BC hydro

Columbia River Project Water Use Plan

Kinbasket and Revelstoke Reservoirs Kokanee Population Monitoring

Implementation Year 4

Reference: CLBMON-2

Kinbasket and Revelstoke Reservoirs Kokanee Population Monitoring – Progress Report Year 4

Study Period: 2011

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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 4 (2011)

Prepared by D. Johner and T. Weir

INTRODUCTION

The Fish, Wildlife and Habitat Management Branch of the Ministry of Forests, Lands and Natural Resource Operations (FLNRO) (formerly Ecosystems Branch of the Ministry of Environment) and BC Hydro (BCH) under its Columbia River Water License Requirements (WLR) program undertook the fourth year of a proposed twelve year study to monitor kokanee in the limnetic habitat of two Columbia Basin reservoirs, Revelstoke and Kinbasket, during the end of July and the beginning of August 2011. This 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 to date on the study as part of the terms outlined in the July 2008 Contribution Agreement (No. Q8-8539). 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 2011 field survey in relation to previous years of trend data. The same survey design, methods and equipment were employed, however due to extreme weather and debris conditions in 2011, 2 of the 30 standard transects were not completed.

In June 2012, Addendum 1 was created for the Kinbasket and Revelstoke Reservoirs Kokanee Population Monitoring (CLBMON-2) Terms of Reference. The addendum added a task to include escapement monitoring and biological sampling at established index streams in Kinbasket and Revelstoke Reservoirs each fall.

METHODS AND EQUIPMENT

Hydroacoustic data collection and trawl sampling were done at night from a closed cabin 7.3m Ministry research boat fully equipped for night work and navigation. Acoustic data were collected continuously along 28 of the 30 established transects using a Simrad EK60 split beam scientific sounder operating at a frequency of 120 KHz. Transects 20 and 23 were omitted due to high wind/wave activity. Digital raw data were stored on a Panasonic Toughbook laptop computer and backed up on external hard drive. The files were

compressed and analysed using SONAR-5 version 6.0.0 software operating on a Windows XP platform. Software settings were tested and refined over the winter of 2009-10 in order to ensure results are comparable to the existing time series dataset which was collected over a period of 10 years with a Simrad EY200P single beam echosounder operating at 70kHz as described in Sebastian et al (2010; 1995). Transect echograms were viewed and some preliminary analyses performed on site to ensure data quality. Radar and a Global Positioning System (GPS) were used for efficiency of night-time navigation and to locate and verify sampling locations. Transect fish densities for Kinbasket and Revelstoke reservoirs are summarized in Appendices 1 and 2, respectively. 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. All other statistical bounds represent 95% confidence limits using two times standard error.

Trawl sampling on Kinbasket and Revelstoke reservoirs occurred using a 3 x 7m opening/closing trawl net deployed by a hydraulic dual drum winch and boom. The net was lowered and opened at the top of the visible fish layer and fished for 30-60 minutes per layer covering one or two seven meter layers at a speed of 0.7-0.9 $m \cdot s^{-1}$ (see Appendix 5 for depths and duration fished and a summary of biological data). A total of three 1 hour trawls were completed on Kinbasket Reservoir and two on Revelstoke Reservoir. Note that trawl sampling was directed at the most dense parts of the fish layer to optimize numbers of fish in hand. The net depth, water temperature and distance from the boat were measured using a Notus trawl depth sensor system. Total length of habitat trawled was determined by GPS. The purpose of trawling was to verify the assumption that kokanee was the main species observed at night with the echosounder, and to collect biological samples for determining length, weight, age and growth.

Temperature and dissolved oxygen profiles were obtained using a Seabird water profiler unit. Seabird casts were made at two locations in Kinbasket Reservoir; in the main pool at Transect 14 and in Old Kinbasket Pool at Transect 24. Revelstoke Reservoir Seabird casts occurred at two locations; Transect 8 and Transect 26 (Fig. 1).

Kokanee have been enumerated annually by spawner surveys in up to 11 index streams for Kinbasket Reservoir including the Columbia River mainstem since the mid 1990's based on Oliver (1995). Escapement counts have been conducted by aerial survey on Dutch Creek, Columbia River (upper), Toby Creek, Horsethief Creek, Forster Creek, Luxor Creek, Bush River, Succour Creek, Kinbasket River, Wood River and Camp Creek. On Revelstoke Reservoir kokanee counts were conducted on seven streams in the 1990s while only a single stream system, Downie Creek and its tributary Standard Creek, continue to be enumerated as an index of escapement for Revelstoke Reservoir.

Surveys consisted of one over-flight by helicopter at approximately 16-30 kph at a height of 50 meters. Either one or two observers grouped the fish into schools of 50, 100, 500 individuals etc and summed to provide a total count. Flights were conducted during the approximate peak of spawning activity during the first week of October. Due to external circumstances, from 2010 onward one of the key areas with the highest annual counts (i.e. Upper Columbia River) could no longer be enumerated by helicopter so is no longer available as an index. The three Kinbasket tributaries with the most complete and consistent datasets provide the best indices of kokanee abundance annually; these include Camp Creek at the north end, Bush River at the south end of the reservoir, and Luxor Creek, tributary to the Upper Columbia River near Columbia Lakes.

Biological sampling of spawners captured by dip-net or angling has been conducted at Camp Creek (1998, 00-11) and Luxor Creek (2007, 2009-11) for Kinbasket Reservoir and at Standard Creek (2007, 2009-11) for Revelstoke. Sex, fork length and age data were collected for estimating mean length and age composition, relying on otolith analyses (Manson and Porto, 2005). Otolith interpretations follow protocols based on Casselman (1990).

Results and Discussion

Survey timing, general flow conditions, pool elevation and habitat

Acoustic and trawl surveys (ATS) in 2011 were conducted July 24-27 on Revelstoke Reservoir and August 2-6 on Kinbasket Reservoir.

The maximum monthly discharge of the largest tributary, the Columbia River near Golden BC provides an index of the magnitude of annual spring freshet. In 2011 the maximum monthly flow was 581 $m^3 \cdot sec^{-1}$ or 113% of the long-term average (maximum monthly discharge) of 512 $m^3 \cdot sec^{-1}$ based on all years of record (Fig. 2). The maximum freshet flows have been below the long term average for the last 3 years leading up to above average flows in 2011. The mean annual discharge in 2011 was 194 $m^3 \cdot sec^{-1}$, 118% of the 38 year average of 164 $m^3 \cdot sec^{-1}$ since the Mica Dam was constructed (Fig. 3). 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.

The average elevation of Kinbasket Reservoir during the time of the survey was approximately 752.99m above sea level. At the start of the survey on August 2nd the elevation was 752.85m rising slightly to 753.07 near the end of the survey on August 5th (MCA Elevation at FB). The average elevation of 753m results in an

estimated 23,568 ha of pelagic habitat surveyed and a reduction of 0.7% in full pool pelagic habitat (Table 1).

A summary of survey dates, pool elevation and pelagic habitat area for all previous summertime surveys are shown in Table 2. Note that habitat sections 1 and 9 are not included in the annual surveys due to hazards for night navigation and marginal quality of pelagic habitat for kokanee with depth being the major

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

Section	Location/ Description	Full pool[1] Surface area (ha)	Full pool[2] Pelagic	2011[3] Pelagic area (ha)	Pelagic[4] % reduced
	Kinbasket Reservoir				
1	Canoe Reach Valemont to 40m contour	2,400	1,305	1,250	4.2
2	Canoe Reach 40m contour to narrows	4,560	4,060	4,042	0.4
3	Canoe Reach - narrows to Mica pool	4,900	4,360	4,340	0.5
4	Mica Pool above dam	6,940	5,580	5,520	1.1
5	Wood Arm	2,020	1,560	1,526	2.2
6	Mica Pool to Old Kinbasket Lake	2,120	1,805	1,790	0.8
7	Old Kinbasket Lake	5,270	5,055	5,044	0.2
8	South Columbia Reach	1,500	1,315	1,306	0.7
9	Bush Pool to Upper Columbia River	11,350	6,980	6,560	6.0
Total		41,060	32,020	31,378	2.0
2-8	***Total surveyed***	***27,310***	***23,735***	***23,568***	0.7
	Revelstoke Reservoir				
1	Main basin - dam to Downie Cr	6,100	5,250	5,250	0
2	Narrows - Downie to Nicholls Cr	3,100	2,000	2,000	0
3	Riverine - Nicholls Cr to Mica Dam	2,100	450	450	0
Total		11,300	7,700	7,700	0
1&2	***Total habitat surveyed***	***9,200***	***7,250***	***7,250***	***0***

1. Full pool elevation for Kinbasket = 754m
2. Full pool pelagic area = area at 20m or greater depth at full pool
3. 2011 pelagic area for Kinbasket is area at 753m pool elevation and 20m or greater depth
4. Percent reduction of pelagic area over full pool estimates due to lower pool elevation

limitation. The “flatness” of sections 1 and 9 make them particularly sensitive to changes in pool elevation (Table 1). Furthermore, the age 1-3+ kokanee would have to re-colonize zones 1 and 9 following each winter drawdown period.

On Revelstoke Reservoir, the pool elevations remained fairly constant and the surface area and pelagic habitat area surveyed (sections 1 and 2) remained at approximately 9,200 and 7,250 ha, respectively. Note, Section 3 of Revelstoke is not included in annual abundance surveys since it is shallow, riverine and has very little pelagic habitat suitable for kokanee rearing (Table 1).

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

Year	Dates	Pool elevation[1] (m)	Drawdown (m)	Pelagic habitat Area[2] (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-Aug 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

1. Pool elevation at time of survey rounded to nearest meter
2. refers to area surveyed in sections 2-8 only at time of survey

Water temperature

Kinbasket Reservoir had a very weak thermocline at both Transect 14 in the main pool and at Transect 24 in old Kinbasket Lake on the Columbia Arm (Fig. 4). The main pool had a surface temperature of 15.7 °C and declined fairly steadily to about 6°C at 50m depth. Only slight thermal stratification occurred around 6m depth at 15°C and again at ~17m depth and 13°C but neither were very pronounced. Old Kinbasket Lake showed an even more uniform drop in temperature with depth than the main pool, with surface temperatures decreasing from 17°C down to 7°C at 50m depth. Both temperature profiles indicated water temperatures of about 4°C below 60m depth.

Temperature profiles in Revelstoke Reservoir did not show thermal stratification in 2011 as they did in 2010 (Fig. 4). At approximately 14°C, surface temperature at both Transect 17 and Transect 4 were about 3-4° cooler than at a similar time of year in 2010. The temperature at Transect 4 decreased at a relatively uniform rate down to 10°C at 17m depth and then decreased at a slower, but still relatively uniform, rate to 5°C at around 50m depth. The Seabird cast at Transect 17 showed a bit more variation in temperature gradient but not as much as previous years. The top 10m of the water column was around 13°C and decreased to 10°C at 23m depth. The temperature at transect 17 at 50m depth remained 5°C warmer than in the main basin at the same depth, suggesting deeper mixing in the narrow reach than in the larger basin occurred in 2011.

Kokanee Distribution

The weak thermal stratification, possibly due to cool summer air temperatures and/or high wind events, in both Kinbasket and Revelstoke Reservoirs provided ideal temperatures for kokanee of 9-13°C from near the surface down to over 40m depth. The fish layer reflected this and was not as vertically concentrated as some years.

The vertical distribution of fish in Kinbasket during the survey in 2011 varied slightly along the reservoir (Fig. 5a). The fish layer from Canoe reach to the main basin extended from the surface to 30m depth, but was most dense between 10-20m depth. Transects 9, 10, and 11 immediately upstream of Mica dam had a much more spread out fish layer from 5-40m with the highest densities at 15-25m. Columbia reach at the southern end had a vertical distribution of fish between 10-35m, with highest densities found at 20-30m depth.

Longitudinal fish distribution in Kinbasket Reservoir ranged from 110 fish·ha^{-1} at Transect 6 in Canoe reach to 442 fish·ha^{-1} at Transect 29 in the Columbia reach (Fig. 6). Densities were below the 10 year average for most transects, most notably in the southern end of Canoe reach and the northern portion of the main Kinbasket basin (Transects 5-8 and 13-16) which typically contain the highest densities of fish. Fish densities immediately upstream of Mica Dam in transects 9 and 10 however were among the highest in the reservoir in 2011, and were higher than the 10 year average. Typically densities just upstream of the dam are much lower than adjacent transects in the main pool.

Revelstoke Reservoir had a vertical distribution of fish which occurred mainly in the 3-25m depths (Fig. 5b). Fry size fish were concentrated in the 5-10m habitat layer with bigger fish concentrated in the 10-20m habitat layer.

Longitudinal density distribution of fish in Revelstoke Reservoir in 2011 was similar to previous years; densities were higher in the basin near to Revelstoke Dam (Zone 1) and lower in the upper reaches (Zone 2) (Fig. 7). However, the higher densities in 2011 only extended from Transect 1 halfway up the basin to Transect 6. The ten year average shown in figure 7a indicates that typically, higher densities of fish have extended up the entire basin from transect 1 to 14. There was also a non-typical higher density area of fish present just upstream of the main basin at Transect 17. As mentioned previously, fish density values by transect for all years are presented in Appendix 1 and 2 for Kinbasket and Revelstoke reservoirs respectively.

Kokanee Abundance

Total kokanee abundance in Kinbasket Reservoir for 2011 was estimated at 5.65 (4.95 - 6.42) million (Fig. 8a, Appendix 3a). This is significantly less than the 10 year average of 9.72 ±2.03 million. Kokanee abundance has been declining

since 2007 when it peaked at over 17 million, the highest population recorded for this reservoir.

The acoustic size distribution showed a size break at -45dB between age 0+ (fry sized fish) and age 1-3+ fish in Kinbasket Reservoir. The resulting abundance estimate for fry was ~4.50 million and for 1-3+ fish was ~1.15 million (Fig. 9a, Appendix 3b). This is one of the lowest populations on record for age 1-3+ fish, which normally average 2.01 ±0.22 million).

The estimated total abundance of kokanee in Revelstoke Reservoir was 0.94 (0.72 - 1.10) million (Fig. 8b, Appendix 4a). This was significantly lower than the 10 year average of 1.42 ±0.24 million.

The acoustic size distribution was used to proportion the total Revelstoke Reservoir fish population into age 0+ (fry sized fish) and 1-3+ fish with a break evident at a size of -46dB. Using this threshold provides an estimate of 0.83 million fry and 0.11 million age 1-3+ kokanee (Fig. 9a, Appendix 4b).

In Revelstoke Reservoir, the numbers of age 1-3+ kokanee can vary considerably (e.g. from -54% to plus 63% of the mean). Although kokanee populations in other lakes can show this level of variation, the changes are typically more gradual, whereas large fluctuations in Revelstoke populations have occurred in adjacent years. This along with the extremely low numbers of spawners leads to the tentative conclusion that population levels must be influenced by entrainment at upper and lower ends (i.e. both immigration and emigration). It is hoped that continuous time series information will assist in better understanding the role that entrainment and dam operations play in these populations.

Trawl & Spawner Sampling

Trawl sampling was conducted on Kinbasket Reservoir to collect fish samples for size at age and species composition to assist in interpretation of acoustic data. Trawling was targeted on sampling the densest portion of the fish layer in order to maximize catch. Consequently catches were not expected to reliably represent age class proportions, especially since age classes may not have been distributed uniformly by depth at the time of this survey. A total of 227 kokanee were caught and only 1 sculpin, confirming that a strong majority of the fish population in the pelagic area sampled by acoustics was comprised of kokanee (Appendix 5a).

The kokanee catch consisted mostly of fry with only one age 1+ and four age 2+ kokanee caught (Table 3). Fry averaged 42 ±1 mm, similar to the 2010 survey which was completed in early August. Figure 10 presents the length distribution of all trawl captured kokanee compared with spawner lengths for 2011, 2010 and an average of 2001-05. Often the frequency distribution of 2+ fish from the trawl

can be used to verify spawner ages, however this approach was of limited use in Kinbasket due to small sample sizes of age 2+ trawl caught fish. Otolith analysis from spawners collected from Camp Creek (n=30) and Luxor Creek (n=10) indicated that the dominant age at maturity in 2011 was 2+ (Appendix 6 & 7), as in 2009 and 2010. Additionally, all four 2+ captured in the trawl were expected to spawn in 2011 based on observations of gonad development. While spawner age composition was very similar between Camp and Luxor in 2011, this has not always been the case. In 2007 the age composition between the two tributaries was remarkably different, with only 13% of spawners aged 3+ in Luxor while 100% were age 3+ in Camp. This difference, assuming it is real and not a function of sampling bias or errors in otolith interpretation, is interesting and deserves further attention in the future. It could indicate that the factors determining the age at maturity may vary between spawning populations even though they rear in the same reservoir.

Table 3. Summary of kokanee length and weight data by age from trawl sampling in Kinbasket and Revelstoke reservoirs during July and August 2011

Location	Age*	FL (mm)	FL range (mm)	S.D.	N (FL)	WT (g)	S.D. (WT)	N (WT)
Kinbasket	0+	42	29-79	7.9	222	0.8	0.65	133
Kinbasket	1+	166			1	47.2		1
Kinbasket	2+	210	199-219	8.5	4	99.5	12.8	4
					227			138
Revelstoke	0+	38	27-55	5.9	96	0.51	0.26	96
Revelstoke	1+				0			0
Revelstoke	2+				0			0
					96			96

*Note: Add one year to spawner age to determine brood year (e.g. an age 2+ in 2011 is from a fall 2008 spawner).

The average size of age 2+ spawners in 2011 was 237 ±3 mm, slightly larger than 2009 and 2010 at 223 ±4 mm and 228 ±3 mm, respectively (Appendix 7). This increase in average size is also evident in Figure 11, which shows changes in size at age and age composition of spawners over twelve consecutive years (2000-2011). Figure 11 presents Camp Creek data only, which provides the greatest continuity and most robust sample sizes. Over the last 12 years, spawner age composition has shifted from a combination of age 2+ and 3+ to 100% age 3+ spawners in 2006-07 and then has shifted nearly all to age 2+ fish in 2009-2011. This recent condition (i.e. low numbers of small young spawners) is unusual and has not previously been observed in Kinbasket Reservoir.

Trawling in Revelstoke Reservoir collected 96 kokanee in 2011. Directed trawls of one hour duration were completed near transects 2-4. All 96 kokanee were young of the year with an average length of 38 ±1 mm, smaller than fry in 2010 that averaged 42 ±2 mm. The trawl results, along with the acoustic abundance

estimate, follow the trend seen in previous years of a high proportion of kokanee fry compared to older age groups and particularly to adult kokanee present in Revelstoke Reservoir.

Revelstoke spawner samples (n=20) from Standard Creek were also mostly age 2+ fish in 2011 (Appendix 7 & 8, Figure 12), although only 70% versus 93% and 100% 2+ for Camp and Luxor Creeks respectively in Kinbasket Reservoir. The age at maturity of ≥90% 2+ in 2009 and 2010 for Revelstoke spawners was very similar to Kinbasket tributaries (~100% both years).

Average size was 265 (±5) mm for all 20 spawners measured; 260 (±4) mm for 2+ and 277 (±4) mm for 3+ fish (Appendix 7 & 8). The frequency distribution by age of Standard Creek spawners for 2011 is presented in Figure 12 for comparison to spawner size at age for the remainder of available years (2007, 09-11). It appears that size at maturity for 2+ spawners has remained relatively stable from 2009-11, with perhaps some decline in size at age of 3+ spawners through 2011, although the sample size is not adequate to draw any firm conclusions. Both spawner size and their size at age are considerably larger in Revelstoke compared with Kinbasket Reservoir fish, and is testament to good growth in Revelstoke Reservoir.

Considerably more trawl effort at an increased number of sample locations would be required to assess the age structure on Kinbasket and Revelstoke reservoirs by conducting standardized stepped oblique trawling. This is not practical given the remoteness, submerged hazards (trees) and low densities of age 1-3+ fish. Alternatively, with further refinement of acoustic fish size distributions using limited size at age information from the trawl and spawner size estimates, it may be possible to develop indices of age structure from the acoustic data. Even though acoustic data may provide the best option for estimating age structure on this system, the results may not make biological sense in terms of cohort survival and spawner numbers on Revelstoke if the population variations are largely a result of entrainment (immigration and emigration) rather than survival between cohorts. It is important to continue collecting kokanee spawner data from Kinbasket and Revelstoke tributaries to assist in monitoring the status of these populations.

Methods development

An area of continued development in analysis of acoustic data for Kinbasket and Revelstoke Reservoirs using SONAR5 software is small target and noise separation. Determining threshold value of targets at the lower end of the fish size range when noise levels overlap in echo strength with fish targets is not always evident using the standard graphing techniques that are commonly utilized in less noisy data. Therefore, other attributes of target echoes, such as echo length, track association in relation to mean size, and phase deviation have

been investigated to “clean” the acoustic data and refine the results. This should continue in the future.

It is recommended that more fish samples are obtained, especially from Revelstoke Reservoir. Ages 1-3+ catches in the trawl have often been too low to reliably determine average size at age for tracking growth. Alternative methods of sampling (i.e. gillnetting or angling) would assist in acquiring the quantity of data needed for statistically significant results, albeit each with their own biases.

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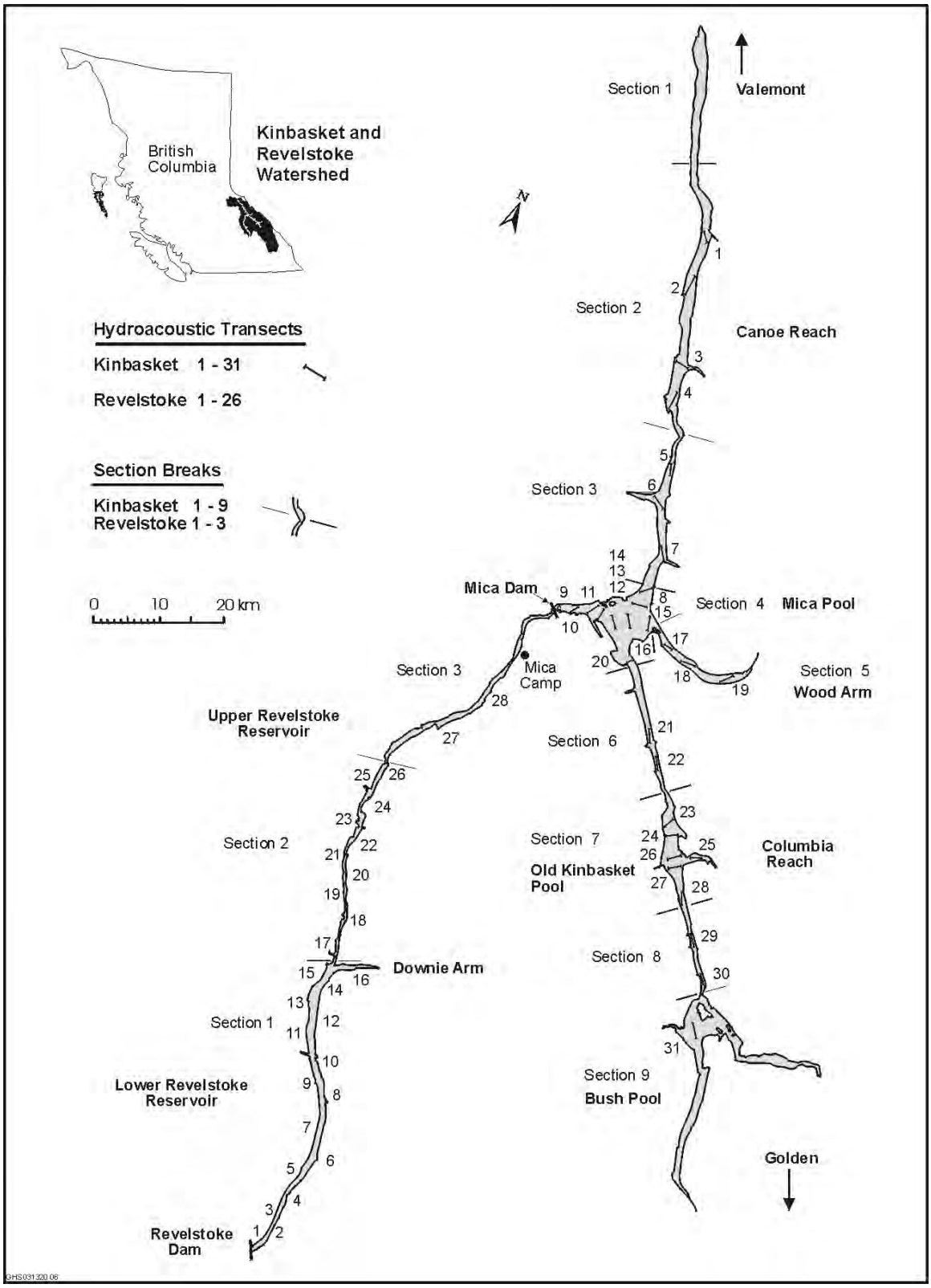

Figure 1. Map of Kinbasket and Revelstoke reservoirs showing location of reaches and acoustic transects.

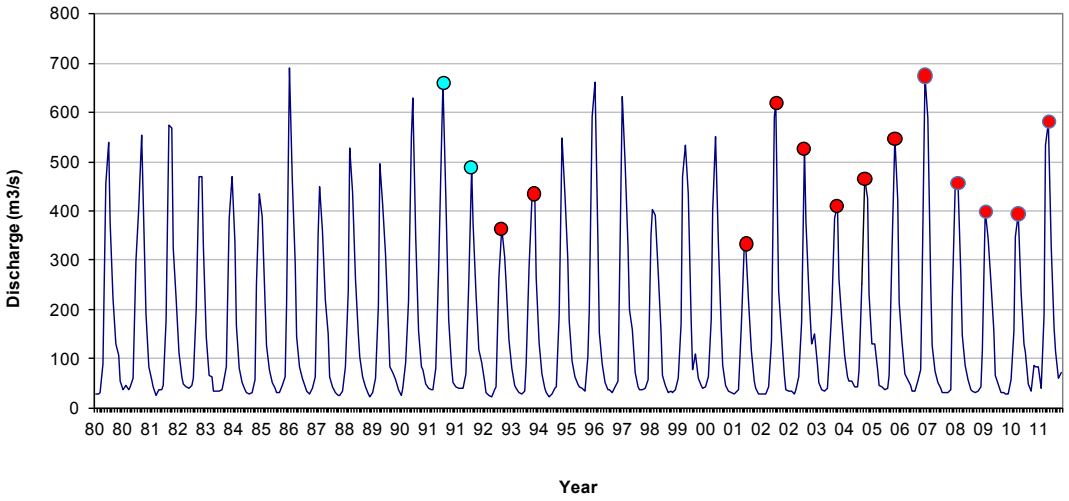

Figure 2. Monthly mean flows for unregulated Columbia River inflows to Kinbasket Reservoir measured by Water Survey of Canada at Donald Station near Golden BC. Note that red circles indicate study years with standardized ATS survey design, blue circles indicate non-standard preliminary survey years.

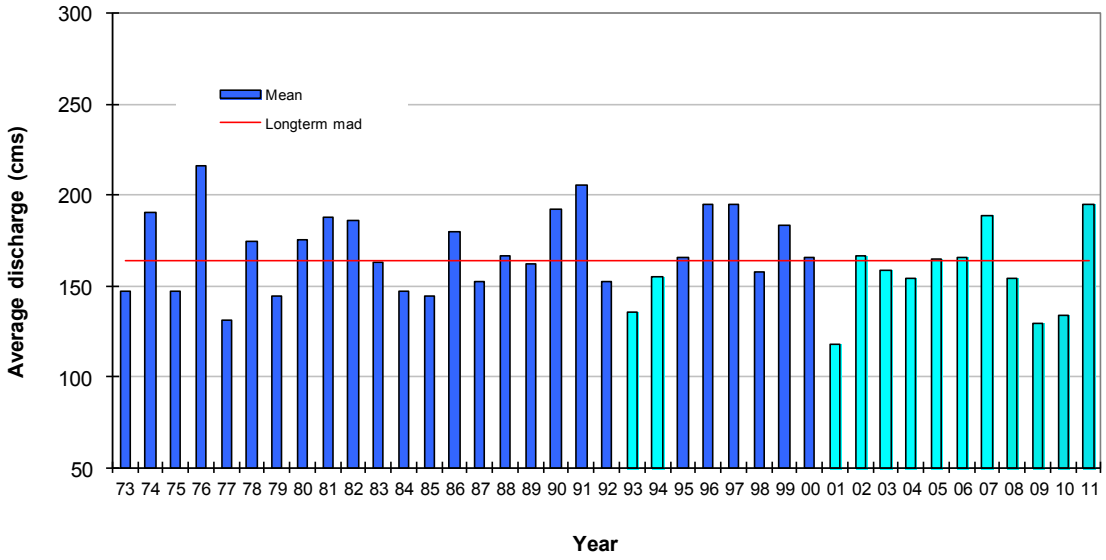

Figure 3. Mean Annual Discharge of unregulated Columbia River inflows to Kinbasket Reservoir based on Water Survey of Canada near Golden BC. The red line indicates the average annual flow of 164 cms since construction of Mica Dam in 1973.

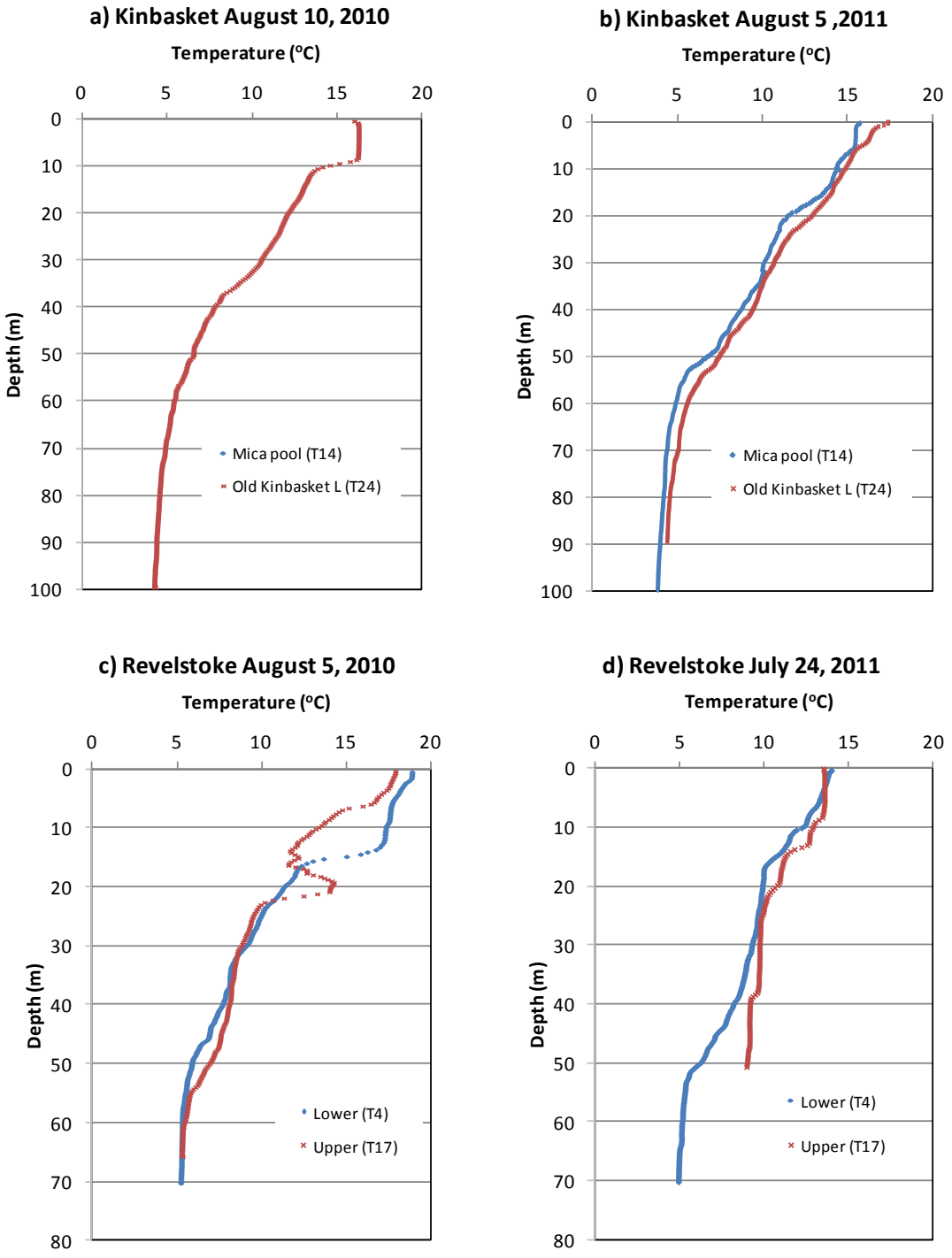

Figure 4. Water temperature profiles for Kinbasket main pool and old Kinbasket Lake during a) Aug 10, 2010 and b) August 5, 2011 and for lower and middle basins of Revelstoke Reservoir during c) Aug 5, 2010 and d) July 24, 2011. Note: locations are shown by transect numbers in legend in brackets.

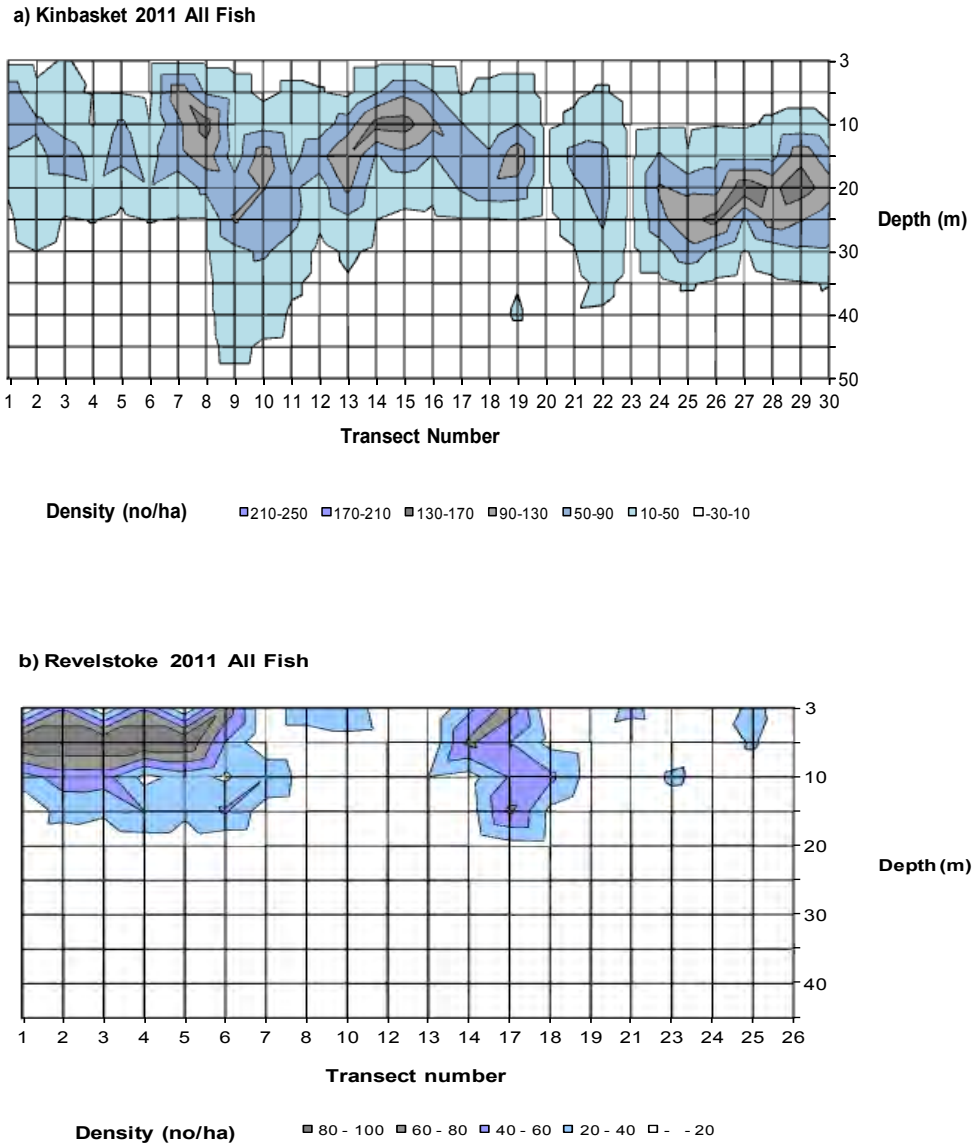

Figure 5. Contour plots showing kokanee distribution by depth and transect for a) Kinbasket and b) Revelstoke reservoirs based on 2011 acoustic surveys. Note that density (no/ha) scales are different between the two basins as a result of major differences in fish abundance.

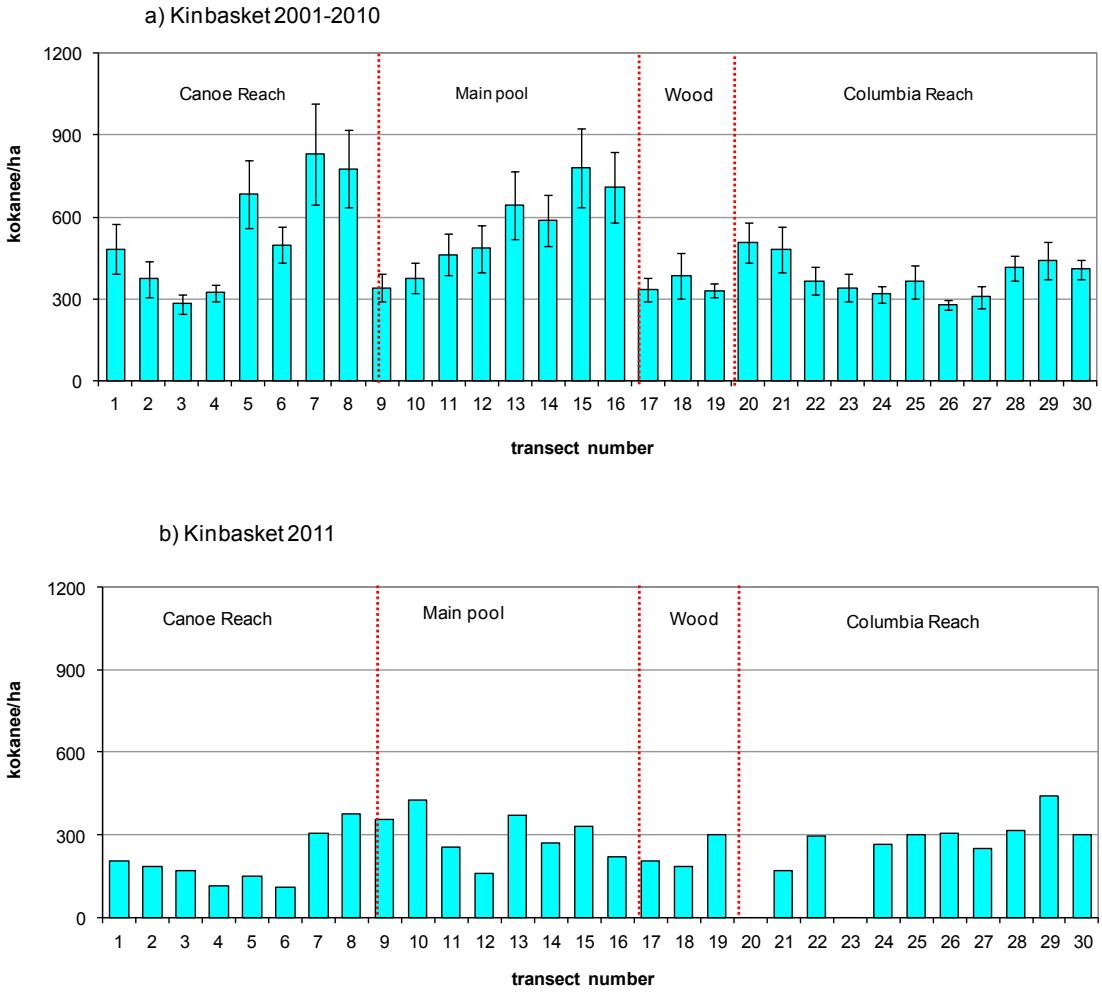

Figure 6. Longitudinal density distributions for kokanee in Kinbasket Reservoir based acoustic survey comparing a) 2001-010 average and b) 2011. Error bars on upper figure indicate 95% confidence limits on the ten year mean.

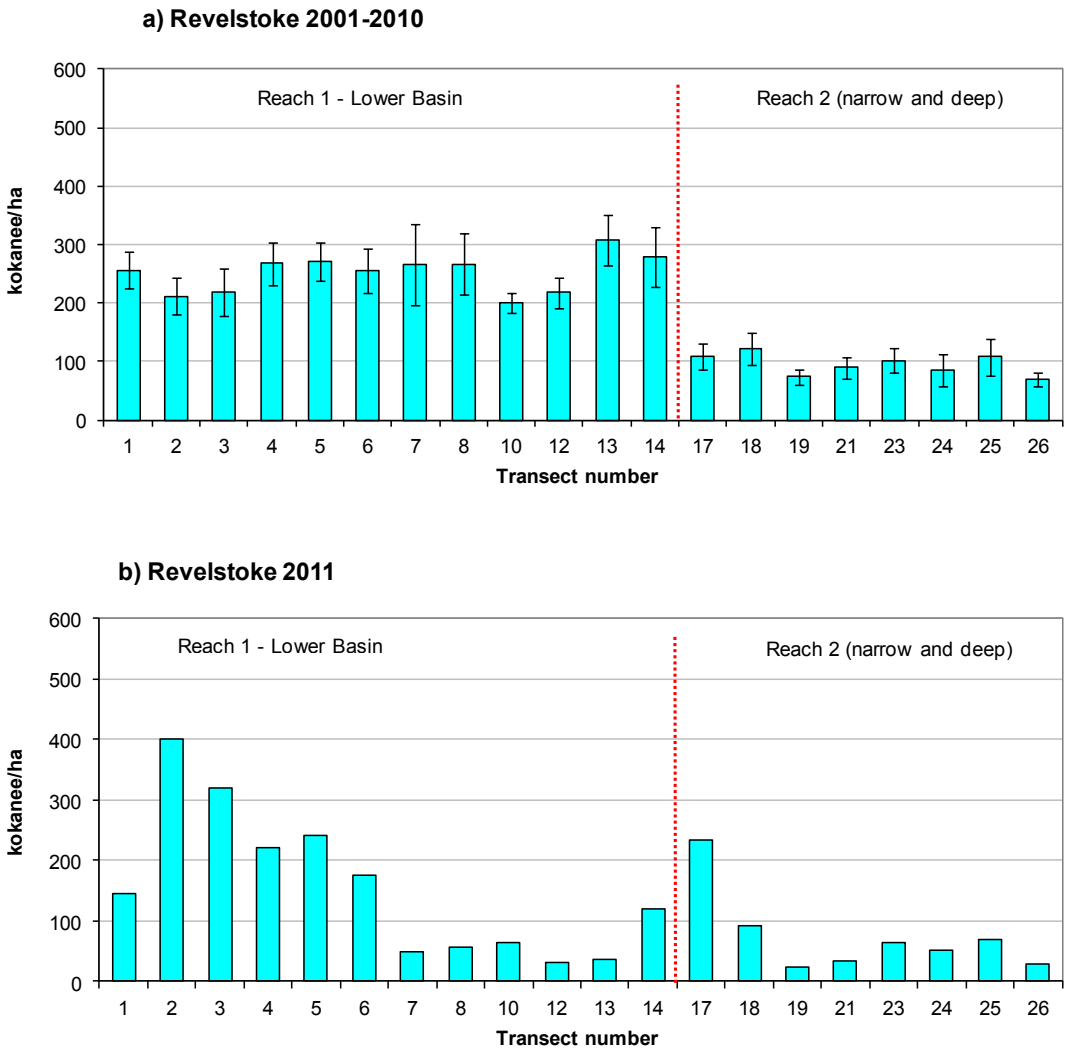

Figure 7. Longitudinal density distributions for kokanee in Revelstoke Reservoir based acoustic surveys comparing a) 2001-010 average and b) 2009. Note: bounds indicate 95% C.L. on ten year mean.

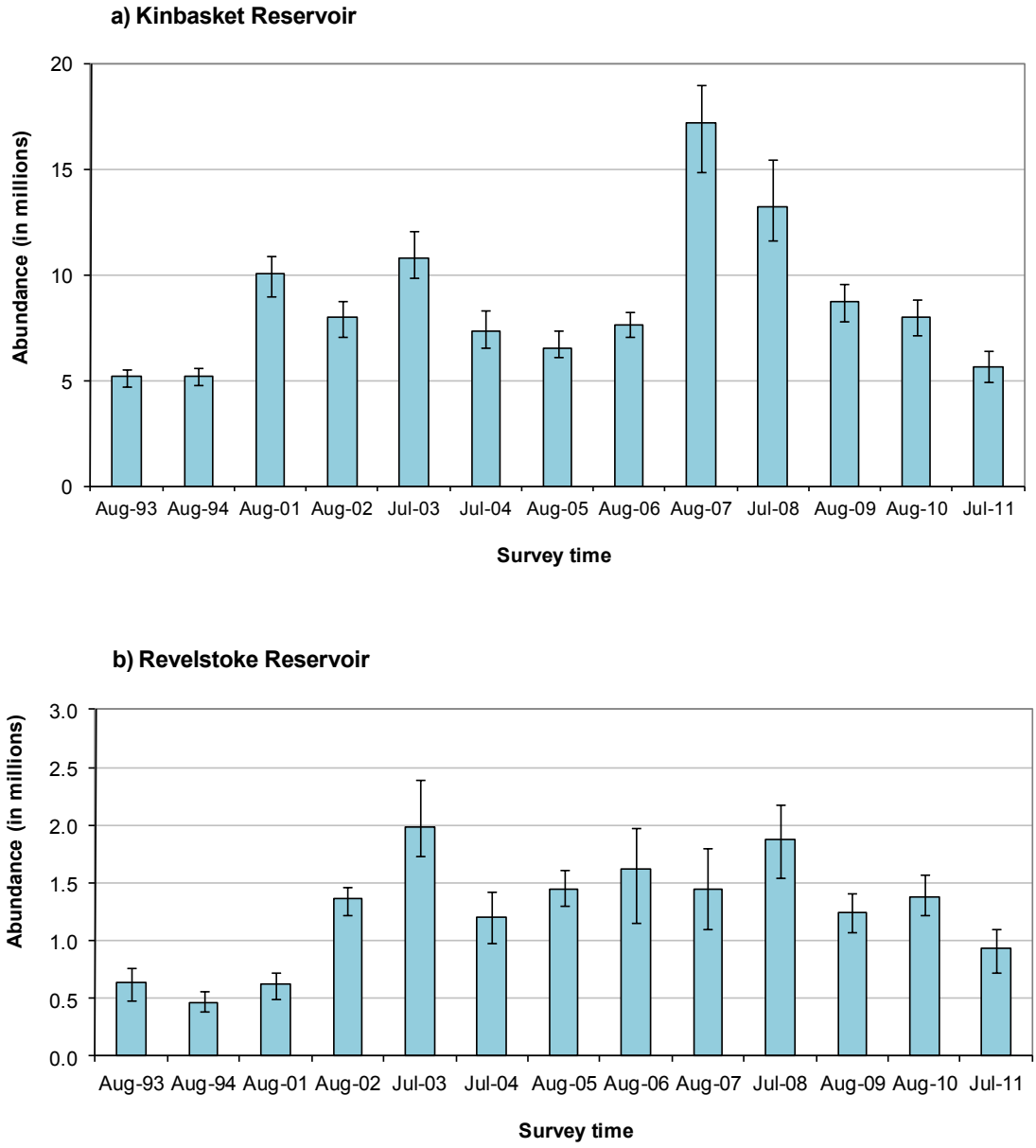

Figure 8. Kokanee trends in total abundance (all ages) in a) Kinbasket and b) Revelstoke reservoirs based on acoustic surveys, 1993-94 and 2001-2011. Note: error bars denote 95% confidence limits on maximum likelihood estimates.

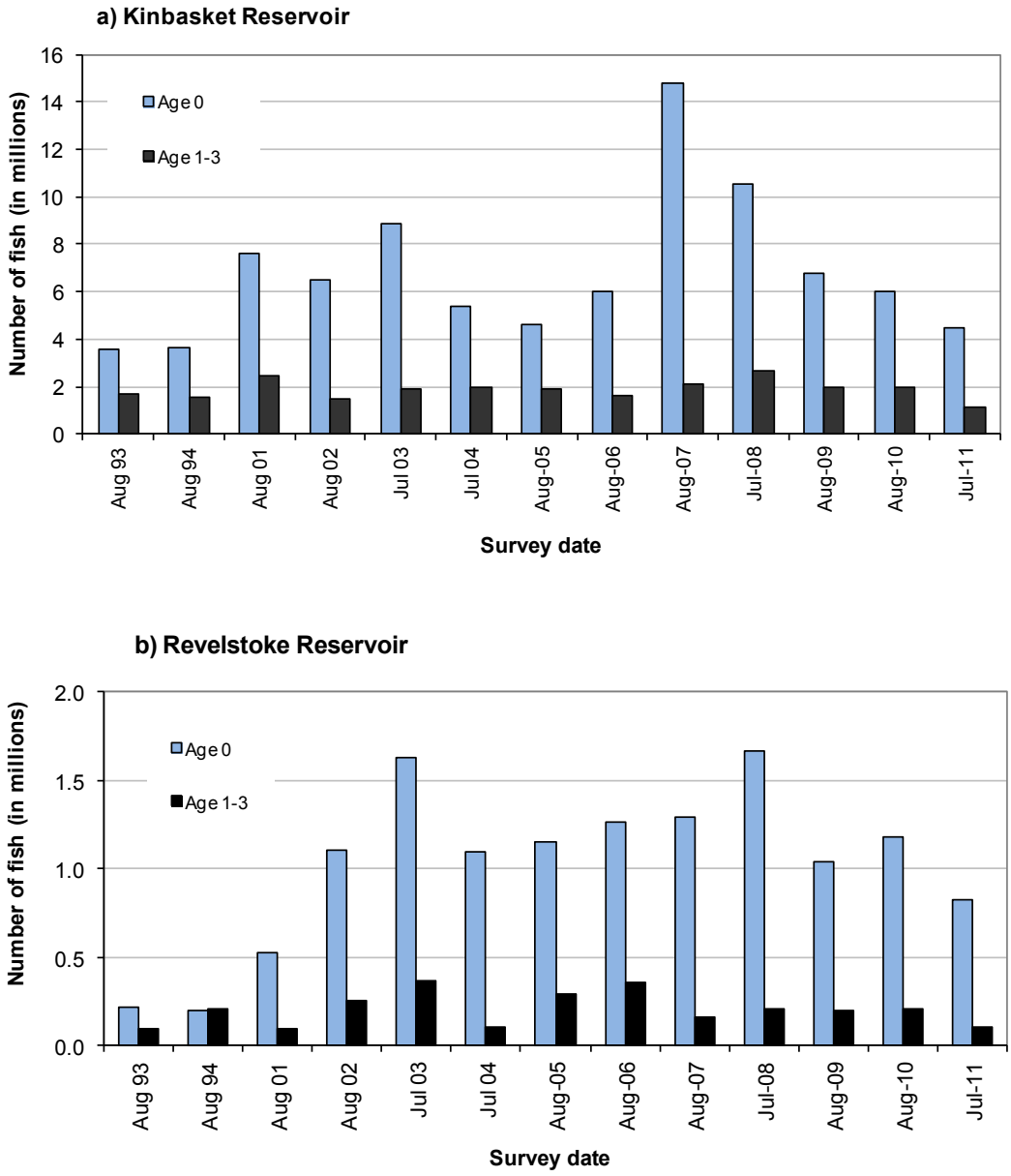

Figure 9. Abundance trends for age 0+ and age 1-3+ kokanee in a) Kinbasket and b) Revelstoke reservoirs based on mid- summer acoustic surveys, 1993-94 and 2001-2011.

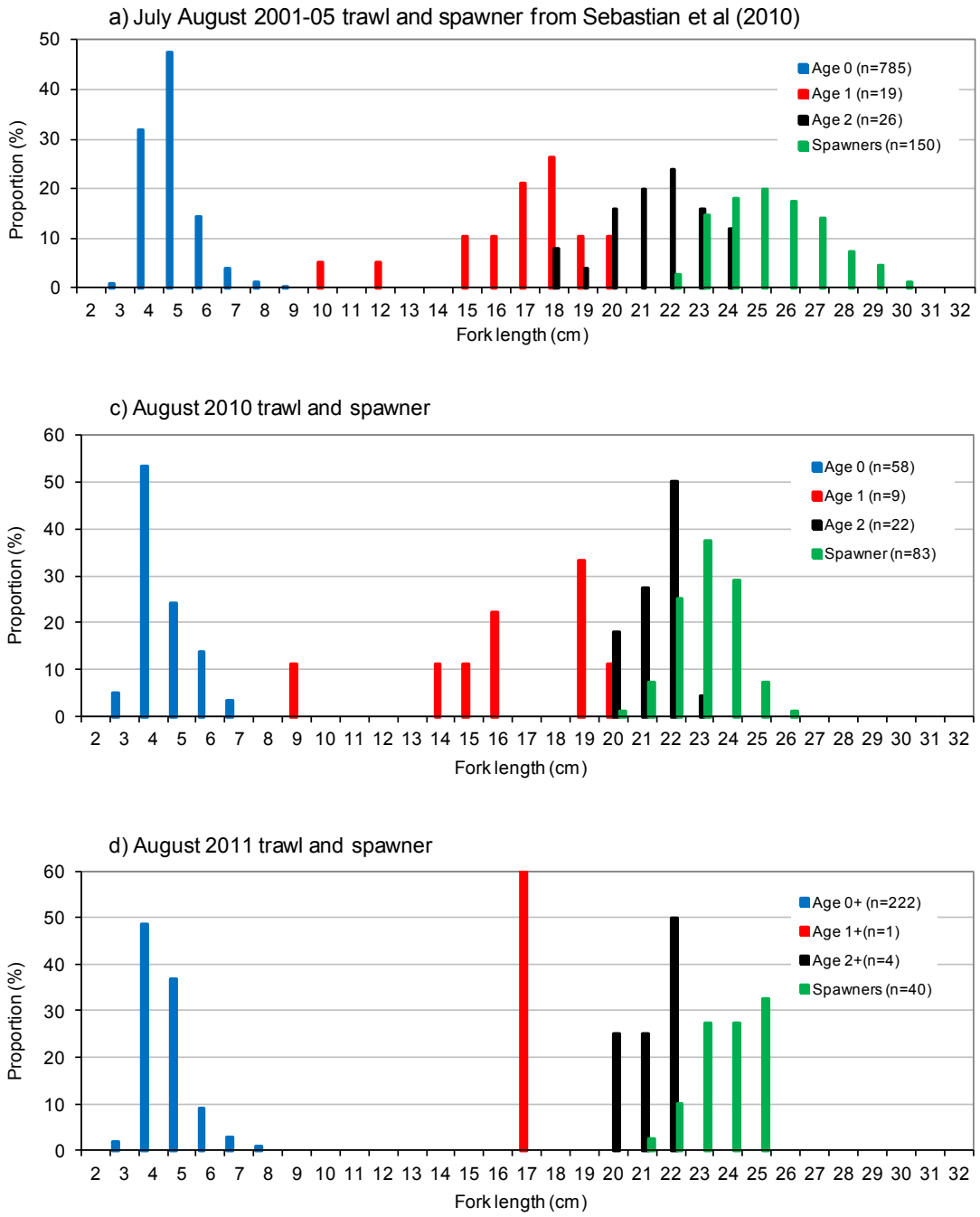

Figure 10. Kokanee length frequency proportion by age for a) 2001-05; b) 2010 and c) 2011 based on trawl sampling in Kinbasket pool and spawner surveys at Camp Creek. Karen Bray, BCH Revelstoke provided spawner data. Note: 2010 and 2011 spawners include a small sample from Luxor Creek.

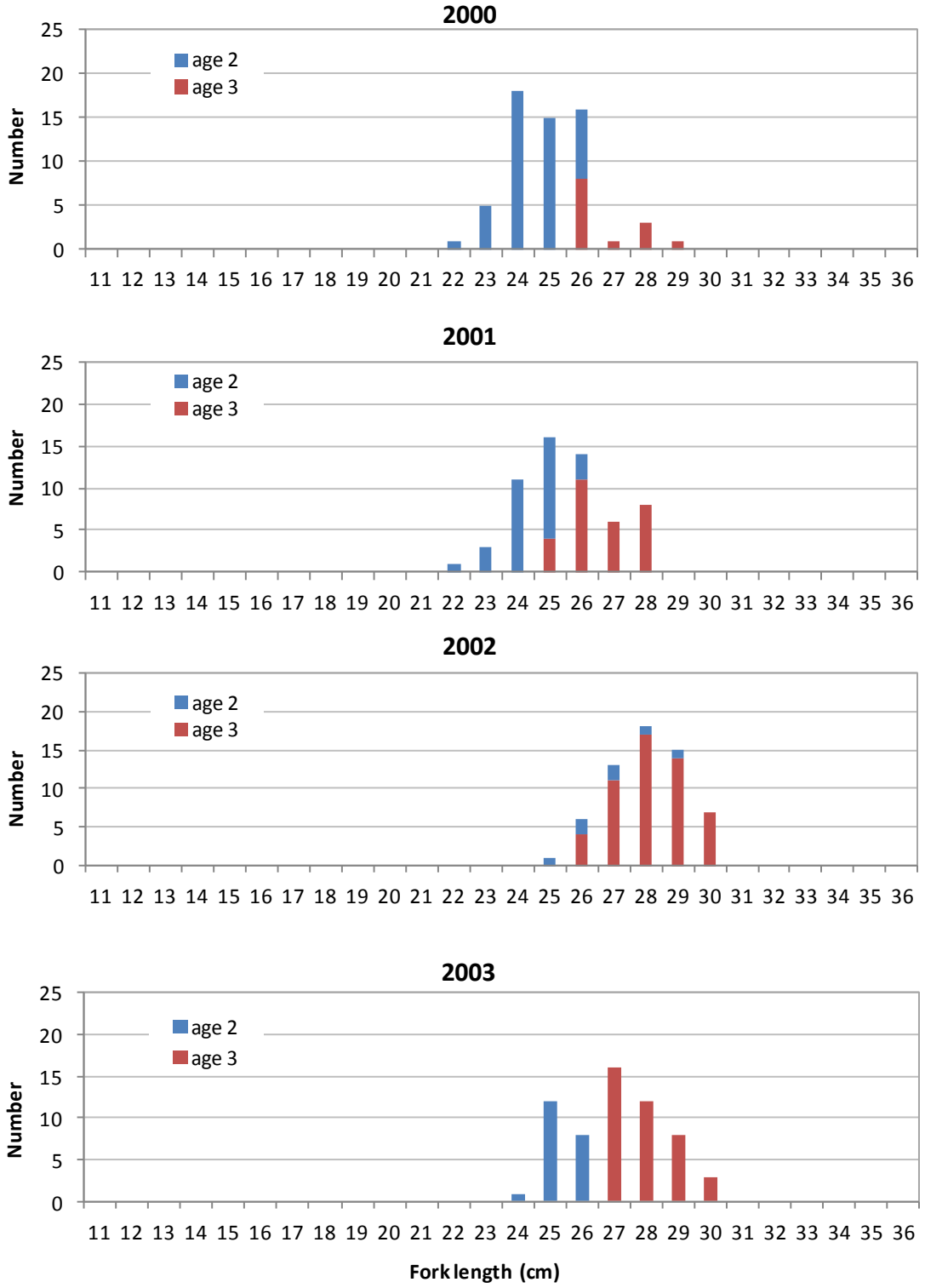

Figure 11. Kokanee spawner length frequency by age for Camp Creek (Kinbasket Reservoir). Data source: K. Bray, BCH Revelstoke.

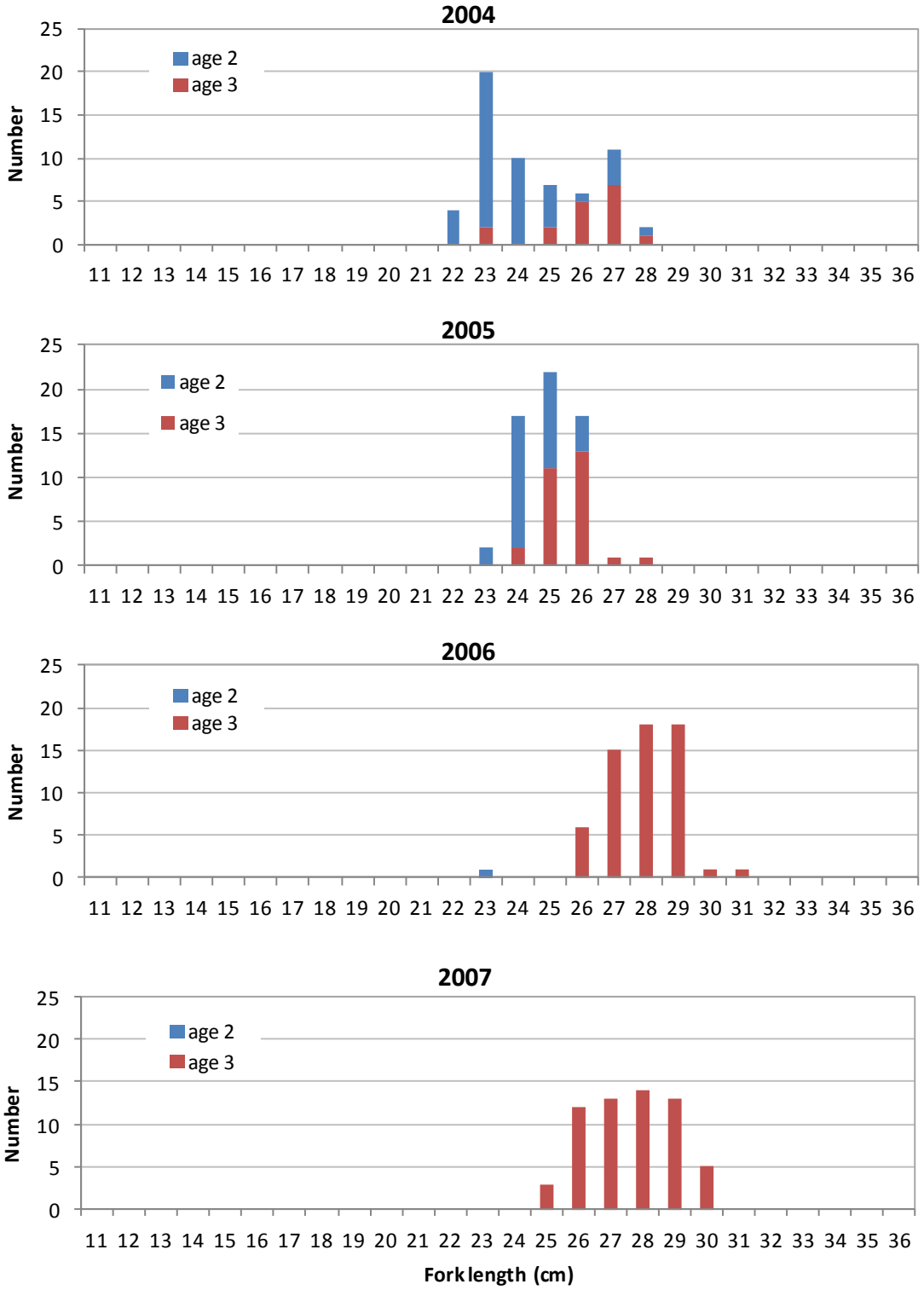

Figure 11 (cont.). Kokanee spawner length frequency by age for Camp Creek (Kinbasket Reservoir). Data source: K. Bray, BCH Revelstoke.

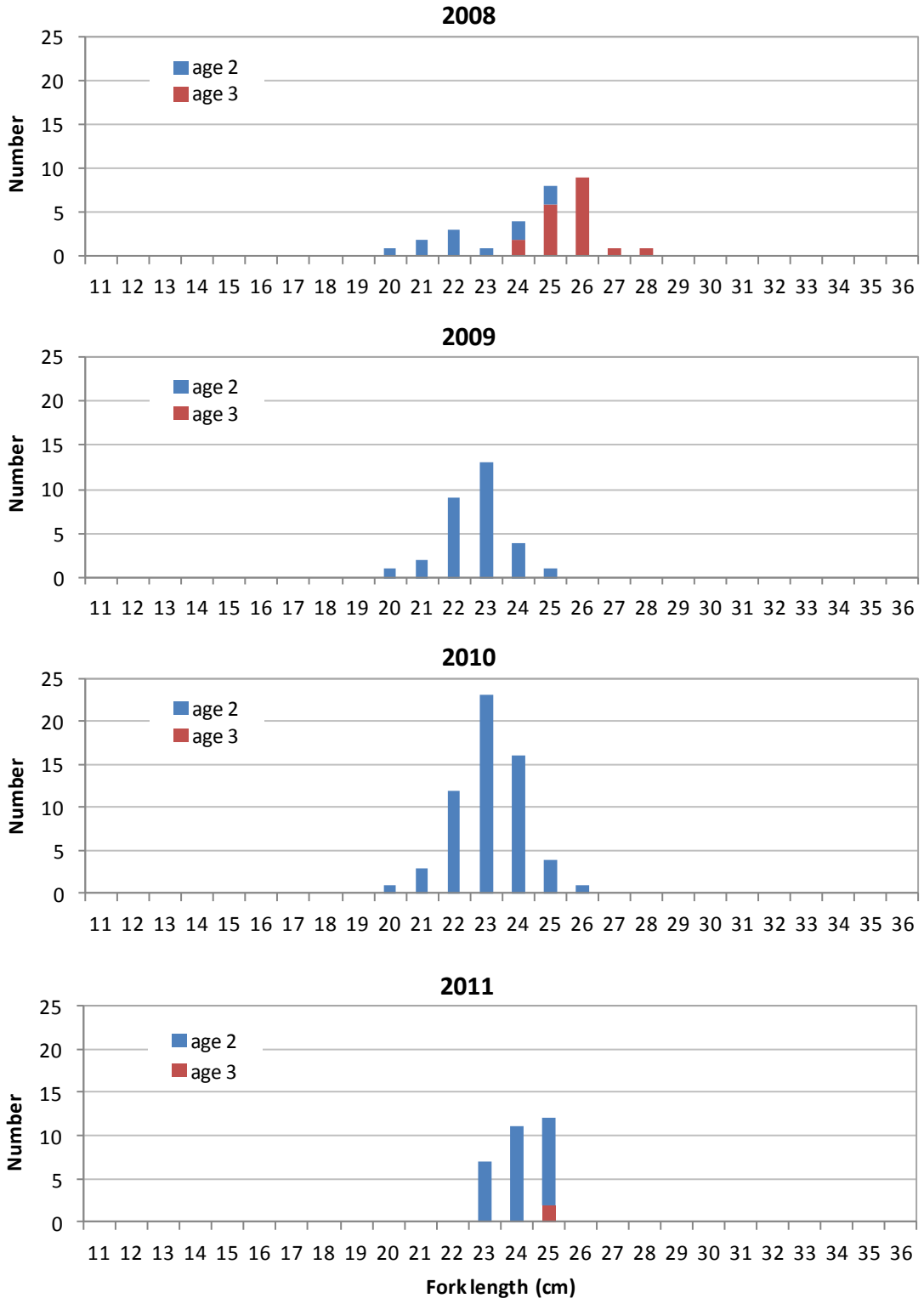

Figure 11 (cont.). Kokanee spawner length frequency by age for Camp Creek (Kinbasket Reservoir). Data source: K. Bray, BCH Revelstoke.

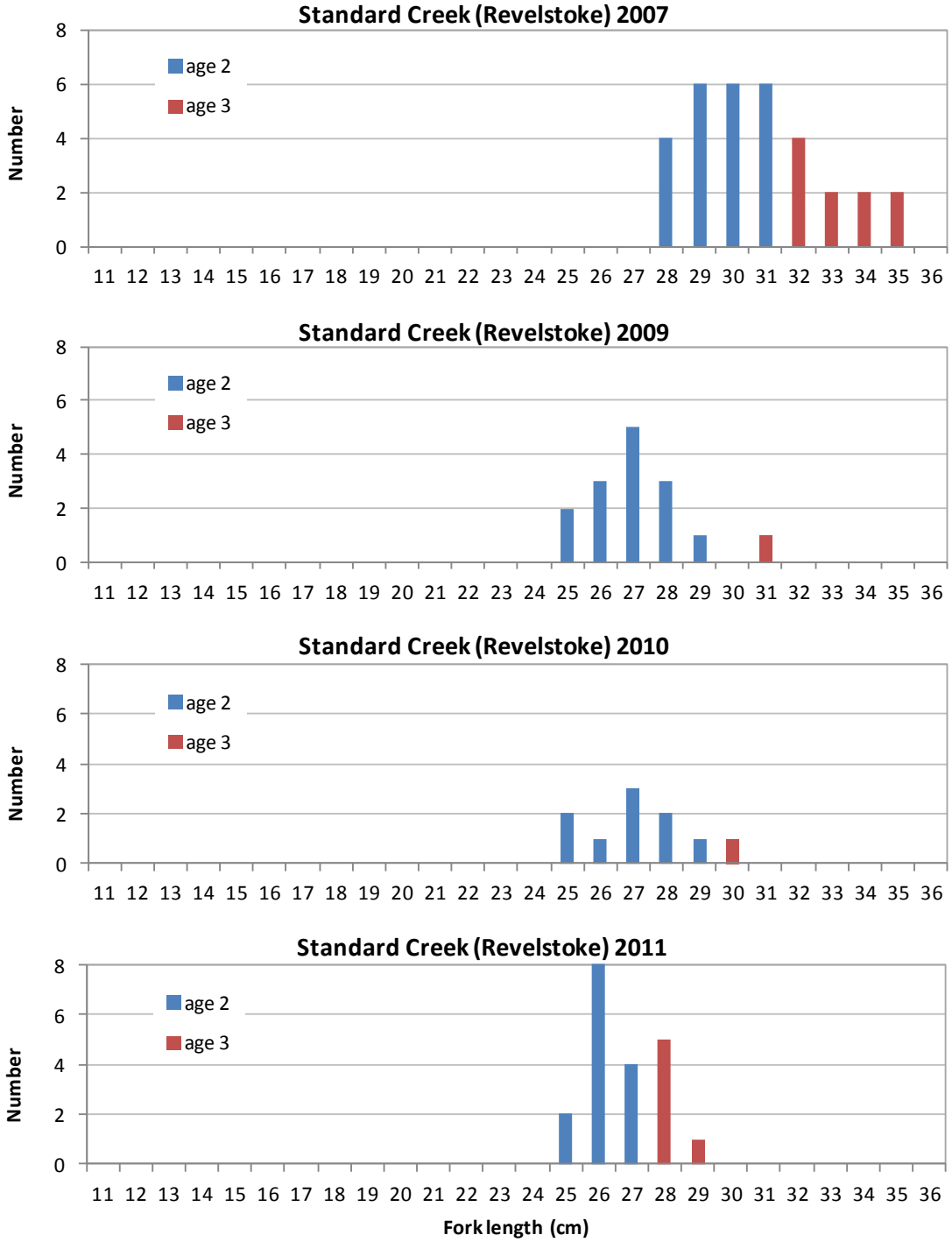

Figure 12. Kokanee spawner length frequency by age for Standard Creek (Revelstoke Reservoir). Data source: K. Bray, BCH Revelstoke.

Appendix 1. Kinbasket Reservoir fish densities by transect from hydroacoustic surveys, 2001-2011. Note densities reported here represent all depths and are not weighted by the amount of habitat at depth.

Location	Zone	Trans No.	2001 Aug	2002 Aug	2003 July	2004 July	2005 Aug	2006 Aug	2007 Aug	2008 July	2009 Aug	2010 Aug	2011 Aug
Ptarmigan Cr	2	**1**	379	848	266	815		200		364	272	701	206
		2	709	291	304	687	231	184		427	224	268	183
Hugh Allan Cr		**3**	126	452	252	254	267	162		451	253	279	169
Howard Bay		**4**	232	474	414	311	247	299	258	383	185	284	113
	3	**5**	1148	1056	320	490	398	1300	686	635	274	397	149
Foster Arm		**6**	622	460	437	295	720	303	954	484	298	323	110
		7	504	761	825	401	439	697	1910	1906	443	444	303
Dainard Cr		**8**	1007	515	582	707	336	558	1078	1855	509	420	377
Mica Dam	4	**9**	346	147	376	151	428	447	564	197	265	309	353
Mica Arm		**10**	529	238	547	108	614	247	572	316	336	194	424
Mica Arm		**11**	551	352	501	373	245	370	1099	365	336	342	253
Sprague By		**12**	286	302	939	538	178	282	802	801	390	293	160
Main pool		**13**	740	229	898	530	419	222	1392	1083	630	300	370
Main pool		**14**	918	698	423	464	196	331	736	1176	502	341	269
Main pool		**15**	1904	591	798	718	371	424	1133	543	819	365	332
East side		**16**	950	672	1602	543	254	275	961	910	515	350	222
South side		**2 0**	372	233	319	221	323	170	361	632	427	452	205
Wood Arm	5	**17**	409	270	910	126	438	162	361	828	241	265	185
		18	215	355	440	208	425	301	415	300	246	226	299
		19	280	329	915	283	433	255	627	847	315	597	
Lower	6	**21**	296	181	955	671	215	430	727	660	454	201	168
Columbia		**22**	294	226	619	426	186	394	194	662	426	324	295
Old Kinbasket	7	**23**	225	140	496	495	177	388	196	621	374	285	
Pool		**24**	423	287	348	364	169	384	261	455	336	184	263
SullivanArm		**25**	539	132	427		375	208		448	230	597	300
Kyanite Cr		**26**	377	277	242	228	203	300	372	285	296	237	307
		27	331	250	240	198	272	198	596	259	476	222	249
Garrett Cr		**28**	283	360	466	361	223	350	674	496	423	553	317
Upper	8	**29**	286	316	750	199	438	240		478	785	382	442
Columbia		**30**	346	370	274		534	331			513	463	302
Bush Pool	9	**31**					178						

Appendix 2. Revelstoke Reservoir fish densities by transect from hydroacoustic surveys, 2001-11. Note densities reported here represent all depths and are not weighted by the amount of habitat at depth.

Location	Zone	Trans No.	2001 Aug	2002 Aug	2003 July	2004 July	2005 Aug	2006 Aug	2007 Aug	2008 July	2009 Aug	2010 Aug	2011 July
Rev. Dam	1	**1**	158	333	371	348	172	347	293	74	211	261	145
Coursier Cr.		**2**	146	402	289	121	180		293	170	182	126	401
		3	205	289	226	80	144	319	491	240	142	65	319
Martha Cr.		**4**	135	312	470	96	287	207	368	360	235	213	221
Sale Cr.		**5**	257	158	481	150	243	274	374	312	256	188	241
LaForme Cr.		**6**	91	157	479	209	252	275	248	431	151	230	177
		7	66	316	819	127	222	253	234	384	112	131	49
Carnes Cr.		**8**	71	201	268	246	449	201	227	651	213	122	57
Frisby Cr.		**9**	49					121		705		162	
Mars Cr.		**10**	128	261	156	272	244	174	239	192	123	205	65
		11						126					
Park Cr.		**12**	66	177	344	214	295	170	196	171	252	300	31
Bourne Cr.		**13**		225	580	125	304	189	230	327	251	432	36
Keystone		**14**	139		629					300	143	366	121
Downie		**15**		245		241	210	114	102				
Downie Arm		**16**											
Power line	2	**17**	112	74	70	57	293	58	42	90	134	119	234
Fissure Cr.		**18**		118	78	29	193	52	8	117	270	169	93
Ferry		**19**	118	64	83	53	87	52	11	65	76	158	23
Liberty Cr.		**20**	98										
Old Goldstrm		**21**		82	52	19	129	47	25	98	180	153	35
Goldstream		**22**	79										
Stump field		**23**	65	79	196	253	46	144	39	72	68	87	65
Powerline		**24**	28	43	33	297	99	23	32	59	67	186	52
Hoskins Cr.		**25**	78	100	18	323	175	5	26	52	149		69
Nichols Cr.		**26**		71	24	121	60	10	21	95	97	83	29

Blank values indicate no data.

Appendix 3. Summary of fish density statistics and Maximum Likelihood Estimates from Monte Carlo Simulations for Kinbasket Reservoir in August 2011.

a) fish all ages

Kinbasket August 2011 layered analyses statistics for fish >-61 dB ; 1 zone Transects 1-30								
Zone	**Depth**	**N**	**Density**	**Standard Error**	**Area**	**Stratum population**	**Statistic[1]**	**Abundance**
1	3-5	30	0.43	0.43	24069	10430		
1	5-10	30	19.37	5.23	24069	466136		
1	10-15	30	41.53	7.91	24069	999666		
1	15-20	30	58.17	6.21	24069	1400014	**All Fish**	**>-61 dB**
1	20-25	30	58.97	7.54	23234	1370032	**Lower**	4,948,939
1	25-30	30	37.47	7.52	22501	843037	**MLE**	5,654,327
1	30-35	30	16.13	3.68	21836	352287	**Upper**	6,418,497
1	35-40	30	5.77	1.68	20961	120875		
1	40-45	30	4.23	1.40	19946	84438		
1	45-50	30	2.10	0.74	18799	39478		

b) age 1-3 kokanee

Kinbasket August 2011 layered analyses statistics for fish >-45 dB ; 1 zone								
Zone	**Depth**	**N**	**Density**	**Standard Error**	**Area**	**Stratum population**	**Statistic[2]**	**Abundance**
1	5-10	30	2.83	1.02	24069	68196		
1	10-15	30	4.87	1.20	24069	117136	**Big Fish**	**>-45dB**
1	15-20	30	13.13	2.16	24069	316106	**Lower**	961,741
1	20-25	30	13.10	2.07	23234	304365	**MLE**	1,153,308
1	25-30	30	9.40	2.09	22501	211509	**Upper**	1,343,180
1	30-35	30	4.40	1.12	21836	96078		
1	35-40	30	1.23	0.50	20961	25852		
1	40-45	30	0.53	0.43	19946	10638		

Note: strata with density= zero have been omitted (e.g. zone 1 depth 3-5m)

[1] Key: LB=Lower bounds (95% C.L.), UB=Upper bounds, MLE=Maximum likelihood estimate

[2] Key: LB=Lower bounds (95% C.L.), UB=Upper bounds, MLE=Maximum likelihood estimate

Appendix 4. Summary of fish density statistics and Maximum Likelihood Estimates from Monte Carlo Simulations for Revelstoke Reservoir in August 2011.

a) fish all ages

Revelstoke August 2011 layered analyses statistics for fish >-61 dB ; 2 zones Z1 (Transects 1-6) and Z2 (Transects 7,8,10,12-14,17-19,21,23-26)								
Zone	**Depth**	**N**	**Density**	**Standard Error**	**Area**	**Stratum population**	**Statistic[3]**	**Abundance**
1	3-5	6	31	14	2423	75440		
1	5-10	6	155	35	2423	375428	**All fish**	**>-61dB**
1	10-15	6	31	6	2423	74360	**Lower**	724,420
1	15-20	6	26	6	2423	63973	**MLE**	940,834
1	20-25	6	4	1	2423	10236	**Upper**	1,135,424
1	25-30	6	2	2	2308	5398		
1	35-40	6	1	1	2123	1210		
1	45-50	6	0	0	1892	558		
2	3-5	14	17	6	4827	81761		
2	5-10	14	13	5	4827	64267		
2	10-15	14	18	4	4827	86633		
2	15-20	14	11	4	4827	51592		
2	20-25	14	3	1	4827	15832		
2	25-30	14	1	0	4492	4231		
2	30-35	14	2	1	4185	8304		
2	35-40	14	1	1	3877	4373		
2	40-45	14	1	0	3442	3410		
2	45-50	14	1	1	3008	3529		

[3] Key: LB=Lower bounds (95% C.L.), UB=Upper bounds, MLE=Maximum likelihood estimate

Appendix 4 - continued.

b) age 1-3+ kokanee

Revelstoke August 2011 layered analyses statistics for fish >-46 dB ; 2 zones Z1 (Transects 1-7), Z2 (Transects 8,10,12-14,17-19,21,23,24,26)								
Zone	**Depth**	**N**	**Density**	**Standard Error**	**Area**	**Stratum population**	**Statistic[4]**	**Abundance**
1	3-5	6	31	14	2423	75440		
1	5-10	6	148	35	2423	359531	**Big Fish**	**>-46dB**
1	10-15	6	25	4	2423	59573	**Lower**	81,830
1	15-20	6	15	3	2423	35978	**MLE**	113,989
1	25-30	6	2	2	2308	4677	**Upper**	150,092
1	35-40	6	1	1	2123	1210		
1	45-50	6	0	0	1892	558		
2	3-5	14	17	6	4827	81761		
2	5-10	14	13	5	4827	62741		
2	10-15	14	12	3	4827	60143		
2	15-20	14	8	3	4827	39123		
2	20-25	14	2	1	4827	11540		

[4] Key: LB=Lower bounds (95% C.L.), UB=Upper bounds, MLE=Maximum likelihood estimate

Appendix 5. Trawl sampling logs and catch data for Kinbasket and Revelstoke in 2011.

The following key identifies abbreviations used in column headers:
No = sample number SP = Species KO=kokanee Len = length in mm Wt = weight in g Age = estimated by length unless SN (Scale number) is filled in
Mat = maturing, Imm = immature, R = ripe Sex: M or F

a) Kinbasket Mica Pool, August 2011

	Location	Trawl #	Time in	Time out	Distance (m)	Target Depth (m)	# layers
	Mica pool						
	T16	1	2228	2328	~2600	10-17	1

No.	SP	Len	Wt	Age	SN	Mat	Sex	No.	SP	Len	Wt	Age	SN	Mat	Sex
1	KO	213	103.61	2	6	m	m	35	KO	31	0.23				
2	KO	38	0.48					36	KO	43	0.72				
3	KO	41	0.62					37	KO	37	0.45				
4	KO	50	1.22					38	KO	38	0.5				
5	KO	36	0.37					39	KO	40	0.6				
6	KO	49	1.16					40	KO	46	0.94				
7	KO	33	0.25					41	KO	38	0.53				
8	KO	42	0.7					42	KO	35	0.4				
9	KO	43	0.73					43	KO	67	2.69		7		
10	KO	43	0.76					44	KO	33					
11	KO	36	0.45					45	KO	39					
12	KO	31	0.2					46	KO	37					
13	KO	32	0.43					47	KO	42					
14	KO	37	0.46					48	KO	43					
15	KO	40	0.5					49	KO	33					
16	KO	35	0.32					50	KO	43					
17	KO	51	1.27					51	KO	42					
18	KO	45	0.9					52	KO	37					
19	KO	36	0.38					53	KO	45					
20	KO	41	0.69					54	KO	47					
21	KO	50	1.17					55	KO	40					
22	KO	37	0.42					56	KO	40					
23	KO	48	1.07					57	KO	49					
24	KO	37	0.45					58	KO	36					
25	KO	58	1.83					59	KO	35					
26	KO	33	0.3					60	KO	39					
27	KO	43	0.64					61	KO	41					
28	KO	42	0.59					62	KO	42					
29	KO	42	0.69					63	KO	32					
30	KO	37	0.42					64	KO	34					
31	KO	42	0.6					65	KO	54					
32	KO	47	1.01					66	KO	34					
33	KO	39	0.52					67	KO	54					
34	KO	41	0.5					68	KO	40					

Appendix 5a - continued.

	Location	Trawl #	Time in	Time out	Distance (m)	Target Depth (m)	# layers
	Mica pool T16	1	2228	2328	~2600	10-17	1

No.	SP	Len	Wt	Age	SN	Mat	Sex	No.	SP	Len	Wt	Age	SN	Mat	Sex
69	KO	38						97	KO	38					
70	KO	47						98	KO	44					
71	KO	40						99	KO	34					
72	KO	47						100	KO	42					
73	Sculpin	32	0.32			imm		101	KO	40					
74	KO	51						102	KO	42					
75	KO	35						103	KO	40					
76	KO	50													
77	KO	47													
78	KO	40													
79	KO	39													
80	KO	35													
81	KO	31													
82	KO	35													
83	KO	38													
84	KO	41													
85	KO	34													
86	KO	37													
87	KO	35													
88	KO	34													
89	KO	38													
90	KO	38													
91	KO	36													
92	KO	40													
93	KO	34													
94	KO	40													
95	KO	34													
96	KO	40													

Appendix 5a - continued.

	Location	Trawl #	Time in	Time out	Distance (m)	Target Depth (m)	# layers
	Mica pool						
	T14	2	0000	0100	~2600	14-21	1

No.	SP	Len	Wt	Age	SN	Mat	Sex	No.	SP	Len	Wt	Age	SN	Mat	Sex
1	KO	199	86.75	2	4	m	f	35	KO	41	0.52				
2	KO	39	0.41					36	KO	53	1.33				
3	KO	38	0.43					37	KO	30	0.17				
4	KO	46	0.91					38	KO	40	0.58				
5	KO	38	0.44					39	KO	42	0.62				
6	KO	39	0.5					40	KO	42	0.66				
7	KO	61	2.07					41	KO	36	0.4				
8	KO	59	1.83					42	KO	68	2.88		5	imm	
9	KO	47	0.92					43	KO	40	0.48				
10	KO	45	0.81					44	KO	43	0.71				
11	KO	45	0.82					45	KO	51	1.17				
12	KO	42	0.59					46	KO	36	0.37				
13	KO	50	1.16					47	KO	44	0.74				
14	KO	38	0.42					48	KO	52	1.25				
15	KO	33	0.32					49	KO	50	1.07				
16	KO	65	2.68					50	KO	42	0.63				
17	KO	51	1.21					51	KO	54	1.38				
18	KO	33	0.26					52	KO	44	0.68				
19	KO	37	0.39					53	KO	45	0.76				
20	KO	43	0.65					54	KO	42					
21	KO	39	0.45					55	KO	36					
22	KO	38	0.4					56	KO	49					
23	KO	63	2.23					57	KO	42					
24	KO	50	1.14					58	KO	58					
25	KO	44	0.82					59	KO	56					
26	KO	41	0.63					60	KO	44					
27	KO	55	1.45					61	KO	47					
28	KO	55	1.74					62	KO	42					
29	KO	43	0.62					63	KO	47					
30	KO	30	0.17					64	KO	40					
31	KO	42	0.71					65	KO	35					
32	KO	40	0.54					66	KO	38					
33	KO	36	0.4					67	KO	40					
34	KO	54	1.46					68	KO	48					

Appendix 5a - continued.

	Location	Trawl #	Time in	Time out	Distance (m)	Target Depth (m)	# layers
	Mica pool						
	T14	2	0000	0100	~2600	14-21	1

No.	SP	Len	Wt	Age	SN	Mat	Sex		No.	SP	Len	Wt	Age	SN	Mat	Sex
69	KO	45														
70	KO	41														
71	KO	38														
72	KO	40														
73	KO	40														
74	KO	44														
75	KO	40														
76	KO	54														
77	KO	43														
78	KO	46														
79	KO	43														
80	KO	35														
81	KO	38														
82	KO	41														
83	KO	40														
69	KO	45														

Appendix 5a - continued.

	Location Mica Pool		Trawl #			Time in			Time out	Distance (m)		Target Depth (m)		# layers	
	T15		3			0125			0230	~2600		17-24		1	
No.	**SP**	**Len**	**Wt**	**Age**	**SN**	**Mat**	**Sex**	**No.**	**SP**	**Len**	**Wt**	**Age**	**SN**	**Mat**	**Sex**
1	KO	219	115.61	2	1	m	m	35	KO	29	0.15				
2	KO	207	92.01	2	2	m	m	36	KO	55	1.45				
3	KO	166	47.17	1	3	imm	f	37	KO	37	0.4				
4	KO	79	4.18					38	KO	38	0.45				
5	KO	61	1.93					39	KO	39	0.51				
6	KO	73	3.55					40	KO	37	0.41				
7	KO	42	0.66					41	KO	41	0.59				
8	KO	55	1.51					42	KO	36	0.38				
9	KO	45	0.078												
10	KO	38	0.46												
11	KO	47	0.9												
12	KO	43	0.71												
13	KO	39	0.5												
14	KO	57	1.73												
15	KO	37	0.43												
16	KO	48	0.97												
17	KO	48	0.97												
18	KO	47	0.92												
19	KO	41	0.56												
20	KO	37	0.34												
21	KO	39	0.42												
22	KO	40	0.53												
23	KO	40	0.53												
24	KO	39	0.52												
25	KO	49	1.07												
26	KO	31	0.2												
27	KO	41	0.56												
28	KO	40	0.53												
29	KO	34	0.33												
30	KO	31	0.21												
31	KO	32	0.23												
32	KO	29	0.16												
33	KO	31	0.21												
34	KO	37	0.39												

Appendix 5 – continued.

b) Revelstoke Reservoir trawl catches, July 2011

	Location	Rev	Trawl #		Time in		Time out	Distance (m)		Target Depth (m)	# layers
	T2 to T3		1		2352		0032	~2600		6-13	1

No.	SP	Len	Wt	Age	SN	Mat	Sex	No.	SP	Len	Wt	Age	SN	Mat	Sex
1	Ko	28	0.16					35	Ko	31	0.27				
2	Ko	41	0.61					36	Ko	36	0.38				
3	Ko	40	0.68					37	Ko	31	0.26				
4	Ko	42	0.8					38	Ko	36	0.38				
5	Ko	46	0.96					39	Ko	38	0.51				
6	Ko	48	0.95					40	Ko	32	0.27				
7	Ko	55	1.42					41	Ko	29	0.16				
8	Ko	48	1.02					42	Ko	46	0.98				
9	Ko	46	0.86					43	Ko	32	0.31				
10	Ko	42	0.67					44	Ko	34	0.31				
11	Ko	47	0.93					45	Ko	39	0.55				
12	Ko	46	0.96					46	Ko	43	0.66				
13	Ko	40	0.59					47	Ko	38	0.46				
14	Ko	33	0.3					48	Ko	36	0.37				
15	Ko	37	0.44					49	Ko	34	0.31				
16	Ko	44	0.72					50	Ko	27	0.13				
17	Ko	38	0.37					51	Ko	41	0.69				
18	Ko	41	0.67					52	Ko	42	0.72				
19	Ko	39	0.55					53	Ko	36	0.38				
20	Ko	48	0.94					54	Ko	33	0.27				
21	Ko	39	0.58					55	Ko	38	0.48				
22	Ko	29	0.15					56	Ko	33	0.28				
23	Ko	42	0.69					57	Ko	34	0.36				
24	Ko	42	0.52					58	Ko	35	0.42				
25	Ko	46	0.89					59	Ko	46	0.82				
26	Ko	40	0.49					60	Ko	45	0.82				
27	Ko	50	1.16					61	Ko	35	0.35				
28	Ko	40	0.57					62	Ko	40	0.61				
29	Ko	42	0.6					63	Ko	31	0.21				
30	Ko	38	0.45					64	Ko	42	0.67				
31	Ko	38	0.49					65	Ko	27	0.11				
32	Ko	39	0.51					66	Ko	32	0.29				
33	Ko	36	0.33					67	Ko	33	0.33				
34	Ko	46	0.93					68	Ko	32	0.3				

Appendix 5b – continued.

	Location	Rev	Trawl #			Time in			Time out	Distance (m)		Target Depth (m)	# layers
	T2 to T3		1			2352			0032	~2600		6-13	1

No.	SP	Len	Wt	Age	SN	Mat	Sex		No.	SP	Len	Wt	Age	SN	Mat	Sex
69	Ko	40	0.63													
70	Ko	39	0.5													
71	Ko	32	0.25													
72	Ko	35	0.35													
73	Ko	36	0.33													
74	Ko	38	0.53													
75	Ko	42	0.62													
76	Ko	43	0.71													
77	Ko	42	0.62													
78	Ko	42	0.66													
79	Ko	40	0.54													
80	Ko	36	0.42													
81	Ko	36	0.37													
82	Ko	30	0.21													
83	Ko	40	0.58													
84	Ko	30	0.17													
85	Ko	39	0.55													
86	Ko	37	0.39													
87	Ko	38	0.45													
88	Ko	45	0.81													
89	Ko	34	0.3													
90	Ko	28	0.14													
91	Ko	30	0.19													
92	Ko	28	0.13													
93	Ko	34	0.34													
94	Ko	31	0.23													
95	Ko	29	0.17													
96	Ko	35	0.35													

Appendix 6. Kokanee spawner length, weight and age data for 2011 from Camp Creek, tributary to Canoe Reach on Kinbasket Reservoir (Source: K. Bray, BCH Revelstoke).

Year	Date	Sex	FL (mm)	Wt (g)[1]	Age[2]	Date	Sex	FL (mm)	Wt (g)	Age[2]
2011	23-Sep	M	245	210	2	23-Sep	F	235	130	2
2011	23-Sep	M	247	200	2	23-Sep	F	223	130	2
2011	23-Sep	M	246	160	2	23-Sep	F	221	110	2
2011	23-Sep	M	240	170	2	23-Sep	F	226	120	2
2011	23-Sep	M	240	180	2	23-Sep	F	235	140	2
2011	23-Sep	M	240	200	2	23-Sep	F	241	140	2
2011	23-Sep	M	237	160	2	23-Sep	F	224	110	2
2011	23-Sep	M	245	190	2	23-Sep	F	231	130	2
2011	23-Sep	M	244	170	2	23-Sep	F	246	150	2
2011	23-Sep	M	235	160	2	23-Sep	F	226	130	2
2011	23-Sep	M	237	170	2	23-Sep	F	244	120	2
2011	23-Sep	M	240	160	2	23-Sep	F	238	130	2
2011	23-Sep	M	243	180	3	23-Sep	F	230	130	2
2011	23-Sep	M	230	170	2	23-Sep	F	245	152	3
2011	23-Sep	M	244	180	2	23-Sep	F	245	150	2
Mean		**M**	**241**	**177**	**2**	**Mean**	**F**	**234**	**131**	**2**

1. includes spawned out fish
2. Ages by Carol Lidstone, Birkenhead Scale Analysis

*Note: Add one year to spawner age to determine brood year (e.g. an age 2+ in 2011 is from a fall 2008 spawner).

Appendix 7. Kokanee spawner mean length by age data from Camp Creek, and Luxor Creeks (Kinbasket Reservoir) and Standard Creek (Revelstoke Reservoir) (Source: K. Bray, BCH Revelstoke).

	Age 2		Age 3		Age 4	
	n	FL (mm)	n	FL (mm)	n	FL (mm)
Kinbasket						
Camp Creek						
1998	62	238	15	264		
2000	47	244	13	267		
2001	30	242	30	264		
2002	7	265	53	278		
2003	21	250	39	277		
2004	43	235	17	257		
2005	32	242	27	253	1	260
2006	1	226	59	277		
2007			60	273		
2008	11	223	19	253		
2009	30	223				
2010	60	228				
2011	28	237	2	244		
Luxor Creek						
2007	27	249	4	268		
2009	30	209				
2010	29	224	1	244		
2011	10	223				
Revelstoke						
Standard Creek						
2007	22	292	10	329		
2009	14	263	1	306		
2010	9	264	1	293		
2011	14	260	6	277		

*Note: Add one year to spawner age to determine brood year (e.g. an age 2+ in 2011 is from a fall 2008 spawner).

Appendix 8. Mean length and age of spawners in Standard Creek, a tributary to Revelstoke Reservoir during October 2011.

Year	Date	Sex	FL(mm)	Wt (g)	Age[1]	Date	Sex	FL (mm)	Wt (g)	Age[1]
2011	3-Oct	F	260		2	3-Oct	M	279		3
2011	3-Oct	F	255		2	3-Oct	M	277		3
2011	3-Oct	F	258		2	3-Oct	M	257		2
2011	3-Oct	F	270		2	3-Oct	M	259		2
2011	3-Oct	F	268		2	3-Oct	M	249		2
2011	3-Oct	F	271		3	3-Oct	M	269		2
2011	3-Oct	F	260		2	3-Oct	M	285		3
2011	3-Oct	F	269		2	3-Oct	M	271		3
2011	3-Oct	F	245		2	3-Oct	M	280		3
2011						3-Oct	M	257		2
2011						3-Oct	M	257		2
Mean		**F**	**261**		**2**	**Mean**	**M**	**278**		**2**

1. Ages by Carol Lidstone, Birkenhead Scale Analysis
*Note: Add one year to spawner age to determine brood year (e.g. an age 2+ in 2011 is from a fall 2008 spawner).