which smolts will effectively

contribute to the adult return cohort. This is only one year of data and it will be interesting to see if there is any inter-annual variability to that jacking event.

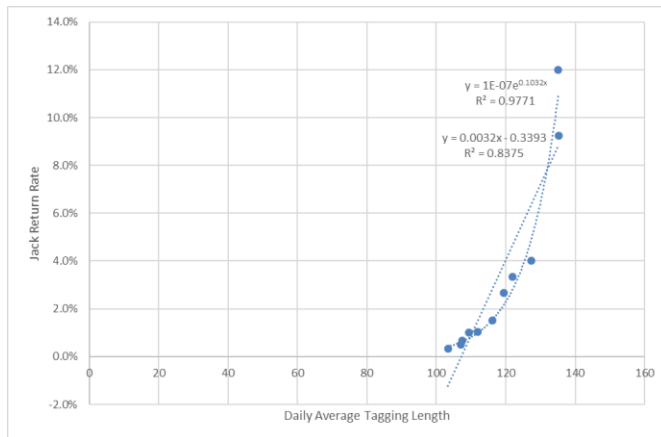


Figure 12. Correlation curve plotting Jacking rate vs. daily average smolt length

### **Other PIT Tag Recoveries:**

On May 30<sup>th</sup>, 2018 the Oyster River Enhancement Society conducted some juvenile beach seining in the Salmon Point Marina, which is between the mouth of the Oyster River and Black Creek. A-Tlegay Fisheries Society technicians participated in the beach seine events to monitor all fish captured for presence of PIT and CWT tags. Of the fish sampled, 1 coho was found to have a PIT tag, none with CWT. This PIT tag recovery was a fish from Black Creek that was using the marina as an early marine staging area. It was tagged at the fence on May 9<sup>th</sup>, and was 98 mm in length. The fish was released back into the marina shortly after sampling.

In future, looking for PIT tags in this type of beach seining/capture work could be conducted and used to evaluate early ocean rearing habitat usage by coho.

### **Recommendations from 2018 and Moving Forward (2019):**

There are a couple of recommendations from 2018 tagging and monitoring that are being implemented. Vidalife water conditioner will be used in the tagging recovery bath to help protect smolts against fungus. Smaller tag groups will be placed in the tag retention box, and for shorter periods of time (to reduce stress related mortality). PIT tagging will commence earlier in 2019 to try and capture, or evaluate the jacking window. Improvements will be focused on antenna electrical interference. The noise interference sources will be replaced with alternatives, and antennas will be tested and operational prior to expected 2019 returns.

2019 will see a further 4,000 PIT tags applied to juvenile coho leaving Black Creek in April and May as a continuation of this multi-year SEF funded project. In the fall both adults and jacks will be returning providing more data to support DFO salmon stock assessment information. A summary and evaluation of the PIT tag work will again be compiled and proved to the SEF committee.