

**Annual Incidental Take Report for 2017 – Bull Trout  
Skagit River Hydroelectric Project (FERC 553)  
Seattle City Light**

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***Introduction***

The U.S. Fish and Wildlife Service (USFWS) issued a Biological Opinion (BO) and Incidental Take Statement (ITS) (Reference Number O1EWF00-2012-F-0302) for the Skagit River Hydroelectric Project (FERC Project No. 553) on February 12, 2013. The ITS was issued under the terms of sections 7(b)(4) and 7(o)(2) of the Endangered Species Act (ESA), which provides that taking incidental to, and not intended as part of the agency action, is not considered prohibited, provided that such taking is in compliance with the terms and conditions of the ITS. The ITS requires that Seattle City Light (City Light) submit a take report for bull trout (*Salvelinus confluentus*) on an annual basis.

This Take Report for 2017 summarizes the monitoring methods used by City Light to estimate the annual incidental take of bull trout from the ongoing operations and maintenance of the Skagit River Hydroelectric Project (Project). The results of the monitoring are then used to provide an estimate of bull trout take from the following operational and maintenance activities and events:

- Turbine entrainment at Ross, Diablo, and Gorge dams
- Spillway entrainment at Ross, Diablo, and Gorge dams

***Bull Trout Monitoring for Estimating Incidental Take***

In 2017, City Light continued the acoustic monitoring program in the three Project reservoirs (Ross, Diablo, and Gorge) to estimate the number of bull trout entrained into the power tunnel intakes at the dams, and subsequently passing through the turbines of the power plants. This monitoring program was initiated in early 2013 following the issuance of the ITS by USFWS. Vemco VR2W acoustic receivers installed in all three reservoirs were used to monitor the movement of bull trout, to detect the entrainment of fish surgically implanted with acoustic transmitter tags into the power tunnel intakes, and to determine whether any entrained fish survived passing from the power tunnels through the turbines. City Light and their consultant, R2 Resource Consultants, maintained and periodically uploaded tag detection data from these receivers throughout the 2017 monitoring period.

## Ross Lake Receivers

A total of 18 acoustic receivers were active in Ross Lake during the 2017 monitoring period, with the majority of these (14) in the forebay, the deep basin area of the reservoir immediately upstream of Ross Dam (Figure 1; Table 1). The monitoring effort was greatest in Ross Lake because it supports higher numbers of bull trout compared to the other two project reservoirs.

The Ross Lake forebay acoustic receiver array was designed specifically to track movement of tagged bull trout in the area of the reservoir where entrainment of fish into the power intakes and spillways would occur. The configuration of forebay receivers allows for an accurate assessment of the vulnerability of bull trout in Ross Lake to both power intake and spillway entrainment. Two of the receivers, RFB11 and RFB 12, are located immediately in front of the Ross Dam intake structure to monitor the entrainment of bull trout into the two power tunnel intakes (Figure 1). The power intake tunnels are located about 185 ft below the surface of the reservoir at full pool. These two receivers, along with receivers situated at the Ross Dam boathouse (RFB10) and along the shore just north of the intake facility (RFB15), were used to monitor the area of the forebay where bull trout would be vulnerable entrainment into the power intakes. Any fish entrained into the power intakes would subsequently pass through the turbines, and then into Diablo Lake via the Ross Powerhouse tailrace. Three receivers, RFB08, RFB09, and RFB10, were located immediately in front of Ross Dam to monitor the entrainment of fish into the spillways during spill events.

Four receivers were used to monitor the movement of bull trout in the middle area of the forebay: RFB05, RFB06, RFB07, and RFB14 (Figure 1). Finally, four receivers were also used to monitor fish in the outer forebay area: RFB01 and RFB02 located near Ross Lake Resort, and RFB03 and RFB04 located on a long boom located at the far outer forebay area. For the 2017 monitoring period, the Ross Dam forebay receivers were downloaded in March 2017, October 2017, and April 2018.

In addition to the forebay receiver array, four receivers were also stationed near the mouths of major tributaries to Ross Lake to detect the movement of tagged bull trout in these streams for spawning (Figure 2). Receivers were located outside of the mouth of Ruby Creek (RLK01), in Big Beaver Creek (RLK02), and in Lightning Creek (RLK04). A tributary receiver (RLK05) was also stationed in the upper Skagit River, British Columbia approximately 0.8 miles upstream of the reservoir. For the 2017 monitoring period, the Ross Lake receivers were downloaded in March 2017, October 2017, and April 2018.

### Diablo Lake Receivers

A total of 10 receivers were deployed in Diablo Lake for bull trout monitoring purposes in 2017 (Figure 3; Table 2). The most downstream of these receivers (DLK01) was stationed at Diablo Dam near the power intakes. Two additional receivers were deployed in 2017 in response to prolonged spills that occurred at Diablo Dam due to generator maintenance (i.e., rewind of Generator Unit 31). One of the receivers (DLK09) was located at the south spillways where most of the spill was released during 2017, and the other (DLK10) was located near the north spillways and intakes.

Three receivers (DLK02, DLK03, and DLK05) were stationed around the main body of Diablo Lake to monitor the movement of bull trout within the reservoir. Two receivers were deployed in Thunder Arm area of the reservoir: one located near the mouth of Thunder Creek at the Highway 20 bridge (DLK07), and the second located midway in Thunder Arm (DLK04). The two Thunder Arm receivers are important for monitoring the movement of bull trout into Thunder Creek, which is the largest bull trout spawning area in the Diablo basin.

The most upstream receiver (DLK06) was located at the tailrace of Ross Powerhouse. This receiver was used to detect any tagged bull trout in Ross Lake that were entrained into the Ross Dam power tunnel intakes and released into Diablo Lake. An additional receiver (DLK08) was deployed in the middle of the Diablo canyon area, which is narrow channel located between Ross Powerhouse the main body of Diablo Lake. For the 2017 monitoring period, the Diablo Lake receivers were downloaded in March 2017, October 2017, and April 2018.

### Gorge Lake Receivers

A total of eight receivers were deployed in Gorge Lake during the 2017 bull trout monitoring period (Figure 4; Table 3). The most downstream of these receivers (GLK01) was located in the forebay of Gorge Dam. This receiver was located just upstream of Gorge Dam, and was used to detect the entrainment of tagged bull trout into the power intake tunnels. This receiver was also important for detecting the entrainment of bull trout into the Gorge Dam spillways, since any bull trout passing into this area of the reservoir would also be vulnerable to entrainment during periods of spill.

Five receivers were situated throughout the main body of Gorge Lake (GLK02, GLK03, GLK04, GLK05) to monitor the movement and habitat use of tagged bull trout in the reservoir. A receiver was also placed in the reservoir immediately across from the Diablo powerhouse tailrace (GLK06). The purpose of this receiver was to detect any bull trout that were tagged in Diablo Lake, and subsequently entrained into the power intakes and through the turbines into Gorge Lake. In 2017, another receiver (GLK07) was added in the upper area of the Gorge Lake at

Reflector Bar to better detect any tagged fish that had passed over the Diablo Dam spillways. Finally, a receiver was deployed for the first time in 2017 at the lower end of Stetattle Creek (GLK08) to monitor the movement of bull trout into and out of this tributary. Stetattle Creek is the only bull trout spawning stream located in the Gorge Lake basin.

A receiver (SKG01) continued to be deployed in the Skagit River immediately downstream of the Gorge Powerhouse tailrace (Table 3) to detect any tagged bull that were entrained into the power tunnel intake or spillway of Gorge Dam and passed downstream into the Skagit River. For the 2017 monitoring period, the Gorge Lake and Skagit River receivers were downloaded in March 2017, September 2016, and April 2018

### Acoustic Tags

Beginning in 2011, adult bull trout from all three reservoirs have been captured using hook-and-line and surgically implanted with Vemco V13 acoustic tags. Fish are captured and tagged each year to replace those with expired tags. The collection and handling of fish, and surgical implantation of tags is conducted following the methods described in City Light's current USFWS scientific collection permit for an ESA-listed species (Permit TE 005885-4).

The acoustic tags currently implanted in bull trout at the Skagit Hydroelectric Project reservoirs have a lifespan ranging from 876 to 1583 days (2.4 to 4.3 years). All of the tags used were the low power version, which were found to be detectable by the VR2W receivers at distances exceeding 500 meters during range testing conducted in Ross Lake in 2014. The main advantage of the low power tags is their extended lifespan. The use of these tags has resulted in a substantial reduction in the number of bull trout that need to be captured and tagged each year, since a tagged fish can now be tracked from between 2.4 and 4.3 years depending upon the tag type used. Temperature and depth sensor tags have a 2.4-year lifespan, while the non-sensor "pinger" tags have a lifespan of 4.3 years. Bull trout have lifespans that can exceed 10 years, which means that a tagged bull trout can be tracked for several years.

In Ross Lake, a total of 37 tags were active during the 2017 monitoring period (Table 4). Most of these tags (23) were implanted in bull trout in 2014 and 2015, and continued to transmit data through 2017. The majority of acoustic tags (34) used in Ross Lake were temperature and pressure (TP) sensor tags. The sensors in these tags provide the ability to track the depths used by bull trout, as well as the temperature regimes used by the fish in this thermally stratified reservoir. This is especially useful for detecting and monitoring fish that swim close to the Ross Dam power tunnel intakes, which are located 185 ft below the surface of the reservoir at full pool elevation. Three bull trout were implanted with non-sensor "pinger" tags that transmit a unique identification code for each fish.

A total of four tags were implanted in bull trout in Diablo Lake and were active during the 2017 monitoring period (Table 5). All the tags used in Diablo Lake were “pinger” tags. Bull trout remain very difficult to capture in Diablo Lake, and several attempts were made during the year to capture and tag bull trout in this reservoir. Diablo Lake does not have a very large population of bull trout compared to Ross Lake, and unlike Gorge Lake, the bull trout in Diablo Lake use deeper waters where they are difficult to capture. The results of recent genetic analysis conducted by the Washington Department of Fish and Wildlife’s (WDFW) genetics lab suggest that most native char in Diablo Lake are Dolly Varden, which are substantially smaller in size than bull trout. All of the native char captured and tagged in Diablo Lake were bull trout based upon their large size. The WDFW Molecular Genetics Lab (Olympia) has confirmed that all the fish tagged to date were bull trout.

A total of 10 tags implanted in bull trout in Gorge Lake and were active during the 2017 monitoring period (Table 6). All of these tags were implanted from 2014 through 2016, and will remain active until 2019 through 2021. All of the tags in Gorge Lake are “pinger” tags.

In Ross Lake, 19 of the 37 bull trout with active acoustic tags were detected in 2017 (Table 7). Ross Lake has a very large volume (1.4 million acre-ft) and tributary drainage network (1,000 sq-miles) compared to the two smaller Project reservoirs, so detecting all the tagged fish is challenging. The receiver array detected 51 percent of the bull trout with active tags in 2017. A total of 137,555 unique detections of tagged bull trout were recorded by the Ross Lake acoustic receiver array during 2017, an average of 6,878 data points for each fish detected. This detection rate was similar to that observed during the 2016 monitoring period.

Of the 37 bull trout with active tags in Ross Lake, only 7 (19 percent) were found to have used the forebay area of the reservoir during the 2017 monitoring period (Table 7). This is substantially lower than the percentage of tagged fish detected in the forebay in 2016 (65 percent), indicating that bull trout used the forebay area of the reservoir much less in 2017. A total of 24,977 detections were recorded by the receivers deployed in the forebay, accounting for 18 percent of all the detections observed in the Ross Lake drainage during 2017. The percentage of detections observed in the forebay in 2017 was much lower than that observed in 2016 (68 percent), indicating that tagged bull trout spent less time in the forebay during 2017. This suggests that the risk of entrainment was considerably less in 2017 than in 2016.

Five (5) of the 37 tagged bull trout (14 percent) were detected within the power intake zone of the forebay during 2017 (i.e., detected by receivers RFB10, RFB11, RFB 12, or RFB14). The 2,954 detections in the intake area of Ross Dam accounted for 2.1 percent of the detections observed in the Ross Lake study area in 2017. The bull trout tag detections in the intake zone represented 11.8 percent of the detections in the forebay area. The relatively small number of tags and low number of detections in the intake zone in 2017 confirms our conclusion from prior

years that the intake zone is a low-use area for bull trout. Low entrainment rates into the power intakes would be expected because of the infrequent use of the intake zone by bull trout.

All four bull trout implanted with tags in Diablo Lake were detected during the 2017 monitoring period (Table 8). A total of 82,682 detections were observed in Diablo Lake during 2017, representing an average of 27,542 detections per fish. One of the tagged fish was entrained into the power intakes of Diablo Dam in 2016, survived turbine passage, and is now residing in Gorge Lake. Of the three tagged bull trout remaining in Diablo Lake, none were detected at the receiver located in front of the Diablo Dam power intakes (DLK10) in 2017. Two of the tagged fish were detected in the proximity of the Diablo Dam spillways by receivers DLK01 and DLK09. However, the 1,498 detections in the Diablo Dam forebay area (including spillway and intake zones) only amounted to 1.8 percent of all detections observed in Diablo Lake in 2017 (Table 8). Most detections of tagged bull trout in Diablo Lake were observed in the area immediately downstream of the Ross Powerhouse tailrace, and in the Thunder Arm area of the reservoir (see Figure 3). This observation supports our conclusion from previous years that the power intake and spillway zones of Diablo Lake are infrequently used by bull trout.

As described in the 2016 monitoring report, one of the bull trout tagged in 2016 (tag A69-1601-58468) was entrained into the Diablo Dam power intakes during December 2016, survived passage through the turbines, and was released via the tailrace into Gorge Lake where this fish now resides. This fish was observed in Gorge Lake throughout the 2017 monitoring period, accounting for 125,678 detections in this reservoir (Table 8). Analysis of the temporal detections patterns indicated that this fish remained active throughout the 2017 monitoring period, frequently moving into and out of the Diablo Powerhouse tailrace area of Gorge Lake during the year.

In Gorge Lake, 6 of 10 bull trout tagged in this reservoir (60 percent) were detected in 2017 (Table 9). A total of 149,587 detections were recorded in this reservoir during this monitoring period (not including the bull trout from Diablo Lake that was described earlier), with an average 14,960 detections per fish with an active tag. None of the tagged bull trout were detected in the forebay area of Gorge Dam, where the power intakes and spillways are located, in 2017. This supports our conclusion from prior take monitoring reports that the forebay area of Gorge Dam is a low-use habitat zone for bull trout. Most bull trout detections in Gorge Lake were recorded in the Diablo Powerhouse tailrace area of the reservoir (receiver GLK06), and in deep pools located immediately downstream and upstream of the tailrace (receivers GLK05 and GLK07). Together, these three receivers accounted for over 95 percent of the detections in the reservoir. The Diablo Powerhouse tailrace has been consistently the most highly used area by bull trout in Gorge Lake since monitoring commenced in 2011, which is likely a result of the excellent foraging opportunities provided at this location. No fish were observed at the Stetattle Creek receiver (GLK08), indicating that none of the tagged bull trout migrated into this tributary during 2017.

### ***Turbine Entrainment and Mortality***

None of the bull trout tagged in Ross Lake were later detected in Diablo Lake or Gorge Lake (Table 7), indicating that none passed through the Ross Powerhouse turbines. Of 19 bull trout detected in the Ross Lake, none were last detected at the two receivers (RFB11 and RFB12) located in front of the Ross Dam power intakes, or at the two receivers (RFB10 and RFB 15) located adjacent to this intake area (Table 7). Any bull trout that would have been last detected near the Ross Dam power intakes would be assumed to have been entrained into the intakes. The tagged bull trout in Ross Lake were last detected at the outer areas of the dam forebay (RFB02 and RFB04), or at receivers located near the mouths of Ruby Creek (RLK01) and Big Beaver Creek (RLK02). Any tag passing through the Ross Powerhouse turbines, including the tag of a dead fish, would have been detected by a receiver (station DLK06) located immediately downstream of the Ross Powerhouse tailrace.

None of the tagged fish in Diablo Lake were entrained into the power intakes of Diablo Dam during the 2017 monitoring period (Table 8). As described earlier, one of the bull trout that was tagged in this reservoir in 2016 was entrained into the power intakes in December 2016. This fish survived passage through the turbines as described in the 2016 monitoring report, and now resides in Gorge Lake. Of the three remaining active bull trout tags in the Diablo Lake, none were last detected at receivers DLK01, DLK09, and DLK10, which are situated in the Diablo Dam forebay area where the spillways and intakes area located (Table 8). Any fish entrained into the power intakes and spillways would have been last detected at one of these three receivers. The majority of bull trout tag detections in Diablo Lake occurred in the Ross Powerhouse tailrace and Thunder Arm areas of the reservoir.

No tagged bull trout were entrained into the Gorge Dam power intakes during the 2017 monitoring period. Of 11 bull trout with active tags in Gorge Lake (including tag A69-1601-58468 which originated from Diablo Lake), none were detected in the forebay area of the reservoir during 2017 (Table 9). In addition, no tags were detected in the Gorge Powerhouse tailrace area (receiver SKG01) during this monitoring period. Any tagged bull trout passing through the Gorge Powerhouse turbines would likely be detected at this location. Of the tagged bull trout in Gorge Lake, all were last observed in the upper half of reservoir (Table 9) at receivers GLK05K, GLK06, and GLK07. Any fish that was entrained into the power intakes or spillways would have been last detected in the lower half of Gorge Lake by receivers GLK02 and GLK03, and especially at receiver GLK01 which is located near the power intakes and spillways of Gorge Dam.

In conclusion, the results of acoustic monitoring conducted in 2017 found that none of the tagged bull trout in Ross Lake, Diablo Lake, and Gorge Lake were entrained into the power intakes of the dams and subsequently through the powerhouse turbines. *Therefore, the total Incidental*

*Take for bull trout turbine mortality at the Skagit Hydroelectric Project for 2017 was determined to be zero.*

### ***Spillway Mortality***

As described in the previous section, no tagged bull trout were detected passing either into the power intakes or over the spillways of the three Skagit dams.

The 2013 Biological Opinion and ITS for bull trout for the Skagit Hydroelectric Project requires the estimation of spillway mortality based upon the number of days of spill that are recorded during the year at each dam.

There were zero days of spill at Ross Dam in 2017 (see Figure 5). Spills at this dam are rare due to the large storage capacity of Ross Lake, with an average of three (3) days of spill per year observed from 2013 through 2016.

The number of days of spill at Diablo Dam was much higher in 2017 than previous years due to an extended maintenance outage at Diablo Powerhouse. Generator Unit 31 was taken offline starting on March 27, 2017 for rewinding the generator. This unit, which provides approximately 45 percent of the generating capacity at Diablo Powerhouse, remained offline for the remainder of the year. Due to the reduced generating capacity of the Diablo power facility, spills at Diablo Dam occurred between March 27 and July 17 (Figure 5). Minor spills (< 500 cfs) occurred from July 18 through November 12, with many days of zero spill observed during this period. Major spilling (> 1,000 cfs) at Diablo Dam occurred between November 13 and December 4 due to large winter storms and high inflows to the reservoir. As a result of generator maintenance, spill occurred for 195 days at Diablo Dam in 2017. In comparison, Diablo Dam spilled an average of 37 days per year from 2013 through 2016.

At Gorge Dam, spills were associated with large Pacific storms that occurred in early March and early December, and from high snowmelt runoff in early June (Figure 5). Spills were observed on 29 days at Gorge Dam in 2017, compared to an average yearly total of 28 days from 2013 through 2016. Thus, the number of spill days observed at Gorge Dam in 2017 was very close to the average value.

The BiOP for the Skagit Hydroelectric project (USFWS 2013) describes the method for calculating spillway mortality of bull trout based upon the percent of time that spill occurs during the year at each of the three dams.

For Ross Dam, this method assumes an annual take of 1 bull trout (fish entrained by the spillways and subsequently killed), given that the dam spilled on average 0.6 percent of the time



(2.2 days) on an annual basis. Adjusting for the spills observed at Ross Dam in 2017 (zero days during the year), the annual take estimate for spill at this dam would be **zero** bull trout.

For Diablo Dam, this method estimates an annual take of 6 bull trout (fish entrained by the spillways and subsequently killed), assuming that the dam spilled, on average, 6.2 percent of the time (22.6 days) on an annual basis. Adjusting for the spills observed at Diablo Dam in 2017 (53.4 percent of the days during the year), the annual take estimate for spill at this dam would be **52** bull trout.

Finally, for Gorge Dam, this method estimates an annual take of 6 bull trout (spillway passage mortality) assuming that spills occur on average 5.5 percent of the time (20.1 days) on an annual basis. Based on the observed spill rate at Gorge Dam in 2017 (7.9 percent of the days during the year), the annual estimated take would be **4** bull trout.

*Combining the spill mortalities estimated at the three dams, the total estimated Incidental Take for spillway mortality at the Skagit Hydroelectric Project for 2017 is therefore **56** bull trout.*

#### ***Total Incidental Take Estimate for 2017***

The total estimated Incidental Take of bull trout attributed to the ongoing operation of the Skagit Hydroelectric Project (including the Ross, Diablo, and Gorge power facilities) for the 2017 can be summarized as follows:

- Turbine mortality – zero
- Spillway mortality – 56 fish (assumed to be adults)

The total annual Incidental Take at the Skagit Hydro Project is therefore estimated to be **56** bull trout.



Figure 1. Acoustic receiver array in Ross Lake forebay for 2017.



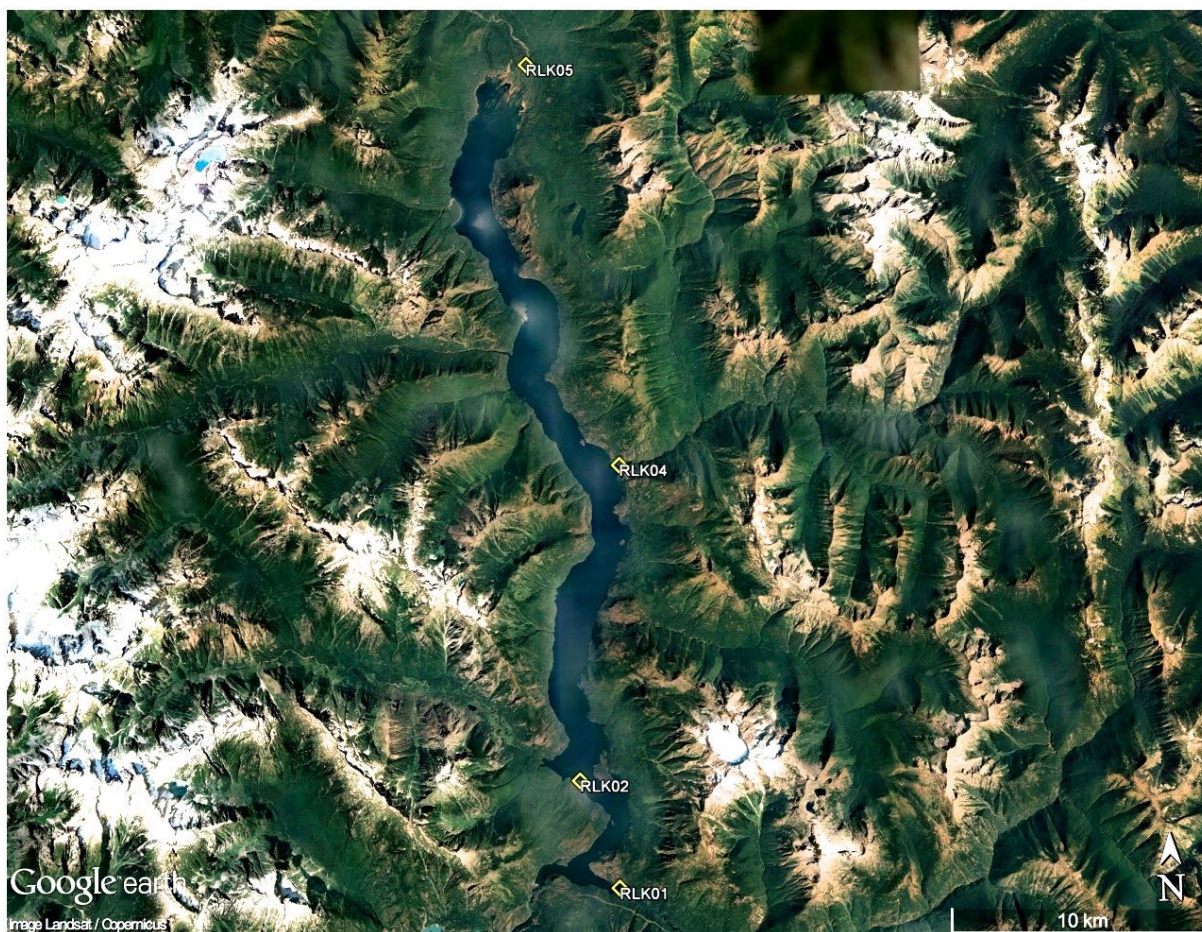


Figure 2. Acoustic receiver array in Ross Lake outside the forebay for 2017.





Figure 3. Acoustic receiver array in Diablo Lake for 2017.



Figure 4. Acoustic receiver array in Gorge Lake for 2017.



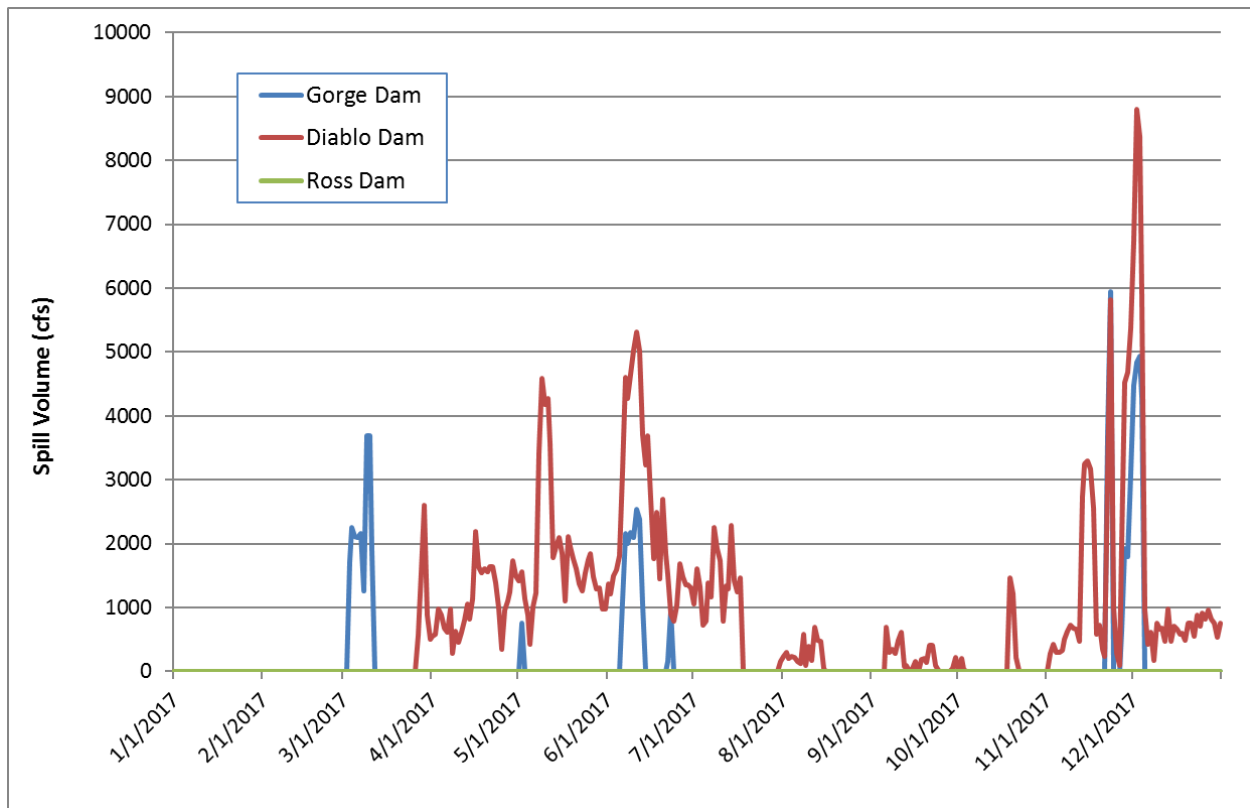


Figure 5. Spill timing and spill volumes at Ross, Diablo, and Gorge dams in 2017.

Table 1. Acoustic receivers deployed in Ross Lake during 2017 monitoring period.

Receiver	Location	Station	Deployment	Latitude	Longitude
			Date		
VR2W-105049	Resort Boom West	RFB01	2/23/2012	48.73759	-121.06577
VR2W-105034	Resort Boom East	RFB02	2/23/2012	48.73890	-121.06072
VR2W-122250	Outer Boom North	RFB03	2/23/2012	48.73764	-121.05405
VR2W-122843	Outer Boom South	RFB04	2/23/2012	48.73670	-121.05563
VR2W-105035	Inner Boom South	RFB05	2/23/2012	48.73449	-121.06480
VR2W-105037	Inner Boom Middle	RFB06	2/23/2012	48.73470	-121.06595
VR2W-105045	Inner Boom North	RFB07	2/23/2012	48.73419	-121.06817
VR2W-102681	Dam Boom North	RFB08	2/23/2012	48.73283	-121.06866
VR2W-105671	Ross Boathouse North	RFB09	2/23/2012	48.73254	-121.06784
VR2W-105044	Ross Boathouse South	RFB10	10/20/2011	48.73236	-121.06760
VR2W-101961	Ross Dam Intakes West	RFB11	2/23/2012	48.73168	-121.06695
VR2W-105046	Ross Dam Intakes East	RFB12	2/23/2012	48.73180	-121.06638
VR2W-102788	Ross Resort Shoreline	RFB14	3/19/2013	48.73420	-121.06863
VR2W-122857	Ross Dam Intake Shoreline	RFB15	3/19/2013	48.73276	-121.06527
VR2W-104295	Ruby Arm Outlet	RLK01	2/7/2013	48.73004	-121.02532
VR2W-104779	Big Beaver Mouth	RLK02	2/7/2013	48.76682	-121.04427
VR2W-101602	Lightning Creek Mouth	RLK04	2/7/2013	48.87482	-121.01878
VR2W-101960	Upper Skagit River, B.C.	RLK05	10/10/2012	49.01927	-121.06065

Table 2. Acoustic receivers deployed in Diablo Lake during 2017 monitoring period.

Receiver	Location	Station	Deployment	Latitude	Longitude
			Date		
VR2W-105039	Diablo Dam North Spillways	DLK01	3/2/2012	48.71376	-121.13133
VR2W-102789	Diablo Lake North	DLK02	3/2/2012	48.71690	-121.11940
VR2W-103973	Diablo Lake South	DLK03	11/14/2013	48.70840	-121.10806
VR2W-102780	Middle Thunder Arm	DLK04	10/17/2012	48.70165	-121.09862
VR2W-105038	Lower Diablo Canyon	DLK05	3/2/2012	48.71213	-121.09091
VR2W-104781	Ross Powerhouse Tailrace	DLK06	3/2/2012	48.72961	-121.07244
VR2W-105036	Thunder Arm Bridge	DLK07	3/19/2015	48.69101	-121.09552
VR2W-102787	Middle Diablo Canyon	DLK07	11/17/2017	48.71935	-121.07662
VR2W-105036	Diablo Dam South Spillways	DLK07	11/17/2017	48.71302	-121.13143
VR2W-101959	Diablo Dam Intakes	DLK07	11/17/2017	48.69110	-121.09548

Table 3. Acoustic receivers deployed in Gorge Lake during 2017 monitoring period.

Receiver	Location	Station	Deployment	Latitude	Longitude
			Date		
VR2W-105047	Gorge Dam Logboom	GLK01	12/7/2011	48.69951	-121.20055
VR2W-103974	Gorge Lake Right Bank	GLK02	12/7/2011	48.70361	-121.18240
VR2W-105041	Gorge Lake Left Bank	GLK03	12/7/2011	48.70845	-121.16502
VR2W-104300	Davis Ranch	GLK04	12/5/2013	48.71327	-121.15244
VR2W-102680	Gorge Lake Hollywood	GLK05	12/7/2011	48.71625	-121.14826
VR2W-102682	Diablo Powerhouse Tailrace	GLK06	12/7/2011	48.71518	-121.14468
VR2W-122848	Reflector Bar	GLK07	11/17/2017	48.71188	-121.14317
VR2W-122853	Stetattle Creek	GLK08	8/3/2017	48.71708	-121.14993
VR2W-104294	Skagit River Newhalem	SKG01	12/7/2011	48.67210	-121.24653



Table 4. Active acoustic tags in Ross Lake during 2017 monitoring period (TP = temperature/depth sensor tag; PING = pinger tag).

Tag Number	Tagging Site	Sensor	Tagging Date	Tag End Date	Sex	Length (mm)	Weight (g)
A69-1105-60/61	Big Beaver Cr	TP	11/5/2014	3/30/2017	m	530	1650
A69-1105-62/63	Ruby Cr	TP	6/25/2015	11/17/2017	m	503	1450
A69-1105-64/65	Ruby Cr	TP	6/25/2015	11/17/2017	f	500	1600
A69-1105-66/67	Big Beaver	TP	11/5/2014	3/30/2017	m	585	1900
A69-1105-68/69	Big Beaver	TP	11/5/2014	3/30/2017	m	610	2100
A69-1105-70/71	Big Beaver Cr	TP	6/24/2015	11/16/2017	m	600	1850
A69-1105-72/73	Big Beaver Cr	TP	6/24/2015	11/16/2017	m	510	1450
A69-1105-74/75	Big Beaver Cr	TP	6/24/2015	11/16/2017	f	473	1100
A69-1105-76/77	Big Beaver Cr	TP	6/24/2015	11/16/2017	f	620	2100
A69-1105-78/79	Big Beaver Cr	TP	6/24/2015	11/16/2017	m	490	1250
A69-1105-80/81	Big Beaver Cr	TP	6/24/2015	11/16/2017	m	610	1750
A69-1105-82/83	Big Beaver Cr	TP	6/24/2015	11/16/2017	f	430	1000
A69-1105-84/85	Big Beaver Cr	TP	6/24/2015	11/16/2017	m	418	850
A69-1105-86/87	Ruby Cr	TP	6/12/2015	11/4/2017	f	530	1350
A69-1105-88/89	Ruby Cr	TP	6/12/2015	11/4/2017	f	505	1400
A69-1105-90/91	Ruby Cr	TP	6/12/2015	11/4/2017	m	550	1800
A69-1105-92/93	Big Beaver Cr	TP	6/24/2015	11/16/2017	m	531	1550
A69-1105-94/95	Big Beaver	TP	6/11/2015	11/3/2017	m	435	1200
A69-1105-96/97	Ruby Cr	TP	6/12/2015	11/4/2017	m	520	1650
A69-1105-98/99	Ruby Cr	TP	6/12/2015	11/4/2017	m	495	1350
A69-1601-58455	Big Beaver Cr	PING	11/12/2015	3/13/2020	m	570	1800
A69-1601-58456	Big Beaver Cr	PING	11/12/2015	3/13/2020	m	473	1050
A69-1601-58457	Big Beaver Cr	PING	11/12/2015	3/13/2020	m	448	950
A69-9006-15678/15679	Big Beaver Cr	TP	10/26/2017	11/29/2020	m	490	1350
A69-9006-15680/15681	Big Beaver Cr	TP	10/26/2017	11/29/2020	m	500	1280
A69-9006-15682/15683	Big Beaver Cr	TP	10/11/2017	11/14/2020	m	510	1230
A69-9006-15684/15685	Big Beaver Cr	TP	10/11/2017	11/14/2020	m	530	1420
A69-9006-15686/15687	Big Beaver Cr	TP	10/17/2017	11/20/2020	m	510	1300
A69-9006-15688/15689	Big Beaver Cr	TP	10/26/2017	11/29/2020	m	650	2280
A69-9006-15690/15691	Big Beaver Cr	TP	10/11/2017	11/14/2020	m	565	1500

Table 4. (Continued).

Tag Number	Tagging Site	Sensor	Tagging Date	Tag End Date	Sex	Length (mm)	Weight (g)
A69-9006-15692/15693	Big Beaver Cr	TP	10/11/2017	11/14/2020	m	531	1240
A69-9006-15694/15695	Big Beaver Cr	TP	10/11/2017	11/14/2020	m	550	1360
A69-9006-15696/15697	Big Beaver Cr	TP	10/11/2017	11/14/2020	m	480	1200
A69-9006-15698/15699	Big Beaver Cr	TP	10/11/2017	11/14/2020	m	500	1280
A69-9006-15700/15701	Big Beaver Cr	TP	10/11/2017	11/14/2020	m	540	1560
A69-9006-15702/15703	Big Beaver Cr	TP	10/11/2017	11/14/2020	m	540	1480
A69-9006-15704/15705	Big Beaver Cr	TP	10/11/2017	11/14/2020	m	560	1650

Table 5. Active acoustic tags in Diablo Lake during 2017 monitoring period (PING = pinger tag).

Tag Number	Tagging Site	Sensor	Tagging Date	Tag End Date	Sex	Length (mm)	Weight (g)
A69-1601-22793	Thunder Arm	PING	2/19/2015	6/21/2019	m	555	1650
A69-1601-58460	Ross PH Tailrace	PING	11/17/2016	3/19/2021	m	507	1350
A69-1601-58467	Thunder Arm	PING	4/17/2017	8/17/2021	m	640	2500
A69-1601-58468	Ross PH Tailrace	PING	12/2/2016	4/3/2021	m	505	1250

Table 6. Active acoustic tags in Gorge Lake during 2017 monitoring period (PING = pinger tag).

Tag Number	Tagging Site	Sensor	Tagging Date	Tag End Date	Sex	Length (mm)	Weight (g)
A69-1601-22788	Diablo PH Tailrace	PING	11/4/2014	3/6/2019	m	750	3250
A69-1601-22789	Diablo PH Tailrace	PING	11/4/2014	3/6/2019	f	535	1900
A69-1601-22791	Diablo PH Tailrace	PING	2/19/2015	6/21/2019	m	558	1675
A69-1601-22794	Diablo PH Tailrace	PING	2/19/2015	6/21/2019	f	480	1150
A69-1601-58454	Diablo PH Tailrace	PING	11/13/2015	3/14/2020	m	755	3250
A69-1601-58458	Diablo PH Tailrace	PING	11/6/2015	3/7/2020	f	760	4400
A69-1601-58459	Diablo PH Tailrace	PING	11/13/2015	3/14/2020	f	563	2400
A69-1601-58461	Diablo PH Tailrace	PING	11/18/2016	3/20/2021	m	670	3500
A69-1601-58462	Diablo PH Tailrace	PING	11/18/2016	3/20/2021	f	520	1600
A69-1601-58463	Diablo PH Tailrace	PING	11/18/2016	3/20/2021	m	438	1100

Table 7. Acoustic tag detection summary for bull trout tagged in Ross Lake during 2017 monitoring period (ND = no detections).

Tag Number	Tagging Date	Last Detection Date	Last Detection Site	Ross Lake	Ross Dam Forebay	Ross Dam Intakes	Diablo Lake	Gorge Lake
A69-1105-60/61	11/5/2014	ND	ND	0	0	0	0	0
A69-1105-62/63	6/25/2015	ND	ND	0	0	0	0	0
A69-1105-64/65	6/25/2015	ND	ND	0	0	0	0	0
A69-1105-66/67	11/5/2014	ND	ND	0	0	0	0	0
A69-1105-68/69	11/5/2014	ND	ND	0	0	0	0	0
A69-1105-70/71	6/24/2015	ND	ND	0	0	0	0	0
A69-1105-72/73	6/24/2015	ND	ND	0	0	0	0	0
A69-1105-74/75	6/24/2015	ND	ND	0	0	0	0	0
A69-1105-76/77	6/24/2015	5/19/2017	RLK02	1,357	0	0	0	0
A69-1105-78/79	6/24/2015	5/24/2017	RLK02	1	0	0	0	0
A69-1105-80/81	6/24/2015	ND	ND	0	0	0	0	0
A69-1105-82/83	6/24/2015	5/6/2017	RLK02	2	0	0	0	0
A69-1105-84/85	6/24/2015	5/16/2017	RLK02	332	0	0	0	0
A69-1105-86/87	6/12/2015	ND	ND	0	0	0	0	0
A69-1105-88/89	6/12/2015	ND	ND	0	0	0	0	0
A69-1105-90/91	6/12/2015	ND	ND	0	0	0	0	0
A69-1105-92/93	6/24/2015	ND	ND	0	0	0	0	0
A69-1105-94/95	6/11/2015	7/22/2017	RLK02	492	0	0	0	0
A69-1105-96/97	6/12/2015	ND	ND	0	0	0	0	0
A69-1105-98/99	6/12/2015	9/21/2017	RLK01	80,846	1,504	12	0	0
A69-1601-58455	11/12/2015	ND	ND	0	0	0	0	0
A69-1601-58456	11/12/2015	ND	ND	0	0	0	0	0
A69-1601-58457	11/12/2015	ND	ND	0	0	0	0	0
A69-9006-15678/15679	10/26/2017	4/8/2018	RLK02	85	0	0	0	0
A69-9006-15680/15681	10/26/2017	4/22/2018	RFB04	3,089	2,793	101	0	0
A69-9006-15682/15683	10/11/2017	12/26/2017	RLK02	11,300	9,482	914	0	0
A69-9006-15684/15685	10/11/2017	10/17/2017	RLK02	32	0	0	0	0
A69-9006-15686/15687	10/17/2017	10/20/2017	RLK02	6	0	0	0	0
A69-9006-15688/15689	10/26/2017	4/22/2018	RFB04	5,279	5,136	1,229	0	0
A69-9006-15690/15691	10/11/2017	4/15/2018	RLK02	0	0	0	0	0

Table 7. (Continued).

Tag Number	Tagging Date	Last Detection Date	Last Detection Site	Ross Lake	Ross Dam Forebay	Ross Dam Intakes	Diablo Lake	Gorge Lake
A69-9006-15692/15693	10/11/2017	4/11/2018	RLK02	3,177	0	0	0	0
A69-9006-15694/15695	10/11/2017	4/23/2018	RFB02	20,483	1	0	0	0
A69-9006-15696/15697	10/11/2017	4/22/2018	RLK02	9,215	6,011	698	0	0
A69-9006-15698/15699	10/11/2017	4/23/2018	RLK02	751	0	0	0	0
A69-9006-15700/15701	10/11/2017	12/7/2017	RLK02	281	50	0	0	0
A69-9006-15702/15703	10/11/2017	4/18/2018	RLK02	1	0	0	0	0
A69-9006-15704/15705	10/11/2017	4/2/2018	RLK02	826	0	0	0	0
TOTAL DETECTIONS				137,555	24,977	2,954	0	0

Table 8. Acoustic tag detection summary for bull trout tagged in Diablo Lake during 2017 monitoring period (ND = no detections).

Tag Number	Tagging Date	Last Detection Date	Last Detection Site	Diablo Lake	Diablo Dam Spillways	Diablo Dam Intakes	Gorge Lake
A69-1601-22793	2/19/2015	2/25/2017	DLK07	5,080	0	0	0
A69-1601-58460	11/17/2016	11/24/2017	DLK06	37,972	1,482	0	0
A69-1601-58467	4/17/2017	2/25/2018	DLK04	39,630	16	0	0
A69-1601-58468	12/2/2016	4/12/2018	GLK06	0	0	0	125,678
TOTAL DETECTIONS				82,682	1,498	0	125,678

Table 9. Acoustic tag detection summary for bull trout tagged in Gorge Lake during 2017 monitoring period (ND = no detections).

Tag Number	Tagging Date	Last Detection Date	Last Detection Site	Gorge Lake	Gorge Dam Forebay	Gorge Powerhouse Tailrace
A69-1601-22788	11/4/2014	ND	ND	0	0	0
A69-1601-22789	11/4/2014	10/2/2017	GLK06	20,255	0	0
A69-1601-22791	2/19/2015	ND	ND	0	0	0
A69-1601-22794	2/19/2015	ND	ND	0	0	0
A69-1601-58454	11/13/2015	6/21/2017	GLK06	10,038	0	0
A69-1601-58458	11/6/2015	ND	ND	0	0	0
A69-1601-58459	11/13/2015	6/15/2017	GLK06	13,334	0	0
A69-1601-58461	11/18/2016	4/12/2018	GLK06	51,408	0	0
A69-1601-58462	11/18/2016	10/1/2017	GLK06	29,750	0	0
A69-1601-58463	11/18/2016	4/12/2018	GLK06	24,812	0	0
TOTAL DETECTIONS				149,597	0	0