Arrow Lakes Reservoir Nutrient Restoration Program
(COL-F20-F-3006-DCA)
2019-20 (F20) Activity Report
1 April 2019 to 31 March 2020

Prepared for: Fish & Wildlife Compensation Program (FWCP)

Prepared by: Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Resource Management (FWCP – Section)

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Prepared with financial support from the Fish & Wildlife Compensation Program, on behalf of its program partners BC Hydro, the Province of B.C., Fisheries and Oceans Canada, First Nations and Public Stakeholders

Nutrient additions, in the form of liquid agricultural grade fertilizer occurred in Upper Arrow following the same methods as recent years. In total, 40.5 MT of phosphorus and 248.8 MT of nitrogen were added to the Reservoir between early May and end of September. The annual tonnes of phosphorus from fertilizer additions has been around 40 MT since 2016 (this is the fourth year of holding similar loading rates). The 2019 schedule was only adjusted once in mid-August, where the blend was adjusted to only nitrogen, this was due to nitrate levels reported below detection in Lower Arrow water samples.

The April- September daily mean flow for Arrow (total outflow) in 2019 was low compared to the previous eight years. These lower flows were observed in the early summer, from April to June, as well as late August in September. The flows in July and early August were near average. The air temperature in winter of 2018/2019 and spring, summer and fall of 2019 were all below average, as well the lowest temperatures (since 1992) in February were noted in 2019, where the monthly mean temperature was below 5 °C.

Secchi depth is a measure of water clarity, where the higher the number, the clearer the water is. In 2019, the Secchi in Upper Arrow was 5.9 m, and in Lower Arrow 5.5 m. These means are slightly lower, i.e. the water was slightly less clear than the long-term Basin means. Total phytoplankton abundance in 2019 was lower than the long term means for all basins. This result is surprising since the Secchi depths were low - i.e. water clarity was less in 2019 which typically is associated with more phytoplankton in the water column. The lower phytoplankton community in addition to lower air temperatures observed in the spring, summer and fall of 2019 may be a contributing factor to the lower Daphnia biomass observed.

Daphnia (the preferred food source to Kokanee) biomass was lower than average in both Upper and Lower Arrow in 2019. This may be attributed to lower than average summer temperatures (Air Temperatures at Castlegar Airport, data on file FLNRORD). These low numbers are likely not due to Kokanee grazing, since in-lake Kokanee estimates and fall spawners were low. Mysid density increased in 2019 from 2018 in both Upper and Lower Arrow basins. In Upper Arrow, the 2019 mean was above the long term 1997-2019 mean, however in the range of mean densities observed over the course of the NRP. In Lower Arrow, the 2019 mean was below the long term mean, a trend since 2015.

Kokanee spawner returns in 2019 were slightly higher in 2019 compared to 2018 results. However, the Hill Creek returns were slightly lower than the 2018 Hill Creek returns (additional details are provided in the Hill Creek Spawning Channel final report).

The in-lake 2019 fry population (based on hydroacoustic estimates) was among the lowest post fertilization abundance. Upper Arrow fry numbers (2.9 million) were relatively better than Lower Arrow, which had the lowest number on record at 0.85 million. Abnormally poor survival occurred over the period between egg deposition and fall fry, well below what would be predicted by egg density along. The environmental variable that stands out was the record (since 1992) cold month of February (can result in intergravel freezing and embryo mortality). Presuming this was the case, the stability of fry production from the spawning channel likely ensured the fry population was not at record low levels in Upper Arrow as well as Lower Arrow in 2019.

Age 1-3 kokanee numbers were below average and similar to 2018 results at ~1.1 million. Survival between age 0-1 was below average (basins combined) at 16% and near average for age 1-2 at 34%.

Kokanee biomass density for combined in-lake and spawners was 45% of the post NRP average and similar to the pre-NRP average

The angler creel survey was completed with a total of 1,428 anglers interviewed at the three major access locations in the 2019 calendar year. Residents of BC comprised 93% of the anglers, with non-resident Canadians (primarily from Alberta) making up most of the remainder. About 85% of angling effort was targeting Bull Trout and/or Rainbow Trout, with only 13% of angler-days targeting Kokanee, or Kokanee and other species. There has been a trend towards decreased effort for Kokanee and small Rainbow Trout since 2015, coinciding with a reduction in the size of harvested Kokanee to about 20 cm. There was, however, an increase in 'Kokanee only' effort at the Castlegar access; this may be a response to an increase in the daily limit from 5 to 15 fish. Burbot remained the smallest component of the fishery, detected only at the Nakusp access.

Average size of harvested Kokanee was 21 cm (129 g); catch rate was 0.83, the highest in more than a decade. Average size of Burbot was 66 cm (1.7 kg); catch rate was 0.38 fish/rod-hour. Average size of harvested Bull Trout (59 cm, 2.4 kg) was 6.8 kg; catch rate was 0.07 fish/rod-hour. Average size of harvested Rainbow Trout (39 cm, 1.0 kg) was similar to previous years; highest recorded weight was 5.75 kg, and catch rate was 0.07 fish/rod-hour. Piscivorous Rainbow Trout (≥ 50 cm) catch was relatively low.

Relative condition factor (Kn) of Bull Trout declined from the two previous years to 5% above the pre-nutrient average. Total harvest, condition factor and maximum size of the apex predators (Bull and Rainbow Trout) in 2019 were near or slightly below expected levels based on long term relationships with Kokanee spawners and phosphorus.

Stomach samples were collected from 87 Bull Trout and seven Rainbow Trout; slightly less than half of the predators had fish in the gut, with most consumed fish being Kokanee. Overflight boat counts were conducted in 2019 – 2020 to determine appropriate expansion factors for whole lake catch and harvest estimates.

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Introduction

Arrow Lakes Reservoir has been influenced by the construction of 3 dams – Hugh Keenleyside (1968), Mica (1973) and Revelstoke (1984). Hugh Keenleyside raised maximum water levels inundating the former Upper and Lower Arrow Lakes to form Arrow Lakes Reservoir. The increased water levels impacted high quality spawning and rearing habitat in tributaries. Revelstoke Dam blocked access to spawning and rearing habitat in tributaries upstream of the reservoir, and both Mica and Revelstoke Dams caused long-term changes in light penetration and nutrients in the lentic habitat of Arrow Lakes Reservoir. As a result of decreased upstream nutrient inputs, kokanee stocks in Arrow Lakes declined substantially by the mid-1990s. To address the nutrient losses in Arrow Lakes Reservoir, a bottom-up approach was taken with the addition of nutrients (nitrogen and phosphorus in the form of liquid fertilizer) to increase phytoplankton populations that are suitable for the production of *Daphnia*, a main food source for kokanee. Nutrients have been added to Upper Arrow since 1999 and are dispensed from Waterbridge ferries from the end of April through mid-September. Columbia Power Corporation contributes 25 % of the costs to this project to compensate for fish entrainment through the Arrow Lakes Generating Station as per DFO Authorization No. 5300-10-002. Nutrient addition has been a successful technique used for the enhancement and conservation of sockeye salmon populations as well as being successful in restoring kokanee populations in lakes and reservoirs altered by hydroelectric construction.

Goals and Objectives and Linkage of FWCP Action Plans and specific actions

The goals and objectives of the nutrient restoration program are a priority one habitat-based action described in the Columbia Region reservoir and large lakes plan. The following is a snapshot from the plan with the description of the Kootenay and Arrow nutrient restoration programs.

8	Habitat-based	**COLRLL.ECO.HB.08.01 Implementation of Kootenay Lake and Arrow Lakes Nutrient Restoration Programs-P1**	1	Kootenay Lake Arrow Lakes	Fish	Implement and adaptively manage nutrient restoration programs in Kootenay Lake and Arrow Lakes Reservoir to sustain in-lake productivity at levels sufficient to support secondary productivity (forage for Kokanee).	Successfully demonstrate improved health and productivity of reservoirs.	Directed
9	Habitat-based	**COLRLL.ECO.HB.09.01 Operation of Meadow Creek and Hill Creek spawning channels-P1**	1	Kootenay Lake Arrow Lakes	Fish	Support the maintenance and operation of the Meadow Creek and Hill Creek spawning channels to ensure sufficient kokanee production in Kootenay Lake and Arrow Lakes Reservoir.	Improved Kokanee productivity to support a healthy and resilient reservoir ecosystem.	Directed
10	Monitoring and Evaluation	**COLRLL.ECO.ME.10.01 In-season Monitoring of Kootenay Lake and Arrow Lakes Nutrient Restoration Programs-P1**	1	Kootenay Lake Arrow Lakes	Fish	Implement in-season monitoring and evaluation of indicators and trends in ecosystem components (e.g. water chemistry, plankton, Kokanee) related to the Kootenay Lake and Arrow Lakes Reservoir nutrient restoration programs.	Improved understanding of indicators and annual trends of in lake productivity.	Directed

- **Habitat-based Actions** – These actions will conserve, restore, and enhance reservoir and large lake habitats. Examples include habitat creation, restoration, and enhancement; enhancing habitat connectivity; nutrient restoration; and invasive species prevention.
- **Monitoring and Evaluation** – These actions will monitor and evaluate reservoir and large lake projects supported by the FWCP to understand the effectiveness of habitat- or species-based actions.

The following is the link to the Columbia region reservoir and large lakes plan.
http://fwcp.ca/app/uploads/2019/08/Action-Plan-Columbia-Region-Reservoirs-Large-Lakes-Aug-21-2019.pdf

Study Area – Arrow Lakes Reservoir

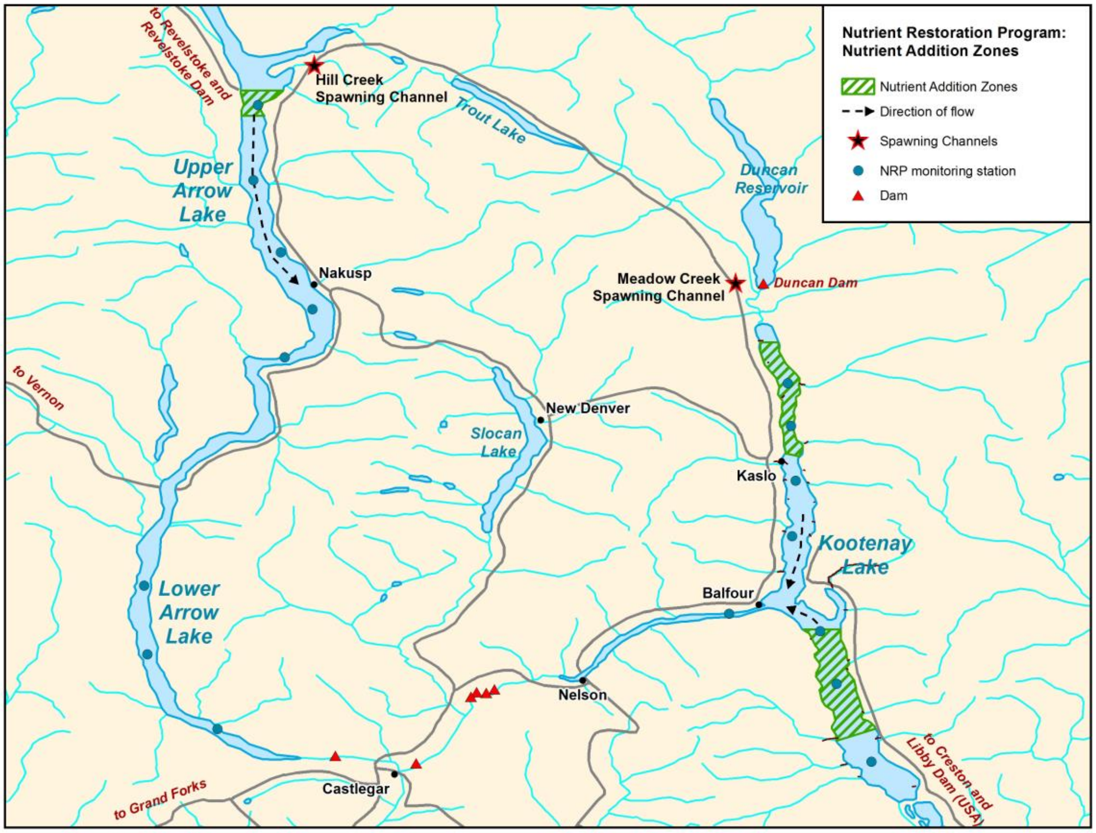


Figure 1. Map of Arrow Lakes Reservoir with the nutrient addition zone and monitoring stations identified (described in the legend on the map).

Methods

Methods for sampling of various components for the nutrient restoration program are listed in Arndt, 2020 for the creel survey and Bassett et al. 2020 for all other parameters monitored.

Results

Nutrient additions occurred in Upper Arrow following the same methods as recent years. In total, 40.5 MT of Phosphorus and 248.8 MT of Nitrogen were added to the Reservoir in the form of liquid agricultural grade fertilizers, 10-34-0 and 28-0-0. The annual tonnes of phosphorus from fertilizer has been around 40 MT since 2016. The 2019 schedule was only adjusted once in mid-August, where the blend was adjusted to only nitrogen, this was due to nitrate levels reported below detection in Lower Arrow water samples. Fertilization began early May and ceased end of September. This was later than other years and was due to contract delays.

The April- September daily mean flow for Arrow (total outflow) in 2019 was low compared to the previous eight years (Fig. 2). These lower flows were observed in the early summer, from April to June, as well as late August in September (Fig. 3). The flows in July and early August were near average. The air temperature in winter of 2018/2019 and spring, summer and fall of 2019 were all below average, as well the lowest temperatures (since 1992) in February were noted in 2019, where the monthly mean temperature was below 5 °C (data not shown).

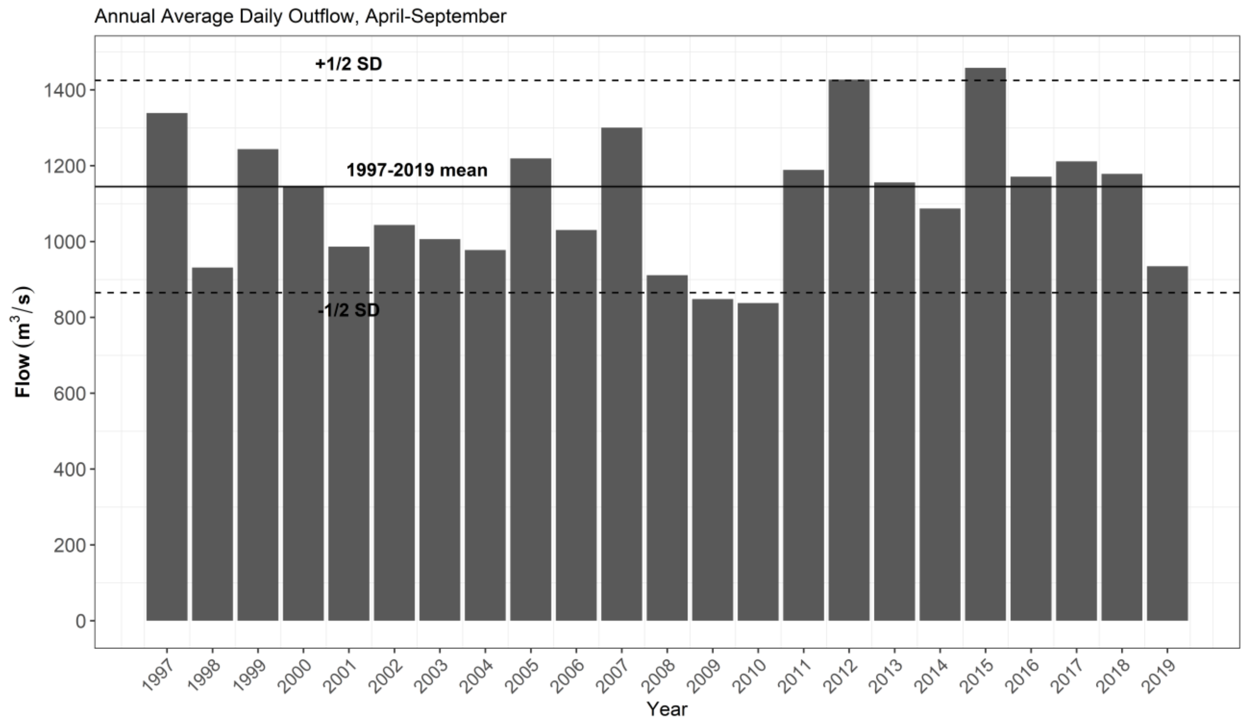


Figure 2. Annual mean of daily outflow at Arrow Lakes Reservoir (m3/s) 1997-2019. Solid horizonal line is 1997-2019 mean and dashed horizonal lines are ±1/2 SD.

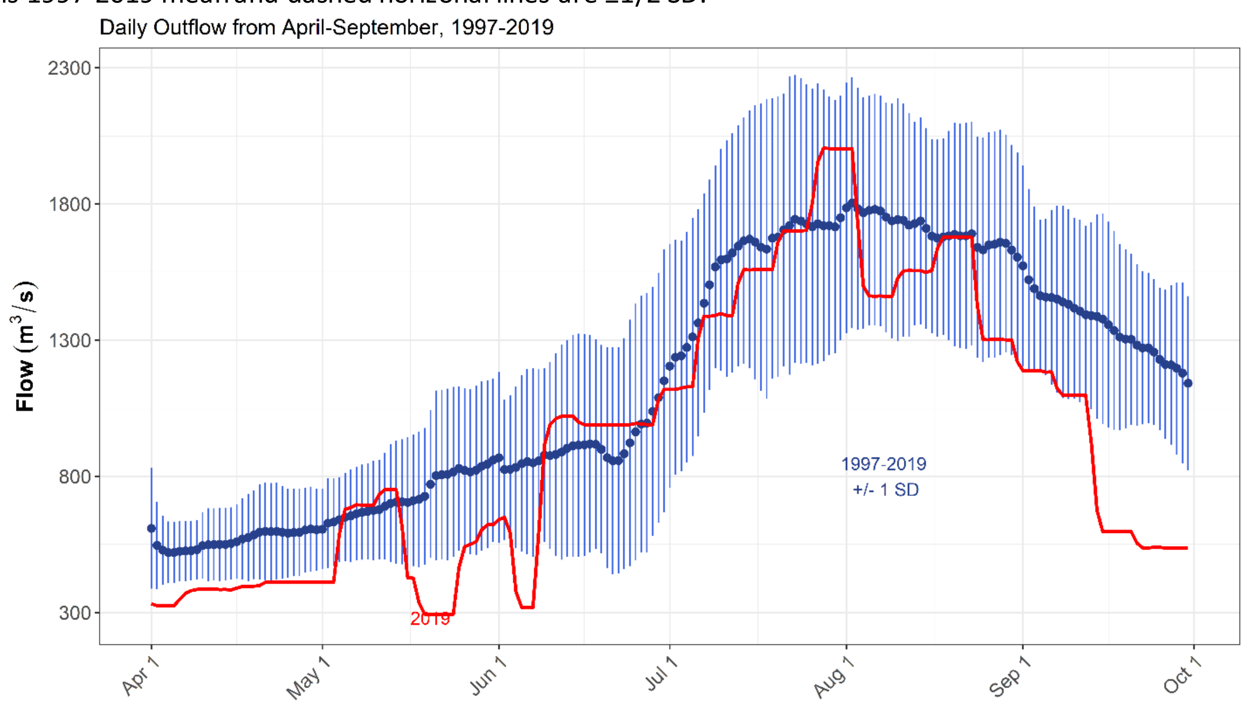


Figure 3. Arrow Lakes Reservoir April-September daily outflow 1997-2016. Blue circles are 1997–2019 daily average, blue vertical lines ± 1 standard deviation and red line is 2019 daily outflow.

Secchi depth is a measure of water clarity, where the higher the number, the clearer the water is. In 2019, the secchi in Upper Arrow was 5.9 m, and in Lower Arrow 5.5 m. These means are slightly lower, i.e. the water was slightly less clear than the long-term Basin means (Fig. 4).

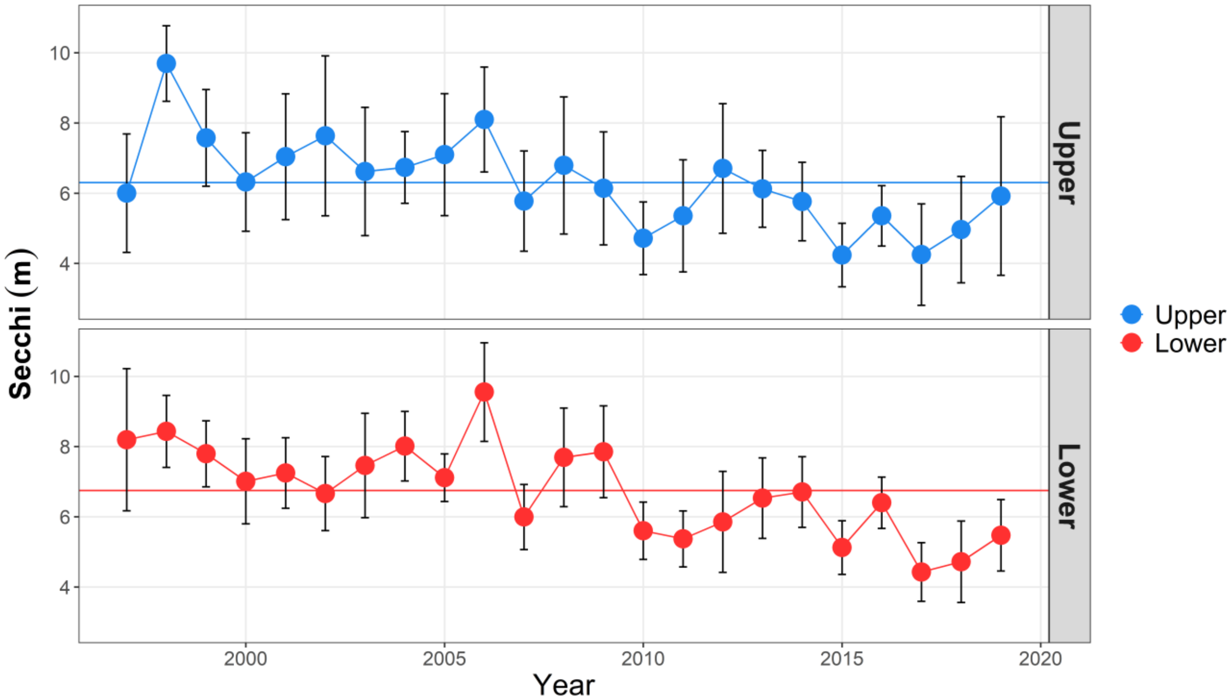


Figure 4. Secchi (m) monthly annual means for Arrow Lakes Reservoir by Basin.

Total phytoplankton abundance in 2019 was lower than the long term means for all basins (data not shown). This result is surprising since the secchi depths were low (Fig. S1), i.e. water clarity was less in 2019 which typically is associated with more phytoplankton in the water column. The lower phytoplankton community may be a contributing factor to the lower Daphnia biomass (Fig. 5) in 2019.

Daphnia (the preferred food source to Kokanee) biomass was lower than average in both Upper and Lower Arrow in 2019 (Fig. 5). This may be attributed to lower than average summer temperatures (Air Temperatures at Castlegar Airport, data on file FLNRORD). These low numbers are likely not due to Kokanee grazing, since in-lake Kokanee estimates (Fig. 9) were low and fall spawners (Fig. 7) were not high.

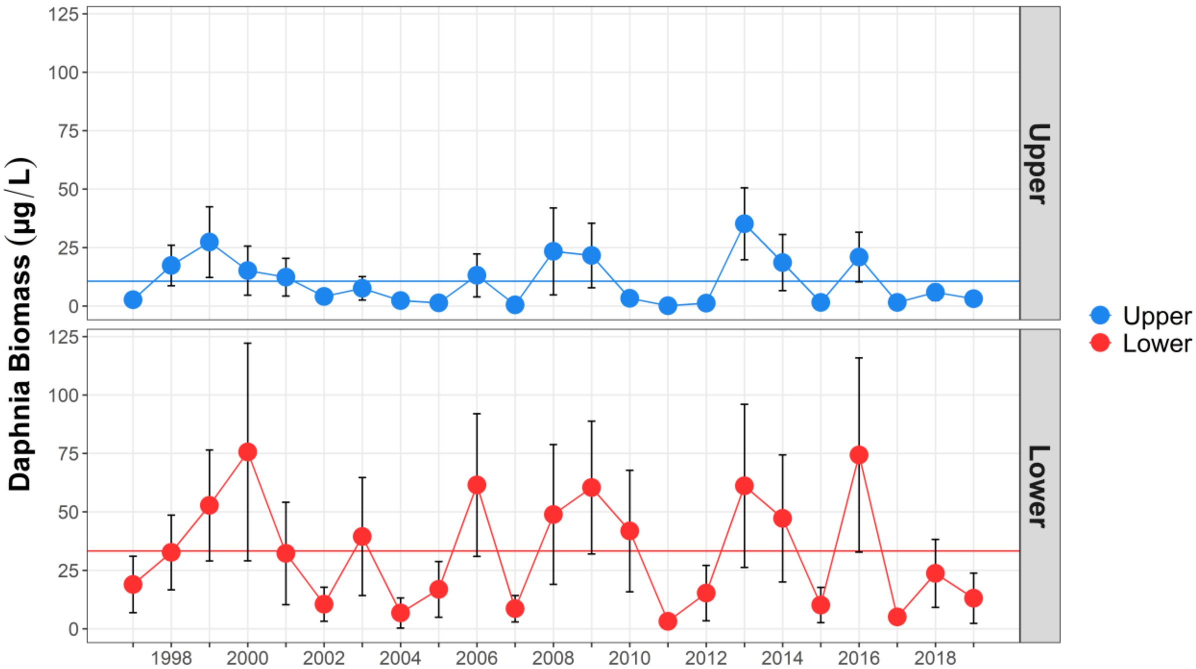


Figure 5. Arrow zooplankton Daphnia biomass (ug/L) annual monthly mean (April – October), by basin. Horizontal lines are the basin means for the time series (1997-2019).

Mysid density increased in 2019 from 2018 in both Upper and Lower Arrow basins (Fig. 6). In Upper Arrow, the 2019 mean was above the long term 1997-2019 mean, however in the range of mean densities observed over the course of the NRP. In Lower Arrow, the 2019 mean was below the long term mean, as it has been since 2015. The Upper Arrow, the higher mean was from high density samples collected from two Upper Arrow stations in July and August.

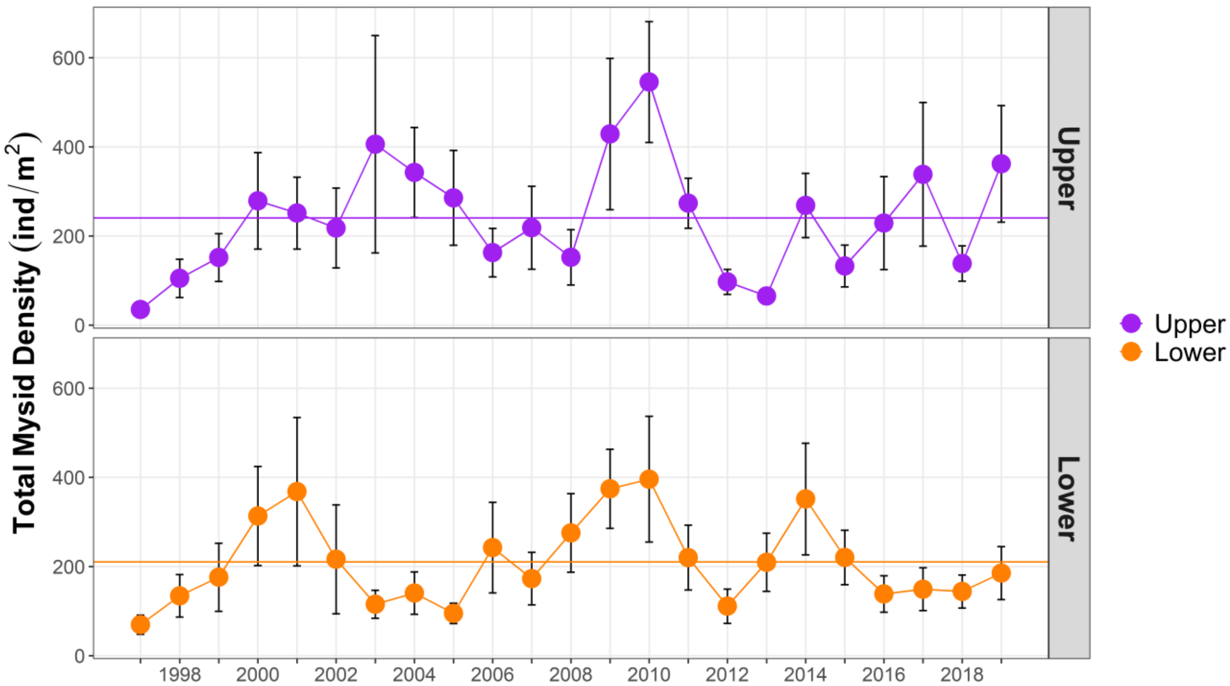


Figure 6. Arrow mysid density (ind/m2) annual monthly mean (April – October), by basin. Horizontal lines are the basin means for the time series (1997-2019).

Kokanee escapement in 2019 was slightly higher compared to 2018. However, the Hill Creek returns were slightly lower than the 2018 Hill Creek returns (Fig. 7). The spawner forecast for both basins combined for 2020 is 265,000 (72% of post NRP average) (Fig. 8). The Upper Arrow forecast is for a decline to ~115,000 spawners in 2020 (63% of post NRP average).

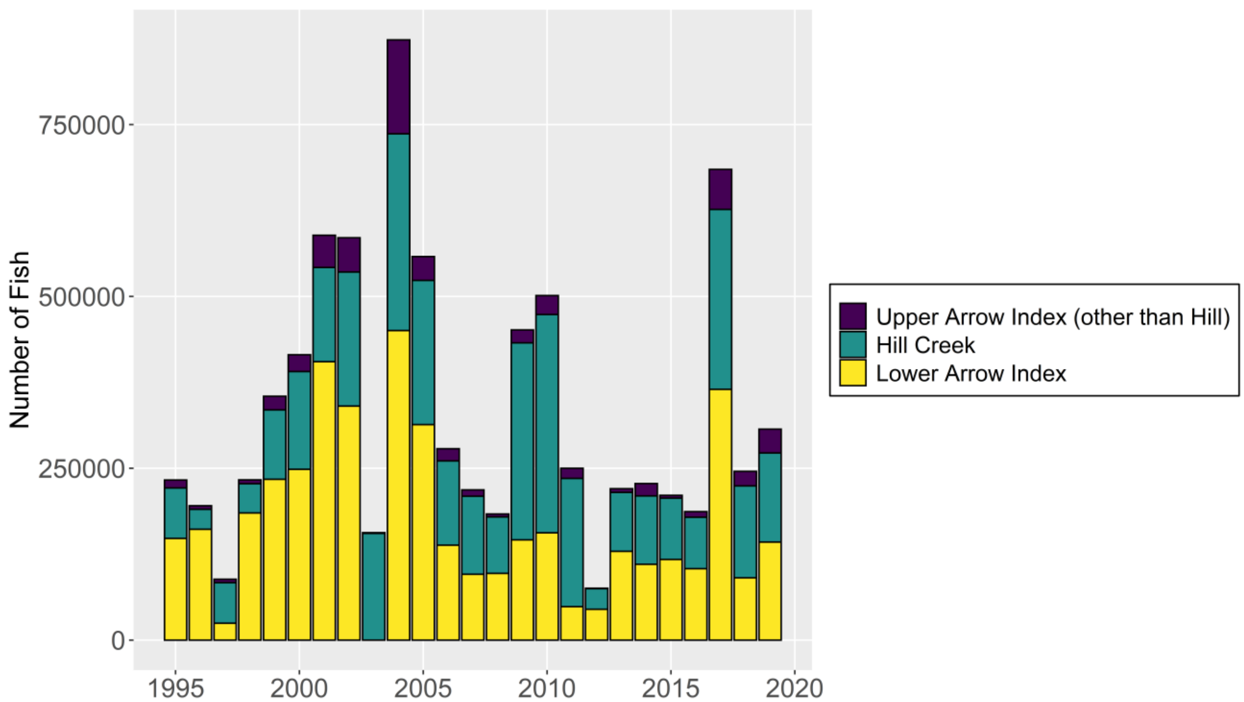
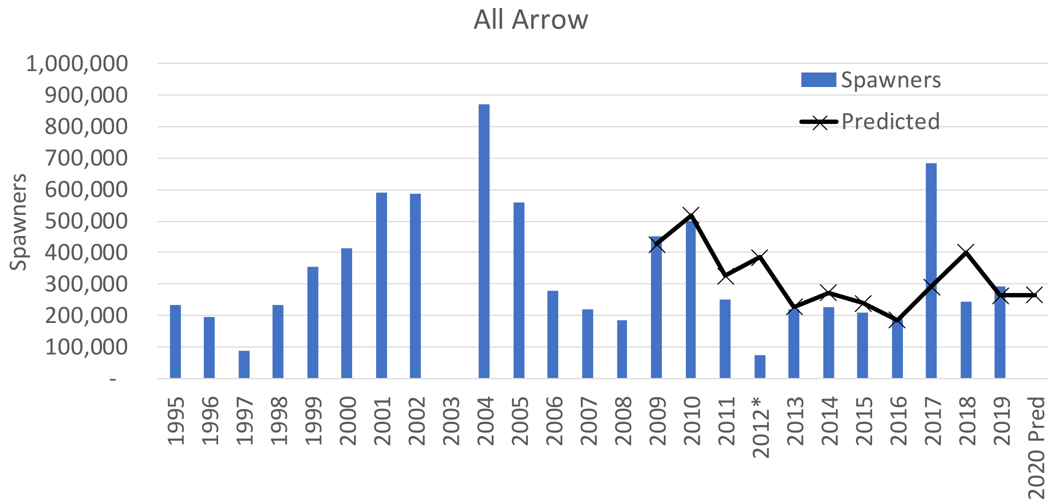


Figure 7. Kokanee Escapement of index tributaries on Arrow Lakes Reservoir by Area (Upper Arrow Index (other than Hill), Hill Creek and Lower Arrow Index 1995-2019. Note No Lower Arrow Index counts occurrent in 2003.



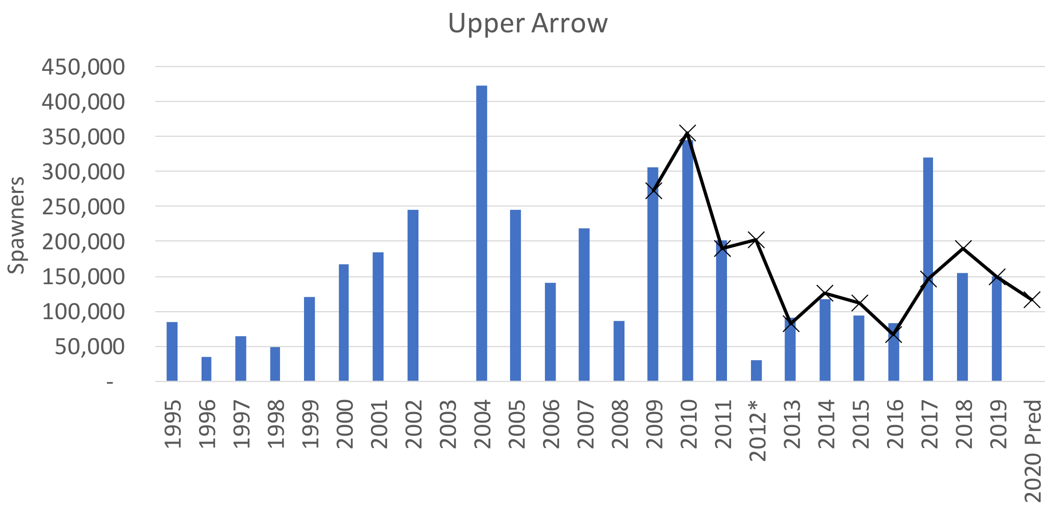


Figure 8. Spawner escapement trends (index tributaries) for All Arrow (basins combined) and Upper Arrow spawners since 1995, and predicted spawner estimates for 2020 based on October acoustic data from year prior. *A high proportion of age-3 Kokanee in 2012 delayed spawning to age-4 (92% of 2013 spawners were age-4), and a large-scale die-off event in May 2012 resulted in wide discrepancy between forecast and actual returns.

In 2019 the fry population estimated from the hydroacoustic survey was among the lowest post fertilization results. Upper Arrow fry numbers (2.9 million) were relatively better than Lower Arrow, which had the lowest number on record at 0.85 million. Age 1-3 kokanee numbers were below average and similar to 2018 at ~1.1 million (Fig. 9). The trawl catch for fry in Lower Arrow was 3, also the lowest on record.

Abnormally poor survival occurred over the period between egg deposition and fall fry, well below what would be predicted by egg density alone and this could be a contributing factor to the poor survival. The environmental variable that stands out was the record (since 1992) cold month of February in 2019, cold weather can result in intergravel freezing and embryo mortality. Presuming this was the case, the stability of fry production from the spawning channel likely ensured the fry population was not at record low levels in Upper Arrow as well as Lower Arrow in 2019.

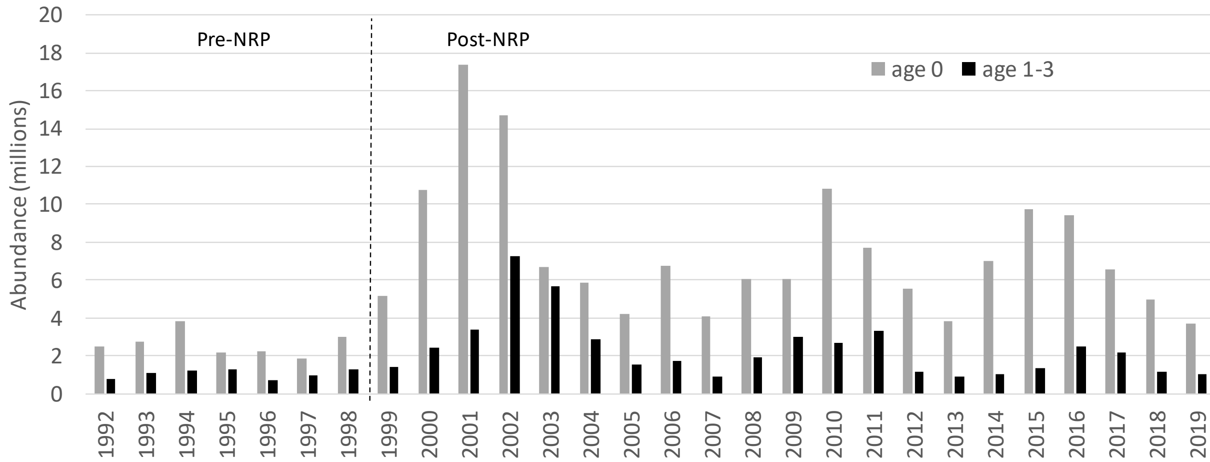


Figure 9. Kokanee abundance from October acoustic surveys in Arrow Lakes Reservoir (combined Upper and Lower Arrow basins). 2019 data are preliminary. A recently completed acoustic time-series re-evaluation has resulted in changes to previously reported estimates, particularly prior to 2008; however, the overall trend remains similar. Confidence intervals on estimates have not yet been re-calculated for the timeseries.

Kokanee survival between age 0-1 was below average (basins combined) at 16% and near average for age 1-2 at 34%.

Kokanee Biomass density for combined in-lake and spawners was 45% of the post NRP average and similar to the pre-NRP average (Fig. 10).

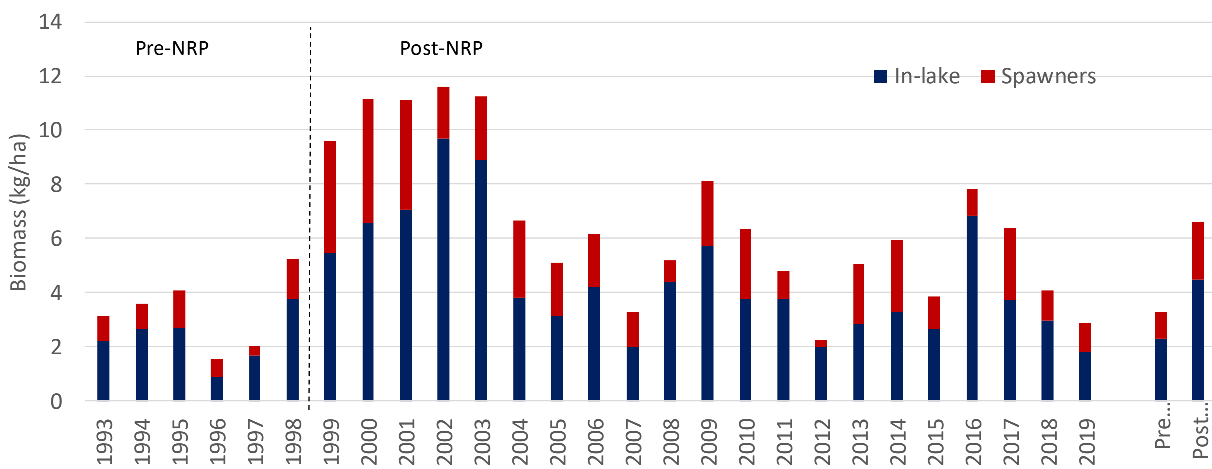


Figure 10. In-lake and spawner biomass density estimates for combined basins in Arrow Lakes Reservoir.

Average size of angled Kokanee remained small for the fourth year in a row at just over 21 cm [Note – 2010 and 2011 were not sampled all year (Fig. 11). Preliminary review of the data suggests there may be increases in the Kokanee fishing effort and harvest this year in response to the increase in daily harvest limit.

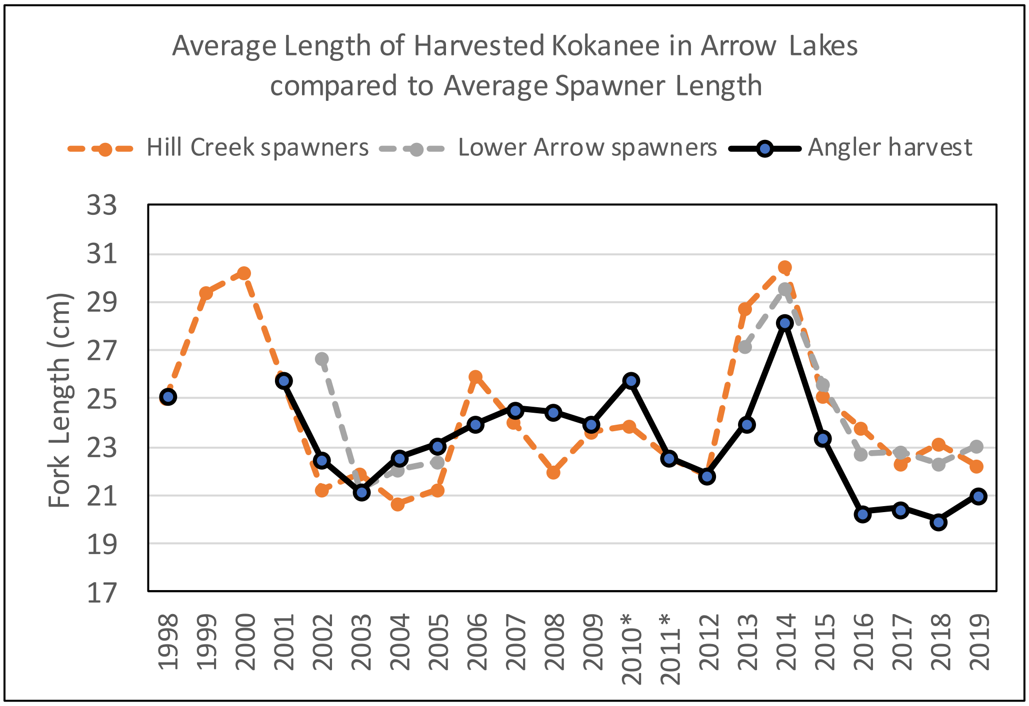


Figure 11. Average fork length of Kokanee harvested in the Arrow Lakes Reservoir fishery, and average length of Kokanee spawners in the fall of the same year.

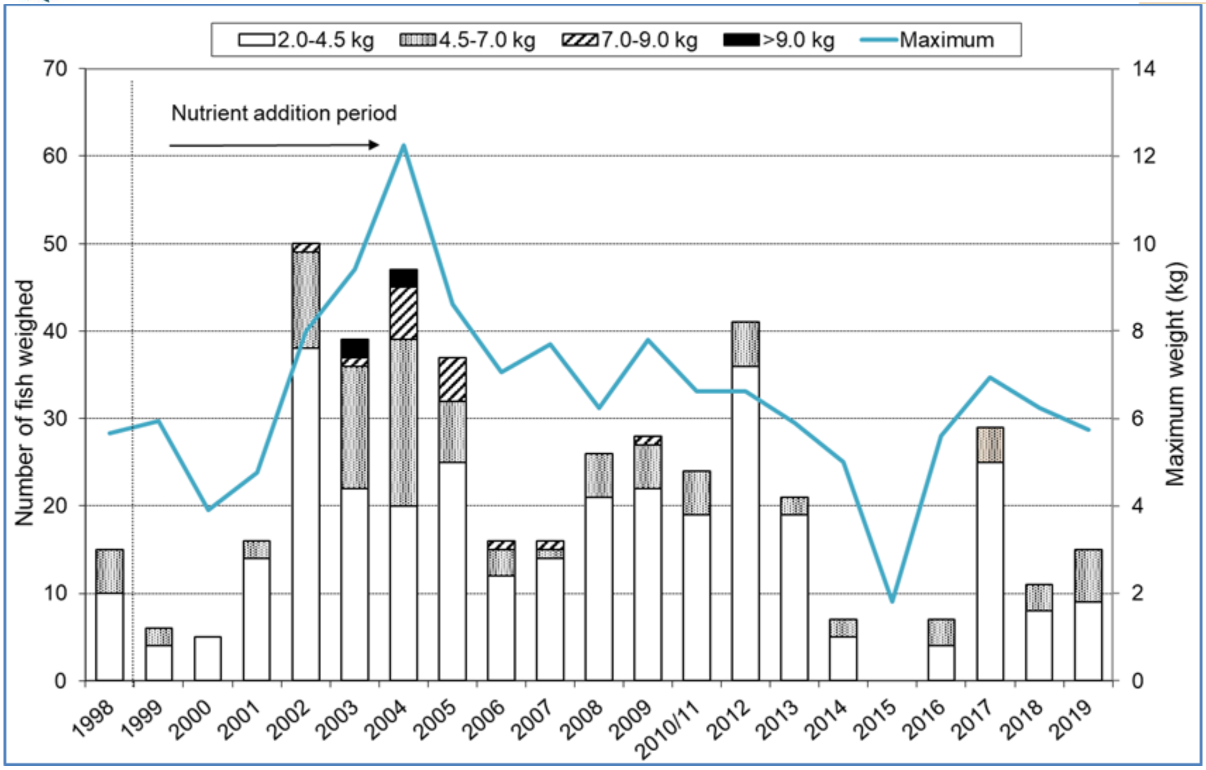


Figure 12. Number of large Rainbow Trout sampled and maximum size in the Arrow Lakes Reservoir creel survey since 1998.

The time series of the number of Rainbows over 2 kg sampled in the creel since 1998 (bars are size categories and blue line is the largest fish weighed in on creel days). [Note: 5 days/month are sampled at 3 locations all year] (Fig. 12). Fifteen Rainbows > 2 kg weighed in 2019 with the largest fish 5.75 kg. This may be about the norm for piscivorous Rainbow Trout production in Arrow under the current level of nutrient additions (from fertilizer - 40 T). Annual inputs from upstream tributaries are variable.

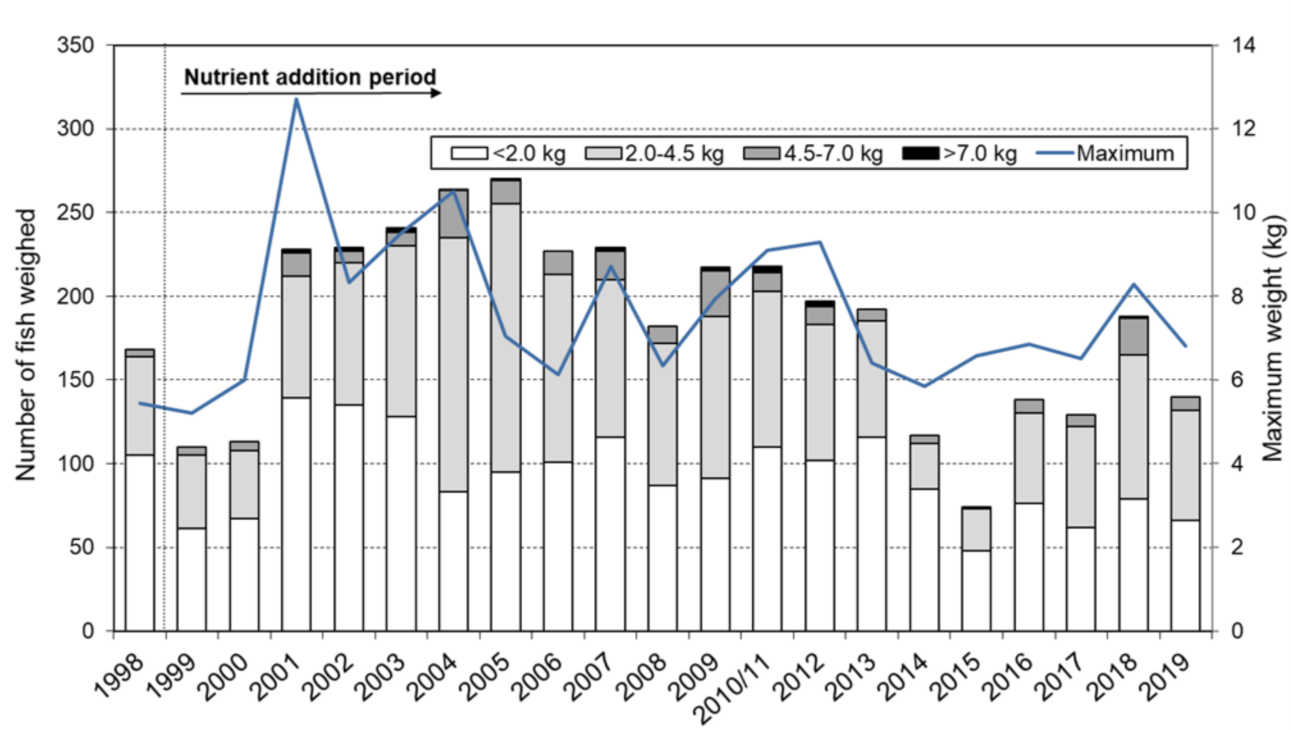


Figure 13. Number of weighed Bull Trout by size category sampled at three access locations in Arrow Lakes Reservoir from 1998 to 2019. The time series of the number of Bull Trout sampled in the creel since 1998 (bars are size categories and blue line is the largest fish weighed in on creel days). [Note: 5 days/month are sampled at 3 locations all year]

The largest Bull Trout weighed during the creel surveys in 2019 was 6.75 kg.

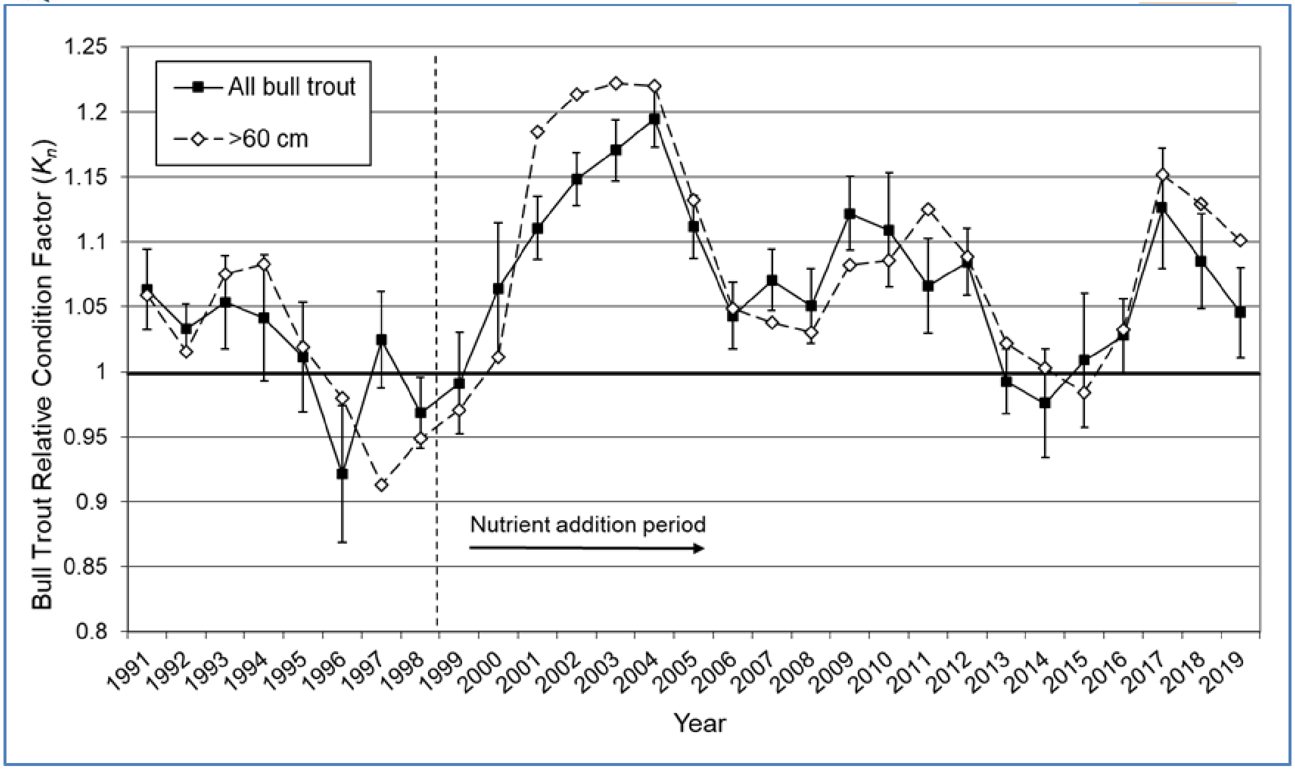


Figure 14. Average condition factor of Bull Trout sampled in the Arrow Lakes Reservoir creel survey since 1991. This is a time series of the average condition factor with 95% confidence intervals indicated by the bars. The line at 1 is the average condition for the pre-nutrient years.

The condition factor of Bull Trout (Fig. 14) is a key metric for looking at the food supply for predators. The 2019 average is above the pre-nutrient average and slightly below expected for 40 T of phosphorus based on the longterm results. The same average condition factor as above is graphed in relation to the total Kokanee spawner counts in Arrow index streams (Fig. 15) . The condition of bull trout is at the expected level given the current Kokanee spawner abundance.

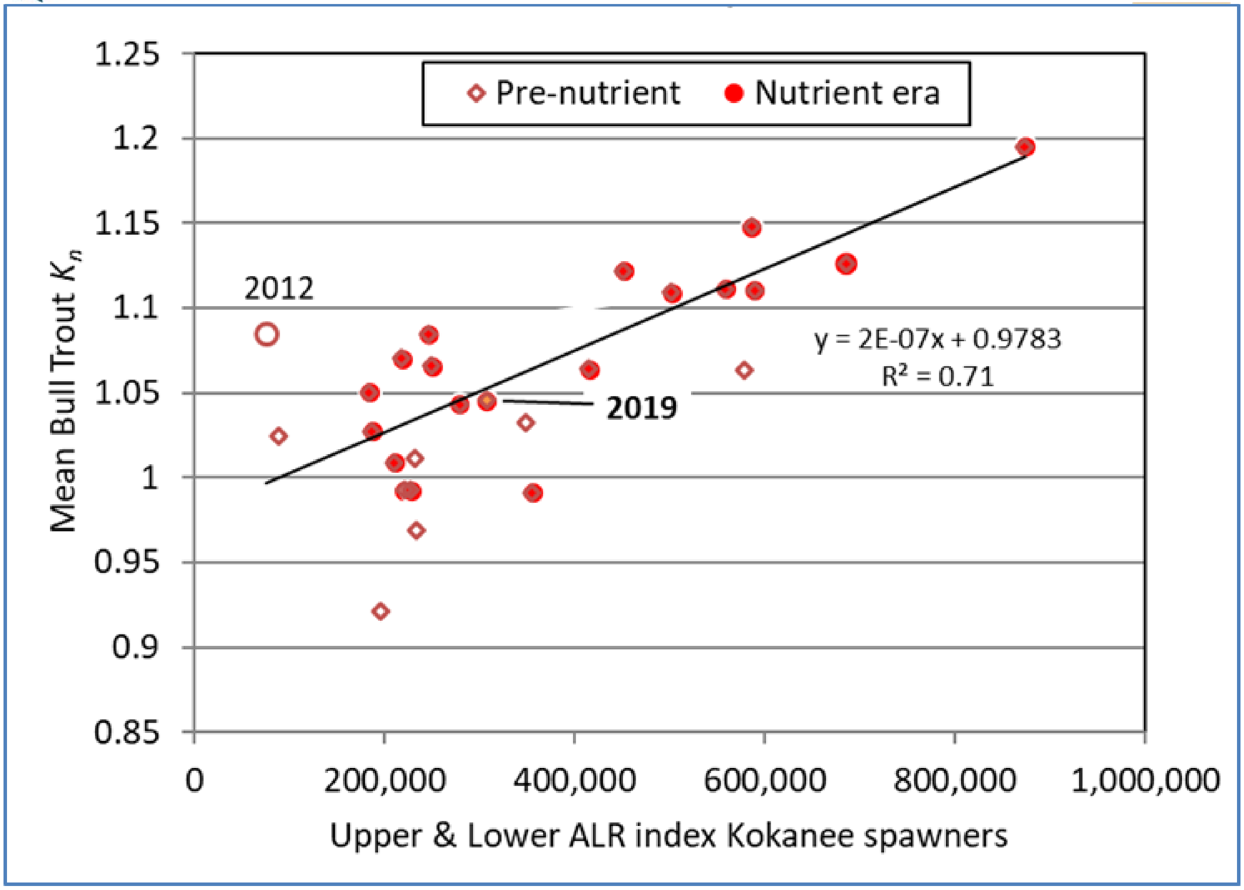


Figure 15. Average condition factor of Bull Trout compared to the estimate of Kokanee spawner abundance in Arrow Lakes Reservoir.

Discussion and recommendations

There was an overall increase in Kokanee biomass since the onset of nutrient additions in 1999 when compared to the years prior. There are several factors that have implications on the success of the nutrient restoration program: the interactions of flow, nutrients and spawning channel loading. There are also uncertain impacts of climate change as temperature and precipitation can impact nutrient uptake and loading.

Mechanisms of early maturity (age-2) of Kokanee at a smaller size are not well understood; smaller size of kokanee reduces angler interest and the kokanee fishery remains well below pre-nutrient period. The condition factor of bull trout remains above the pre-nutrient addition era. Consecutive years of poor egg to fall-fry survival and below average in-lake survival from age 0 to age 1 resulted in low numbers for all three in-lake age classes of Kokanee in 2019. As a result, in-lake biomass was very low, an outcome that was amplified by the failure of a substantial density dependant growth response to materialize. The below average density of *Daphnia* in 2019 was likely a key factor affecting the below average length at age for most Kokanee age classes including spawners in 2019 and given the low Kokanee densities/biomass it is unlikely that grazing by Kokanee was a primary factor driving down *Daphnia* densities.

The following list are recommendations for the program moving forward.

- Continue with nutrient additions; status quo as a review of the nutrient program is scheduled for F22.
- Analyze air and water temperature dynamics and their influence on zooplankton productivity. Bray et al. (2018) found that a colder winter significantly delayed the onset of summer stratification for Revelstoke Reservoir, and had calculated these data for 2013-2017. Exploration of whether more recent data are available for Revelstoke (to 2019), whether Revelstoke data are a reasonable proxy for Arrow, and how well they correlate with zooplankton dynamics including the timing of first appearance of Daphnia is recommended. The potential to estimate timing of stratification using Arrow water profile data should also be evaluated.
- Review weather/climate mediated processes and their relevance to annual outcomes versus localized or lake-specific factors. The degree to which climatic/weather related factors drive outcomes observed at all trophic levels is an important consideration that requires greater understanding in order to determine the relevance of lake specific factors (i.e., reservoir operations, spawning channel operations, fertilization amount/timing) on an annual scale, and with respect to evaluating the long-term outcomes of the NRP. Evaluation of trends across multiple systems was initiated for Columbia Basin reservoirs by Bray et al. (2018) and this effort should be continued and expanded upon for all trophic levels and systems where comparable data exist.
- Kokanee Egg to fall fry survival. Egg to fall fry survival was below average for three consecutive years and was exceptionally low in 2019. Survival across this life stage has a dramatic impact on cohort strength in subsequent years; a better understanding of what factors are important in what years would increase our understanding of the overall outcomes for Kokanee.
- Piscivore consumption rates and creel metrics. Review bioenergetics and other estimates of consumption rates of piscivores on kokanee to determine what the top-down effects are in the reservoir. Review creel metrics in relation to bottom-up effects.

Acknowledgements

This project was prepared with financial support Fish & Wildlife Compensation Program on behalf of its partners, BC Hydro, the Province of B.C., Fisheries and Oceans Canada, First Nations, and Public Stakeholders to conserve and enhance fish and wildlife in watersheds impacted by BC Hydro dams. Funding was also provided by Arrow Lakes Power Corporation (ALPC) which is jointly owned, on a 50/50 basis, by Columbia Power Corporation and CBT Arrow Lakes Power Development Corporation (an indirect subsidiary of Columbia Basin Trust). We would like to thank Waterbridge ferries for their continued in-kind support especially in 2019; during the workers strike this summer, nutrient additions were considered an essential service. The personnel who contributed to the project are listed in Appendix 1.

References

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Appendix 1. Arrow Lakes Reservoir NRP – Personnel - 2019

Project Focus	Personnel - Affiliation
Project co-ordination, management and scientific liaison	Marley Bassett - Resource Management, FLNRORD Kristen Peck - Resource Management, FLNRORD
Report compilation	Marley Bassett - Resource Management, FLNRORD Tyler Weir - Fish and Aquatic Habitat Branch, FLNRORD David Johner - Fish and Aquatic Habitat Branch, FLNRORD Rob Fox - Resource Management, FLNRORD
Report editing and review	Eva Schindler - Resource Management, FLNRORD Steve Arndt - Resource Management, FLNRORD Mike Hounjet - Columbia Basin Trust, Castlegar
Fertilizer schedule, loading	Marley Bassett - Resource Management, FLNRORD Eva Schindler - Resource Management, FLNRORD Ken Ashley - BC Institute of Technology Rivers Institute
Fertilizer supplier	Alan Jelfs - Agrium
Fertilizer application	Crescent Bay Construction - Crescent Bay Construction The Columbia Ferry - Waterbridge ferries
Physical limnology, water chemistry, phytoplankton, zooplankton and mysid sampling	Golder Associates Ltd. Staff - Golder Associates Ltd. Marley Bassett - Resource Management, FLNRORD Rob Fox - Resource Management, FLNRORD Dave Heagy BC Parks, ENV Tom Roos - BC Parks, ENV
Chemistry analysis	ALS Global staff - ALS Global
Chlorophyll analysis	ALS Global staff - ALS Global
Phytoplankton analysis	Advanced Eco-Solutions Inc.
Zooplankton and mysid analysis	Dr. Lidija Vidmanic, Limno-Lab Ltd., Vancouver
Kokanee acoustic surveys	Tyler Weir - Fish and Aquatic Habitat Branch, FLNRORD David Johner - Fish and Aquatic Habitat Branch, FLNRORD
Kokanee trawling	Golder Associates Ltd. Staff - Golder Associates Ltd. Tyler Weir - Fish and Aquatic Habitat Branch, FLNRORD David Johner - Fish and Aquatic Habitat Branch, FLNRORD
Kokanee aerial spawner surveys	Marley Bassett - Resource Management, FLNRORD Eva Schindler - Resource Management, FLNRORD Albert Chirico - Environmental Sustainability and Strategic Policy Division, ENV Mark Homis - Highland Helicopters Molly Teather – Resource Management, FLNRORD
Kokanee ground spawner surveys	Steve Arndt - Resource Management, FLNRORD Rob Fox - Resource Management, FLNRORD Tim Davis - Resource Management, FLNRORD Kristen Murphy - Resource Management, FLNRORD Kersti Vaino - Resource Management, FLNRORD Molly Teather - Resource Management, FLNRORD Aaron MacGregor - Resource Management, FLNRORD Julien Gullo- Resource Management, FLNRORD Karen Bray - BC Hydro Beth Manson - BC Hydro
Kokanee analysis and Reporting	Tyler Weir – Fish and Aquatic Habitat Branch, FLNRORD David Johner - Fish and Aquatic Habitat Branch, FLNRORD
Kokanee scale ageing	Morgan Davies - BC Provincial Aging Lab - FFSBC Carol Lidstone - Birkenhead Scale Analyses
Hill Creek Spawning Channel monitoring	Brian Barney – Kingfisher Silviculture Ltd. Steve Arndt – Resource Management FLNRORD
Regional support	Jeff Burrows - Resource Management, FLNRORD Matt Neufeld - Resource Management, FLNRORD