

## **Columbia River Project Water Use Plan**

### **Kinbasket Fish and Wildlife Information Management Plan**

### **Kinbasket and Revelstoke Reservoirs Kokanee Population Monitoring**

### **Implementation Year 10**

### **Reference: CLBMON-2**

### **Kinbasket and Revelstoke Reservoirs Kokanee Population Monitoring – *Year 10 (2017)***

**Study Period: 2017**

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This is a progress report for a long-term monitoring program and, as such, contains preliminary data. Conclusions are subject to change and any use or citation of this report or the information herein should note this status.

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## **Kinbasket and Revelstoke Reservoirs Kokanee Population Monitoring – Year 10 (2017)**

Prepared by D. Sebastian and T. Weir

### **INTRODUCTION**

During July of 2017, the tenth year of a proposed twelve-year study to monitor kokanee in the limnetic habitat of two Columbia Basin reservoirs, Revelstoke and Kinbasket, was undertaken by the Fish & Aquatic Habitat Branch of the Ministry of Forests, Lands, Natural Resource Operations & Rural Development (FLNRORD) and BC Hydro (BCH) under its Columbia River Water License Requirements (WLR) program. The project is part of a long-term monitoring program to determine if there is a correlation between reservoir operations and the abundance and growth of kokanee.

This report documents progress up to and including the 2017 study year as part of the terms outlined in the CLBMON 2 Contribution Agreement 2016-2019. The agreement outlines roles and responsibilities in this mutually beneficial partnership between BC Hydro and the Province of BC.

This report presents summary data and results of the 2017 field survey in relation to previous years of trend data using the same survey design, equipment and methods.

In June 2012, Addendum 1 was created for the Kinbasket and Revelstoke Reservoirs Kokanee Population Monitoring (CLBMON-2) Terms of Reference. The addendum allowed for continued escapement monitoring and biological sampling for selected tributaries to Kinbasket and Revelstoke in 2013 and for continued escapement and biological monitoring in Camp Creek beyond 2013. Data for the Columbia River mainstem spawning population in 2016 and 2017 were collected by the Freshwater Fisheries Society of BC (FFSBC) as part of an egg collection conducted to mitigate production shortfalls in Kootenay Lake. These data were collected through direction and funding from outside our study but are presented herein.

### **METHODS AND EQUIPMENT**

Hydroacoustic data collection and trawl sampling were done at night from a closed cabin 7.3m FLNRORD research boat fully equipped for night work and navigation. From 2009 onward, acoustic data were collected using a Simrad

EK60 split beam scientific sounder operating at a frequency of 120 KHz. Details on data storage, software and standard analyses and statistical treatments are described in Sebastian and Weir (2017). Transect fish densities for Kinbasket and Revelstoke reservoirs are summarized in Appendices 1 and 2, respectively. Thirty standard transects for Kinbasket were completed in 2017 and an additional 6 short transects were undertaken in Bush Pool. Reservoir levels used to estimate habitat areas by depth strata at the time of survey were obtained from BC Hydro. Statistics used to calculate Maximum Likelihood population estimates (MLE) and bounds using Monte Carlo simulations are shown in Appendices 3 and 4 for Kinbasket and Revelstoke reservoirs respectively. Other statistical bounds represent 95% confidence limits on mean values using  $\pm 2$  times standard error. Inferences on statistical significance throughout this report are made based on whether confidence intervals overlap between estimates and are not based on specific statistical tests.

A method for setting the lower acoustic thresholds was developed in 2013 to reduce the impact of low-end noise (i.e. non-fish targets) encroaching on the fish distribution. The method as described by Sebastian and Weir (2015) has been applied to all SONAR5 analyses from 2009 through 2017 on both Kinbasket and Revelstoke Reservoirs. The resulting size distributions were plotted separately for noise and fish to show the suggested degree of overlap by this method for Revelstoke (Appendix 5) and Kinbasket (Appendix 6) reservoirs.

Biomass (kg) of standing crop was estimated directly from acoustic data following methods outlined in Bray et al. (2018). The method relies on two new empirical relations: 1) acoustic size distributions from seven years were compared with the kokanee size distribution from combined trawl and gillnet catches over the same period to develop a regression between acoustic echo target strength (decibels) and kokanee fork length (cm); and 2) an empirical relation between kokanee fork length (cm) and weight (g) for Kinbasket and Revelstoke reservoirs was used to estimate the mean weight of kokanee by 1dB size increments of echo target strength. Biomass (kg) was converted to a biomass density ( $\text{kg}\cdot\text{ha}^{-1}$ ) to facilitate comparisons between Kinbasket and Revelstoke and with other kokanee systems.

Trawl sampling was conducted to verify the assumption that kokanee was the dominant species observed at night during the hydroacoustic survey, and to collect biological samples for determining length, weight, age and growth. Sampling occurred during the night-time hours and began a minimum of 1 hour after civil sunset. Trawling was conducted from the FLNRORD research boat outfitted with a dual drum hydraulic winch and boom arm, towing a 7 m deep by 3 m wide and 21 m long beam net, with graduated mesh (92 mm down to 6 mm, stretched). Acoustic data collected during the nights immediately prior to trawl sampling were evaluated to determine the vertical fish distribution and the highest density layers were targeted during trawl sampling. The net depth and

distance from the boat were measured in real-time using a Notus trawl depth sensor system attached to the top trawl bar. Trawl speed was 2.7 kph to 3.0 kph (0.75 – 0.83 m/s) and was measured using a GPS chart plotter with external antenna for improved accuracy.

Two trawls were conducted at one location (midway up Wood Arm) on Kinbasket Reservoir in 2017. Trawl sampling was discontinued on Revelstoke Reservoir in 2017 due to very low kokanee densities. Trawl depths, duration fished, and a summary of biological data are presented in Appendix 7.

Gillnetting was conducted to complement trawl catches on Kinbasket Reservoir, and as the sole method of capturing kokanee samples for Revelstoke Reservoir. Two pelagic gillnets were set over-night in Revelstoke Reservoir with one set at each of transects 5 and 11. Four pelagic gillnets were set in Kinbasket Reservoir with two sets in Wood Arm near transect 18 and two sets in Bush Pool at Transect 33 (south of Bear Island) and Transect 36 (east side of Bush Pool). Gillnet sites were chosen to maximize catch by targeting locations and depths with the highest age 1-3 kokanee densities, based on evaluation of acoustic data collected just prior to gillnetting.

Each gillnet set consisted of three or four modified<sup>1</sup> Resources Information Standards Committee (RIC) standard nets attached end to end for a total length of 320 or 427m per set respectively. Gillnet set and retrieval followed the methods outlined by Sebastian and Weir (2016). Gillnetting details including GPS coordinates, net depth and area, soak time, kokanee and Bull Trout catch and CPUE are presented in Appendix 8 and biological information from captured fish is shown in Appendix 9. Note that live fish were released at the time of net retrieval and ages were estimated. Ages for trawl and gillnet caught kokanee were determined through scale analyses by specialists under contract to the Ministry of Environment using Ministry equipment at the lab in Abbotsford, BC.

Kinbasket spawners were sampled for biological data by angling in Camp Creek, dip net in Luxor Creek, and gillnet in Bush River. Revelstoke spawners were collected from Standard Creek, a tributary to Downie Creek, with a dip net. Sex, fork length, and age structures were collected for estimating mean length at age. In 2017, otolith and scale interpretations were provided by the BC provincial ageing lab in Abbotsford, BC following ageing protocols outlined in Casselman (1990).

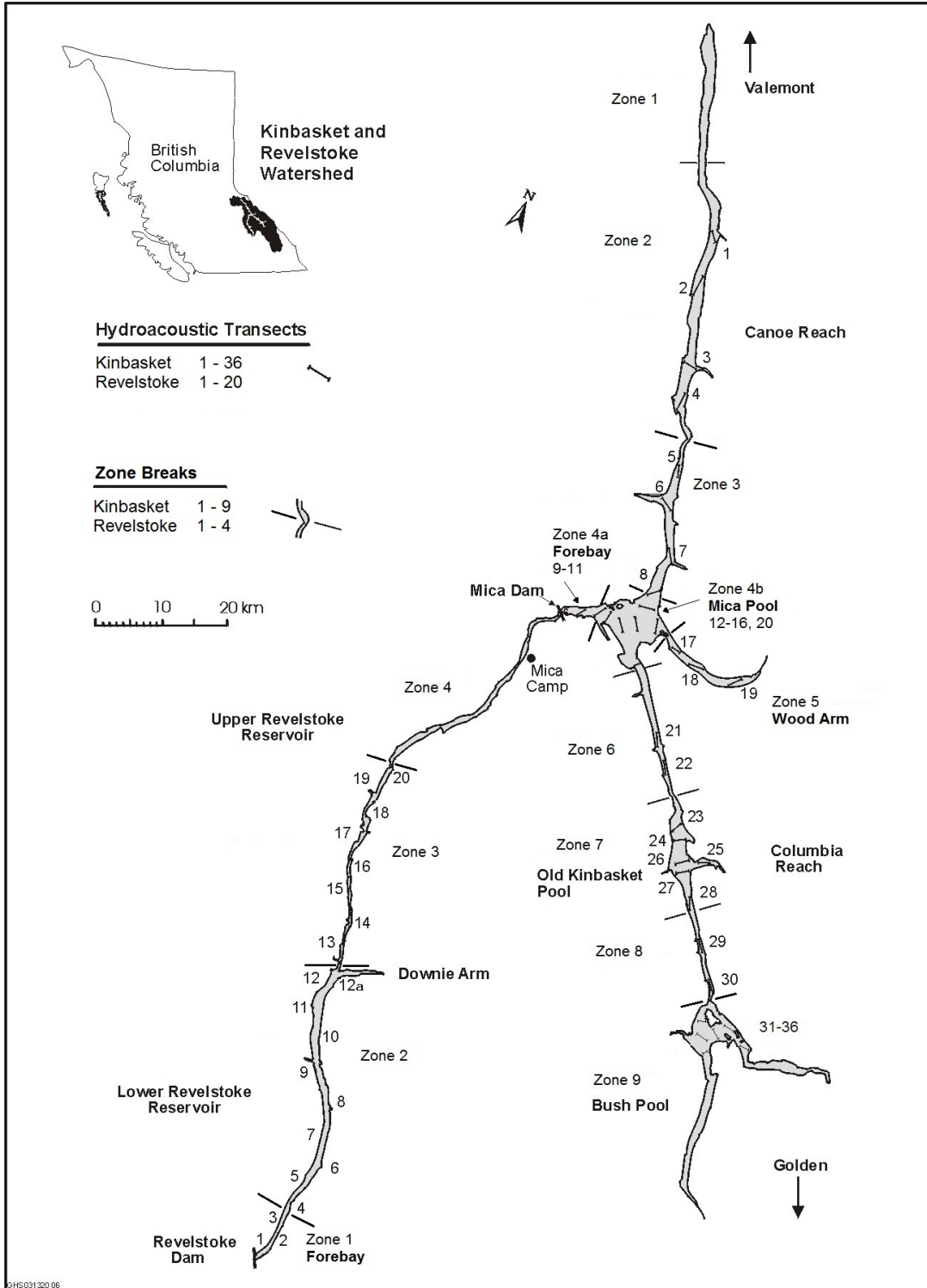
Camp Creek and Bush River counts were conducted from a helicopter while total escapement for the main spawning area of the Upper Columbia River near Fairmont was estimated using a fish fence and trap by the Freshwater Fisheries

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<sup>1</sup> A modification was made to RIC standard nets starting in 2015 when an additional panel of 32 mm stretched mesh size was added to each net (see Appendix 8 in Sebastian and Weir (2016) for RIC net modifications).

Society of BC (FFSBC) as part of an egg collection program for Kootenay Lake kokanee recovery efforts. The fence was located near the north end of the Fairmont Hot Springs airport.

Viewing conditions for escapement counts on glacial tributaries in particular can be variable depending on water levels and turbidity driven by rain events. Aerial escapement counts for Kinbasket and Revelstoke Reservoirs are conducted partly as an index to assist with estimating spawner numbers. To provide another line of evidence we developed an alternative index of potential spawner numbers for each reservoir and year by multiplying the acoustic estimate of age 2 and older fish abundance (labelled as 2++ fish) by the percentage of age 2 and older fish captured in gillnets that were maturing in the summer surveys; see Bray et al. 2018 for further details.



**Figure 1.** Map of Kinbasket and Revelstoke reservoirs showing location of reaches, habitat zones and acoustic transects.

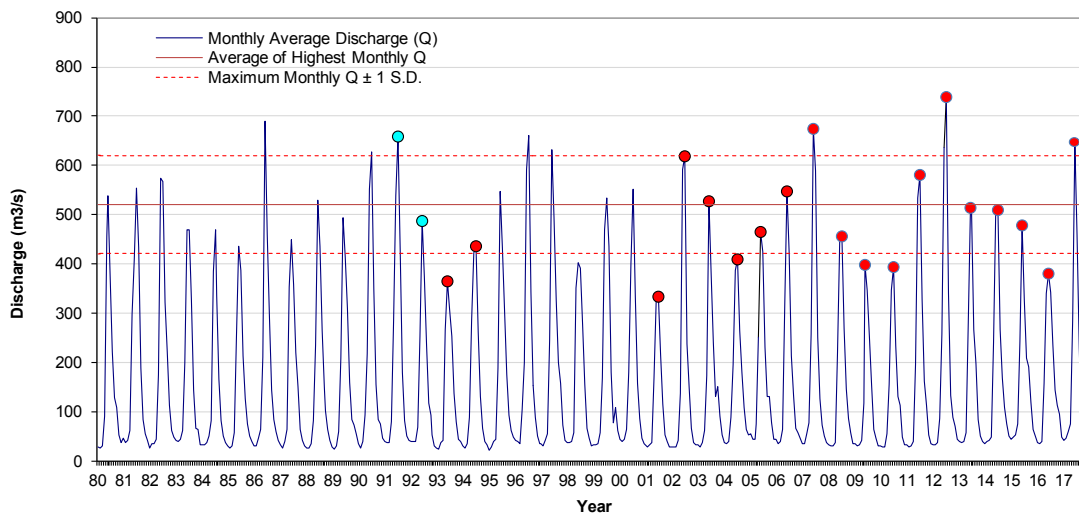
## RESULTS AND DISCUSSION

### ***Survey timing, general flow conditions, pool elevation and habitat***

Acoustic surveys and trawl and gillnet sampling in 2017 were conducted between July 18-24 on Kinbasket Reservoir and on July 23-25 (acoustic survey) and July 31 (gillnetting) on Revelstoke Reservoir.

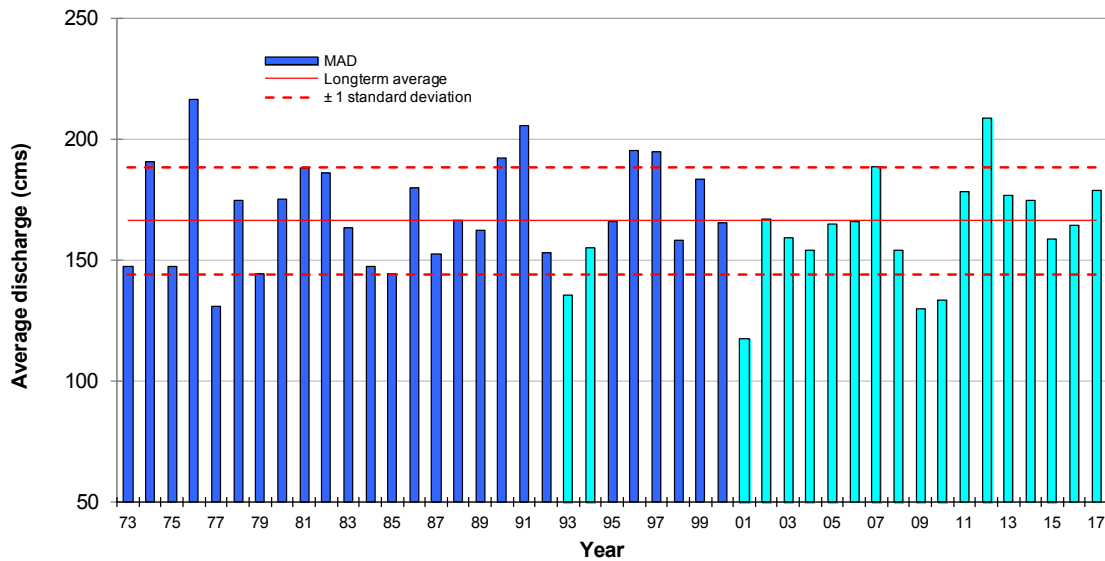
The maximum monthly discharge of the largest tributary, the Columbia River near Donald, BC, provides an index of the magnitude of annual spring freshet. In 2017 the maximum monthly discharge was  $647 \text{ m}^3\text{sec}^{-1}$  or 124% of the long-term average of  $520 \text{ m}^3\text{sec}^{-1}$  (Fig. 2). This was considered a very high freshet flow as it was beyond one standard deviation above the long-term mean the third highest in the 17 consecutive survey years. The 2017 freshet flows were exceeded only in 2007 and 2012.

The mean annual discharge of  $179 \text{ m}^3\text{sec}^{-1}$  was only 8% above the 37-year average of  $166 \text{ m}^3\text{sec}^{-1}$  (Fig. 3). This marked the fifth consecutive year that inflows to Kinbasket Reservoir from the Columbia River were within 1 standard deviation of the 22-year average since Mica Dam was built. Although flows in the Columbia River upstream of Kinbasket Reservoir only provide a coarse index of annual climatic conditions in the drainage, any significant changes in the natural run-off patterns that might affect kokanee distribution and abundance should be detectable at this scale.



**Figure 2.** Monthly mean flows for unregulated Columbia River inflows to Kinbasket Reservoir at Donald Station (Water Survey of Canada hydrometric station 08NB005) near Golden BC. Note that red circles indicate study years with standardized acoustic survey design, blue circles indicate non-standard preliminary survey years. Red line shows the 38-year (1980-2017) average of maximum monthly discharges with dotted lines at  $\pm$  one standard deviation.





**Figure 3.** Mean Annual Discharge (MAD) of unregulated Columbia River inflows to Kinbasket Reservoir based on Water Survey of Canada station 08NB005 near Golden BC. The red line indicates the average annual flow since Mica Dam construction in 1973, with red dashed lines indicating  $\pm 1$  standard deviation. Light blue bars indicate survey years.

The average pool elevation of Kinbasket Reservoir during the survey window in was 751m above sea level compared to the normal full pool level of 754.38m. Unlike other recent years, the amount of floating woody debris was not a problem in 2017. At 3 meters below full pool the pelagic area was 23,234 ha for the standard reaches surveyed and 30,094 ha for the entire reservoir (Table 1). For standard areas surveyed the pelagic habitat area was only 2% less than at full pool and 6% less for the entire reservoir. In 2017, the Bush Pool transects resulted in an additional 5720 ha of pelagic area surveyed, adding nearly 25% to the standard pelagic habitat surveyed in zones 2-8.

A cold fall and winter in 2016-17 with above average precipitation in early spring led to slightly higher than average freshet flows in June of 2017 followed by slightly lower than average summer flows (Pieters et al, 2019). The summer was relatively dry and hot and substantial wildfire smoke was observed during the beginning of the Kinbasket survey.

**Table 1.** Summary of surface area and pelagic habitat area (>20m depth) by zone based on full pool elevations for Kinbasket and Revelstoke.

Zone	Location/description	Full pool <sup>1</sup> surface area (ha)	Full pool <sup>2</sup> Pelagic area (ha)	2017 <sup>3</sup> Pelagic area (ha)	Pelagic <sup>4</sup> % reduced
<b>Kinbasket Reservoir</b>					
1	Canoe Reach - Valemont to 40m contour	2,400	1,305	1,140	13%
2	Canoe Reach - 40m contour to narrows	4,560	4,060	4,006	1%
3	Canoe Reach - narrows to Mica Pool	4,900	4,360	4,300	1%
4a,b	Mica Pool above dam <sup>5</sup>	6,940	5,580	5,400	3%
5	Wood Arm	2,020	1,560	1,458	7%
6	Mica Pool to Old Kinbasket Lake	2,120	1,805	1,760	2%
7	Old Kinbasket Lake	5,270	5,055	5,022	1%
8	South Columbia (Old Kin to Surprise Rapids)	1,500	1,315	1,288	2%
9	Bush Pool Surprise rapids to Upper Col R.	11,350	6,980	5,720	18%
Total		41,060	32,020	30,094	6%
2-8	<b>Total habitat surveyed</b>	27,310	23,735	23,234	2%
<b>Revelstoke Reservoir</b>					
1	Forebay - Revelstoke Dam to T3	1,525	1,315	1,315	0%
2	Lower Revelstoke - T4 to Downie Creek	4,575	3,935	3,935	0%
3	Middle Revelstoke - Downie to Nicholls Creek	3,100	2,000	2,000	0%
4	Upper Revelstoke - Nicholls Creek to Mica Dam	2,100	450	450	0%
Total		11,300	7,700	7,700	0%
1-3	<b>Total habitat surveyed</b>	9,200	7,250	7,250	0%

1. Full pool elevation for Kinbasket Reservoir = 754.38m
2. Full pool pelagic area = area at 20m or greater depth at full pool (area at elevation 734.38m)
3. 2017 pelagic area for Kinbasket is area at 751m elevation that is 20m depth or greater
4. % reduction in pelagic area over full pool estimates due to the lower pool elevation at survey
5. Includes Forebay zone and the main Mica Pool zone

A summary of survey dates, pool elevation and pelagic habitat area for all previous summertime surveys is shown in Table 2. Note that habitat zones 1 and 9 were typically not included in the annual surveys due to hazards for night navigation and assumed marginal quality of pelagic habitat for kokanee with depth being the major limitation. Relatively high pool levels and relatively low amounts of debris enabled hydroacoustic and gillnet surveys to be undertaken in Bush Pool (habitat zone 9) for the third consecutive year in 2017. The rationale was to determine the extent to which kokanee utilize this basin at high summer pool levels given that the area normally has to refill each year. The low gradient of zones 1 and 9 make the habitat area particularly sensitive to changes in pool elevation (Table 1). The minimum depth of water suitable for kokanee through the winter/spring is unknown, but it is likely that the age 1-3 kokanee must recolonize zones 1 and 9 following drawdown periods due to insufficient water depth. The spring of 2015 was exceptional as the spring minimum pool level was well above average (11 m above average at 737m on May 15, 2015). As a result, the minimum habitat area in zone 9 was ~4000ha with depths exceeding 10 m; although, by definition, no “pelagic” habitat remained (i.e. 20 m or more

depth is considered pelagic habitat during summer surveys). In 2016, a minimum pool elevation of 729.4 m was reached on April 1, and the minimum pool elevation in 2017 was reached in May 4, 2017 a 728.7 m. At these elevations, the maximum depths in Bush Pool were 10 m in 2016 and 9 m in 2017. By comparison with 2015, the habitat area with depth of 10 m or greater at minimum pool was reduced from 4,000 ha in spring 2015 to 200 ha during spring of 2016 and 0 ha in 2017.

**Table 2.** Survey dates, pool elevation and pelagic habitat area at the time of survey for Kinbasket Reservoir.

Year	Survey Dates	Pool elevation <sup>1</sup> (m)	Drawdown (m)	Pelagic habitat area <sup>2</sup> (ha)
1993	August 11-13	741	13	21,836
1994	August 8-10	743	11	22,102
2001	August 24-29	742	12	21,969
2002	August 9-14	750	4	23,067
2003	July 23-28	742	12	21,969
2004	July 14-20	740	14	21,703
2005	August 6-12	750	4	23,067
2006	August 19-20	751	3	23,234
2007	August 8-10	754	0	23,735
2008	July 28 - August 1	747	7	22,634
2009	August 21-25	750	4	23,067
2010	August 7-10	749	5	22,900
2011	August 2-5	753	1	23,568
2012	August 16-20	754.5 <sup>3</sup>	-0.3	23,735
2013	August 2-7	752	2	23,401
2014	July 25-29	751	3	23,234
2015	July 11-19	751	3	23,234
2016	July 31-Aug 5	752	2	23,401
2017	July 20-25	751	3	23,234

1. pool elevation at time of survey rounded to nearest meter

2. refers to area surveyed in sections 2-8 at the time of survey

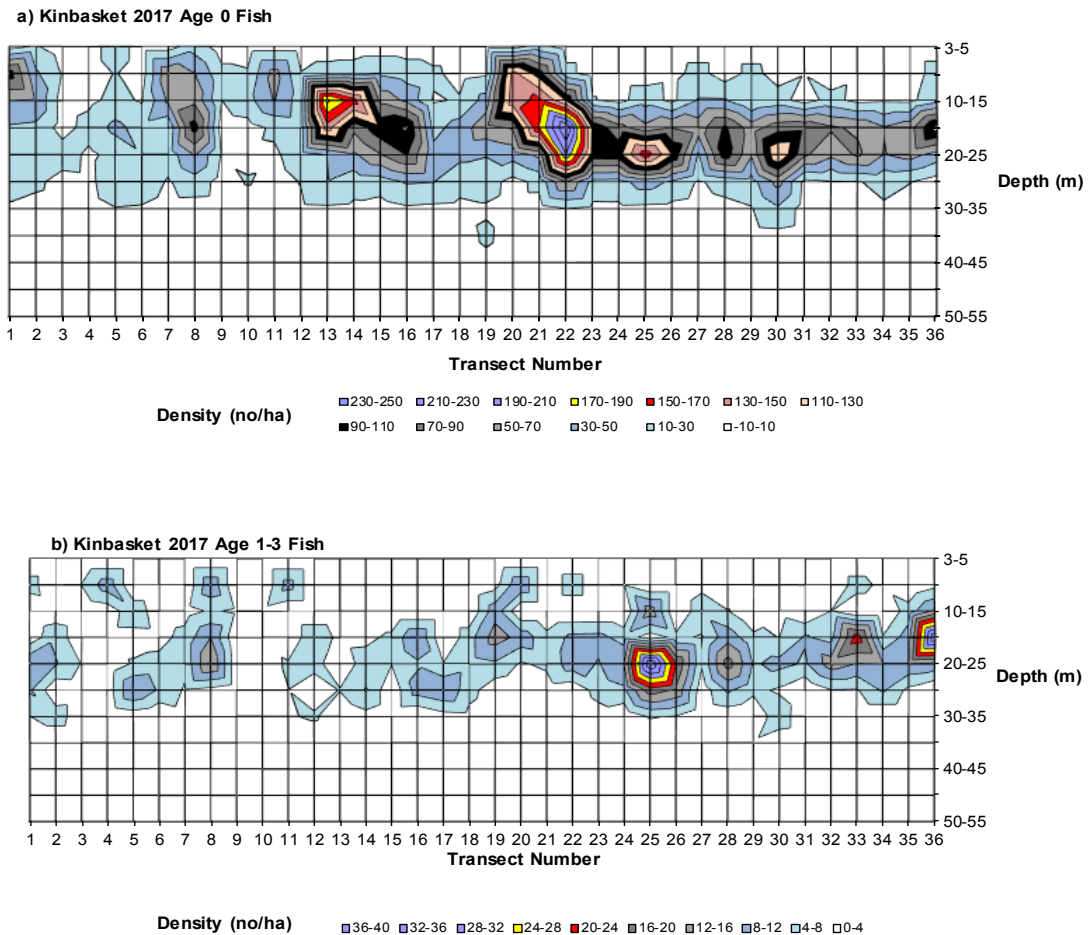
3. pool elevation in 2012 exceeded maximum through surcharging (~30cm)

On Revelstoke Reservoir, pool elevations remained constant and the surface area and pelagic habitat area surveyed (zones 1-3) remained at approximately 9,200 and 7,250 ha, respectively. Zone 4 of Revelstoke has never been included in annual abundance surveys since it is shallow, riverine and has very little pelagic habitat suitable for kokanee rearing (Table 1).

### ***Kokanee Distribution***

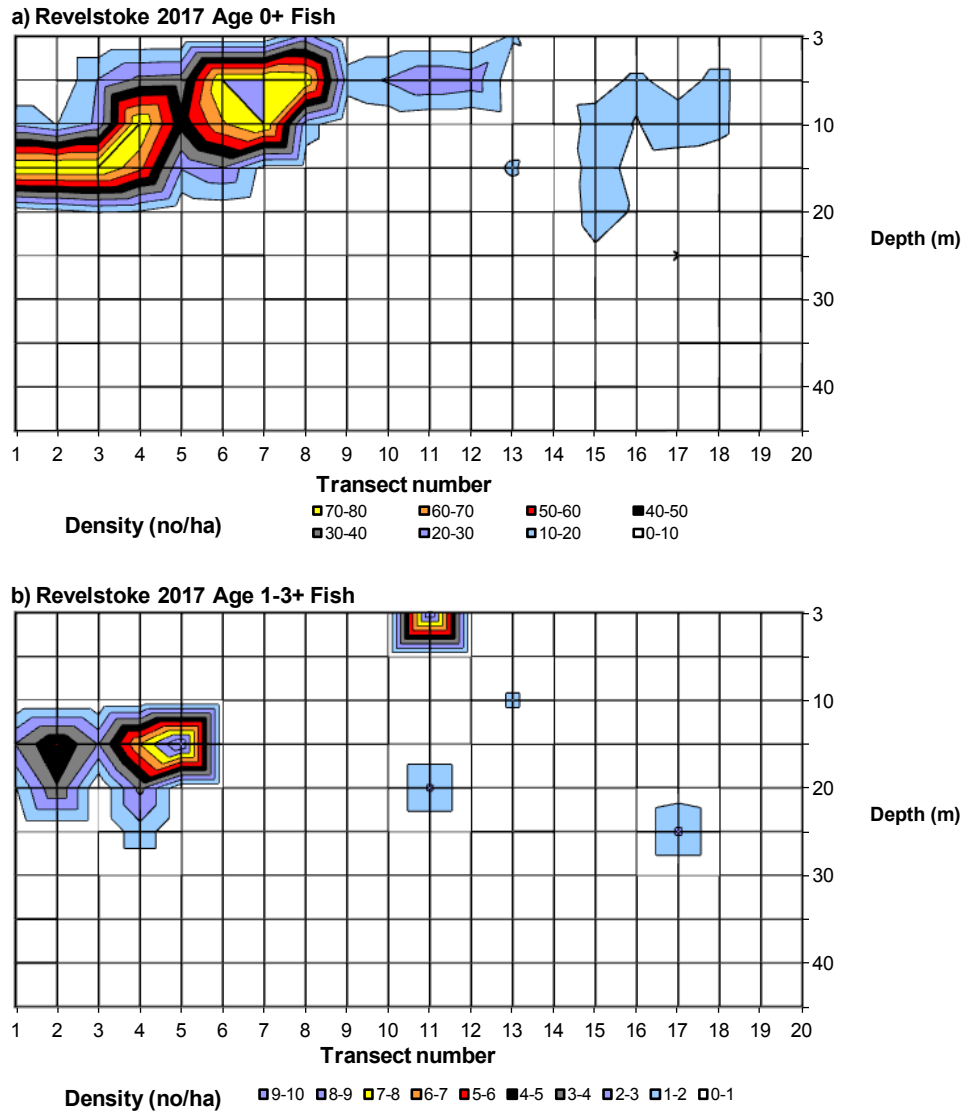
Kokanee age 0 (fry) were found at 15-25 m over much of Kinbasket Reservoir in 2017 and were evenly distributed from Bush Pool to the outlet of Old Kinbasket Lake. Fry were highly concentrated from 5-20 m depth in the Columbia Reach

downstream of Old Kinbasket Lake and in the centre of the main pool (Fig. 4a). Fry densities decreased significantly between the Main Pool and Mica Dam and were scattered between the surface and 25 m at low but variable densities throughout Canoe Reach. The age 1-3 fish were found at 15-30 m (slightly deeper than fry) over much of the reservoir between Mica Dam and Bush Pool. Highest fish densities were found at 20 m deep in Old Kinbasket Lake and at 15 m deep toward the upstream end of Bush Pool where the Columbia River enters (Fig. 4b). Like fry, age 1-3 densities were quite low and variable throughout Canoe Reach and near the Forebay and extended to near the surface at some transects.



**Figure 4.** Contour plot showing kokanee distribution in Kinbasket Reservoir by depth and transect for a) age 0 and b) age 1-3 fish. Note: transects 31-36 show fish distribution in Bush Pool sampled in 2017.

In Revelstoke Reservoir the contour plot demonstrates a strong fry layer in the 15-20 m layer near the forebay. From transects 4-8 there was also a very strong fry layer but slightly higher in the water column at 5-15 m. For transects 9 through 12 the fry were at low densities and located in the 5-10 m depth layer (Fig. 5a). Upstream of Downie Creek (transects 12-20) fry densities were very low and no longer found in a distinct layer.



**Figure 5.** Contour plots showing 2017 kokanee distribution by depth and transect in Revelstoke Reservoir for a) age 0 and b) age 1-3 kokanee based on 2017 acoustic surveys.

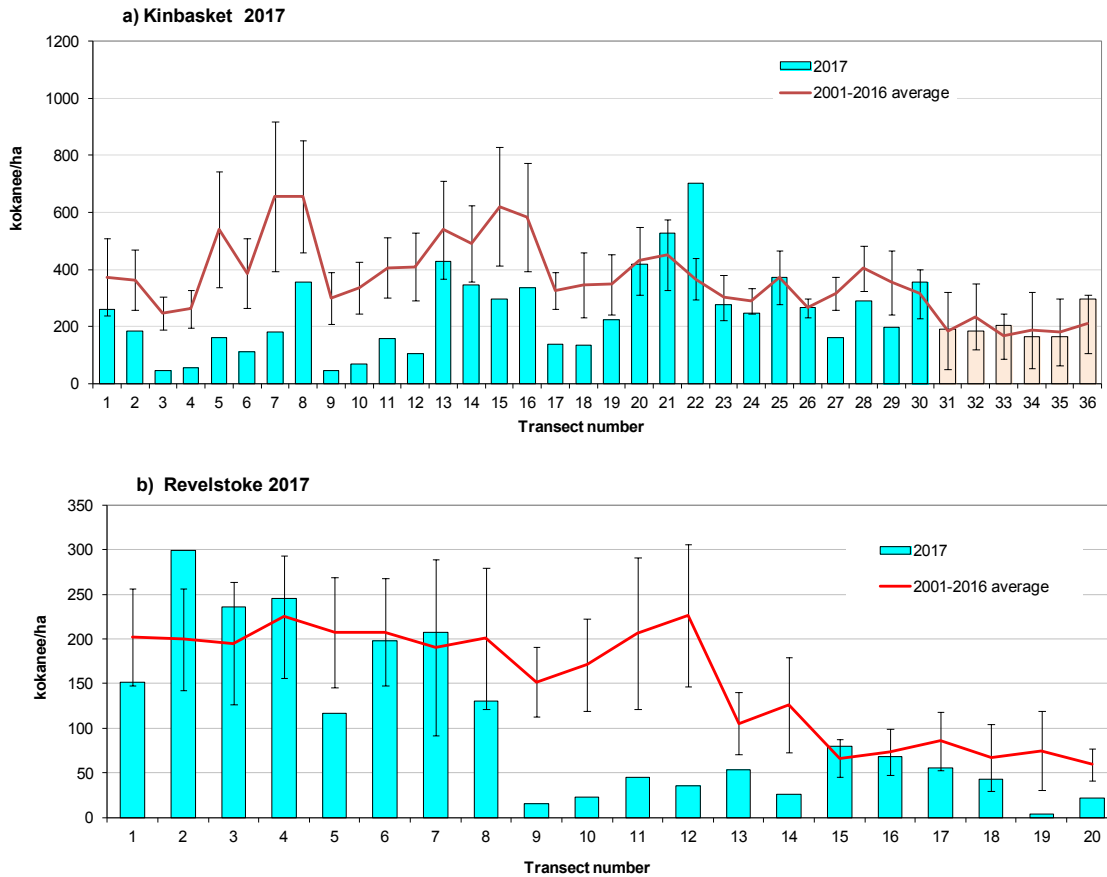
Age 1-3 kokanee in Revelstoke Reservoir were distributed in a distinct depth layer from 15-20 m near the southern end of the reservoir at transects 2-5 (Fig.

5b). Elsewhere in the reservoir, densities were extremely low with most transect densities at  $<1$  fish·ha<sup>-1</sup> (or zero) and there was no fish layer apparent.

Fish densities at individual transects in Kinbasket Reservoir ranged from 45 fish·ha<sup>-1</sup> at Transect 9 in Mica Forebay to 702 fish·ha<sup>-1</sup> at Transect 22 in Columbia Reach upstream of the main pool (Fig. 6a). The highest and lowest densities of fish were found at similar locations in 2016.

Compared with the long-term (2001-2016) average shown by the red line in Figure 6a, transect densities in 2017 were at or near average at most transects in Columbia Reach (transects 21-30) except transect 22 where densities were well above average and transects 27-29 where densities were lower than 2 SE below average. Only 2 of 5 transects in the Main Pool (transects 12-16, 20) were near average, while others were below average. Except for transect 1, kokanee densities in 2017 were well below average at all transects in the Canoe and Forebay reaches and in Wood Arm. Densities in Bush Pool (transects 31-36) were generally intermediate between those of 2015 and 2016 except for transect 36 where densities were highest in 2017.

Fish densities in Revelstoke Reservoir ranged from 4 fish·ha<sup>-1</sup> at transect 19 to 299 fish·ha<sup>-1</sup> at transect 2 in the Forebay Reach (Fig. 6b). Compared to previous years, the 2017 transect densities were about average for the southern half of the main basin (transects 1-8) and the middle section of the Middle Reach (transects 15-18). However, transect densities were well below average in the upper half of the Lower Basin) with densities for transects 9-12 ranging between 10% and 22% of their respective long-term averages. At transect 19 at the upper end of the middle reach the density was only 6% of the long-term average.



**Figure 6.** Longitudinal density distributions for kokanee in a) Kinbasket and b) Revelstoke reservoirs based on acoustic surveys. The long-term average transect densities for 2001-2016 are shown by the red line for standard survey transects. Only three years of data exist for Bush Pool (Kinbasket, transects 31-36) so 2015 and 2016 data are provided for context. Error bars represent the 95% confidence limits ( $\pm 2$  standard errors) of the 16-year average.

### **Kokanee Abundance**

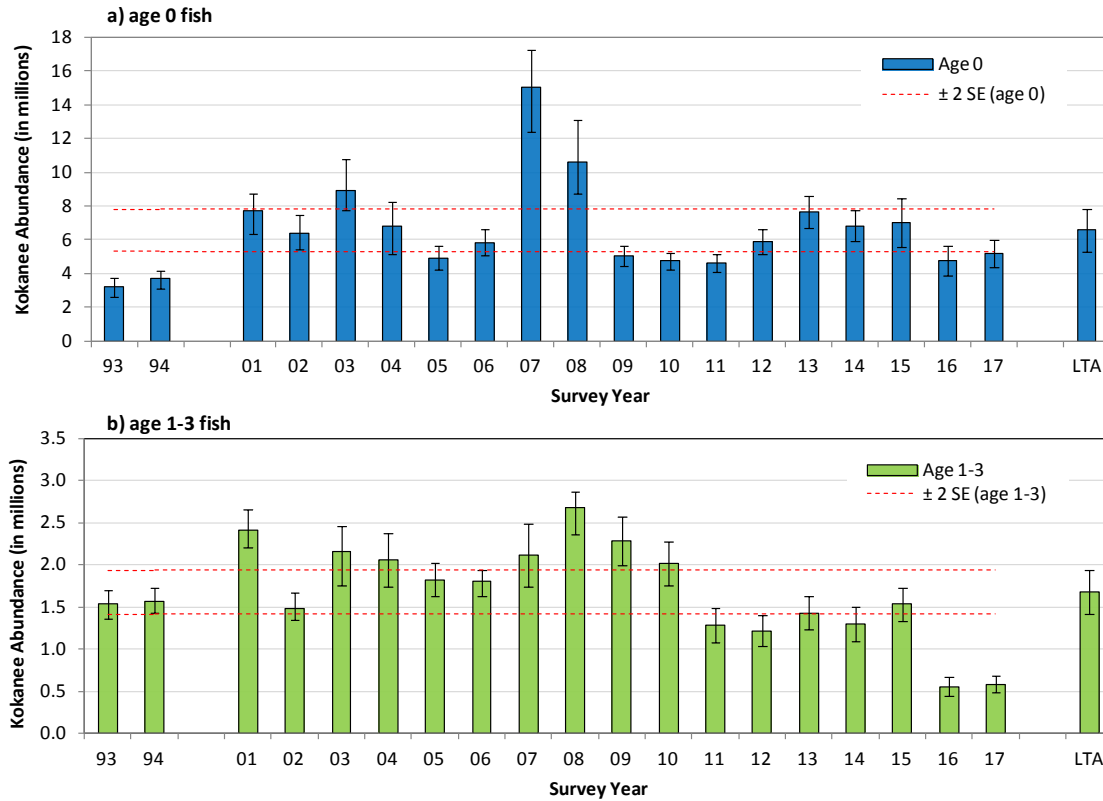
The total kokanee abundance (standard survey zones 2-8) in Kinbasket Reservoir for 2017 was estimated at 5.76 (4.89-6.64) million (Appendix 3a). This was similar to 2016 but represented a significant decline from the 2015 estimate of 8.55 million. The 2017 estimate was the fifth of 19 years on record where densities were significantly below the long-term average of  $8.72 \pm 1.56$  million. Survey years below average were 1993, 1994, 2011, 2016 and 2017 while abundance estimates in 2003, 2007 and 2008 were above average.

The abundance estimate for kokanee fry was 5.19 (4.84-6.83) million and for age 1-3 fish was 0.58 (0.48-0.68) million for the standard survey zones 2-8 in 2017 (Fig. 7a and b). While the 2016 and 2017 fry estimates were lower than those from 2012-2015, the confidence intervals overlapped with the bounds ( $\pm 2$  standard errors) of the long-term average for fry. By this measure, only four of nineteen years (1993, 1994, 2010 and 2011) had fry densities significantly below average, while only two of nineteen years (2007, 2008) had fry abundance above average.

The age 1-3 population has ranged from 0.55-2.68 million and averaged 1.67 (1.42-1.93) million over the 19-year time series. The age 1-3 abundance in 2017, estimated at 0.58 (0.48-0.68) million, was similar to 2016, which is the lowest on record (Fig. 7b). Despite average levels of fry recruitment in 2016, the 2017 age 1-3 abundance was the second lowest in 19 years and one of only three years in the time series with abundance significantly below the long-term average. It appears that age 0 to age 1 survival has declined since 2015, although it is likely that the large-scale kokanee mortality event in the spring of 2016 (Sebastian and Weir, 2017) was a primary factor in low age 1-3 populations in both 2016 and 2017.

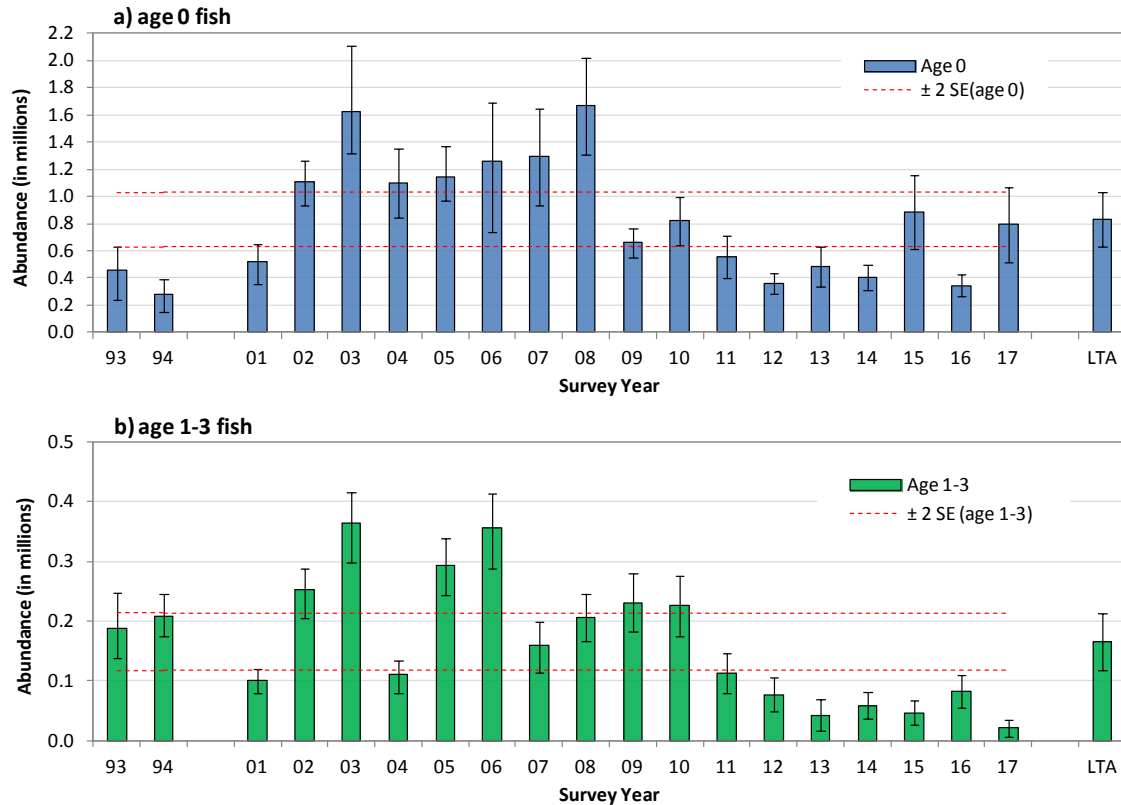
The 2017 survey of Bush Pool (zone 9) resulted in a population of 728,000 age 0 and 132,700 age 1-3 kokanee. Combining the Bush Pool estimate to the standard (zones 2-8) fry estimate of 5.77 million ( $\pm 16\%$ ) increased the total fry estimate by 12% to 6.50 million. Combining the age 1-3 estimate for Bush Pool to the standard zone 2-8 estimate of 583,000 ( $\pm 17\%$ ) increases the total age 1-3 estimate by 23% to 715,700. The age 1-3 abundance estimate for Bush Pool, and the wide confidence intervals on the estimate, were affected by the exceptionally high density at transect 36 (Fig. 6a).





**Figure 7.** Kinbasket Reservoir kokanee abundance trends for a) age 0 and b) age 1-3 fish based on acoustic surveys. LTA identifies the long-term averages (1993-94, 2001-17). Error bars for survey years denote 95% confidence limits on maximum likelihood estimates. The dashed lines demonstrate  $\pm 2$  standard errors on the 17-year average. Estimates presented include zones 2-8 for all years.

In Revelstoke Reservoir the total abundance of kokanee (all ages) was estimated at 0.83 (0.55-1.11) million in 2017 (Appendix 4a) and marked a return to near the long-term average of  $1.00 \pm 0.23$  million. Fry abundance in 2017 was estimated at 0.79 (0.52 – 1.07) million, similar to the long-term average fry abundance of 0.83 (0.63 -1.03) million (Fig. 8a). The 2017 age 1-3 abundance, at 0.021 (0.007 – 0.035) million, was by far the lowest on record (Fig. 8b) and followed the second lowest fry abundance in the time series in 2016.



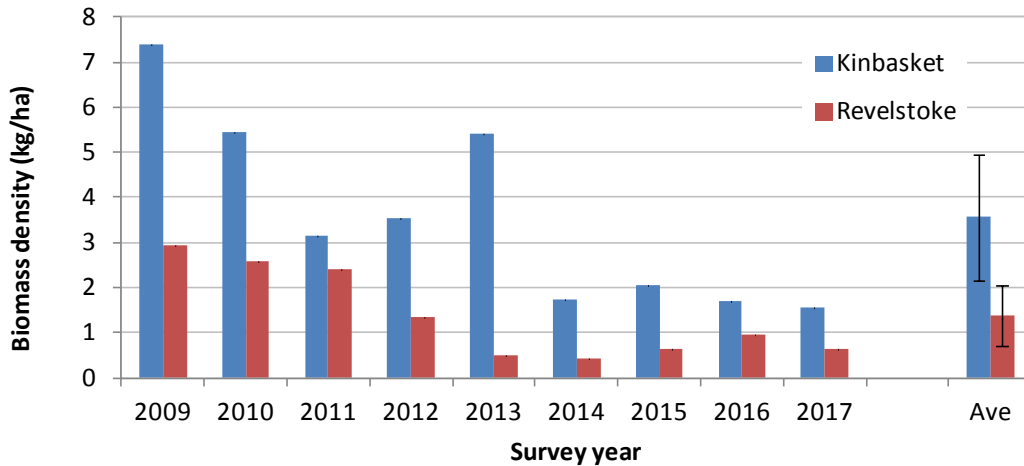
**Figure 8.** Revelstoke Reservoir kokanee abundance trends for a) age 0 and b) age 1-3 fish based on acoustic surveys. LTA identifies the long-term averages (1993-94, 2001-17). Error bars for survey years denote 95% confidence limits on maximum likelihood estimates. The dashed lines demonstrate  $\pm 2$  standard errors on the 17-year average. Estimates presented include zones 2-8 for all years.

### **Kokanee Biomass**

Kokanee biomass in Kinbasket Reservoir has ranged from 36 to 170 metric tons and averaged  $83 \pm 32$  MT over the last nine study years (2009-2017). The 2017 estimate was 36.3 MT, the lowest in nine years. In Revelstoke biomass ranged from 3.1 to 21 MT with an average of  $9.9 \pm 4.8$  MT. The 2017 estimate for Revelstoke was 3.7 MT and was the third lowest of the last nine years.

Total biomass estimates were converted to comparable density estimates by dividing by the pelagic habitat area and are presented in Figure 9. Kinbasket Reservoir supported roughly 2.5 times more kokanee biomass per unit area than Revelstoke Reservoir. Trends in biomass density are similar with both reservoirs showing a dramatic decline recently, by 2013 in Revelstoke and 2014 for Kinbasket, followed by relatively low biomass since. Biomass values by 1dB size

increments and rolled up to approximate age groups are shown in Appendix 10 and 11 for Kinbasket and Revelstoke reservoirs, respectively.



**Figure 9.** Trends in kokanee biomass density for Kinbasket and Revelstoke Reservoirs, 2009-2017.

### ***Kokanee size at age from trawl, gillnet and spawner sampling***

Gillnet and trawl sampling were conducted on Kinbasket Reservoir to obtain fish samples for determining size at age and to confirm species composition. A total of 127 kokanee and one Pygmy Whitefish were captured in two trawls on Wood Arm (Appendix 7). The combined trawl catch consisted of 108 fry and 19 age 1 kokanee.

Additional age 1-3 kokanee were targeted with four overnight gillnet sets; two in Wood Arm near transect 18 and two in Bush Pool, one set near transect 33 (south of Bear Island) and another near transect 36 (east side of main Bush Pool). A total of 67 kokanee and 20 Bull Trout were captured in the four sets (Table 3). Gillnet catch per unit effort for kokanee averaged  $18.4 \text{ kokanee} \cdot \text{ha} \cdot \text{hr}^{-1}$

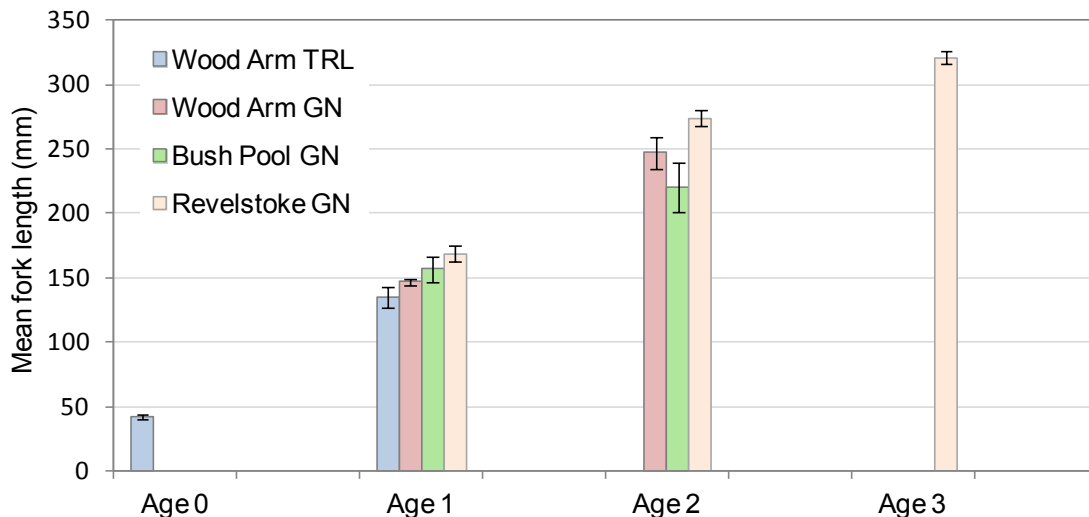
**Table 3.** Gillnet catch by species and location for four sets on Kinbasket Reservoir conducted August 1, 2017.

Location	Set number	Transect number	Number of Kokanee	Number of Bull Trout
Wood Arm	1	18	26	10
Wood Arm	2	18	18	4
Bush Pool	3	36	12	2
Bush Pool	4	33	11	4
Total Kinbasket			67	20

in Wood Arm and 10.6 kokanee·ha·hr<sup>-1</sup> in Bush Pool (Appendix 8a). Caution must be used when interpreting gillnet CPUE since the sampling effort and coverage of the reservoir was quite limited in this study.

A comparison of kokanee size at age between locations was continued in 2017, with comparison of size between sampling methods in Wood Arm only. Trawl caught age 1 in Wood Arm were significantly smaller than gillnet caught age 1. There was however no difference between the mean length of gillnet caught age 1 fish in Wood Arm and Bush Pool. Age 1 fish were larger in Revelstoke than either Wood Arm or Bush Pool but were only significantly larger than Wood Arm fish (Fig. 10).

Age 2 fish were similar in size in Wood Arm and Bush Pool, while age 2 fish caught in Revelstoke were significantly larger than Kinbasket age 2 kokanee. Small sample sizes of age 2 fish though (Bush Pool n=4, Wood Arm n=6) compromise the ability to compare between locations. The average length of age 3 fish in Revelstoke was significantly larger than age 2 fish in Revelstoke. There were no age 3 fish captured in Kinbasket for comparison. Interestingly, it appears that the large size of spawners in Revelstoke compared with Kinbasket is largely a result of more rapid growth occurring after they reach age 1, i.e. after their second summer based on scale analyses.



**Figure 10.** Comparison of mean length at age between sampling locations in Wood Arm and Bush Pool and Revelstoke Reservoir, and between different sampling methods; trawl (TRL) and gillnet (GN) at the same location where available. Error bars indicate  $\pm 2$  Standard Errors of the means (95% confidence level).

Size statistics for the pooled catch of all kokanee captured in Kinbasket Reservoir sampling in 2017 are summarized in Table 4. The mean length at age was  $42 \pm 2$

mm for age 0,  $146 \pm 4$  mm for age 1 and  $236 \pm 13$  mm for age 2 fish. Compared with 2016, age 0 fish were significantly smaller in 2017 while age 1 and 2 fish were similar in size.

Mean length at age estimates for spawners presented in Table 4 were based on combined samples from three key spawning areas (Camp, Bush and Luxor) with no attempt to weight samples based on the number of spawners returning to each system. Further details on spawner size and age composition for individual tributaries are presented later in the report. The mean length at age for spawning fish in 2017 was estimated at  $264 \pm 3$  mm for age 2 and  $289 \pm 4$  mm for age 3 where ranges ( $\pm$ ) represent 95% confidence intervals of the means. The mean spawner length at age for 2017 was significantly larger than in 2016 for both age 2 and age 3 fish. The age composition of spawners based on total numbers captured in all tributaries was 82% age 2 and 18% age 3 fish, which was very similar to the age composition in 2015 and 2016. There was again considerable overlap in the length between age 2 and age 3 spawners even though the difference in mean size at age was statistically significant.

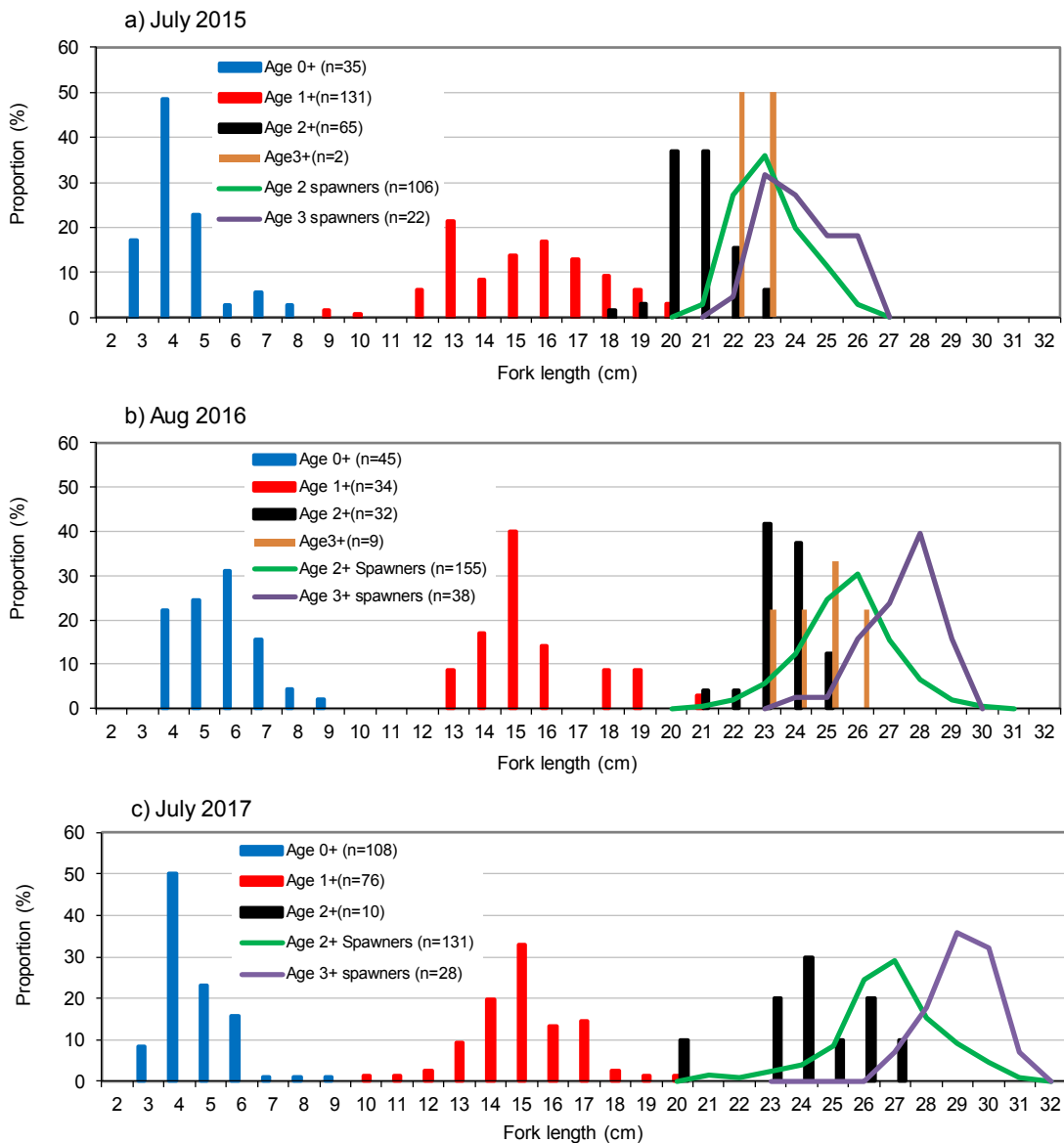
**Table 4.** Kokanee length and weight statistics by age for combined trawl and gillnet samples from Kinbasket Reservoir during July and from spawner samples obtained from Camp and Luxor Creeks and Bush River during late September, 2017.

Type of Sampling	Age	FL(Ave) (mm)	FL range (mm)	S.D. (FL)	No. (FL)	Weight (g)	S.D. (Wt)	No. (Wt)
Trawl	0+	42	28-81	9.7	108	1.1	0.8	62
Trawl and GN	1+	146	95-192	16.9	76	34.0	11.5	76
Trawl and GN	2+	236	192-263	20.7	10	142.5	36.7	10
Spawner	2+	264	202-305	17.6	131			
Spawner	3+	289	265-310	11.4	28			

Age specific length frequencies from combined trawl and gillnet catches illustrate annual growth of kokanee in Kinbasket and Revelstoke Reservoirs and help verify spawner ages each year. Gillnetting efforts were increased in 2014 and again in 2015 to obtain larger numbers of age 1-3 fish and to obtain samples from more areas around Kinbasket Reservoir. However, in 2016, weather was unsettled throughout field surveys and consequently only a minimum amount of trawling and gillnetting was completed. In 2017, GN effort returned to 2014 sampling levels with four sets in Kinbasket Reservoir. A total catch of 66 kokanee was down by 25%, however this may have been a result of the lower abundance of age 1-3 fish compared to 2014 and 2015.

Figure 11 compares age specific length frequencies for fish captured in Kinbasket Reservoir (bar graphs) and spawners obtained from key tributaries

(line graphs) for 2015, 2016 and 2017. Previous reporting has shown that in 2013, length frequency modes for all age groups including spawners were shifted to the right indicating a very good growth year for all age classes (Sebastian and Weir, 2014). By comparison, all modes including spawners shifted to the left in 2014 and again in 2015 indicating slower growth and a return to more typical growth rates for this system (Sebastian and Weir, 2016); although we note that changes in the age 1 length distributions are less clear over time. In 2016 the age 2 and 3 in-lake and spawner modes shifted to the right again indicating growth improved over the 2014 and 2015. In 2017 the in-lake age 2 were similar to 2016, and the age 2 and 3 spawners increased in size. The 2017 fry length distribution shifted to the left compared to 2016 and could be a result of later emergence and slightly earlier survey time compared with 2016.



**Figure 11.** Kokanee length frequency proportion by age for a) 2015, b) 2016 and c) 2017 based on combined trawl and gillnet samples in Kinbasket and fall spawner sampling. Spawner data was from Camp, Wood, Bush, Luxor and Upper Columbia in 2016 and from Camp, Bush and Luxor in 2017.

The stage of maturation in combined trawl and gillnet samples was as follows: in Kinbasket Reservoir age 0 and 1 were 100% immature, and age 2 fish consisted of 30% immature and 70% maturing (expected to spawn by fall of 2017). There were no age 3 fish captured in Kinbasket. The average size of maturing age 2 fish was about 25 mm larger than non-maturing age 2, however the difference in length was not significant due to small sample sizes. These data support the notion of a minimum size that triggers maturity since only the largest individuals within a cohort reach maturity by the fall of age 2 (Patterson et al, 2008) (Basset et al, 2015).

The addition of gillnet sampling to the Kinbasket program has proven successful at capturing larger numbers of age 1-3 fish which enable tracking their growth within the reservoir from year to year. Gillnetting is recommended as a necessary annual monitoring activity to enable the further study and assessment of kokanee growth and maturity in Kinbasket Reservoir.

### ***Spawner size at age and age proportions in Kinbasket***

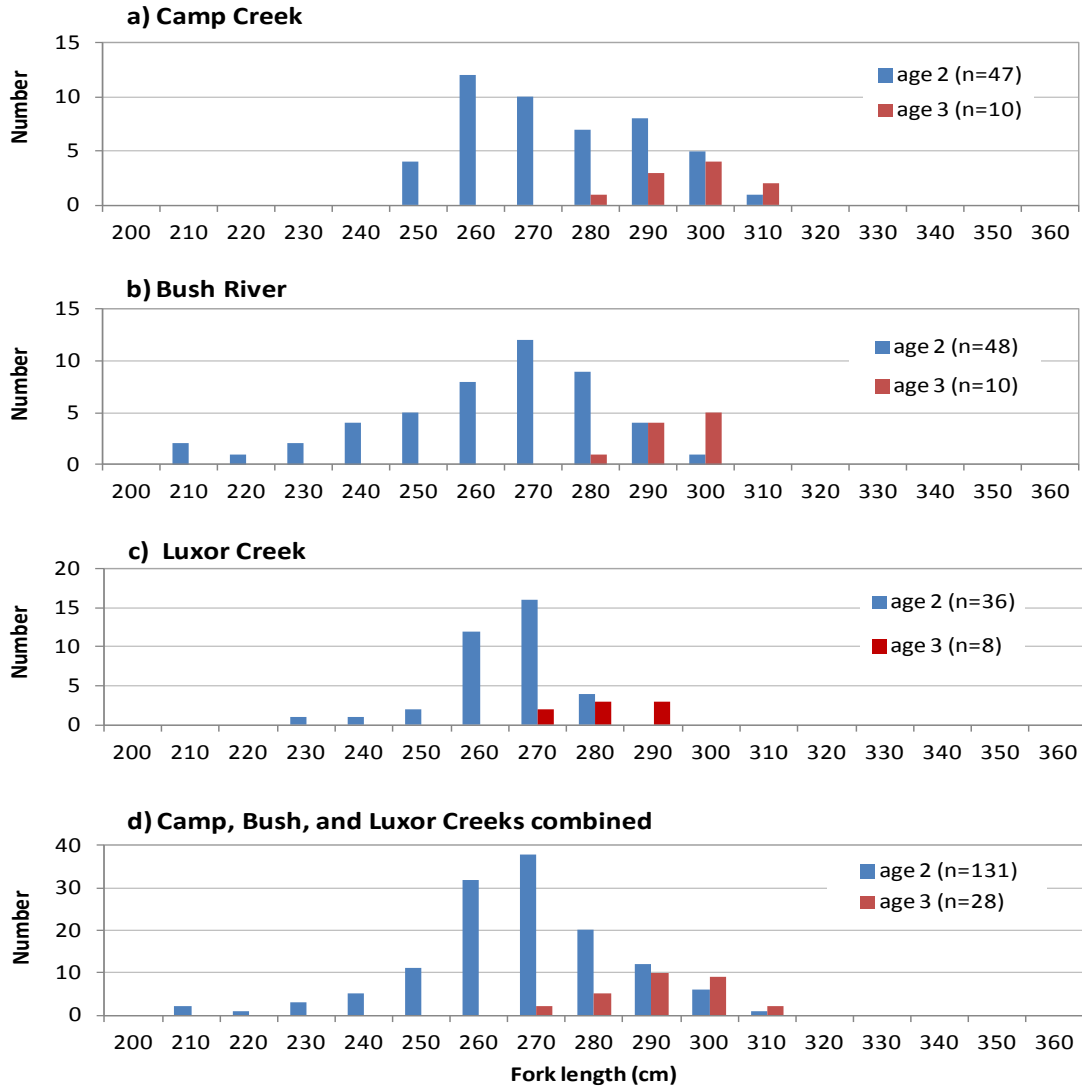
Spawner samples were again collected from Camp Creek, Luxor Creek and Bush River. Spawner size statistics have been summarized by stream and age in Table 5, and complete spawner sampling data are presented in Appendix 12. In 2017 the age 2 fish were significantly larger in Camp Creek than in Bush River or Luxor Creek. Age 3 fish in Camp Creek were also significantly larger than in Luxor Creek but not statistically larger than in Bush River where mean length fell in between Camp and Luxor Creeks. Age composition was similar in all three tributaries in 2017 (82-83% age 2); whereas Camp Creek typically had a higher proportion of age 3 spawners than the southern tributaries. Prior to 2015 we attributed the size difference between Camp Creek and southern tributaries to the higher proportion of 3 fish in Camp Creek. It was previously believed that north end kokanee grew slower and therefore matured later. However, in 2015, the average length of age 2 spawners from Camp Creek ( $237\pm 3$  mm) was significantly larger than in all other tributaries. In 2016, the average length of age 2 fish in Camp Creek of  $271\pm 9$  mm was again larger than all other tributaries. This appears to also hold true for 2017 (Table 5). It is possible that Camp Creek fish may have experienced continued growth benefits from the lower rearing densities observed in 2015 to 2017 throughout the Canoe Reach.

**Table 5.** Kokanee length statistics by age for spawners sampled in Kinbasket Reservoir tributaries during late September, 2017.

<b>Spawning Location</b>	<b>Age</b>	<b>Number of samples (n)</b>	<b>FL range (mm)</b>	<b>S.D.</b>	<b>Mean FL (mm)</b>	<b>95% C.L. on mean FL</b>
Camp Creek	2+	47	205-305	15.1	273	268-277
Bush River	2+	48	202-292	20.8	258	252-264
Luxor Creek	2+	36	227-276	10.1	261	257-264
Camp Creek	3+	10	275-310	10.6	297	290-303
Bush River	3+	10	276-300	7.0	290	285-294
Luxor Creek	3+	8	265-289	8.5	278	272-284

The length frequencies by spawner age are illustrated individually for Camp, Bush, and Luxor (Figs. 12a-c) and as a cumulative length frequency (Fig. 12d). Age specific length frequency plots show how extensive the overlap is between age 2 and age 3 fish for all tributaries.





**Figure 12.** Kokanee spawner length frequency by age for a) Camp Creek, b) Bush River, c) Luxor Creek and d) all sampled tributaries to Kinbasket Reservoir combined.

### ***Gillnet sampling on Revelstoke Reservoir***

Overnight gillnet sets have become the new standard for assessing size at age for age 1-3 kokanee on Revelstoke Reservoir. In 2017 two sets captured a total of 52 kokanee, 5 Bull Trout, 3 Mountain Whitefish and one Rainbow Trout (Table 6). The average CPUE for kokanee was  $18 \text{ fish}\cdot\text{ha}\cdot\text{hr}^{-1}$  and was similar to the 2013-2015 average of  $16 \text{ kokanee}\cdot\text{ha}\cdot\text{hr}^{-1}$ . The nets at 10 m depth caught the

most kokanee and their CPUE was nearly twice as high as CPUE from 15 and 20 m nets.

**Table 6.** Summary of gillnet catch by species and net depth from sampling in Revelstoke Reservoir in August 2017.

Net Depth (m)	Number of sets	Number of Kokanee				BT	RB	MWF	All species
		Age 1	Age 2	Age 3	Total KO				
10	2	5	16	4	25	1	1	1	28
15	4	4	10	6	20	3		2	25
20	1	3	2	2	7	1			8
All	7	12	28	12	52	5	1	3	61

Note: catch included 2 age 2 sized KO lost from 15m net and one RB released from the 10m net

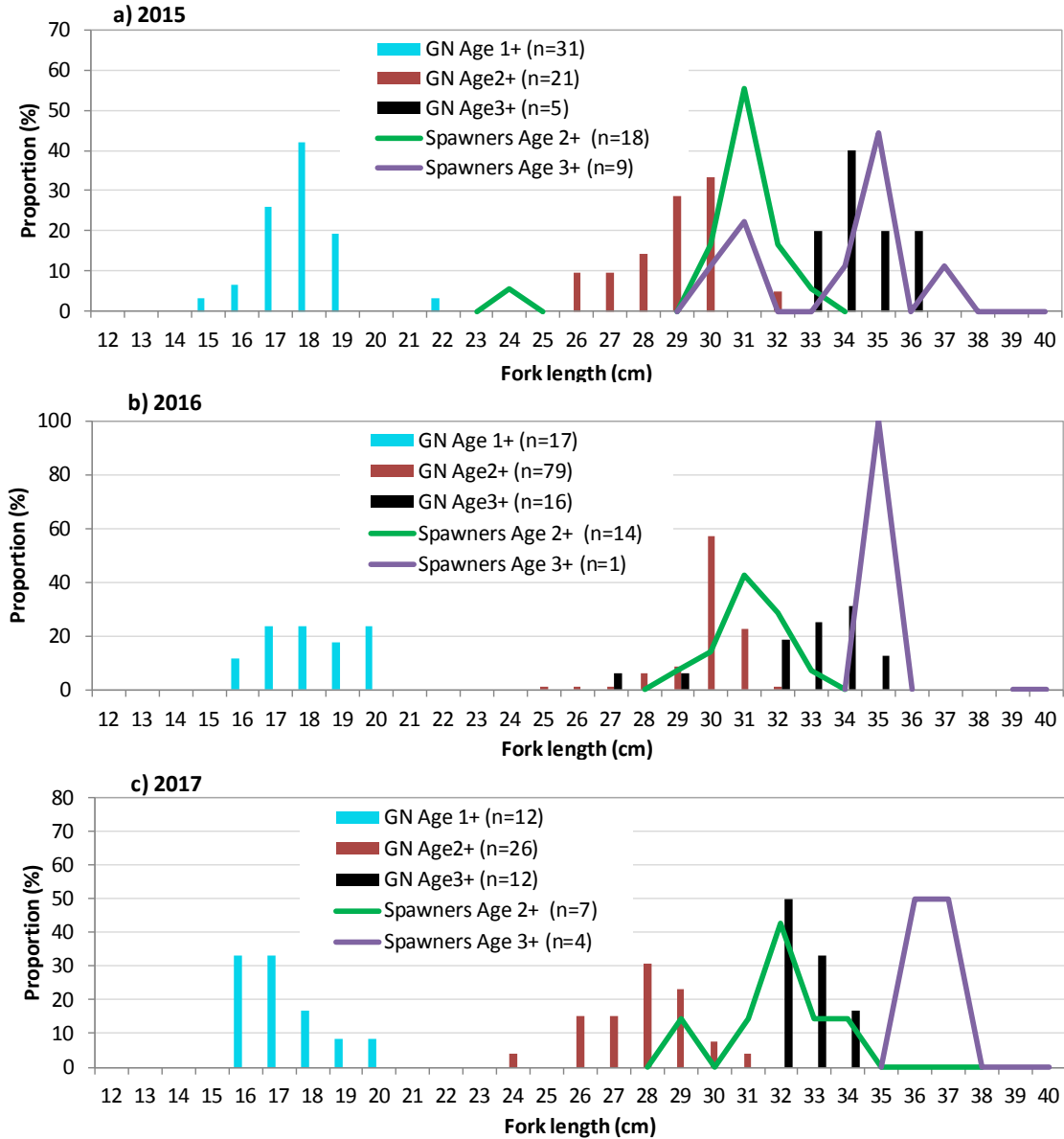
### ***Size at age and age at maturity in Revelstoke Reservoir***

Two gillnet sets caught a total of 52 kokanee in Revelstoke Reservoir; 12 age 1, 26 age 2 and 12 age 3 fish (an additional 2 KO escaped without length measurements). Kokanee mean length at age was estimated at  $169 \pm 8$  mm for age 1,  $274 \pm 6$  mm for age 2 and  $321 \pm 5$  mm for age 3 (Table 7). Compared with 2016, the size in 2017 was the same for age 1 and 3, but significantly smaller for age 2 fish. Compared to 2014 which had the largest reported kokanee length at age for Revelstoke Reservoir, age 1 in 2017 were similar while age 2 and 3 were significantly smaller in 2017.

**Table 7.** Summary of kokanee length and weight statistics by age from gillnet (GN) catches in Revelstoke Reservoirs on Aug 1, 2017 and length statistics (no weights) for spawning kokanee caught by dipnet in Standard Creek during late September, 2017.

Type of Sampling	Age	FL(Ave) (mm)	FL range (mm)	S.D. (FL)	No. (FL)	Weight (g)	S.D. (Wt)	No. (Wt)
Gillnet	1	169	157-199	13.1	12	58	14.8	12
Gillnet	2	274	232-307	16.3	26	260	46.5	26
Gillnet	3	321	311-334	8.4	12	397	27.9	12
Spawner	2	303	214-332	38.4	8			
Spawner	3	361	354-369	6.4	4			

Age specific length frequency distributions for gillnet caught fish are compared with spawner length frequency distributions from Standard Creek for 2015-2017 (Fig. 13). Following a peak year for growth and size at age in 2014 (Sebastian and Weir, 2017), size declined slightly in 2015 then remained similar for most age classes in 2016. Very little growth was apparent between age 2 and 3 sampled in

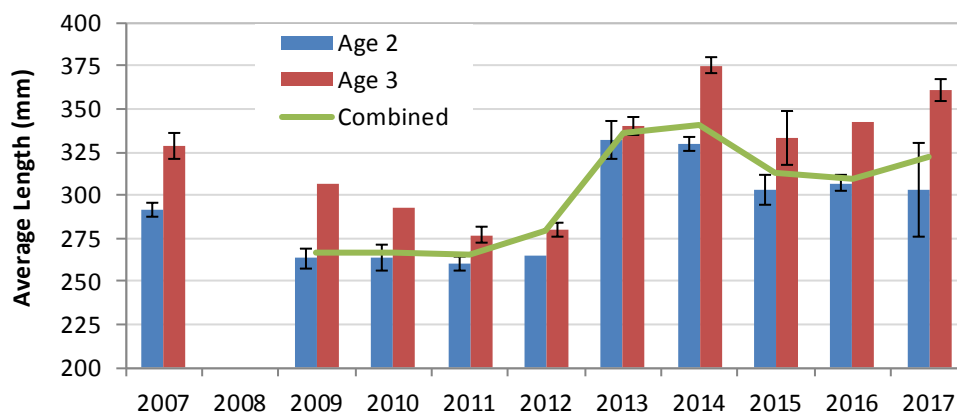


**Figure 13.** Age specific length frequency distributions for gillnet caught fish sampled in mid-summer from Revelstoke Reservoir and for spawners returning to Standard Creek during early late September for a) 2015, b) 2016 and c) 2017 sampling years.

July and the corresponding age 2 and 3 spawners sampled in early October in 2015 or 2016. By comparison, in 2017 gillnet captured age 1 were similar to 2015 and 2016, while gillnet caught age 2 and 3 were slightly smaller. Notably however, late summer growth in 2017 appeared good (similar to 2014), as the spawner sizes had increased in 2017 relative to 2015 and 2016.

Spawners obtained from Standard Creek in 2017 had a mean size of  $303 \pm 27$  mm for age 2 and  $361 \pm 6$  mm for age 3 fish (Fig. 14). Age 3 fish were significantly larger than in 2016 but smaller than the peak size in 2014. Due to a wide range in fork lengths, the age 2 fish in 2017 overlapped in size with 2016 and 2014. Trends in spawner size at age and size overall for Revelstoke show that growth rates have remained above average over the last four consecutive years, which appears to be a density dependent growth response as it follows consecutive years of lower than average age 1-3 density starting in 2012 and accounting for a one-year lag time (Figs. 8 & 15).

The age at maturity for Revelstoke Reservoir kokanee is typically age 2 with a small contingent of age 3 most years. The exception was 2012 when the majority of spawners were age 3 (Appendix 13).



**Figure 14.** Trends in average length of age 2 and 3 spawning kokanee in Standard Creek, a tributary to Downie Creek and Revelstoke Reservoir. Error bars denote  $\pm 2$  standard errors of the mean fork length.

### **Spawner Surveys**

Spawner counts were conducted for Camp Creek, Bush River and the Columbia River in 2017. A return of 8,650 kokanee to Camp Creek in 2017 was about 60% of the 18-year average. Bush River had a return of 14,050 which was 57% of the 17-year average. The Columbia River had a return of 37,181 which was similar to the 2016 count of 40,030. Both the 2016 and 2017 counts were very low compared to historical numbers spawning in the area although direct comparison to historic numbers are challenging. No data have been collected on Columbia River/Fairmont spawner abundance since 2008 (due to restrictions on low level helicopter use), and the counts in 2016 and 2017 were done with fence and trap throughout the spawning run so were more accurate than historical estimates which relied on a single low-level helicopter flight. At the request of the Provincial

Government, the Freshwater Fisheries Society of BC collected 5,291 mature kokanee from the Upper Columbia River spawning grounds near Fairmont which reduced the local spawner abundance by 14% for a total escapement of 31,890.

Using the alternative method to index spawner numbers with acoustic and gillnet data from summer surveys (see Bray et al. 2018), and applying an 87.5% maturity rate to the 2++ abundance of 144,500 resulted in a spawner index value of 126,400 for Kinbasket Reservoir (all tributaries). This was about 44% of the 2009-2017 average and was tied with 2014 for the lowest annual index in this period. In Revelstoke Reservoir, applying a maturity rate of 80.8% to the age 2++ abundance suggested a spawner index of 7,500 for 2017, which was only 35% of the nine-year average in Revelstoke Reservoir and was the third lowest in nine years next to 2013 and 2014.

## SUMMARY

**Flow and Water levels** - Unregulated inflow from the Columbia River into Kinbasket Reservoir was slightly above average but within 1 standard deviation of the mean during 2017, while freshet flows were well above average following heavy snowpack in early spring. The freshet was followed by a dry hot summer. Pool elevation in Kinbasket Reservoir ranged from 728.7m on May 4th to 752.7m on August 19th and was 751.6m at the time of survey.

**Kinbasket Reservoir** – The total kokanee abundance of 5.77 million was the fourth lowest in 19 years of survey data and well below an average of 8.24 million. The fry abundance of 5.19 million was below the long-term average of 6.57 million. The age 1-3 abundance of 0.58 million was similar to the 2016 estimate of 0.55 million, which was the lowest in the 19-year time series. Bush Pool added 25% to the total pelagic area surveyed in 2017, however, this area contributed only 14% (<860,700 kokanee) to the total abundance estimate for the reservoir.

With near average fry production translating into below average 1-3 abundance, it appears the fry to age 1 survival has declined since 2015; the May 2016 kokanee mortality event likely played a role in the reduced survival. An index of total spawner numbers of 126,400 for all Kinbasket Reservoir kokanee was the lowest in the 9-year times series (i.e. 2009-2017 based on all split beam acoustic data available), though similar to 2014. A comparison of 2017 kokanee size at age in the reservoir from combined trawl and gillnet catches indicated that fry were significantly smaller than in 2016 and age 1 and 2 were similar to the previous year. Spawner sizes remained large, the age 2 and age 3 spawners were the largest on record. Kokanee growth was therefore relatively good 2017,

which is attributable, at least in part, to continued low densities of age 1-3 kokanee.

**Revelstoke Reservoir** – The total abundance of kokanee was estimated at 0.83 (0.55-1.11) million and marked a return to the long-term average of  $1.00 \pm 0.23$  million. Fry abundance of 0.71 million was near the long-term average of  $0.83 \pm 0.20$  million and had returned from very low levels in 2016. The age 1-3 abundance of 0.021 (.007 – 0.035) million was by far the lowest on record and followed the second lowest fry estimate on record in 2016. The kokanee population (both fry and age 1-3) has remained well below average since 2012, except for the fry populations in 2015 and 2017, which were near average. Since 2013 there has been a large increase in the average length of spawners, identifying a density dependent growth response. The average length of spawners in 2017 was  $322 \pm 21$ mm and remained above the pre-2013 average of  $276 \pm 14$ mm. A newly developed spawner index for Revelstoke Reservoir suggested a total return of 7500 was 35% of the average returns for the last 9 years and was estimated at the third lowest next to 2013 and 2014.

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Thanks to these people!

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*Kinbasket and Revelstoke Reservoirs Kokanee Population Monitoring - Year 10 (2017)*



## APPENDICES

**Appendix 1.** Kinbasket Reservoir fish densities by transect from hydroacoustic surveys, 2008-2017. Note densities reported here represent all depths and are not weighted by the amount of habitat at depth.

Location	Zone	Trans No.	2008 July	2009 Aug	2010 Aug	2011 Aug	2012 Aug	2013 Aug	2014 July	2015 July	2016 Aug	2017 July
Ptarmigan Cr	2	1	364	272	701	206	487	357	48	167	97	259
		2	427	224	268	183	761	479	308	261	107	183
Hugh Allan Cr		3	451	253	279	169	300	326	126	165	68	47
Howard Bay		4	383	185	284	113	299	364	93	69	54	56
Foster Arm	3	5	635	274	397	149	205	970	176	188	121	162
		6	484	298	323	110	528	264	100	144	52	110
		7	1906	443	444	303	592	619	294	247	132	179
Dainard Cr		8	1855	509	420	377	616	366	415	638	321	354
Mica Dam	4a	9	197	265	309	353	586	234		126	92	45
Mica Arm		10	316	336	194	424	527	279		232	146	68
Mica Arm		11	365	336	342	253	512	378	188	325	231	158
Sprague Bay		12	801	390	293	160	400	361	322	336	139	104
Main pool	4b	13	1083	630	300	370	451	462	559	230	136	428
Main pool		14	1176	502	341	269	226	249	468	414	374	346
Main pool		15	543	819	365	332	338	247	385	502	330	297
East side		16	910	515	350	222	286	804	243	422	267	337
South side		20	632	427	452	205	213	290	452	604	247	419
Wood Arm	5	17	828	241	265	185	456	358	429	351	132	139
Wood Arm		18	300	246	226	299	402	465	154	414	166	133
Wood Arm		19	847	315	597		160	290	183	1041	123	223
Lower	6	21	660	454	201	168	404	278	199	694	672	528
Columbia		22	662	426	324	295	188	363	436	419	501	702
Old Kinbasket	7	23	621	374	285		165	265	388	340	277	275
Pool		24	455	336	184	263	134	246	305	222	295	246
SullivanArm		25	448	230	597	300	141	595	259	360	637	371
Kyanite Cr		26	285	296	237	307	106	295	218	327	201	265
		27	259	476	222	249	200	440	383	449	269	162
Garrett Cr		28	496	423	553	317	190	748	370	239	470	291
Upper	8	29	478	785	382	442	168		447	229	83	196
Columbia		30		513	463	302	158		289	350	130	355
Bush Pool		9	31							300	65	190
		32								349	170	184
		33								210	87	203
		34								314	86	164
		35								289	86	166
		36								210	121	297
		37								168		
		38								224		
		39								240		

A new Forebay Zone (4a) was added during Phase I synthesis grouping transects near the Dam while zone 4b represented the main Mica pool. In Bush Pool transects 31-39 were completed in 2015, six of which were sampled again in 2016 and 2017.

**Appendix 2.** Revelstoke Reservoir fish densities by transect from hydroacoustic surveys, 2008-17. Note densities reported here represent all depths and are not weighted by the amount of habitat at depth.

	Zone <sup>1</sup>	Old Trans No.	New Trans No. <sup>2</sup>	2008 July	2009 Aug	2010 Aug	2011 Aug	2012 Aug	2013 Aug	2014 July	2015 July	2016 July	2017 July
Rev. Dam	1	1	<b>1</b>	74	211	261	145	82	52	125	149	113	151
Coursier Cr.	1	2	<b>2</b>	170	182	126	401	142	53	107	300	81	299
	1	3	<b>3</b>	240	142	65	319	69	28	66	391	59	236
Martha Cr.	2	4	<b>4</b>	360	235	213	221	48	57	97	435	64	246
Sale Cr.	2	5	<b>5</b>	312	256	188	241	50	86	46	116	65	117
LaForme Cr.	2	6	<b>6</b>	431	151	230	177	70	94	119	226	83	198
	2	7	<b>7</b>	384	112	131	49	24	44	123	71	78	208
Carnes Cr.	2	8	<b>8</b>	651	213	122	57	41	88	85	108	164	131
Frisby Cr.	2	9		705		162		85					
Mars Cr.	2	10	<b>9</b>	192	123	205	65	29	65	96	101	77	15
	2	11											
Park Cr.	2	12	<b>10</b>	171	252	300	31	51	34	143	42	263	23
Bourne Cr.	2	13	<b>11</b>	327	251	432	36	29	82	25	54	94	45
Keystone	2	14	<b>12</b>	300	143	366	121	80	383	52	54	185	36
Downie	2	15	<b>12a</b>										
Downie Arm	2	16											
Power line	3	17	<b>13</b>	90	134	119	234	97	99	89	32	44	53
Fissure Cr.	3	18	<b>14</b>	117	270	169	93	405	96	52	22	127	26
Ferry	3	19	<b>15</b>	65	76	158	23	69	13	61	25	125	80
Liberty Cr.	3	20											
Old Goldstream	3	21	<b>16</b>	98	180	153	35	92	42	31	15	69	68
Goldstream	3	22											
Stump field	3	23	<b>17</b>	72	68	87	65	157	51	39	6	32	56
Powerline	3	24	<b>18</b>	59	67	186	52	25	23	28	24	72	43
Hoskins Cr.	3	25	<b>19</b>	52	149		69	2	20	18	1	40	4
Nichols Cr.	3	26	<b>20</b>	95	97	83	29	25	51	41	109	15	22

1. Note a new Forebay zone was added during the Phase 1 synthesis. Sampled zones are as follows: Zone 1 (Forebay), Zone 2 (Lower Revelstoke), Zone 3 (Middle Revelstoke) and Zone 4 (Upper Revelstoke). Zone 4 is too shallow for kokanee.

2. Note new transect numbers in bold font reflect all regular sampling (6 transects discontinued)

Blank values indicate no data.

**Appendix 3.** Summary of fish density statistics and Maximum Likelihood Estimates from Monte Carlo Simulations for Kinbasket Reservoir (zones 2-8) in July, 2017.

a) Fish all sizes (all ages): ( $\geq -60\text{dB}$ ) Transects 1-30 Note: Bush Pool not included

Zone	Depth	N	Mean	SE	Area	StratumPop	CV	Statistic	Abundance
1	3-5	30	2.3	1.1	23761	54,581	0.2	LB=	4,891,695
1	5-10	30	27.9	6.6	23761	662,827	0.2	MLE=	5,769,290
1	10-15	30	48.7	9.5	23761	1,158,262	0.2	UB=	6,645,023
1	15-20	30	69.4	10.6	23761	1,648,073	0.2		
1	20-25	30	63.4	10.2	22926	1,452,843	0.2		
1	25-30	30	25.6	3.2	22261	569,046	0.2		
1	30-35	30	6.8	1.1	21596	147,345	0.2		
1	35-40	30	1.8	0.5	20585	36,198	0.2		
1	40-45	30	1.4	0.3	19570	27,488	0.2		
1	45-50	30	0.7	0.2	18353	13,688	0.2		

b) Age 1-3 kokanee ( $\geq -45\text{db}$ ) Transects 1-30

Zone	Depth	N	Mean	SE	Area	StratumPop	CV	Statistic	Abundance
1	3-5	30	0.0	0	23761	-	0.3	LB=	484,013
1	5-10	30	2.4	0.7	23761	57,876	0.3	MLE=	583,281
1	10-15	30	2.0	0.6	23761	48,251	0.3	UB=	683,469
1	15-20	30	5.2	0.7	23761	122,519	0.3		
1	20-25	30	8.4	1.6	22926	191,731	0.3		
1	25-30	30	5.1	0.9	22261	114,003	0.3		
1	30-35	30	1.8	0.4	21596	38,201	0.3		
1	35-40	30	0.2	0.1	20585	4,870	0.3		
1	40-45	30	0.1	0	19570	1,238	0.3		
1	45-50	30	0.2	0.1	18353	4,492	0.3		
1	50-55	30	0	0	17070				

c) Age 0 kokanee ( $-60\text{dB}$  to  $-45.1\text{db}$ ) Transects 1-30

Zone	Depth	N	Mean	SE	Area	StratumPop	CV	Statistic	Abundance
1	3-5	30	2.3	1.1	23761	54,581	0.2	LB=	4,351,611
1	5-10	30	25.5	6.2	23761	604,950	0.2	MLE=	5,187,903
1	10-15	30	46.7	9.6	23761	1,110,011	0.2	UB=	6,008,849
1	15-20	30	64.2	10.2	23761	1,525,554	0.2		
1	20-25	30	55.0	9.1	22926	1,261,112	0.2		
1	25-30	30	20.4	2.8	22261	455,043	0.2		
1	30-35	30	5.1	0.9	21596	109,144	0.2		
1	35-40	30	1.5	0.5	20585	31,328	0.2		
1	40-45	30	1.3	0.3	19570	26,250	0.2		
1	45-50	30	0.5	0.1	18353	9,197	0.2		

**Appendix 4.** Summary of fish density statistics and Maximum Likelihood Estimates from Monte Carlo Simulations for Revelstoke Reservoir in August 2017.

a) Fish all sizes (all ages): ( $\geq -58\text{dB}$ ) Transects 1-9 and 10-20

Zone	Depth	N	Mean	SE	Area	Stratum Population	CV	Statistic	Abundance
1	3-5	8	2.9	2.9	3500	10,062	0.4	LB=	<b>551,192</b>
1	5-10	8	42.7	13.2	3500	149,582	0.4	MLE=	<b>830,540</b>
1	10-15	8	52.8	16.9	3500	184,886	0.4	UB=	<b>1,105,235</b>
1	15-20	8	88.8	33.8	3500	310,701	0.4		
1	20-25	8	5.8	1.6	3500	20,182	0.4		
1	25-30	8	1.3	0.6	3333	4,322	0.4		
1	30-35	8	1.8	0.7	3200	5,688	0.4		
1	35-40	8	0.9	0.5	3067	2,628	0.4		
1	40-45	8	0.8	0.5	2900	2,300	0.4		
1	45-50	8	0.5	0.3	2733	1,245	0.4		
2	3-5	12	2.0	1.3	3750	7,342	0.4		
2	5-10	12	11.8	2.7	3750	44,275	0.4		
2	10-15	12	5.3	1.7	3750	19,899	0.4		
2	15-20	12	4.2	1.4	3750	15,713	0.4		
2	20-25	12	3.7	1.2	3750	13,877	0.4		
2	25-30	12	2.9	1.1	3467	9,931	0.4		
2	30-35	12	2.6	0.8	3200	8,475	0.4		
2	35-40	12	3.2	0.8	2933	9,348	0.4		
2	40-45	12	2.2	0.8	2550	5,633	0.4		
2	45-50	12	1.5	0.6	2167	3,252	0.4		

b) Age 1-3 kokanee ( $\geq -46\text{db}$ ) Transects 1-20

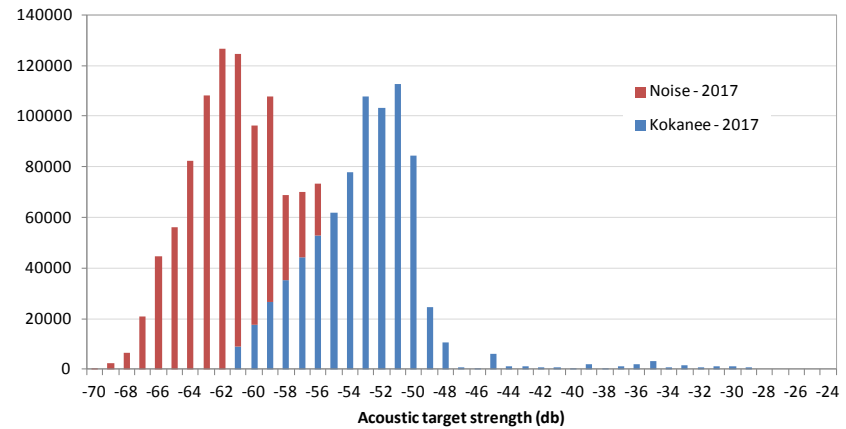
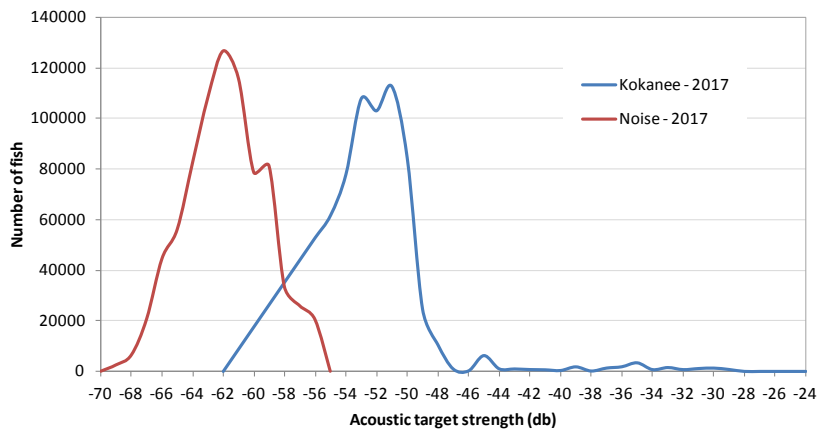
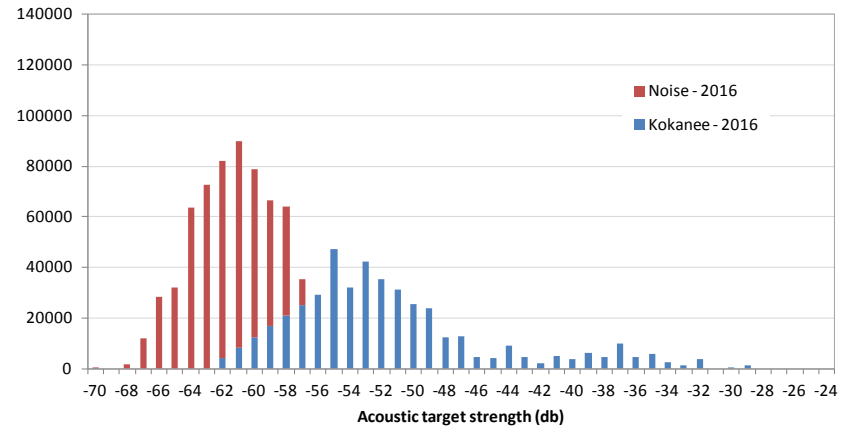
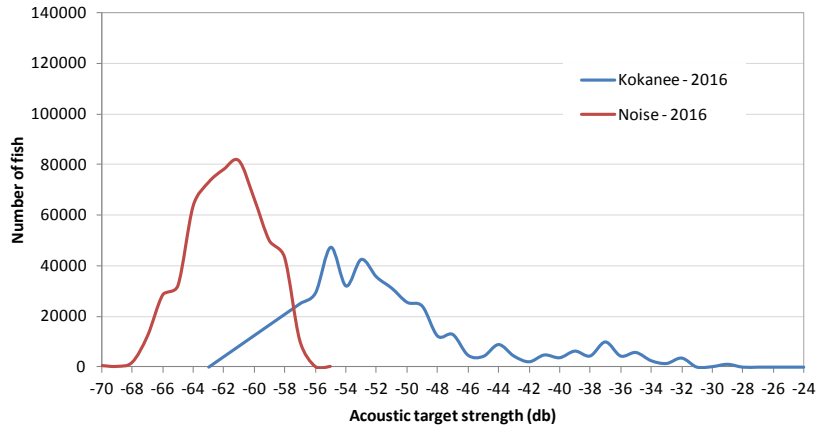
Zone	Depth	N	Mean	SE	Area	Stratum Population	CV	Statistic	Abundance
1	3-5	20	0.6	0.6	7250	4,456	0.8	LB=	<b>7,275</b>
1	5-10	20	0	0	7250		0.8	MLE=	<b>21,179</b>
1	10-15	20	0.1	0.1	7250	433	0.8	UB=	<b>35,133</b>
1	15-20	20	1.5	0.7	7250	10,865	0.8		
1	20-25	20	0.5	0.3	7250	3,836	0.8		
1	25-30	20	0.2	0.1	6800	1,462	0.8		
1	30-35	20	0	0	6000	110	0.8		
1	35-40	20	0	0	5450	95	0.8		
1	40-45	20	0.0	0.0	5088	-	0.8		
1	45-50	20	0.0	0.0	4558	-	0.8		

## Appendix 4 continued

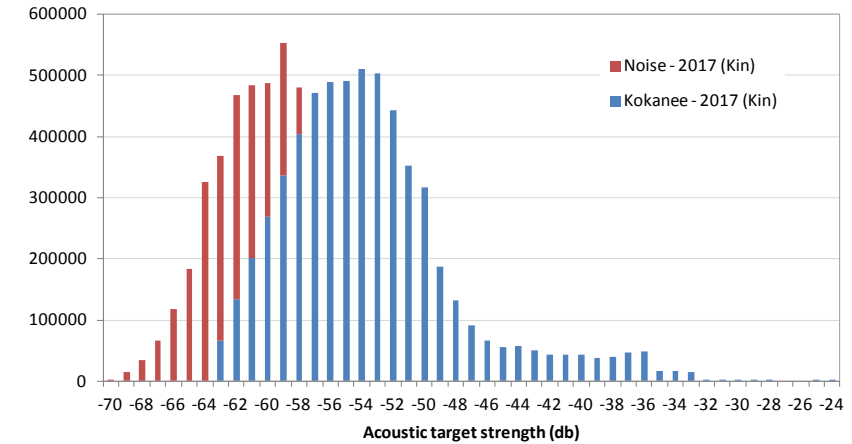
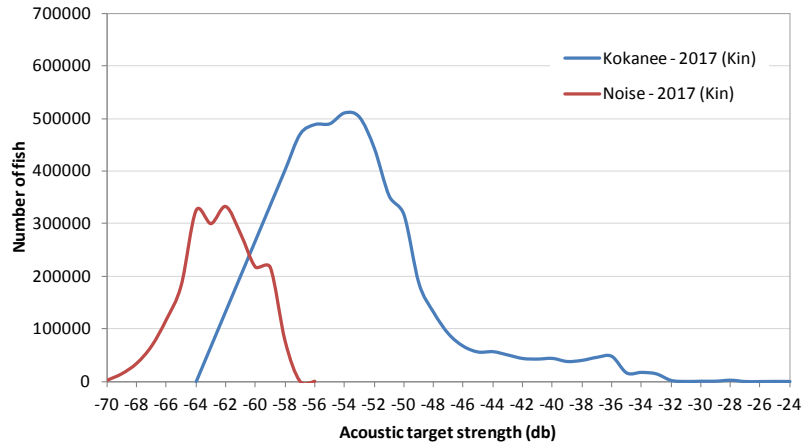
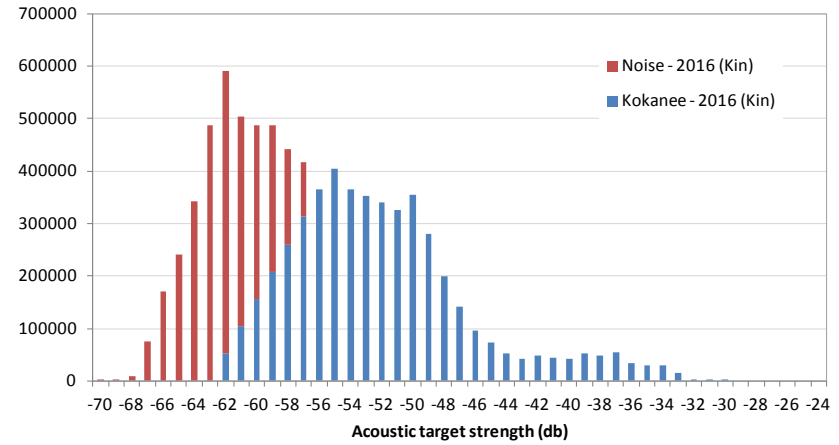
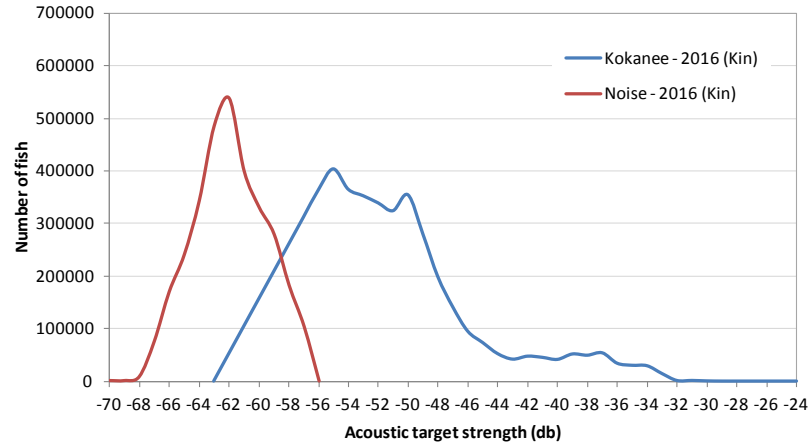
c) Age 0 kokanee (-58dB to -46.1db) Transects 1-8 and 9-20

Zone	Depth	N	Mean	SE	Area	Stratum Population	CV	Statistic	Abundance
1	3-5	8	2.9	2.9	3500	10,062	0.5	LB=	<b>518,252</b>
1	5-10	8	42.7	13.2	3500	149,582	0.5	MLE=	<b>794,345</b>
1	10-15	8	52.8	16.9	3500	184,886	0.5	UB=	<b>1,068,226</b>
1	15-20	8	85.0	33.6	3500	297,588	0.5		
1	20-25	8	4.8	1.3	3500	16,643	0.5		
1	25-30	8	1.1	0.6	3333	3,652	0.5		
1	30-35	8	1.8	0.7	3200	5,688	0.5		
1	35-40	8	0.8	0.5	3067	2,487	0.5		
1	40-45	8	0.7	0.5	2900	2,174	0.5		
1	45-50	8	0.5	0.3	2733	1,245	0.5		
2	3-5	12	0.9	0.9	3750	3,500	0.5		
2	5-10	12	11.8	2.7	3750	44,275	0.5		
2	10-15	12	5.2	1.7	3750	19,527	0.5		
2	15-20	12	4.2	1.4	3467	14,526	0.5		
2	20-25	12	3.5	1.2	3200	11,177	0.5		
2	25-30	12	2.6	1.0	2933	7,745	0.5		
2	30-35	12	2.6	0.8	2550	6,753	0.5		
2	35-40	12	3.2	0.8	2167	6,905	0.5		
2	40-45	12	2.2	0.8	1835	4,054	0.5		
2	45-50	12	1.5	0.6	1503	2,257	0.5		

**Appendix 5.** Acoustic target strength (TS) distributions showing the result of linear noise reduction technique for separating low end noise from kokanee fry in Revelstoke Reservoir for 2016-2017 surveys. Plots to the right show cumulative frequency distribution (i.e. fish and noise).



**Appendix 6.** Acoustic target strength (TS) distributions showing the result of linear noise reduction technique for separating low end noise from kokanee fry in Kinbasket Reservoir for 2016-2017 surveys. Note: the noise levels in Kinbasket tend to be much lower than in Revelstoke Reservoir (Appendix 5).



## Appendix 7. Trawl sampling logs and catch data for Kinbasket in 2017.

**Key:** SN=Scale Number, Mat=maturing, Imm=immature

Location: Kinbasket								Trawl No: 1		Layer #		Sensor Distance & Depth (m)		Target Depth	
Date: July 24, 2017								Transect No. 18a Wood Arm		1		123		21	
UTM start: 52 08 410 N				118 20 400 E				Time start: 00:01							
UTM end: 52 08 270 N				118 18 468 E				Time end: 00:46				Net: 7x3m		Duration: 45 min	
No.	SP	Len	Wt	Age	SN	MAT	Sex	No.	SP	Len	Wt	Age	SN	MAT	Sex
1	KO	150	36.6	1	1	Imm	F	38	KO	49	1.2	0		Imm	
2	KO	128	23	1	2	Imm		39	KO	35		0		Imm	
3	KO	135	25.5	1	3	Imm		40	KO	55	1.5	0		Imm	
4	KO	130	24.5	1	4	Imm		41	KO	56	1.8	0		Imm	
5	KO	139	28	1	5	Imm		42	KO	40	0.6	0		Imm	
6	KO	152	35.4	1	6	Imm		43	KO	51	1.3	0		Imm	
7	KO	139	31.1	1	7	Imm		44	KO	54	1.5	0		Imm	
8	KO	138	30.8	1	8	Imm		45	KO	38		0		Imm	
9	KO	148	35.4	1	9	Imm		46	KO	34		0		Imm	
10	KO	129	23.2	1	10	Imm		47	KO	43	0.8	0		Imm	
11	KO	113	14.2	1	11	Imm		48	KO	35		0		Imm	
12	KO	95	8.2	1	12	Imm		49	KO	48	1.1	0		Imm	
13	KO	81	5	0	13	Imm		50	KO	49	1.2	0		Imm	
14	KO	29	0.2	0		Imm		51	KO	40	0.5	0		Imm	
15	KO	30	0.2	0		Imm		52	KO	34		0		Imm	
16	KO	37	0.5	0		Imm		53	KO	35		0		Imm	
17	KO	46	1	0		Imm		54	KO	40	0.5	0		Imm	
18	KO	44	0.9	0		Imm		55	KO	43	0.7	0		Imm	
19	KO	44	0.9	0		Imm		56	KO	51	1.4	0		Imm	
20	KO	34	0.3	0		Imm		57	KO	39		0		Imm	
21	KO	34	0.3	0		Imm		58	KO	35		0		Imm	
22	KO	31	0.3	0		Imm		59	KO	35		0		Imm	
23	KO	29	0.2	0		Imm		60	KO	42	0.7	0		Imm	
24	KO	37		0		Imm		61	KO	51	1.4	0		Imm	
25	KO	35		0		Imm		62	KO	28		0		Imm	
26	KO	36		0		Imm		63	KO	30		0		Imm	
27	KO	32		0		Imm		64	KO	33		0		Imm	
28	KO	36		0		Imm		65	KO	33		0		Imm	
29	KO	37		0		Imm		66	KO	34		0		Imm	
30	KO	45	0.9	0		Imm		67	KO	60	2.1	0		Imm	
31	KO	43	0.8	0		Imm		68	KO	50	1.3	0		Imm	
32	KO	32		0		Imm		69	KO	43	0.7	0		Imm	
33	KO	33		0		Imm		70	KO	53	1.6	0		Imm	
34	KO	35		0		Imm		71	KO	50	1.2	0		Imm	
35	KO	39		0		Imm		72	KO	46	0.8	0		Imm	
36	KO	34		0		Imm		73	KO	62	2.4	0		Imm	
37	KO	30		0		Imm		74	KO	44	0.7	0		Imm	

Calculated Distance: 2185 m

Average velocity:

0.81 mps



## Appendix 7 – continued (2017 trawl catch data)

Location: Kinbasket							Trawl No: 2		Layer # Sensor Distance & Depth (m)			Target Depth			
Date: July 24, 2017							Transect No. 18a Wood Arm		1	130m	19	22-29			
UTM start: 52 08 260 N			118 18 839 E			Time start: 1:11									
UTM end: 52 08 408 N			118 20 776 E			Time end: 1:56		Net: 7x3m		Duration: 45 min					
No.	SP	Len	Wt	Age	SN	MAT	Sex	No.	SP	Len	Wt	Age	SN	MAT	Sex
75	PW	90				imm		102	KO	47	1	0			imm
76	KO	130	25.4	1	76	imm	F	103	KO	58	1.9	0			imm
77	KO	111	12.1	1		imm	F	104	KO	56	1.3	0			imm
78	KO	136	27.7	1		imm		105	KO	40	0.7	0			imm
79	KO	140	28.4	1	79	imm	F	106	KO	39	0.5	0			imm
80	KO	142	30.7	1	80	imm		107	KO	32		0			imm
81	KO	137	27.7	1		imm		108	KO	40	0.5	0			imm
82	KO	175	55.8	1		imm	F	109	KO	30	0.2	0			imm
83	KO	46	1	0		imm		110	KO	39		0			imm
84	KO	39		0		imm		111	KO	40	0.5	0			imm
85	KO	38		0		imm		112	KO	37		0			imm
86	KO	38		0		imm		113	KO	33		0			imm
87	KO	37		0		imm		114	KO	37		0			imm
88	KO	38		0		imm		115	KO	45	0.9	0			imm
89	KO	38		0		imm		116	KO	60	2	0			imm
90	KO	38		0		imm		117	KO	50	1.1	0			imm
91	KO	35		0		imm		118	KO	59	2.1	0			imm
92	KO	32		0		imm		119	KO	41	0.7	0			imm
93	KO	36		0		imm		120	KO	32	0.3	0			imm
94	KO	36		0		imm		121	KO	43		0			imm
95	KO	37		0		imm		122	KO	29		0			imm
96	KO	39		0		imm		123	KO	52	1.4	0			imm
97	KO	45	0.8	0		imm		124	KO	56	1.9	0			imm
98	KO	51	1.3	0		imm		125	KO	30	0.2	0			imm
99	KO	55	1.6	0		imm		126	KO	72	3.6	0			imm
100	KO	45	0.9	0		imm		127	KO	35	0.4	0			imm
101	KO	56	1.7	0		imm		128	KO	48	1.2	0			imm

Calculated Distance: 2210 m

Average velocity:

0.82 mps

**Appendix 8.** Gillnet set details and summary results for 2017 kokanee effort, catch and CPUE for a) Kinbasket and b) Revelstoke reservoirs.

**a) Kinbasket Reservoir including Bush Pool**

Attribute	GN1	GN2	GN3	GN4
Set date	24-Jul-17	24-Jul-17	19-Jul-17	19-Jul-17
Retrieval date	25-Jul-17	25-Jul-17	20-Jul-17	20-Jul-17
General location	Wood Arm	Wood Arm	Bush Pool	Bush Pool
Site location (near...)	TR18	TR18	TR36	TR33
Net depth(s) in meters	20,20,15,15	20,15,15	20,15,15	20,15,15
Lake depth (m) start/end	65	65	34	29
Start UTM East	E 409411	E 409681	E 462521	E 456068
Start UTM North	N 5777427	N 5776860	N 5733673	N 5672263
Set time	20:30	21:25	20:37	21:24
Retrieval time	4:45	11:20	10:30	11:30
Total time (hrs)	13.25	12.92	13.88	14.1
Net area (m <sup>2</sup> )	1041	781	781	781
Effort (ha·hr)	1.38	1.01	1.08	1.10
Kokanee catch (no)	26	18	12	11
Kokanee CPUE (no·ha·hr <sup>-1</sup> )	18.8	17.8	11.1	10.0
Bull trout catch (no)	10	4	2	4
Bull trout CPUE (no·ha·hr <sup>-1</sup> )	7.2	4.0	1.8	3.6

**b) Revelstoke Reservoir**

Attribute	GN 1	GN 2		
Set date	31-Jul-17	31-Jul-17		
Retrieval date	01-Aug-17	01-Aug-17		
Site location (near...)	TR5	TR11		
Net depth(s) in meters	15,15,10	20,15,15,10		
Lake depth (m) start/end	110	75		
Start UTM East	E 415679	E 398138		
Start UTM North	N 5672263	N 5699436		
Set time	18:50	20:20		
Retrieval time	10:06	12:30		
Total time (hrs)	15.26	16.17		
Net area (m <sup>2</sup> )	781	1041		
Effort (ha·hr)	1.19	1.68		
Kokanee catch (no)	20	32		
Kokanee CPUE (no·ha·hr <sup>-1</sup> )	16.8	19.0		
Bull trout catch (no)	1	4		
Bull trout CPUE (no·ha·hr <sup>-1</sup> )	0.8	2.4		

**Appendix 9.** Gill net catch results for over night sets in a) Kinbasket Reservoir including Bush Pool and for b) Revelstoke Reservoir during summer of 2017. Note: shading highlights non-kokanee captured in gillnets.

a) Kinbasket GN catch

Location: Kinbasket (Wood Arm T18)				Method: Pelagic GN				Net Type: RIC (modified) <sup>1</sup>						
Net Depth: GN#1: 20,20,15,15				Net Area: 1041m <sup>2</sup>										
Net Description: 7 panels of 15.24 x 2.44m end to end				Mesh size: graduated mesh 25-75mm (stretched)										
Gillnet No.	Trans No.	Mon	Day	Net Depth	Fish No.	Spec.	Len.	Weight	Sex	Matur.	Scale Age	Scale No.	Otol. No.	photo
1	18	7	25	20	46	KO	153	40	f	imm	1	46		
1	18	7	25	20	47	KO	148	32.5	f	imm	1	47		
1	18	7	25	20	48	KO	142	33	f	imm	1	48		
1	18	7	25	20	49	KO	143	31	f	imm	1	49		
1	18	7	25	20	50	KO	248	170	m	ming	2	50		
1	18	7	25	20	51	KO	225	126	f	ming	2	51		
1	18	7	25	20	52	KO	150	35.5	f	imm	1	52		
1	18	7	25	20	53	KO	145	31.5	f	imm	1	53		
1	18	7	25	20	54	KO	146	34	u	imm	1	54		
1	18	7	25	20	55	KO	138	29.5	f	imm	1	55		
1	18	7	25	20	56	KO	150	33.5	u	imm	1	56		
1	18	7	25	20	57	KO	136	27	u	imm	1	57		
1	18	7	25	20	58	KO	155	37.5	f	imm	1	58		
1	18	7	25	20	59	KO	148	35	u	imm	1	59		
1	18	7	25	20	60	KO	153	33	u	imm	1	60		
1	18	7	25	20	61	KO	139	28.5	u	imm	1	61		
1	18	7	25	20	62	KO	145	33.5	u	imm	1	62		
1	18	7	25	20	63	KO	148	32.5	u	imm	1	63		
1	18	7	25	20	64	BT	298	248	m	imm				
1	18	7	25	20		BT	~400						released	
1	18	7	25	15	65	KO	233	142.5	m	ming	2	65		
1	18	7	25	15	66	KO	166	46.5	u	imm	1	66		
1	18	7	25	15	67	KO	145	30	u	imm	1	67		
1	18	7	25	15	68	KO	142	27.5	u	imm	1	68		
1	18	7	25	15	69	KO	140	28.5	u	imm	1	69		
1	18	7	25	15	70	KO	124	19.5	f	imm	1	70		
1	18	7	25	15	71	KO	155	33.5	u	imm	1	71		
1	18	7	25	15	72	KO	142	30	u	imm	1	72		
1	18	7	25	15	73	BT	340	397.5	m	imm				
1	18	7	25	15	74	BT	325	360.5	m	imm				
1	18	7	25	15	75	BT	342	416.5	f	imm				
1	18	7	25	15	76	BT	357	358	m	imm				
1	18	7	25	15	77	BT	318	280.5	m	imm				
1	18	7	25	15		BT	~300						released	
1	18	7	25	15		BT	~400						released	
1	18	7	25	15		BT	~600						released	

1) see Appendix 8 for modifications to RIC nets

Note: non-kokanee species have been highlighted in grey and assigned unique fish number

## a) Kinbasket GN catch continued

Gillnet		Trans		Net		Fish		Scale		Scale		Otol.		
No.	No.	Mon	Day	Depth	No.	Spec.	Len.	Weight	Sex	Matur.	Age	No.	No.	photo
2	36	7	25	20	26	KO	150	36.5	u	imm	1	26		
2	36	7	25	20	27	KO	135	23	f	imm	1	27		
2	36	7	25	20	28	KO	153	42	u	imm	1	28		
2	36	7	25	20	29	KO	167	47	u	imm	1	29		
2	36	7	25	20	30	KO	152	35	u	imm	1	30		
2	36	7	25	20	31	BT	290	221	f	imm				
2	36	7	25	20	32	BT	291	263.5	f	imm				
2	36	7	25	15	33	KO	256	181.5	f	ming	2	33		
2	36	7	25	15	34	KO	170	55.5	u	imm	1	34		
2	36	7	25	15	35	KO	150	35	u	imm	1	35		
2	36	7	25	15	36	KO	143	32.5	u	imm	1	36		
2	36	7	25	15	37	KO	141	30	u	imm	1	37		
2	36	7	25	15	38	KO	150	37	u	imm	1	38		
2	36	7	25	15	39	KO	147	33	f	imm	1	39		
2	36	7	25	15	40	KO	135	24.5	u	imm	1	40		
2	36	7	25	15	41	KO	146	31.5	u	imm	1	41		
2	36	7	25	15	42	KO	145	33	u	imm	1	42		
2	36	7	25	15	43	KO	135	25	u	imm	1	43		
2	36	7	25	15	44	KO	254	177	m	ming	2	44		
2	36	7	25	15	45	KO	263	191	m	ming	2	45		
2	36	7	25	15		BT	~400							released
2	36	7	25	15		BT	~700							released

Note: one kokanee escaped at boat - was 2+ size

## a) Kinbasket GN catch continued

Gillnet		Trans		Net		Fish				Scale		Scale		Otol.	
No.	No.	Mon	Day	Depth	No.	Spec.	Len.	Weight	Sex	Matur.	Age	No.	No.	photo	
3	36	7	20	15	13	KO	223	119.0	m	ming	2	13			
3	36	7	20	15	14	KO	184	53.5	u	imm	1	14			
3	36	7	20	15	15	KO	170	51.5	f	imm	1	15			
3	36	7	20	15	16	KO	192	64.0	m	imm	1	16			
3	36	7	20	15	17	KO	167	50.5	u	imm	1	17			
3	36	7	20	15	18	KO	179	65.0	u	imm	1	18			
3	36	7	20	15	19	BT	286	201.5	f	imm					
3	36	7	20	15		BT	~450								released
3	36	7	20	15	20	KO	192	75.0	m	imm	2	20			
3	36	7	20	15	21	KO	165	47.0	f	imm	1	21			
3	36	7	20	15	22	KO	165	47.0	f	imm	1	22			
3	36	7	20	20	24	KO	166	51.0	u	imm	1	24			
3	36	7	20	20	24	KO	166	51.0	u	imm	1	24			
3	36	7	20	20	25	KO	166	51.5	f	imm	1	25			

Gillnet		Trans		Net		Fish				Scale		Scale		Otol.	
No.	No.	Mon	Day	Depth	No.	Spec.	Len.	Weight	Sex	Matur.	Age	No.	No.	photo	
4	33	7	20	20	1	KO	170	50.5	f	imm	1	1			
4	33	7	20	20	2	KO	125	18.5	f	imm	1	2			
4	33	7	20	20	3	KO	110	14.5	u	imm	1	3			
4	33	7	20	20	4	KO	125	14.5	u	imm	1	4			
4	33	7	20	15	5	KO	233	119.5	f	imm	2	5			
4	33	7	20	15	6	KO	231	123.5	m	imm	2	6			
4	33	7	20	15	7	KO	142	30.5	u	imm	1	7			
4	33	7	20	15	8	KO	170	56.0	f	imm	1	8			
4	33	7	20	15	9	KO	152	35.5	u	imm	1	9			
4	33	7	20	15	10	KO	158	39.0	f	imm	1	10			
4	33	7	20	15	11	KO	152	32.5	u	imm	1	11			
4	33	7	20	15	12	BT	255	158.5	u	imm					
4	33	7	20	15		BT	~450								released
4	33	7	20	15		BT	~450								released
4	33	7	20	15		BT	~540								released

## b) Revelstoke GN catch

Gillnet				Trans		Net		Fish		Scale			Scale		Otol.	
No.	No.	Mon	Day	Depth	No.	Spec.	Len.	Weight	Sex	Matur.	Age	No.	No.	photo		
1	5	8	1	15	114	KO	334	422	m	ming	3	114				
1	5	8	1	15	115	KO	331	443.5	m	ming	3	115				
1	5	8	1	15	116	KO	327	417	f	ming	3	116				
1	5	8	1	15	117	KO	281	295.5	f	ming	2	117				
1	5	8	1	15	118	KO	270	253.5	f	ming	2	118				
1	5	8	1	15	119	KO	285	287.5	f	ming	2	119				
1	5	8	1	15	120	KO	271	233.5	m	imm	2	120				
1	5	8	1	15	121	KO	232	151.5	m	imm	2	121				
1	5	8	1	15	122	MWF	220	111	unk	imm		n/a				
1	5	8	1	10	123	KO	315	394.5	f	ming	3	123				
1	5	8	1	10	124	KO	275	258.5	f	ming	2	124				
1	5	8	1	10	125	KO	289	297.5	f	ming	2	125				
1	5	8	1	10	126	KO	264	225.5	m	imm	2					
1	5	8	1	10	127	KO	272	255	m	ming	2	127				
1	5	8	1	10	128	KO	276	274	m	ming	2	128				
1	5	8	1	10	129	KO	280	279.5	f	ming	2	129				
1	5	8	1	10	130	KO	253	214.5	f	imm	2	130				
1	5	8	1	10	131	KO	275	249	f	ming	2	131				
1	5	8	1	10	132	KO	283	284.5	f	ming	2	132				
1	5	8	1	10	133	KO	265	244.5	f	imm	2	133				
1	5	8	1	10	134	KO	253	201	f	imm	2	134				
1	5	8	1	10	135	BT	286	219.5	f	imm						
1	5	8	1	10		RB	~400							released		

1) see Appendix 8 for modifications to RIC nets

Note: non-kokanee species have been highlighted in grey and assigned unique fish number

Note: ages in blue font were estimated based on length using scale ages as a guide

## b) Revelstoke GN catch continued

Location: Revelstoke (near Downie)				Method: Pelagic GN				Net Type: RIC (modified)						
Net Depth: GN#2 depths 20,15,15,10m				Net area: 1041m <sup>2</sup>										
Net Description: 7 panels of 15.24 x 2.44m end to end				Mesh size: graduated mesh 25-75mm (stretched)										
Gillnet No.	Trans No.	Mon	Day	Net Depth	Fish No.	Spec.	Len.	Weight	Sex	Matur.	Scale Age	Scale No.	Otol. No.	photo
2	11	8	1	20	78	KO	174	66.0	m	imm	1	78		
2	11	8	1	20	79	KO	160	52.5	f	imm	1	79		
2	11	8	1	20	80	KO	262	228	f	ming	2	80		
2	11	8	1	20	81	KO	313	352	f	ming	3	81		
2	11	8	1	20	82	KO	317	367.5	f	ming	3	82		
2	11	8	1	20	83	KO	176	67	f	imm	1	83		
2	11	8	1	20	84	KO	257	190.5	f	imm	2	84		
2	11	8	1	20	85	BT	360	415	unk	imm				
2	11	8	1	15	86	KO	280	261.5	m	ming	2	86		
2	11	8	1	15	87	KO	294	332	f	ming	2	87		
2	11	8	1	15	88	KO	312	382.5	m	ming	3	88		
2	11	8	1	15	89	KO	330	432	m	ming	3	89		
2	11	8	1	15	90	KO	311	374.5	f	ming	3	90		
2	11	8	1	15	91	KO	251	201.5	m	ming	2	91		
2	11	8	1	15	92	KO	188	80	f	imm	1	92		
2	11	8	1	15	93	KO	165	44	unk	imm	1	93		
2	11	8	1	15	94	KO	157	45	unk	imm	1	94		
2	11	8	1	15	95	KO	157	46.5	unk	imm	1	95		
2	11	8	1	15		KO	~240				2			released
2	11	8	1	15		KO	~240				2			lost overboard
2	11	8	1	15	96	MWF	188	66.5	f	imm				
2	11	8	1	15	97	BT	368	412.5	f	imm				
2	11	8	1	15	98	BT	320	303	f	imm				
2	11	8	1	15	99	BT	331	312.5	f	imm				
2	11	8	1	10	100	KO	283	290	m	ming	2	100		
2	11	8	1	10	101	KO	295	318.5	m	ming	2	101		
2	11	8	1	10	102	KO	325	384.5	f	ming	3	102		
2	11	8	1	10	103	KO	323	412.5	m	ming	3	103		
2	11	8	1	10	104	KO	288	300.5	m	ming	2	104		
2	11	8	1	10	105	KO	312	384.5	m	ming	3	105		
2	11	8	1	10	106	KO	280	280.5	m	ming	2	106		
2	11	8	1	10	107	KO	307	355	f	ming	2	107		
2	11	8	1	10	108	KO	199	90.5	unk	imm	1	108		
2	11	8	1	10	109	KO	166	51.5	unk	imm	1	109		
2	11	8	1	10	110	KO	168	54	unk	imm	1	110		
2	11	8	1	10	111	KO	159	46.5	unk	imm	1	111		
2	11	8	1	10	112	KO	162	53.5	unk	imm	1	112		
2	11	8	1	10	113	MWF	255	146	unk	imm				

Note: ages in blue font were estimated based on length using scale ages as a guide

**Appendix 10.** Estimates of biomass (kg) and biomass density (kg/ha) for kokanee based on hydroacoustic surveys of Kinbasket Reservoir during 2009-2017.

*Kinbasket and Revelstoke Reservoirs Kokanee Population Monitoring - Year 10 (2017)*

decibels	2009	2010	2011	2012	2013	2014	2015	2016	2017
-62	23	17	3	14	37	16	25	28	22
-61	31	26	6	23	57	33	34	32	31
-60	44	37	10	37	76	49	54	42	42
-59	57	53	21	51	104	74	67	56	65
-58	65	73	45	75	126	101	94	69	76
-57	94	105	66	95	165	131	124	88	101
-56	114	135	95	126	202	180	160	104	142
-55	154	177	184	160	280	241	200	157	193
-54	224	241	224	226	388	273	240	191	272
-53	301	303	344	326	499	311	275	250	362
-52	404	414	447	506	750	362	330	325	432
-51	525	524	579	691	1,045	428	357	421	465
-50	708	534	663	1,058	1,434	495	391	620	565
-49	895	759	704	1,166	1,639	533	432	665	451
-48	927	867	626	1,214	1,535	593	408	638	428
-47	1,120	935	582	1,039	1,443	720	563	616	400
-46	1,040	1,037	740	932	1,301	887	703	559	400
-45	1,367	1,407	1,036	1,042	1,526	1,399	889	582	453
-44	1,742	1,662	1,054	1,412	1,451	1,836	1,172	560	620
-43	2,286	2,327	1,582	1,565	1,866	2,396	1,848	606	745
-42	3,001	3,212	2,002	2,088	2,383	2,447	2,595	923	875
-41	4,057	4,115	2,551	2,837	3,412	3,301	3,971	1,191	1,155
-40	5,991	7,471	3,663	4,748	5,173	4,005	5,469	1,473	1,607
-39	9,652	12,162	6,018	5,846	7,338	4,434	6,615	2,490	1,882
-38	15,120	18,339	6,992	9,265	9,696	3,930	6,477	3,221	2,692
-37	20,453	17,504	9,646	11,019	12,987	3,859	5,343	4,753	4,161
-36	27,553	17,837	10,803	9,661	15,271	2,836	3,895	4,071	5,845
-35	26,395	14,075	11,447	10,605	12,062	2,504	2,415	4,865	2,700
-34	22,542	13,505	7,665	10,300	19,908	1,405	1,375	6,384	3,894
-33	13,121	5,243	4,746	6,162	17,666	831	1,160	4,227	4,416
-32	11,082	1,845	2,116	1,773	5,068	147	764	432	866
-31	1,695	-	-	612	485	84	603	640	102
-30	1,625	627	-	-	324	113	71	258	487
-29	-	-	3,289	-	-	264	-	-	658
-28	-	-	-	1,374	-	-	-	-	3,482
-27	-	-	-	-	-	280	-	-	-
-26	815	-	-	-	-	-	-	-	-
-25	-	-	-	-	-	-	-	-	906
-24	-	-	-	-	-	-	-	-	504
Total	175,068	127,435	79,908	87,925	127,425	41,448	49,116	41,435	42,445
KO fry (kg)	6,571	6,103	5,297	8,707	12,333	4,490	3,189	5,342	4,397
KO 1+ (kg)	43,216	50,696	24,899	27,762	31,319	20,705	23,825	10,463	10,027
KO 2++ (kg)	121,145	68,164	44,308	47,747	82,963	15,365	20,665	24,300	21,881
<b>Appendix 10 Continued</b>									
<b>Total KO (kg)</b>	<b>170,932</b>	<b>124,963</b>	<b>74,503</b>	<b>84,217</b>	<b>126,615</b>	<b>40,560</b>	<b>47,679</b>	<b>40,105</b>	<b>36,306</b>
large targets	4,135	2,472	5,405	3,759	810	888	1,438	1,330	6,139
Total fish	175,068	127,435	79,908	87,976	127,425	41,448	49,116	41,435	42,445



Habitat (ha)	23,067	22,900	23,568	23,735	23,401	23,234	23,234	23,401	23,234
Pool Elev (m)	750	749	753	754.5	752	751	751	752	751
<b>BD in kg/ha</b>									
KO age 0+	0.28	0.27	0.22	0.37	0.53	0.19	0.14	0.23	0.19
KO age 1+	1.87	2.20	1.08	1.20	1.36	0.90	1.03	0.45	0.43
KO age 2++	5.25	2.98	1.88	2.01	3.55	0.49	0.61	1.04	0.94
<b>Total KO</b>	<b>7.41</b>	<b>5.46</b>	<b>3.16</b>	<b>3.55</b>	<b>5.41</b>	<b>1.75</b>	<b>2.05</b>	<b>1.71</b>	<b>1.56</b>
large (kg/ha)	0.18	0.11	0.23	0.16	0.03	0.04	0.06	0.06	0.26
Total (kg/ha)	7.59	5.56	3.39	3.71	5.45	1.78	2.11	1.77	1.83
% large	2%	2%	7%	4%	1%	2%	3%	3%	14%

**Color key:** shaded areas indicate age groups as follows: age 0 beige, age 1 yellow and age 2++ brown.

**Appendix 11.** Estimates of biomass (kg) and biomass density (kg/ha) for kokanee based on hydroacoustic surveys of Revelstoke Reservoir during 2009-2017.

decibels	2009	2010	2011	2012	2013	2014	2015	2016	2017
-61	7	8	4	12	4	6	11	7	10

*Kinbasket and Revelstoke Reservoirs Kokanee Population Monitoring - Year 10 (2017)*

-60	10	12	5	11	6	9	13	9	11
-59	11	15	12	18	8	13	16	10	16
-58	14	14	14	21	9	12	15	13	14
-57	17	16	18	20	10	12	23	9	19
-56	19	27	37	24	12	27	28	10	26
-55	27	36	23	22	25	26	42	23	30
-54	41	58	42	14	26	36	66	21	50
-53	53	90	66	38	35	44	88	37	94
-52	63	96	100	39	86	29	137	41	121
-51	78	160	62	34	62	40	124	49	177
-50	118	186	93	31	105	23	108	54	178
-49	136	227	138	64	126	16	10	68	70
-48	157	123	40	39	27	27	22	47	40
-47	111	75	14	47	29	20	18	66	5
-46	125	78	13	41	11	66	24	32	1
-45	127	170	24	41	14	45	37	39	58
-44	215	172	27	94	21	87	21	111	13
-43	394	274	72	54	16	56	78	73	16
-42	396	343	67	59	81	26	43	48	17
-41	556	374	94	50	114	22	24	146	19
-40	557	468	257	233	208	90	138	151	15
-39	738	701	885	335	186	192	118	347	99
-38	1,472	1,653	1,570	410	301	277	212	325	12
-37	1,830	2,533	1,541	471	284	509	778	985	131
-36	1,905	2,552	2,179	1,046	113	176	618	584	246
-35	1,898	2,134	981	451	211	416	99	1,035	611
-34	1,817	1,694	1,042	1,564	455	306	814	612	173
-33	2,665	2,927	2,245	2,514	296	-	892	468	497
-32	2,518	1,595	2,602	1,940	770	509	388	1,556	312
-31	3,221	367	3,090	13	96	-	-	-	667
-30	480	530	354	318	1,106	-	-	153	1,038
-29	717	-	13	-	-	1,238	-	1,191	809
-28	525	-	-	-	-	1,664	-	-	-
-27	-	-	-	-	-	-	-	-	-
-26	-	-	-	-	-	-	-	-	-
-25	-	-	-	-	-	-	-	-	-
-24	-	-	-	-	-	-	-	-	-
Total	22,988	19,674	17,703	10,026	4,837	5,991	4,967	8,294	5,558
KO fry (kg)	833	1,109	632	326	532	265	658	372	824
KO 1+ (kg)	6,410	6,766	4,550	1,833	1,265	1,417	1,513	2,323	382
KO 2++ (kg)	14,023	10,902	12,139	7,515	1,846	1,406	2,423	4,255	3,543

**Appendix 11 Continued**

<b>Total KO (kg)</b>	<b>21,266</b>	<b>18,777</b>	<b>17,321</b>	<b>9,675</b>	<b>3,642</b>	<b>3,089</b>	<b>4,595</b>	<b>6,950</b>	<b>3,711</b>
large targets	1,722	897	367	331	1,202	2,902	388	1,344	1,846
Total fish	22,988	19,674	17,688	10,005	4,845	5,991	4,983	8,294	5,558
Habitat (ha)	7,250	7,250	7,250	7,250	7,250	7,250	7,250	7,250	7,250
<b>BD in kg/ha</b>									
KO age 0+	0.11	0.15	0.09	0.04	0.07	0.04	0.09	0.05	0.11
KO age 1+	0.88	0.93	0.63	0.25	0.17	0.20	0.21	0.32	0.05
KO age 2++	1.93	1.50	1.67	1.04	0.25	0.19	0.33	0.59	0.49
<b>Tot KO</b>	<b>2.93</b>	<b>2.59</b>	<b>2.39</b>	<b>1.33</b>	<b>0.50</b>	<b>0.43</b>	<b>0.63</b>	<b>0.96</b>	<b>0.66</b>
large (kg/ha)	0.24	0.12	0.05	0.05	0.17	0.40	0.05	0.19	0.25
Total (kg/ha)	3.17	2.71	2.44	1.38	0.67	0.83	0.69	1.14	0.77
% large	7%	5%	2%	3%	25%	48%	8%	16%	33%

**Appendix 12.** Kokanee spawner length and age data for a) Camp Creek, b) Bush River, c) Luxor Creek and d) Standard Creek, tributary to Downie Creek and Revelstoke Reservoir (Source: G. Blackman, BCCF for Camp Creek, K. Bray, BCH Revelstoke for Bush, Luxor and Standard).

**a) Camp Creek (angling)**

Year	Date	Sex	FL (mm)	Age	Ot#	Date	Sex	FL (mm)	Age	Ot#
2017	18-Sep	F	255	2	8	18-Sep	M	280	2	12
2017	18-Sep	F	260	2	6	18-Sep	M	280	2	17
2017	18-Sep	F	265	2	4	18-Sep	M	284	2	15
2017	18-Sep	F	265	2	7	18-Sep	M	285	2	16
2017	18-Sep	F	265	2	9	18-Sep	M	275	3	19
2017	18-Sep	F	268	2	1	18-Sep	M	300	3	18
2017	18-Sep	F	268	2	10	18-Sep	M	300	3	20
2017	18-Sep	F	290	2	3	18-Sep	M	310	3	14
2017	18-Sep	F	295	2	5	18-Sep	M	290		11
2017	18-Sep	F	290	3	2	18-Sep	M	300		13
2017	22-Sep	F	250	2	38	22-Sep	M	270	2	28
2017	22-Sep	F	255	2	35	22-Sep	M	275	2	24
2017	22-Sep	F	260	2	32	22-Sep	M	285	2	22
2017	22-Sep	F	260	2	34	22-Sep	M	285	2	25
2017	22-Sep	F	260	2	39	22-Sep	M	295	2	23
2017	22-Sep	F	270	2	31	22-Sep	M	295	2	26
2017	22-Sep	F	270	2	36	22-Sep	M	300	2	27
2017	22-Sep	F	275	2	40	22-Sep	M	305	2	21
2017	22-Sep	F	280	2	33	22-Sep	M	290	3	29
2017	22-Sep	F	300	3	37	22-Sep	M	290	3	30
2017	28-Sep	F	250	2	55	28-Sep	M	250	2	42
2017	28-Sep	F	250	2	56	28-Sep	M	260	2	45
2017	28-Sep	F	255	2	51	28-Sep	M	260	2	48
2017	28-Sep	F	260	2	53	28-Sep	M	260	2	49
2017	28-Sep	F	260	2	60	28-Sep	M	270	2	46
2017	28-Sep	F	270	2	52	28-Sep	M	290	2	50
2017	28-Sep	F	280	2	54	28-Sep	M	295	2	43
2017	28-Sep	F	280	2	58	28-Sep	M	300	3	41
2017	28-Sep	F	290	2	57	28-Sep	M	310	3	44
2017	28-Sep	F	290	2	59	28-Sep	M	300		47
<b>Mean</b>		<b>F</b>	<b>270</b>			<b>Mean</b>	<b>M</b>	<b>286</b>		

## b) Bush River (gillnet)

Year	Date	Sex	FL (mm)	Age	Ot#	Date	Sex	FL (mm)	Age	Ot#
2017	21-Sep	F	231	2	30	21-Sep	M	279	2	7
2017	21-Sep	F	263	2	29	21-Sep	M	279	2	8
2017	21-Sep	F	265	2	3	21-Sep	M	281	2	13
2017	21-Sep	F	265	2	31	21-Sep	M	283	2	22
2017	21-Sep	F	269	2	5	21-Sep	M	292	2	17
2017	21-Sep	F	271	2	23	21-Sep	M	276	3	10
2017	21-Sep	F	273	2	27	21-Sep	M	288	3	26
2017	21-Sep	F	274	2	25	21-Sep	M	289	3	1
2017	21-Sep	F	281	3	12	21-Sep	M	290	3	2
2017	21-Sep	F	295	3	19	21-Sep	M	291	3	9
2017	29-Sep	F	223	2	49	21-Sep	M	285		20
2017	29-Sep	F	235	2	47	29-Sep	M	202	2	36
2017	29-Sep	F	241	2	37	29-Sep	M	205	2	44
2017	29-Sep	F	251	2	45	29-Sep	M	214	2	38
2017	29-Sep	F	260	2	54	29-Sep	M	230	2	56
2017	29-Sep	F	264	2	33	29-Sep	M	245	2	60
2017	29-Sep	F	269	2	35	29-Sep	M	250	2	59
2017	29-Sep	F	275	2	50	29-Sep	M	254	2	57
2017	29-Sep	F	281	2	48	29-Sep	M	255	2	41
2017	29-Sep	F	270		40	29-Sep	M	257	2	32
<b>Mean</b>		<b>F</b>	<b>263</b>	n=20		29-Sep	M	261	2	52
2017	21-Sep	M	231	2	24	29-Sep	M	265	2	46
2017	21-Sep	M	237	2	28	29-Sep	M	270	2	34
2017	21-Sep	M	247	2	18	29-Sep	M	272	2	58
2017	21-Sep	M	249	2	15	29-Sep	M	278	2	39
2017	21-Sep	M	255	2	4	29-Sep	M	278	2	42
2017	21-Sep	M	257	2	16	29-Sep	M	281	2	51
2017	21-Sep	M	258	2	6	29-Sep	M	294	3	43
2017	21-Sep	M	265	2	21	29-Sep	M	294	3	53
2017	21-Sep	M	270	2	11	29-Sep	M	300	3	55
2017	21-Sep	M	270	2	14					
		<b>M</b>	<b>264</b>	n=40		<b>Mean</b>	<b>M</b>	<b>264</b>		

## c) Luxor Creek (dipnet)

Year	Date	Sex	FL (mm)	Age	Ot#	Date	Sex	FL (mm)	Age	Ot#
2017	12-Sep	F	257	2	13	12-Sep	M	266	2	6
2017	12-Sep	F	261	2	10	12-Sep	M	274	2	4
2017	12-Sep	F	263	2	5	12-Sep	M	288	3	8
2017	12-Sep	F	266	2	11	12-Sep	M	289	3	1
2017	12-Sep	F	276	2	2	12-Sep	M	266		15
2017	12-Sep	F	265	3	7	21-Sep	M	227	2	39
2017	21-Sep	F	243	2	28	21-Sep	M	240	2	18
2017	21-Sep	F	250	2	43	21-Sep	M	251	2	25
2017	21-Sep	F	255	2	20	21-Sep	M	253	2	29
2017	21-Sep	F	259	2	32	21-Sep	M	256	2	35
2017	21-Sep	F	260	2	21	21-Sep	M	256	2	37
2017	21-Sep	F	260	2	23	21-Sep	M	257	2	38
2017	21-Sep	F	265	2	44	21-Sep	M	260	2	27
2017	21-Sep	F	268	2	42	21-Sep	M	265	2	34
2017	21-Sep	F	270	2	24	21-Sep	M	265	2	45
2017	21-Sep	F	270	2	36	21-Sep	M	266	2	41
2017	21-Sep	F	276	3	19	21-Sep	M	268	2	30
2017	21-Sep	F	282	3	26	21-Sep	M	269	2	40
<b>Mean</b>		<b>F</b>	<b>264</b>		n=18	21-Sep	M	271	2	22
2017	12-Sep	M	253	2	12	21-Sep	M	276	2	31
2017	12-Sep	M	261	2	3	21-Sep	M	269	3	33
2017	12-Sep	M	261	2	9	21-Sep	M	275	3	17
2017	12-Sep	M	262	2	14	21-Sep	M	279	3	16
						<b>Mean</b>	<b>M</b>	<b>264</b>		n=27

## d) Standard Creek (Revelstoke Reservoir) (dipnet)

Year	Date	Sex	FL (mm)	Age	Ot#	Date	Sex	FL (mm)	Age	Ot#
2017	29-Sep	F	214	2	2	29-Sep	M	290	2	5
2017	29-Sep	F	330	2	1	29-Sep	M	303	2	13
2017	29-Sep	F	332	2	8	29-Sep	M	311	2	12
2017	29-Sep	F	354	3	9	29-Sep	M	320	2	4
2017	29-Sep	F	362	3	3	29-Sep	M	320	2	7
2017	29-Sep	F	329		11	29-Sep	M	358	3	10
						29-Sep	M	369	3	6
						29-Sep	M	308		14
<b>Mean</b>		<b>F</b>	<b>320</b>		n=6	<b>Mean</b>	<b>M</b>	<b>322</b>		n=8

**Appendix 13.** Kokanee spawner mean length by age and proportion by age for  
 a) Kinbasket Reservoir: data from Camp Creek, Luxor Creek  
 and Bush River and for b) Revelstoke Reservoir; Standard  
 Creek.

a) Kinbasket Reservoir

Tributary	Year	Sample Date(s)	Age 2+ spawners			Age 3+ spawners			% age 3+
			Mean	S.D.	n	Mean	S.D.	n	
Camp Cr	1998	Sep 28-Oct 17	238	9.0	62	264	7.9	15	19
	2000	Sep 24-28	244	9.5	47	267	9.7	13	22
	2001	Sep 23-25	242	8.4	30	264	10.9	30	50
	2002	Sep 28-Oct 17	265	12.3	7	278	11.2	53	88
	2003	Sep 28-Oct 17	250	6.0	21	277	9.0	39	65
	2004	Sep 25	235	14.5	43	257	15.9	17	28
	2005	Oct 4	242	6.6	32	253	8.2	27	46
	2006	Sep 25	226		1	277	10.7	59	98
	2007	Sep 29				273	13.6	60	100
	2008	Sep 28, Oct 4	223	15.6	11	253	8.7	19	63
	2009	Sep 29	223	10.3	30				0
	2010	Sep 30	228	10.6	60				0
	2011	Sep 23	237	7.8	28	244	1.4	2	7
	2012	Sep 29	247	9.4	4	265	10.7	26	87
	2013	Sep 13,19 &26	264	6.3	15	283	10.3	34	69
	2014	Sep 22,29, Oct 6	238	13.0	19	266	18.0	41	68
	2015	Sep 15,21&28	237	9.3	40	241	10.8	17	30
	2016	Sep 15,22 & 28	271	14.3	10	275	8.0	27	73
	2017	Sep 18,22 & 28	273	15.1	47	297	10.6	10	18
	Mean		243			267			49
Wood R	2016	Sep 21	259	6.9	9	264	8.5	3	25
Bush R	2013	Sep 20 &26	259	8.3	34				0
	2014	Sep 15 & 25	234	14.1	16	244	18.8	6	27
	2015	Sep 17	224	7.8	19	233	16.5	3	14
	2016	Sep 15 & 28	248	11.5	51	255	13.2	5	9
	2017	Sep 12*, 21 & 29	258	20.8	48	290	7	10	17
	Mean		245			256			13
Luxor Cr	2007		249	8.4	27	268	3.2	4	13
	2009		209	11.0	30				0
	2010		224	9.2	29	244		1	3
	2011		223	10.3	10				0
	2012	Sep 25	233	8.3	24	247	5.3	5	17
	2013	Sep 13,20 &26	252	6.7	41	264	10.3	6	13
	2014	Sep 15 & 25	231	10.0	36	256		1	3
	2015	Sep 17	221	6.4	33				0
	2016	Sep 15 & 21	243	11.9	46	255	4	3	6
	2017	Sep 12 & 21	261	10.1	36	278	8.5	8	18
	Mean		235			259			7

## b) Revelstoke Reservoir

Tributary	Year	Sample Date(s)	Age 2+ spawners			Age 3+ spawners			% age 3+
			Mean	S.D.	n	Mean	S.D.	n	
Standard Cr	2007		292	10.6	22	329	11.9	10	31
	2009		263	10.7	14	306		1	7
	2010		264	11.8	9	293		1	10
	2011		260	7.5	14	277	5.5	6	30
	2012	Sep 27	265		1	280	8.4	14	93
	2013	Oct 4	332	11.9	5	340	5.7	5	50
	2014	Oct 2	330	8.3	16	375	5.3	5	24
	2015	Oct 2	303	18.8	18	333	23.6	9	33
	2016	Sep 28	307	8.3	14	342		1	7
	2017	29-Sep	303	38.4	8	361	6.4	4	33
	Mean		292			324			

Note: a very small age 3+ spawner contributed to high S.D. and low mean length for age 3+ spawners in Revelstoke in 2015. This fish (236mm age 3) is assumed to have dropped down from Kinbasket Reservoir.