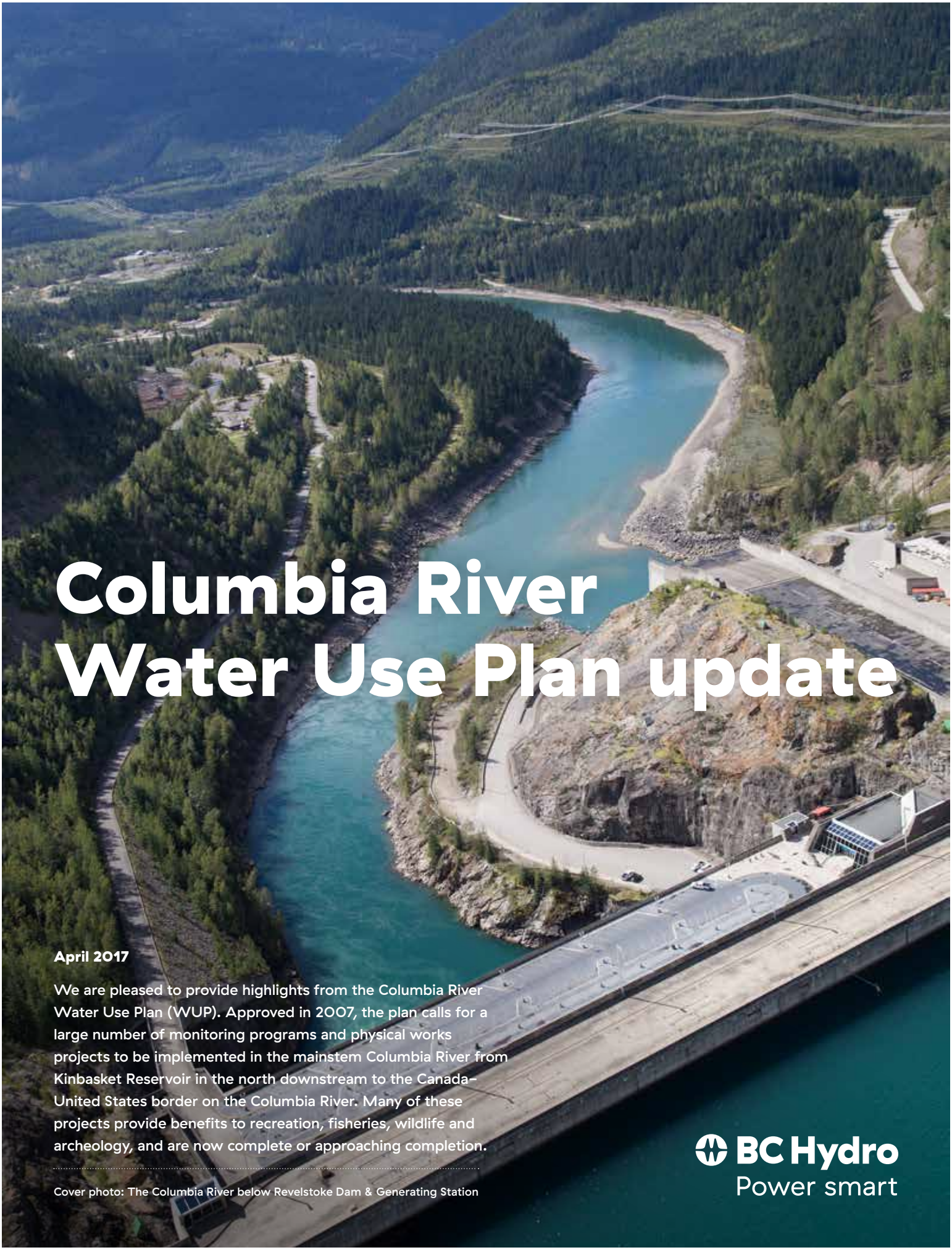


Columbia River Water Use Plan update

April 2017

We are pleased to provide highlights from the Columbia River Water Use Plan (WUP). Approved in 2007, the plan calls for a large number of monitoring programs and physical works projects to be implemented in the mainstem Columbia River from Kinbasket Reservoir in the north downstream to the Canada–United States border on the Columbia River. Many of these projects provide benefits to recreation, fisheries, wildlife and archeology, and are now complete or approaching completion.

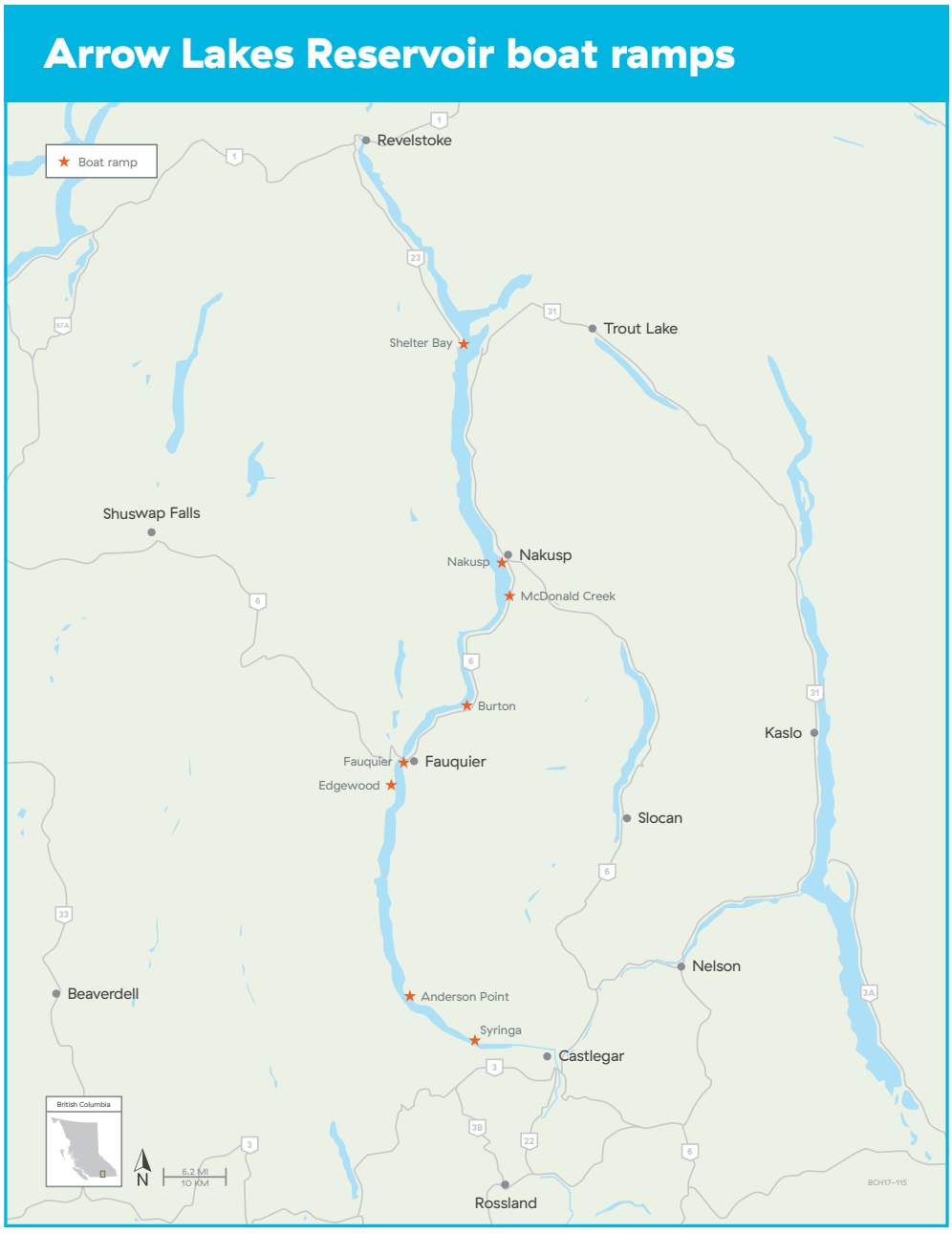
Cover photo: The Columbia River below Revelstoke Dam & Generating Station

BC Hydro
Power smart

Boat ramp use study

We are continuing to monitor use of all the upgraded boat ramps on Kinbasket and Arrow Lakes Reservoirs through the use of vehicle counters. Face-to-face surveys conducted from 2009 to 2013 indicated that user satisfaction has increased significantly with almost all boat ramp upgrades. Another round of face-to-face surveys is planned for the spring, summer and fall of 2017 at the Syringa, Shelter Bay and Nakusp ramps.

Left to right: Director Rick Smith, Regional District of Central Kootenay; Mayor Lawrence Chernoff, City of Castlegar; Matthew Tonner, Columbia Power Corporation and Chris Egan, BC Hydro celebrate the completion of the Anderson Point boat ramp.



BOAT RAMP IMPROVEMENTS

In 2016, we completed the final four Arrow Lakes Reservoir boat ramp improvement projects at Anderson Point, Edgewood, Nakusp and Shelter Bay. These four boat ramp projects are the last of eight to improve boater access to Arrow Lakes Reservoir during the recreation season. In previous years, we also upgraded the existing boat ramps at McDonald Creek, Fauquier and Syringa Creek Park, and built a new ramp at Burton. These new and refurbished ramps and site additions will provide area boaters with safe and improved access to Arrow Lakes Reservoir for many years to come.

Woody debris removal

We continue to remove floating woody debris from Kinbasket and Arrow Lakes Reservoirs and meet with the Debris Management Committees in Castlegar, Nakusp, Golden and Valemount to plan and prioritize work. Since 2007, we have completed close to $6.6 million of debris removal work on Kinbasket and Arrow Lakes Reservoirs and we estimate that we have removed over 425,000 cubic metres of woody debris from Kinbasket Reservoir and over 84,000 cubic metres from Arrow Lakes Reservoir.

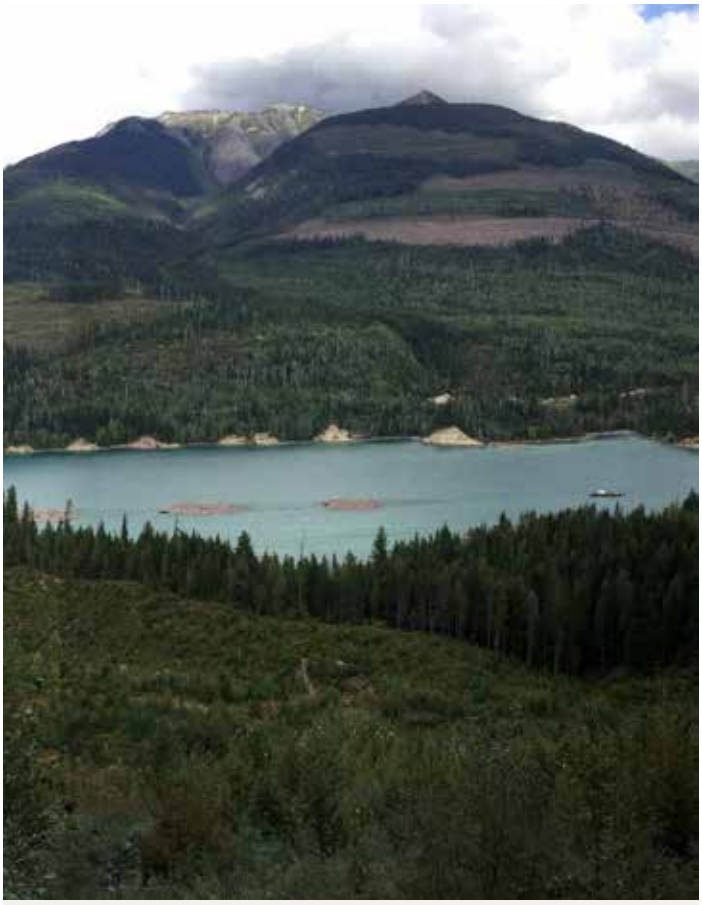
In 2016, 4,200 cubic metres of woody debris was removed from Arrow Lakes Reservoir. We focused our efforts around Edgewood, Eagle Bay, Beaton Arm and around Shelter Bay. On Kinbasket, we piled and burned 25,240 cubic metres of debris and collected an additional 24,000 cubic metres of woody debris which is being stored in the reservoir and will be burned this spring.

This year's work on Arrow Lakes Reservoir will focus on the areas near Edgewood and Burton. Crews mobilized in March to reduce any fire risk and potential risk to wildlife.

On Kinbasket Reservoir, we will focus on removing the debris collected in 2016. This debris is currently stored at Bush Harbour and in the Canoe Reach south of Valemount. Crews will mobilize this spring and will focus on high priority areas identified for the entire reservoir by the Golden and Valemount Debris Management Committees. If reservoir levels reach close to full pool elevation this year, we will continue with a water based collection program and will focus on the northern part of the reservoir where debris accumulations and densities are highest.

Our Reservoir Archaeology Program (RAP) has identified a number of new sites in the upper Kinbasket Reservoir that may affect how we remove woody debris from these sites in the future.

The Bush Harbour storage pen. The debris shown represents 75% of the debris collected in 2016.



Debris on Kinbasket Reservoir is moved to a storage pen.

In 2016, the Kinbasket Reservoir Debris Management Program collaborated with the Reservoir Archaeology Program (RAP) in the Kinbasket Reservoir. The RAP is an archaeological inventory program in Kinbasket Reservoir and a number of Columbia Reservoirs to identify and record archaeological sites within the active erosion zone. The surveys are carried out on an annual basis, and working with the debris program provided a number of efficiencies including a longer field assessment which covered a much larger area. The additional work focused on assessing historical debris management locations for previously unrecorded archaeological material. The goal of the cooperation was to ensure that ground disturbance as a result of debris management work is managed in a way that is consistent with our best management practices for heritage and archaeological resources, even though many of the locations have been used repeatedly in the past. The additional inventory data collected further supports the RAP to better understand settlement patterns and prehistoric land use in the region. The collaboration will continue in the Canoe Reach of Kinbasket Reservoir in 2017, and is anticipated to be trialed in Arrow Reservoir in the spring of 2017.

Cottonwood live stakes at Bush Causeway, eight months after planting. This area was completely covered with woody debris, which prevented the natural establishment of vegetation in the drawdown zone. Photo: LGL Environmental Resources

Revegetation

We are currently evaluating options to potentially construct more physical works in the Kinbasket Reservoir drawdown zone this year. We will continue looking for synergies between the Kinbasket Debris Management Program and the physical works program. We are still waiting for full pool reservoir conditions, which did not occur in 2016, to test the debris mounds that were built in fall 2015 for their resiliency to reservoir water and wave action.

The wood debris cleared from parts of the drawdown zone and used to build the mounds has caused a rebound in the vegetation and some wildlife species in those sites. For instance, Western Toad eggs were found in wetlands in summer 2016 which had been cleared of wood in fall 2015 where previously, large amounts of wood debris had been deposited. Water plantain (an aquatic plant), which has not been previously documented in wetlands in the drawdown zone of Kinbasket Reservoir, was observed in one of the three wetlands cleared of wood debris.

The mounds planted with willow and cottonwood live stakes in 2015 were evaluated in the spring, summer and fall of 2016 for survival. Live stakes planted in fall 2015 survived much better than those planted in the spring of 2016. Approximately 93% of the stakes planted in the fall of 2015 survived, versus a 20% survival rate for those planted in the spring of 2016. Overall, approximately 71% of the live stakes planted were surviving up to one year following planting. Sedges were also transplanted into the newly cleared wetlands, and all of these sedge transplants survived.

Weather conditions were likely an important factor in the differences in survival rates of the live stakes planted in the fall of 2015 compared to those planted in the spring of 2016. The fall of 2015 was milder and wetter than normal, which encouraged root growth in unfrozen soil. The live stakes that were harvested and planted in the spring of 2016 developed leaves early. This was likely due to warmer than normal weather which could have caused moisture stress to the stakes and lowered the likelihood of their survival.

To protect wetland habitats and wood debris mounds at the Bush Arm Causeway North site, a 312 metre long log boom was installed in June 2016. The log boom should function to ensure wood debris doesn't deposit on the recently cleared wetlands and degrade the integrity of the mounds.

White sturgeon

The Canadian portion of the Upper Columbia River white sturgeon population was listed as endangered under the Species at Risk Act (SARA) in 2006. This was the result of recruitment failure, where an insufficient number of young survive to become mature adults. We are working in cooperation with First Nations, stakeholders, and federal and provincial government partners to help restore the Upper Columbia River white sturgeon populations through long–term monitoring programs developed under the Water Use Plan.

We are conducting several studies to better understand white sturgeon spawning and how conditions at identified spawning locations influence when spawning occurs and the rate of egg development. Results have shown that sturgeon spawn from June through August at multiple locations throughout the Columbia River including downstream of Revelstoke Dam, near Kinnaird downstream of the Hugh L. Keenleyside Dam and the Arrow Lakes Generating Station, downstream of Waneta Dam, and in the United States.

A white sturgeon conservation aquaculture program that has released hatchery–raised sturgeon into the Columbia River each year since 2002 has been very successful. Monitoring since the releases began shows that more of the young fish survive than originally expected and we estimate that there are now over 30,000 hatchery–origin white sturgeon in the Columbia River between the Hugh L. Keenleyside Dam in Castlegar and Lake Roosevelt in the U.S. Given this success, the approach of the aquaculture program has shifted and now focuses on collecting eggs and larvae from the wild for rearing in a hatchery. After being collected in the river, wild eggs and larvae are initially reared in a streamside trailer near the Waneta spawning location to ensure they incubate in natural river conditions. They are then transferred to the hatchery and reared until nine months of age. This approach is critical while wild adult sturgeon are still reproducing naturally in the river to ensure the released sturgeon are as genetically diverse as possible.

We are continuing stock assessments that estimate the number of wild white sturgeon remaining in the Columbia River between the Hugh L. Keenleyside and Grand Coulee Dams. This information, along with juvenile survival numbers, is being used to help plan white sturgeon recovery efforts.

Finally, we are evaluating the suitability of available spawning habitat and the feasibility of spawning habitat restoration, if deemed necessary, to help stimulate recruitment.

A juvenile white sturgeon being released into the Columbia River. Photo: Chad Fritz, Cranbrook, BC.

Lower Columbia fish studies

In accordance with the Lower Columbia River Fish Stranding Protocol approved by regulatory agencies and First Nations at COFAC (Columbia Operations Fish Advisory Council), we assess the risk of stranding fish prior to each river reduction event based on previous stranding data collected in the Fish Stranding Database. The database query yields a list of potential effect sites (where more than 200 fish were stranded during a flow reduction under similar conditions) and a list of reconnaissance sites (where we have limited to no information on the site under the proposed conditions or where changes have occurred to the river morphology) which forms our recommendations to the stranding crew who respond to significant flow reductions. From June 8, 2016 to February 28, 2017, BC Hydro sent out stranding crews to 14 flow reduction events on the Lower Columbia River, including both effect sites and reconnaissance sites.

Revelstoke Dam minimum flow

We are continuing a suite of aquatic studies under the Revelstoke Flow Management Plan in the mid-Columbia River to determine whether minimum flows at Revelstoke Dam provide expected fisheries benefits. The studies monitor variables ranging from nutrients, temperature and water level monitoring to productivity at the lowest level of the reservoir and fish communities. We began operating Revelstoke Dam to provide a minimum flow of 142 cubic metres per second (cms) in December 2010, at the same time the fifth unit came into operation. Discharge flows over the last four years have varied throughout the day and have always been maintained above the minimum flow and typically well above it to prevent any damage to the turbines that can be caused by cavitation. The data collected so far has not shown any effect by the new discharge regime on fish distribution, growth or diversity and preliminary results indicate that climate change might be one of the main influences of these aspects of fish community.

Revelstoke Dam & Generating Station.

Understanding effects of reservoir operations

A key component of the Columbia River Water Use Plan is to better understand how our Arrow Lakes Reservoir and Kinbasket Reservoir operations affect fish, wildlife, vegetation, recreation and archaeology to aid future decision making. Although a number of studies are now complete, the following studies are still underway.

RESERVOIR PRODUCTIVITY

We are continuing with programs in 2017 that investigate links between biological reservoir productivity and the operation of Kinbasket and Revelstoke Reservoirs. These programs are focusing on learning how the aquatic food webs work and whether we could make changes to reservoir operations to improve biological production.

The food webs start with how nutrients, such as phosphorus and nitrogen, are made available to phytoplankton (algae) and then up the food chain to zooplankton and kokanee. Field sampling for water and plankton is conducted from April to October and kokanee populations are assessed in late summer and fall.

Dr. Roger Pieters from UBC Earth and Ocean Sciences preparing a mooring for deployment on Kinbasket Reservoir.

Moored temperature monitoring stations were installed in the reservoirs in 2012 to provide more continuous data on how water, and thus nutrients, moves through the system. The results to date suggest a more dynamic pattern of movement through Revelstoke Reservoir than previously thought. Preliminary results depict internal waves that may allow nutrients, once thought to bypass the upper layers, to be available for phytoplankton.

While low in productivity, both Kinbasket and Revelstoke Reservoirs support short, efficient food chains that can result in relatively good kokanee populations. Total kokanee numbers can vary widely by year as they are dominated by fry (up to 86%). Numbers for all other ages (one to three years) in Kinbasket Reservoir have remained relatively consistent over the years, averaging about 1.75 million. Abundance is lower in the smaller Revelstoke Reservoir and commonly more variable. In recent years, kokanee abundance has been lower than the long-term averages, particularly in Revelstoke Reservoir where there has been an increase in the size of fish, an expected response for kokanee. These studies are continuing to investigate influences on kokanee growth and survival in these reservoirs.

BIRD MIGRATION

There are two studies entering their final year of field work which are examining how reservoir operations affect stop-over habitat for birds during the spring and fall migrations. Since 2008, there has been close to year-round monitoring of the abundance and distribution of waterbirds in the wetlands of Revelstoke Reach of Arrow Lakes Reservoir. These wetlands provide a variety of habitats for waterbirds throughout the year. Cartier Bay is the most important wetland for dabbling ducks, but they avoid this wetland in the fall if it is inundated by the reservoir. Airport Marsh provides a high diversity of shallow and deeper pond habitat for a larger diversity of migrating waterbirds and is very rarely impacted by spring or fall reservoir levels. At some reservoir levels, terrestrial grassland habitats are selected by waterfowl during migration when these grasslands become covered with a shallow layer of water. The shorelines of Arrow Lakes provide ephemeral foraging habitat for many different shorebird species during migration. However overall shorebird use of the reservoir is low, and even when suitable habitat is available they are uncommon.

Yellow-headed Blackbird fledgling.

The abundance of and habitat use by migrant songbirds in spring and fall has been monitored annually through field surveying and songbird banding. The largest numbers of songbirds are detected in the shrubs and trees found at higher elevations within the Arrow Lakes Reservoir drawdown zone. Songbird banding takes place at three sites composed of different habitat types, two within the drawdown zone and one outside of it. Results suggest that the reservoir levels do affect abundance and habitat use for certain species, such as the Common Yellowthroat, at sites within the drawdown zone. A more detailed analysis will be conducted when these projects wrap up next year.

Pied-billed Grebe nestling, shortly after hatching and just prior to departure from the nest.

NESTING BIRDS

Since 2008, we have been examining the patterns of habitat use by nesting birds in Kinbasket and Arrow Lakes Reservoir drawdown zones to understand the impact of reservoir operations on bird nests and the significance of nest flooding to bird populations. The drawdown zones of Kinbasket and Arrow Lakes Reservoirs provide important nesting habitat for as many as 65 bird species, including four new species added in 2016 [Blue-winged Teal (*Anas discors*), Northern Shoveler (*Anasclypeata*), Yellow-rumped Warbler (*Setophaga coronata*), and Tennessee Warbler (*Leiothlypis peregrina*)]. Airport Marsh has been identified as a particularly important nesting site for marsh birds and the tall grass habitat found at lower elevations provides nesting habitat for waterfowl. Songbirds within the drawdown zone primarily nest in the trees and shrubs at higher elevations.

Most bird nests are at risk from predators, including snakes, mammals, and other birds; however, birds nesting in reservoir drawdown zones (below the high water mark) also face the risk of flooding. Ground-nesting birds are particularly at risk and the risk continues even after fledging for species such as Savannah Sparrow, whose juveniles run on the ground rather than fly when they first leave their nests. To examine the impact of reservoir operations on the survival of juvenile songbirds, we have been using radio-telemetry to track juvenile songbirds immediately after fledging. Results for Savannah Sparrow so far suggest that predators are a greater danger to the young birds than flooding.

Reservoir operations may have other impacts on nesting birds besides flooding. Since 2009, there has been a trend showing lower productivity for Osprey in Revelstoke Reach in years of higher water levels. It is possible that while reservoirs may expand the area of foraging habitat for Osprey, their ability to capture fish to feed their young may be decreased. However, in 2016, the lower water levels did not result in the expected increase in productivity. Other factors, such as precipitation, will be examined to determine what has the greatest influence on productivity.

Willow Flycatcher nestlings.

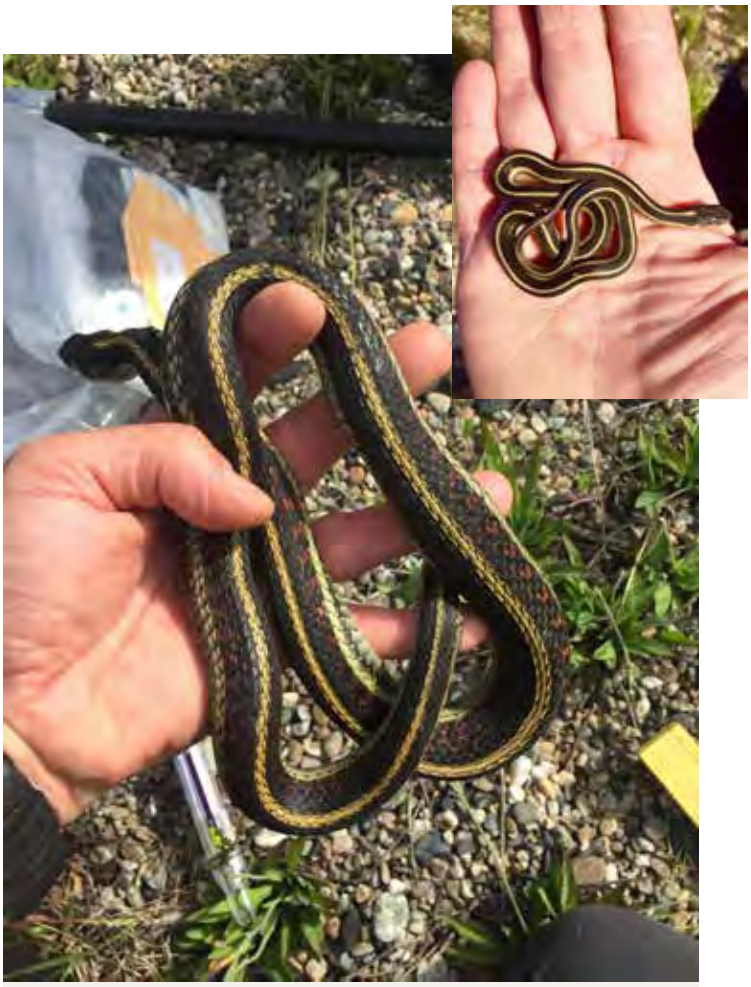
Devon Anderson conducting a land-based shorebird survey.

AMPHIBIANS AND REPTILES

This year marked the sixth year of the monitoring study on Arrow Lakes and Kinbasket Reservoirs, which is part of a larger 10–year amphibian and reptile life history and habitat use monitoring study in the drawdown zones of Kinbasket and Arrow Lakes Reservoirs. Although 2016 was the final year for this study, an ongoing study will continue to be implemented this year that will monitor the potential impact of Mica Units 5 and 6 on amphibian and reptile populations in Kinbasket Reservoir.

2016 was a slightly different year for operations on Arrow Lakes Reservoir with reservoir levels reaching an early peak in June and a subsequent decrease, which led to increased available amphibian habitat in the late summer and fall as compared to 2012 and 2014. Although more habitat was available later in the season, it does not necessarily benefit amphibians as the crucial period for successful breeding is in June when reservoir levels were high and the breeding habitat was inundated. The continued presence of amphibians and reptiles of all life stages in the drawdown zone in consecutive years suggests that these species are not adversely affected by reservoir operations.

A young Western Skink near Edgewood on Arrow Lakes Reservoir. Photo: LGL Environmental Resources



Top right: Juvenile female garter snake near Edgewood on Arrow Lakes Reservoir. Above: Adult female common garter snake near Airport Marsh on Arrow Lakes Reservoir. Photo: LGL Environmental Resources

In 2016, through a variety of survey methods including egg mass surveys, visual encounter surveys, auditory surveys and radiotelemetry, we documented the presence of four species of amphibian and five species of reptile in the drawdown zones of Kinbasket and Arrow Lakes Reservoirs. In Kinbasket Reservoir, Western Toad and Columbia Spotted Frog were the most commonly encountered species.

Western Toad tadpoles on Kinbasket Photo: LGL Environmental Resources

Kinbasket Reservoir fish and wildlife information plan

The Columbia WUP Consultative Committee recognized that there was a lack of data on several species' relative abundance, distribution, life history and seasonal patterns of habitat use in Kinbasket Reservoir. This information plan includes studies to better understand reservoir ecology and the influence of current operations on fish and reservoir productivity, fish stranding, and the Valemount peatland.

BURBOT MONITORING PROGRAM

This study uses biotelemetry to determine biological characteristics, movement and depth preferences of Burbot during their spawning period in late winter and early spring in the Kinbasket Reservoir. Burbot are surgically implanted with small tags that transmit location, depth and temperature, and these fish are tracked year–round from fixed receivers near suspected spawning areas. Although many fish move from deep to shallow water (from more than 50 metres to less than 16 metres) during spawning season, the results to date show no clear movement patterns towards specific spawning sites.

BULL TROUT MONITORING PROGRAM

This study aims to assess whether reservoir level fluctuations affect juvenile bull trout movements from their natal streams to the Kinbasket Reservoir, as well as the habitat use of these fish in the drawdown zone. Juvenile fish are tagged and their movements to and from streams are recorded from buried antennae at the entrance of creeks. Fish are also sampled along the shoreline during summer. Preliminary data indicates that juvenile fish tend to migrate out of streams in the fall and rarely use the drawdown zone, presumably because this habitat is not optimal for them.

RAINBOW TROUT MONITORING PROGRAM

This study primarily aims to assess whether Kinbasket Reservoir operations affect Rainbow Trout access to their spawning streams during spring time and the quality of rearing habitat. Fish are tagged and tracked through fixed receivers set throughout the reservoir. Creeks are also surveyed for the presence of juveniles. Results about effects of operations are inconclusive to date, primarily because of the small sample size. Of note is that several tagged fish migrated to the southern end of the reservoir (Columbia Reach) during spawning season.

A Burbot in a net.

VALEMOUNT PEATLAND

This study's main objectives are to assess whether erosion is increasing or decreasing in the Valemount peatland and the primary causes of any observed erosion. A preliminary study conducted in 2008 concluded that erosion processes were directly related to Kinbasket Reservoir operations, although it would take 2,000 years to erode the entire site at the observed rates. The current study will use the most recent results from aerial and field surveys to update the erosion rates, processes and their main causes, and make recommendations for potential mitigative measures.

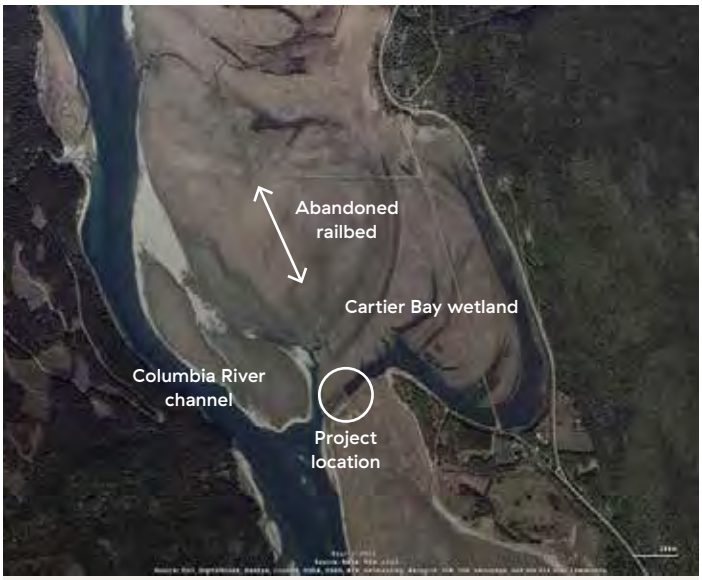
Valemount peatland.

Wildlife enhancement projects

CARTIER BAY

In October 2016, we completed a project to protect the Cartier Bay wetland south of Revelstoke. The wetland is created by a collapsed box culvert in an abandoned railbed within the Arrow Lakes Reservoir drawdown zone that holds water back in Cartier Bay at low reservoir levels. The box culvert was eroding and if it had failed, the entire wetland would have drained. Monitoring programs have shown that Cartier Bay provides valuable habitat for migratory waterfowl and other wetland species. The project installed rock rip–rap to reinforce the culvert and protect the wetland.

The map shown below, taken at low Arrow Lakes Reservoir levels, helps to illustrate the wetland. Except for the water held back in Cartier Bay wetland by the collapsed culvert, the water in the reservoir is confined to the original Columbia River channel. The exposed land was farmland that was flooded when the reservoir was created so you can see the old roads and the old rail line.



Cartier Bay project location.

Cartier Bay project location after work was completed.

Heavy equipment places rock rip–rap to reinforce the collapsed culvert.

MID TO LOWER ARROW LAKES RESERVOIR

BC Hydro is planning to construct a wildlife enhancement project in the drawdown zone of the mid to lower Arrow Lakes Reservoir. This project is expected to benefit nesting and migratory birds as well as other wildlife affected by reservoir operations.

There are two sites currently being considered for the wildlife enhancement project: Burton Flats and Lower Inonoaklin. Burton Creek is located south of Nakusp, on the east side of Arrow Lakes Reservoir. The Lower Inonoaklin site is located south of the Fauquier ferry on the west side of Arrow Lakes Reservoir.

Once the designs for these sites are available, we will share them with local government, stakeholders and the public. If all goes as planned, we expect to be ready to construct in the spring of 2018. The actual start of construction will require suitable conditions in terms of water levels, ground conditions, etc.

Arrow Lakes Reservoir soft constraints performance 2016

Soft constraint	Target	2016 performance
Recreation	Reservoir water levels between 437.3 metres (1,435 feet) and 438.9 metres (1,440 feet) from May 24 to September 30. Flexibility to achieve lower reservoir levels of 434 metres (1,424 feet) during the recreation season would be acceptable with proposed construction/upgrade of boat ramps for recreation interests served by these formal access points.	The reservoir was within the lower target range [>434 metres (1,424 feet)] 45% of the time between May 24 and September 30.
Wildlife	Ensure inundation of nesting bird habitat by rising reservoir levels and availability of fall migratory bird habitat is no worse than recent average (1984–1999). Target a reservoir level of 438.3 metres (1,438 feet) or lower by August 7.	Arrow Lakes Reservoir was below 434 metres (1,424 feet) for about 22% of the time between April 30 and July 16, providing better than average habitat for nesting birds. The reservoir was below 438.3 metres (1,438 feet) for 100% of the time between August 7 and October 31 for fall migratory birds.
Fish	Reservoir levels above 434 metres (1,424 feet) to ensure tributary access during kokanee spawning period from late August to early November.	Reservoir was not above 434 metres (1,424 feet) between August 25 and November 15.
Vegetation	Maintain current (2004) level of vegetation in the drawdown zone by maintaining lower reservoir water levels during the growing season.	Reservoir was below 434 metres (1,424 feet) for 64% of the time between May 1 and July 31. These conditions provided better than average levels for all parts of the drawdown zone in respects to vegetation.
Erosion	Minimize duration of full pool events and avoid sudden drawdown once full pool has been reached to avoid shoreline slumping. Reservoir water level of 438.9 metres (1,440 feet) is ideal.	The reservoir reached a peak level of about 437.2 metres (1,434.5 feet) on June 10. Due to a second consecutive dry summer, the Columbia system was operated in proportional draft starting in June. For this reason, the reservoir drafted quickly to about 430.9 metres (1,414 feet) on August 31 and 427.9 metres (1,404 feet) on September 30.
Culture and Heritage	The original WUP target is 'reservoir levels at or below 435.8 metres (1,430 feet) for as long as possible to limit impacts to archaeological sites'. However during the five-year interim review of the Arrow soft constraints, this target was determined not to be effective due to the presence of 102 archaeological sites at elevations below 435.8 metres (1,430 feet). As a result, BC Hydro will no longer report on the original culture and heritage target.	BC Hydro is implementing a multiyear Reservoir Archaeology Program (RAP) in the Upper and Lower Arrow Lakes to inventory heritage sites and identify impacts as a result of normal reservoir operations. Information gathered by the RAP is expected to assist future decision makers and development of an Archaeological Management Plan.

HOW TO GET MORE INFORMATION

Copies of the Columbia River Water Use Plan, study terms of reference, reports, performance measures, Columbia River WUP Consultative Committee report, and other water use planning information are available at **www.bchydro.com/about/sustainability/conservation/water_use_planning/southern_interior/columbia_river.html**.

Contact a BC Hydro community relations representative

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