Columbia River Treaty Socio-Economic Performance Measures: Kootenay River System

Draft Measures for Public Input – January 2023

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INTRODUCTION AND PROJECT OVERVIEW

The Columbia Basin is host to several dams and reservoirs, including four that were constructed as a result of the Columbia River Treaty (CRT)—a water management agreement between Canada and the United States that regulates Columbia River flows for flood control and power generation. These are:

- On the mainstem of the Columbia River:
  - Kinbasket Reservoir - created by Mica Dam south of Valemount;
  - Arrow Lakes Reservoir - created by Hugh L. Keenleyside Dam near Castlegar; and
- On the Kootenay River system:
  - Duncan Reservoir – created by Duncan Dam north of Kaslo; and
  - Koocanusa Reservoir - created by Libby Dam in Montana south of Cranbrook.

Canadian and US governments are currently in negotiations to modernize the treaty, which was ratified in 1964.

This CRT Socio-Economic Integration initiative—funded by the Province of BC and spearheaded by the Columbia River Treaty Local Governments Committee—supports inclusion of socio-economic interests in the ongoing CRT negotiations. Socio-economic interests that are affected by reservoir levels and river flows, such as flood risk management, navigation, recreation, tourism, health and others are very important to communities. Performance measures describing the required and preferred reservoir elevations and flow levels for these interests are being defined. These measures will be used to evaluate alternative hydro operations scenarios to inform the ongoing CRT negotiations and implementation of the modernized treaty. Other groups are working on performance measures for ecosystem function (learn more here), Indigenous cultural values and power generation.

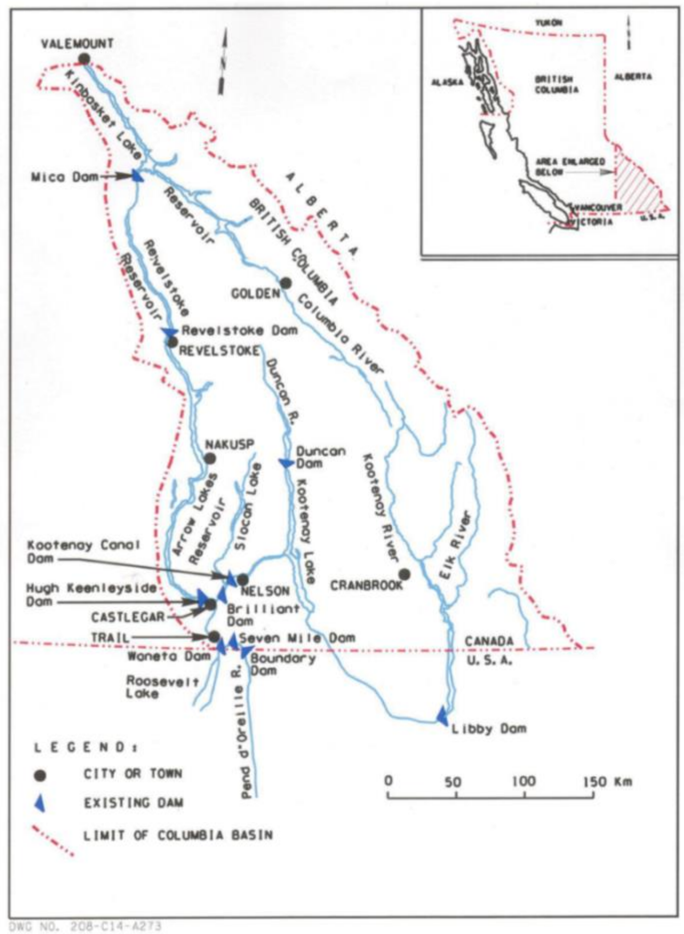


Figure 1: Canadian Columbia Basin with major rivers and dams

For more detailed information on the Columbia River Treaty, see the Province of BC's website.

For more detailed information on the socio-economic performance measures project see the CRT Local Governments Committee's website.

SUMMARY PURPOSE AND OUTLINE

The purpose of this Summary and the related webinar is to provide the public with an overview of the performance measure research and development work, to share the draft performance measures, and to invite feedback. Summaries have been split into two sub-regions: the Columbia System (including the Mica and Hugh Keenleyside Dams, and their associated reservoirs and the Lower Columbia River and) and the Kootenay System (including Koocanusa Reservoir, Kootenay Lake, and Duncan Dam/Reservoir).

This document is focused on performance measures for the Kootenay River System.

You can access the Summary for the Columbia River system here.

The following sections are included in this document:

- The Overview of the Kootenay System section provides basic details about each major segment of the system.
- The Performance Measures section lists the currently recommended performance measures and links to documents that contain detailed information. It also includes an overview of how performance measures were developed.
- Appendix 1: Kootenay System Operations includes additional details on each system segment and provides an overview of the major factors determining how each is operated.

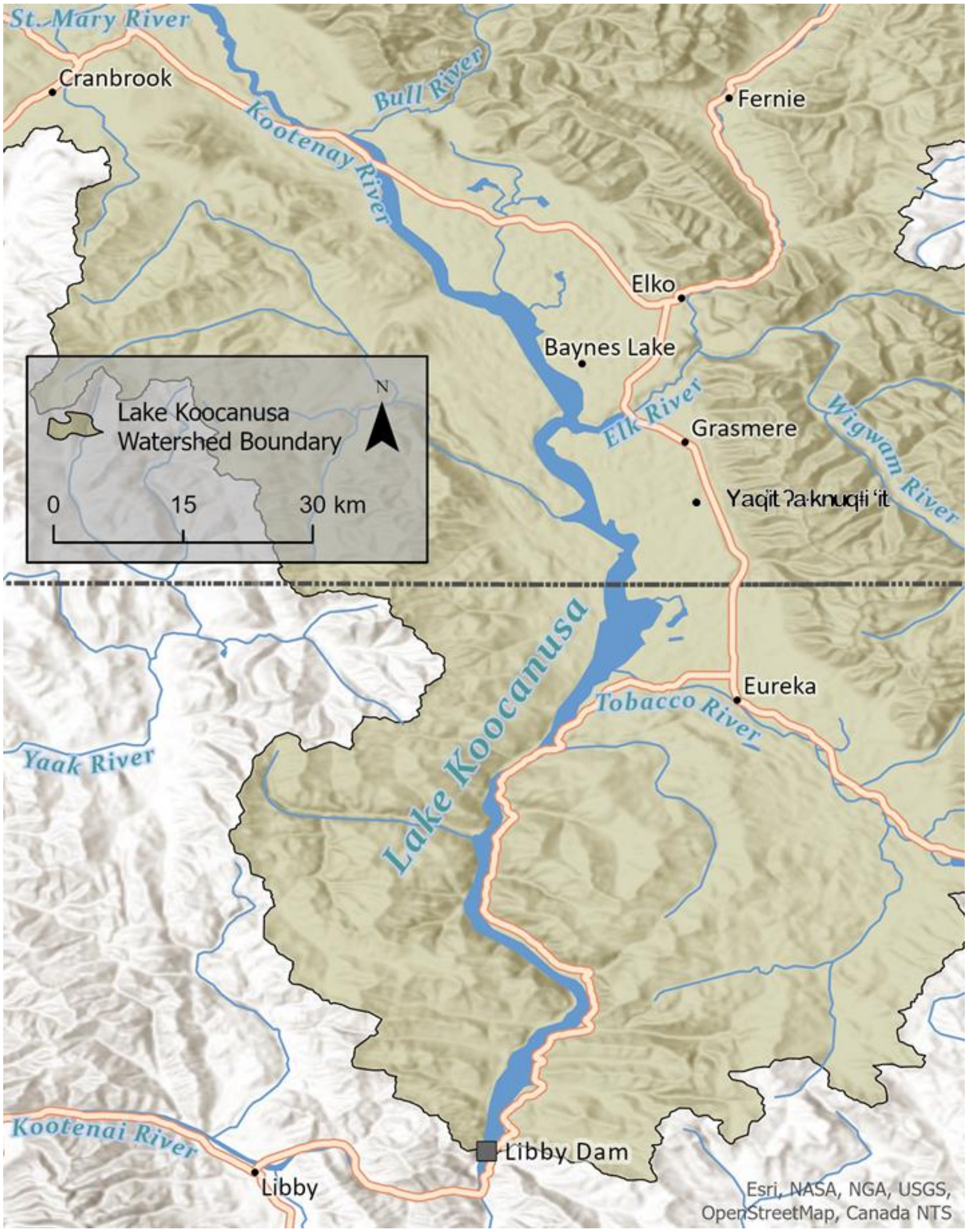
OVERVIEW OF THE KOOTENAY SYSTEM

Below, major segments of the Columbia River system are described, including the location, storage, and inflows for each. For a detailed description of Kootenay System hydroelectric operations, see Appendix 1.

Koocanusa Reservoir

Koocanusa Reservoir is created by Libby dam located 72 km south of the Canada-US border. The main tributaries to the reservoir are the mainstem of the Kootenay River and the Elk River. The map on the following page shows the geography of the reservoir, including major communities and tributaries.

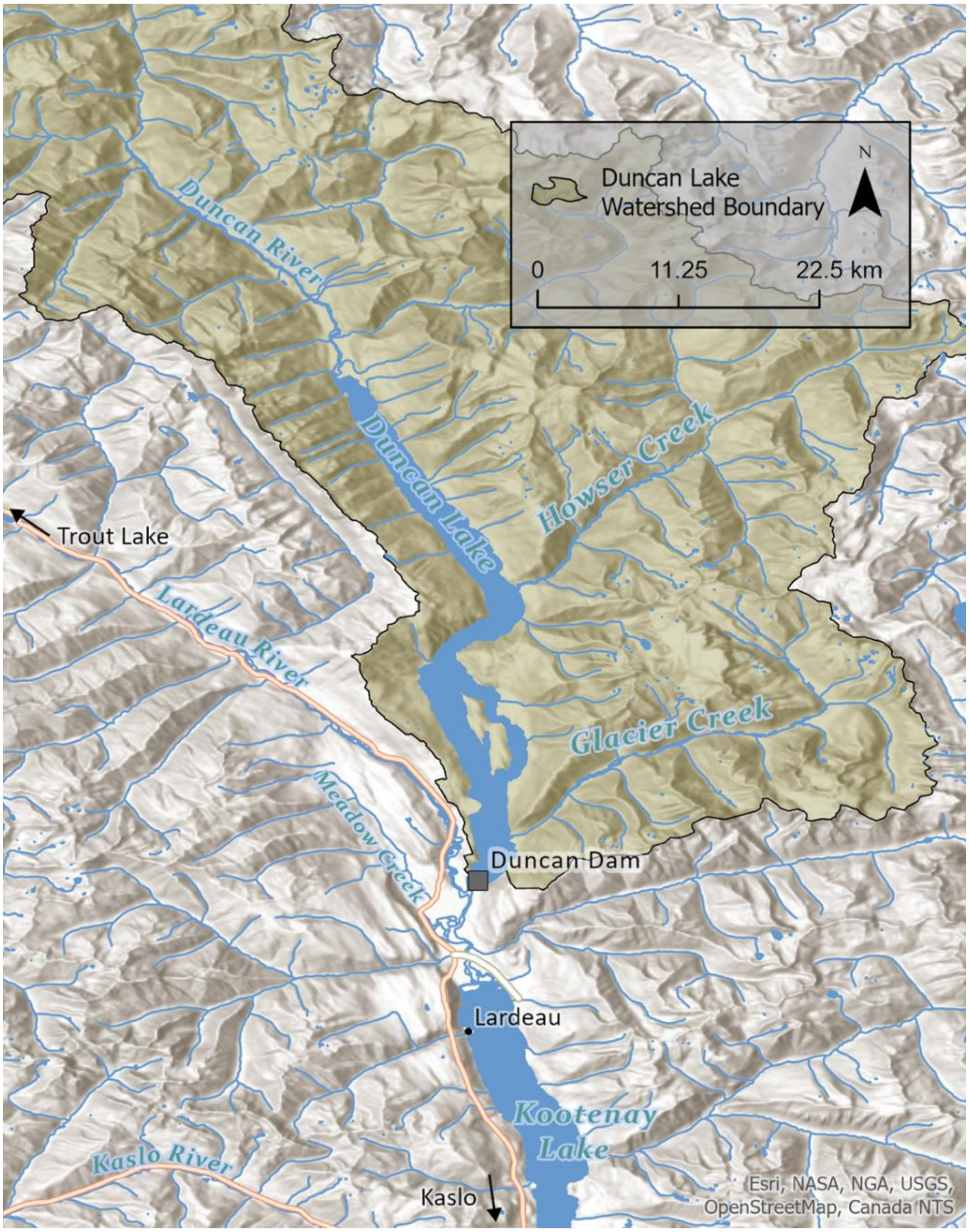
Under the terms of the Columbia River Treaty, Canada permitted the U.S. to build the Libby Dam on the Kootenai River (U.S. spelling) in Montana. The dam was completed in 1973 and the reservoir, flooding approximately 70 kilometres into Canada, filled for the first time in 1974. Libby Dam is capable of generating 600 MW of hydro-electricity. The reservoir was named Koocanusa for Kootenay, Canada and the U.S.A. It has 5 million acre feet (MAF) of storage.



Duncan Reservoir

Duncan Reservoir is created by the Duncan dam located 11 km upstream from the north end of Kootenay Lake, 42 km north of Kaslo and 85 km north of Nelson. This reservoir is the smallest Columbia River Treaty storage reservoir, being 45 km long and providing 1.4 million acre feet of storage.

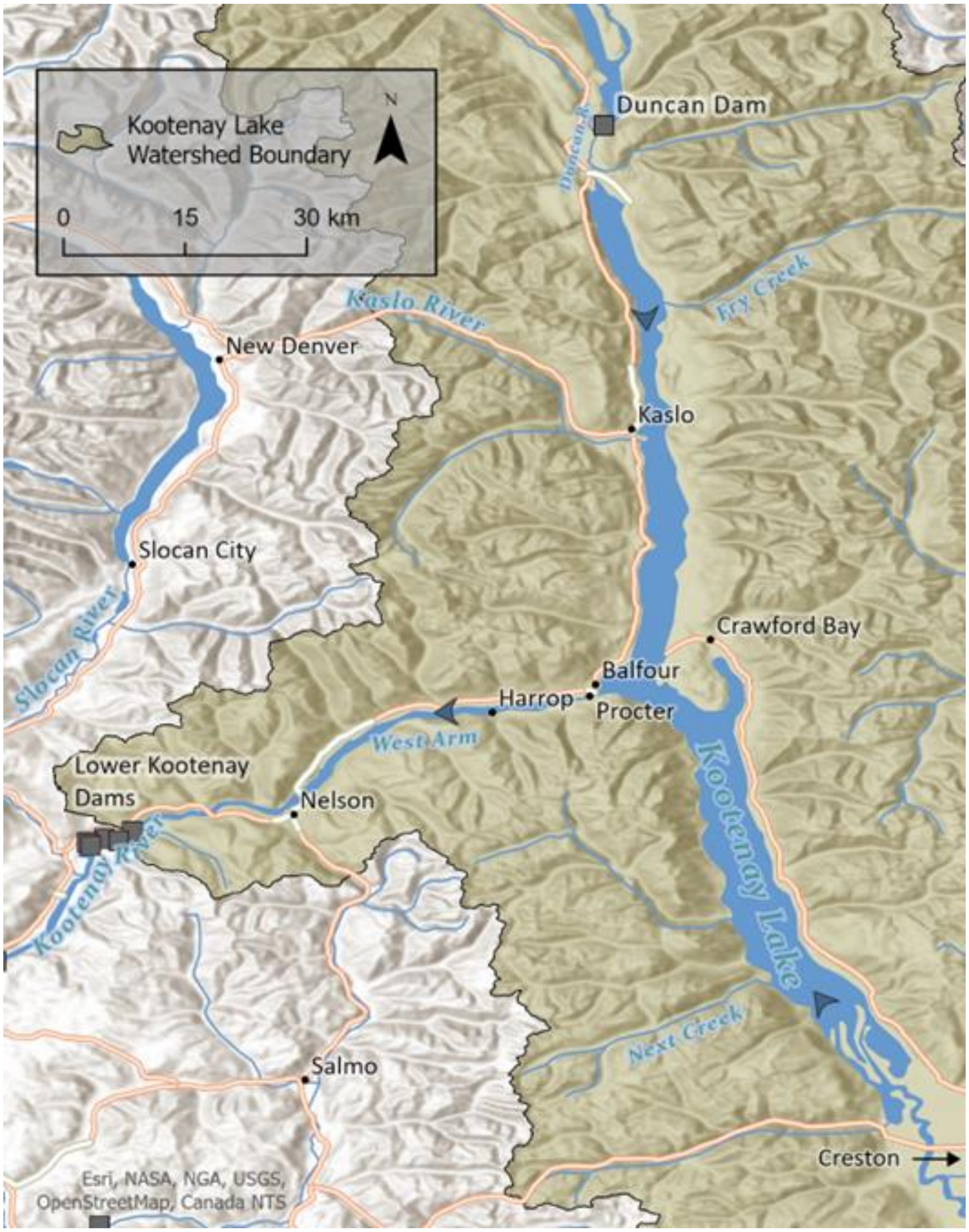
The map below shows the location of the reservoir and the dam. Flows from Duncan Dam affect Kootenay Lake levels; flows and power generation through the Kootenay River from the outlet of the West Arm of Kootenay Lake to its confluence with the Columbia River; and river levels in the free-flowing portion of the Columbia River to the Canada-U.S. border. The main tributaries to the reservoir are the Duncan River, Howser Creek and Glacier Creek. All of the inflows into this reservoir are natural as there are no dams upstream. The Lardeau River joins the Duncan River immediately downstream of the Duncan Dam, with the Duncan River then flowing into the north end of Kootenay Lake.



Kootenay Lake

Kootenay Lake is located on the Kootenay River, downstream of Libby dam, which flows into the south end of the lake at Creston. Duncan dam flows into the north end of the lake. The lake is upstream of the BC Hydro, Fortis, Columbia Power Corporation and City of Nelson dams located between the outlet of the Kootenay River through the West Arm and its confluence with the Columbia River near

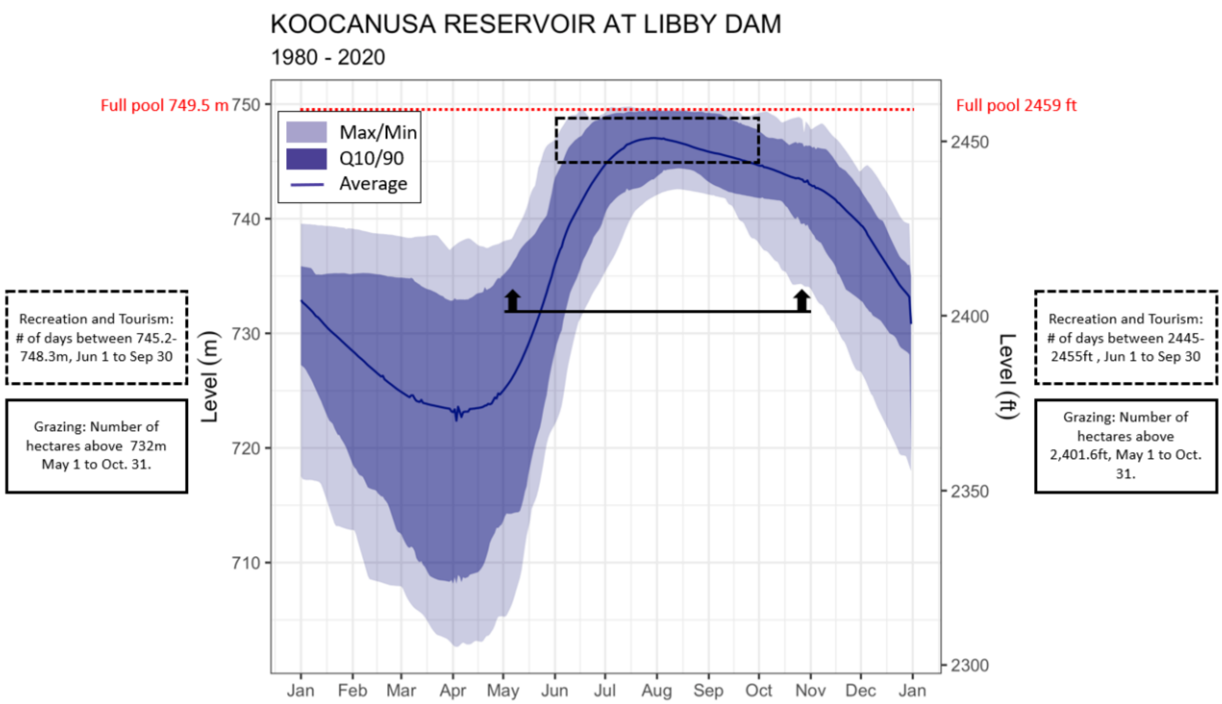
Castlegar. The map below shows Kootenay Lake in more detail, including tributaries, major communities, and dams. The lake is 104 kilometres long and has several communities, including Nelson and Kaslo, and settlement areas along its length, with the greatest concentration along the West Arm.



PERFORMANCE MEASURES

Koocanusa Reservoir

The figure below illustrates the historical range and average levels of Koocanusa reservoir from 1980, six years after the Libby dam was built, to 2020, the latest date that these data are available. The recommended performance measures for this reservoir are overlaid on the reservoir elevations, with further information on each performance measure provided below.



Note: Max/Min is the maximum and minimum levels over the period included in the graph. Q90/10 is the 90th and 10th percentile of levels over the period included in the graph – the 90th percentile is the highest 10% of reservoir levels and the 10th percentile is the lowest 10%.

Grazing

Goal: Maximize the grazing opportunities within the Koocanusa reservoir drawdown zone.

Recommended Performance Measure:

Objective / Location	Performance Measure	Description
Grazing access/ Koocanusa	Hectares of accessible range	Number of hectares above 2,401.6 ft (732 m) May 1 to Oct. 31 per year. More is better.

For more information about the Koocanusa grazing performance measure, view the full info sheet here. Please note that the research team continues to work with local grazing interests to refine this PM.

Recreation and Tourism

Goal: Maximize the community benefits from quality and diversity of recreation and tourism.

Recommended Performance Measure:

Objective / Location	Performance Measure	Description
Recreation/ Koocanusa Reservoir	General Recreation	Total number of days per year that the reservoir water level is within the preferred range (2445-2455 ft/ 745.2-748.3 m) during the recreation season (1 Jun to 30 Sep). More is better.

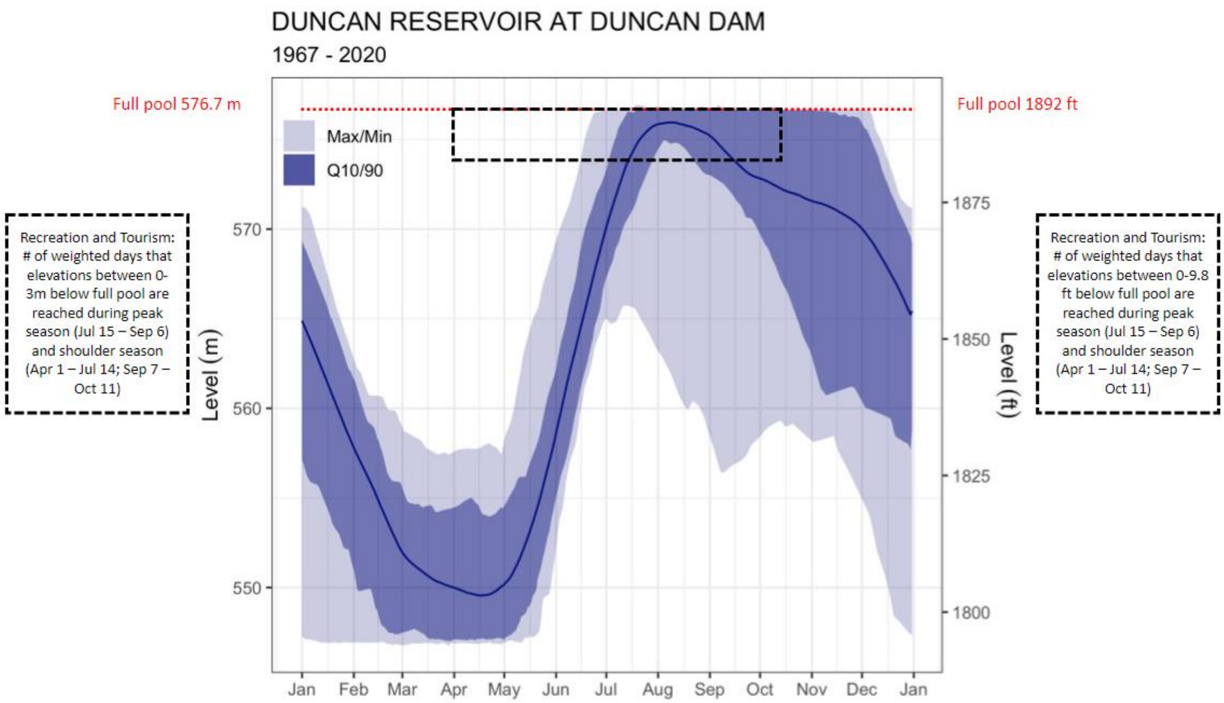
Sub-measures representing preferred elevation ranges for specific recreational activities or sites will inform detailed scenario evaluation.

Sub-Measure Objective	Season	Elevation Range
High water debris avoidance	Jun 1 – Sep 30	Below 2459ft (749.5m)[1]
Motorized boating access – Big Springs	Jun 1 – Sep 30	2440 t (743.7m) and above
Motorized boating experience preference	Jun 1 – Sep 30	Above 2440ft (743.7m)
Kokanee fishing preference	May 24 – Sep 8	2435ft (742.2m) and above
General shore-based preference	Jun 1 – Sep 30	2434ft (741.9m) and above
Kokanee fishing possible	May 24 – Sep 8	2420ft (737.6m) and above
Houseboating possible	Jun 1 – Sep 30	2420ft (737.6m) and above
Motorized boating access - Yaqakxaqłamki/ Kikomun Bridge	Jun 1 – Sep 30	2407ft (733.7m) and above

For more information about the Koocanusa recreation and tourism performance measure, view the full info sheet here.

Duncan Reservoir

The figure below illustrates the historical range and average levels of Duncan Reservoir from 1967, after construction of the dam, to 2020, the latest date that these data are available. The recommended performance measures for this reservoir are overlaid on the reservoir elevations, with further information on each performance measure provided below.



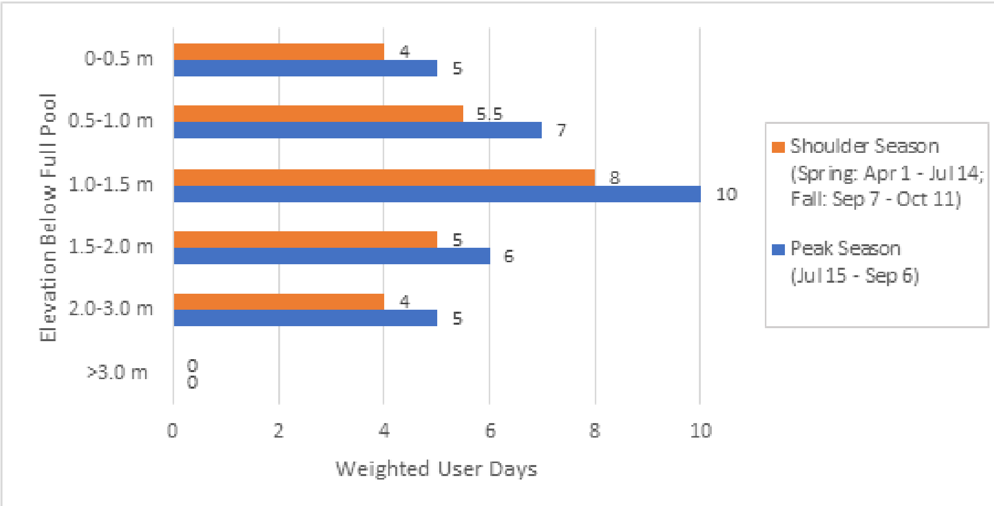
Note: Max/Min is the maximum and minimum levels over the period included in the graph. Q90/10 is the 90th and 10th percentile of levels over the period included in the graph – the 90th percentile is the highest 10% of reservoir levels and the 10th percentile is the lowest 10%.

Recreation and Tourism

Goal: Maximize the quantity and quality of the recreational experience, including reservoir access and visual aesthetics.

Recommended performance measure:

Objective/ Location	Performance Measure	Description
Recreation and Tourism/ Duncan Reservoir	Recreation days	Weighted number of days per year that preferred elevation levels are reached during spring shoulder season (April 1- July 14), peak recreation season (July 15 – Sept. 6) and fall shoulder season (Sept. 7- Oct. 11) – see figure below. More is better.



Recreation quality weightings with new recommended seasons

A sub-measure representing preferred elevations for avoiding high water debris will inform detailed scenario evaluation.

Sub-Measure Objective	Season	Elevation Range
High water debris avoidance	Apr 1 – Oct 11	1891ft (576.4m) and above

For more information about the Duncan Recreation and Tourism performance measure, view the full info sheet here.

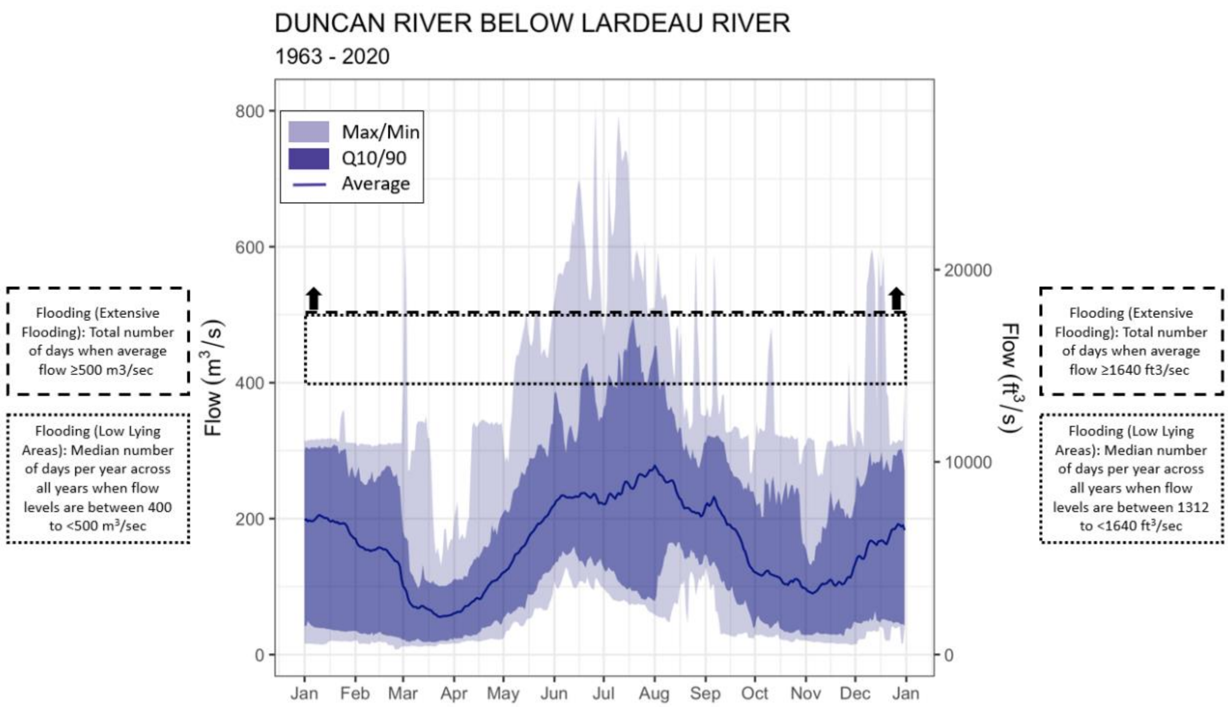
Mosquitos

The research team has thoroughly considered this performance measure after consulting all available information sources, including interviews with the Regional District of Central Kootenay's mosquito control contractor and BC Hydro's former mosquito monitoring contractor/modeler. At this time, we are not recommending a specific performance measure due to information gaps that prevent a confident understanding of how discharges from the Duncan Dam affect mosquito presence and related health risks and quality of life in the area surrounding the Lower Duncan River.

To read the full *Research Status Summary* for Duncan Mosquitos, view this file here.

Lower Duncan River

The figure below illustrates the historical range and average water flow levels for the Lower Duncan River, measured at the "Duncan River below Lardeau River" Water Survey of Canada gauge, from 1963, a few years before construction of the dam, to 2020, the latest date that these data are available. The recommended performance measures for this reservoir are overlaid on the reservoir elevations, with further information on each performance measure provided below.



Note: Max/Min is the maximum and minimum levels over the period included in the graph. Q90/10 is the 90th and 10th percentile of levels over the period included in the graph – the 90th percentile is the highest 10% of reservoir levels and the 10th percentile is the lowest 10%.

Flooding

Goal: Minimize the flood damage to people and property on the Lower Duncan River.

Recommended Performance Measure:

Objective/ Location	Performance Measure	Details	Description
Flooding/ Lower Duncan River	Low lying areas flooding risk	Median number of days per year across all years when flow levels are between 400 to <500 cms. Less is better.	Seepage is starting and there is a risk of flooding from any increases such as rain events.
Flooding/ Lower Duncan River	Extensive flooding	Total number of days per year when average flow ≥500 cms	Extensive flooding of low-lying areas, including hayfields and the former Cooper Creek Cedar industrial site.

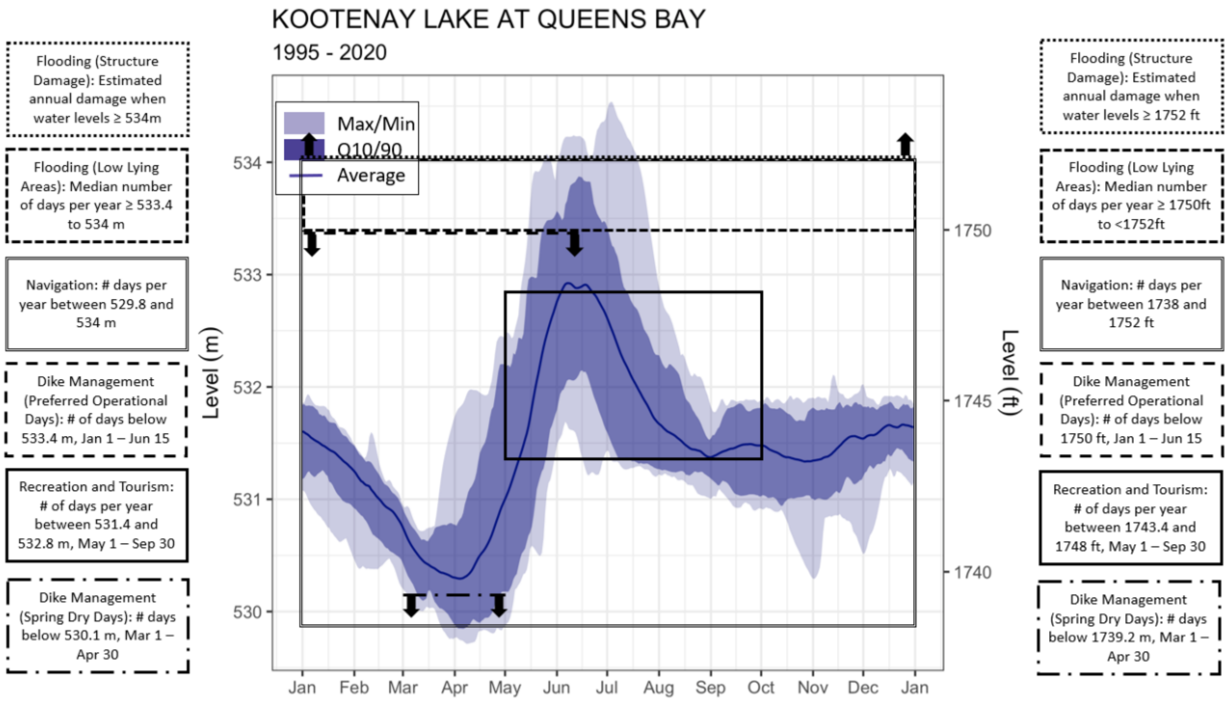
The following sub-measures will inform detailed scenario evaluation:

Flow (cms)	**Total no. of days flow is reached**	**No. of years when flow is reached**
799-800		
700-799		
600-699		
500-599		

For more information about the Duncan flooding performance measure, view the full info sheet here.

Kootenay Lake

The figure below illustrates the historical range and average levels of Kootenay Lake from 1995 to 2020, the latest date that these data are available. The recommended performance measures for this reservoir are overlaid on the reservoir elevations, with further information on each performance measure provided below.



Note: Max/Min is the maximum and minimum levels over the period included in the graph. Q90/10 is the 90th and 10th percentile of levels over the period included in the graph – the 90th percentile is the highest 10% of reservoir levels and the 10th percentile is the lowest 10%.

Creston Valley Floodplain Dike Management Operations

Goal: Support farming and wetland protection by minimizing pumping costs during critical times.

Interim recommended performance measures:

The new Creston Valley Floodplain Management Partnership has not been available to review these performance measures so they are considered interim until this consultation can proceed.

Objective / Location	Performance Measure	Description
Farming and wetland protection, water pumping / Creston Valley Floodplain	Preferred operational days	# Days below 1750ft (533.4m), Jan 1 – June 15. Higher is better.
	Spring dry days	# Days below 1739.32ft (530.1m) in Kootenay Lake, March 1 – April 30. Higher is better.

For more information about the Creston Valley Floodplain Dike Management Operations performance measure, view the full info sheet here.

Navigation

Goal: Minimize disruptions to commercial navigation and transportation.

Recommended Performance Measure:

Objective/ Location	Performance Measure	Description
Navigation/Kootenay Lake	Navigability	Number of days per year that ferry routes are navigable at elevations between 1738ft (529.8m) and 1752ft (534m). More is better.

For more information about the Kootenay Lake navigation performance measure, view the full info sheet here.

Recreation and Tourism

Goal: Maximize community benefits from quality and diversity of recreation and tourism

Recommended Performance Measure:

Objective/Location	Performance Measure	Description
Recreation and tourism/ Kootenay Lake	Preferred recreation days	Total number of days per year between 1743.4ft (531.4m) and 1748ft (532.8m) at Queens Bay during the recreation season – May 1 to September 30. More is better.

Sub-measures representing preferred elevation ranges for specific recreational activities or sites will inform detailed scenario evaluation.

Sub-Measure Objective	Season	Elevation Range
Motorized boating access	May 1 – Sep 30	1744ft (531.6m) and above
Motorized boating experience preference	May 1 – Sep 30	1744ft – 1749 ft (531.6m – 533.1m)
Beach access	May 1 – Sep 30	1754ft (534.6m) and below
Beach experience preference	May 1 – Sep 30	1744ft – 1754ft (531.6m – 534.6m)

For more information about the Kootenay Lake recreation and tourism performance measure, view the full info sheet here.

Flooding

Goal: Minimize flooding of property and infrastructure.

Recommended Performance Measure:

Objective/ Location	Performance Measure	Details	Description
Initial flooding/ Kootenay Lake	Flooding of low-lying areas	Median number of days per year when Kootenay Lake water levels ≥ 1750ft to <1752ft (534 m). Less is better.	Duration of flooding in low lying areas.
Structure damage and transportation limits/Kootenay Lake	Structure damage and transportation limits	Average expected annual damage (in $) when water levels ≥ 1752ft (534m). See figure below. Less is better.	Impact of flooding based on elevation and frequency resulting in structure damage and impacts on ferry operations.

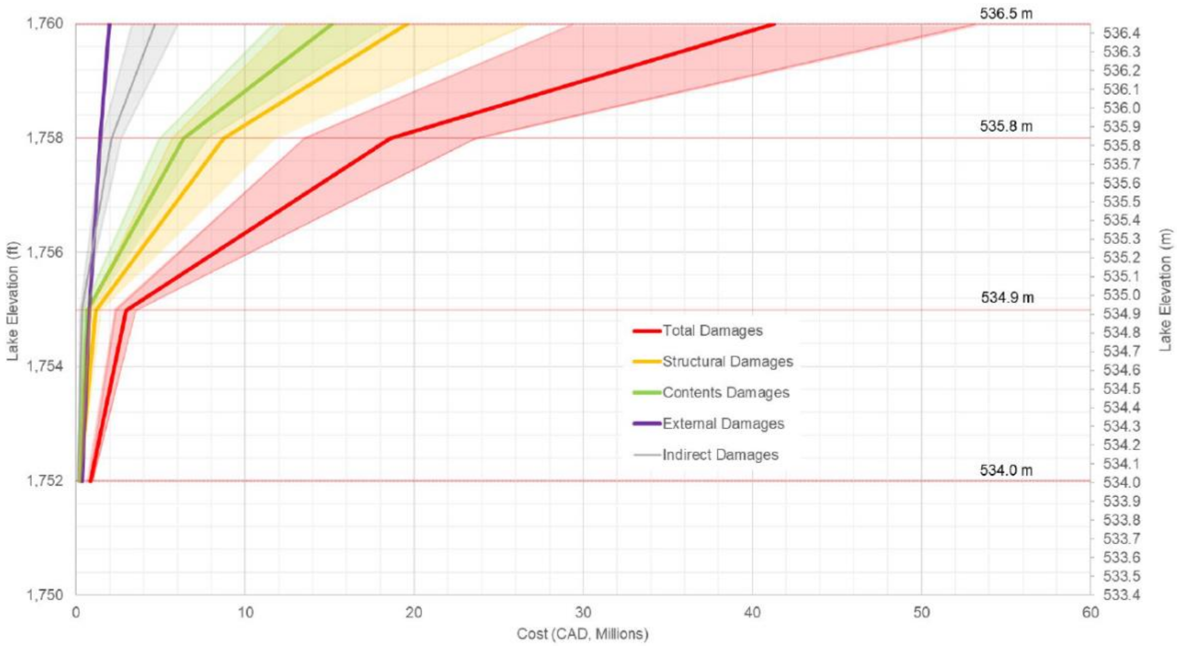


Figure 2: Expected annual damage for various flood stages on Kootenay Lake. From "Kootenay Lake Flood Impact Analysis (Rev. 1)", a report prepared by BGC for the Regional District of Central Kootenay. Note this report is pending approval from the RDCK Board, which is expected in early 2023.

The following sub-measures will inform detailed scenario evaluation:

Elevation	Total no. of days elevation is reached	No. of years when elevation is reached
≥1755'		
1754-1755'		
1753-1754'		
1752-1753'		
1751'-1752'		
1750'-1751'		

For more information about the Kootenay Lake flooding performance measure, view the full info sheet here.

Performance Measure Development Process

In order to identify community interests that are affected by reservoir operations, the research team first consulted overarching assessments of Columbia River Treaty community impacts (such as the Columbia River Treaty Summary of Canadian Dam and Reservoir Issues, CRT Community Meeting Summaries from 2018 and 2019, and a 2004 study named "A Stakeholder Summary of Preferred and Potential Negative Reservoir Levels and River Stages on the Kootenay River System in Canada" which is not available online), as well as two past processes that developed performance measures for the Columbia River system, including:

- The Duncan Dam Water Use Plan Consultative Committee process (2005);
- The Columbia River Treaty Review Technical Studies (2013).

To ensure our performance measures reflected the latest available knowledge on priority issues, the research team reviewed relevant new studies that have been completed since 2013 as well as older studies when needed to verify information used in past processes. In some cases, we reached out to individuals or groups when it was not possible to find information in a formal report.

The draft performance measures presented in this document have undergone two rounds of review with members of the Columbia River Treaty Local Governments Committee and Columbia Basin Regional Advisory Committee. They have therefore been vetted by people or groups representing diverse interests for each reservoir. The research team recognizes, however, that, due to the complexity of socio-economic issues affected by hydro system operations, community members will have further input that is valuable to this process.

APPENDIX 1: KOOTENAY SYSTEM OPERATIONS

Koocanusa Reservoir

Under the Treaty, the U.S. must seek input from BC Hydro regarding Libby operations, but it is not required to coordinate operations as is done for the three Canadian CRT reservoirs. This obligation continues whether the Treaty continues or is terminated. Operations of Libby Dam until the early 1990s were managed to optimize power generation and flood control in the two countries. In the early 1990s, the U.S. Army Corps of Engineers (owner of the dam), responding to U.S. regulatory agency concerns, reviewed Libby operations with the intent of benefitting downstream sturgeon spawning in the Kootenay River below the dam, including the portion that flows in Canada into the south end of Kootenay Lake, and salmon in the US portions of the Columbia River.

Until 2002, Libby dam operations continued to observe the "Standard Flood Control" regime that had been in place since dam operations began. However, in response to the 2000 Biological Opinion, a legal decision under the U.S. Endangered Species Act, Libby began operating to an interim alternative flood control procedure known as "Variable Flow" or "VARQ". In most years, the Libby dam discharges less water during the fall-winter period under the VARQ regime (compared to the Standard regime) and more water during the spring/summer to benefit downstream fish.

Koocanusa Reservoir has 5 million acre-feet (MAF) of active storage, which translates into a 172 ft draft if the reservoir is emptied. Across the fall, the reservoir is drafted 2 MAF (48 ft) by December 31. Typically, to optimize power operations, the Libby discharge is at the minimum 4 kcfs from October 1 to mid-November and then fairly high discharges (weekly load-factored) from mid-November through late December. Then in January, the reservoir continues drafting to stay on the flood control curve in average or high snowpack years. In low snowpack years the flood control curve rises such that, even with the Libby discharge set to minimum, the reservoir cannot fill to reach its Flood Control level until April or late May through to July, which is the reservoir refill period. The reservoir level rate-of-rise depends on the shape of the freshet and how quickly the snowpack melts.

During this period, the extra water stored in the reservoir for fisheries needs is released for sturgeon and bull trout spawning in the Kootenay River between Libby and Kootenay Lake. The volume released for fish changes with runoff volume, and in low water years (when the Libby runoff forecast is less than 4.8 MAF) there is no specified flow release for sturgeon. During refilling of the reservoir, the U.S. Army Corps of Engineers aims to maintain sufficient flood control space for the forecast runoff to come. At times daily changes are made to Libby's discharge to control the refill. Typically, the U.S. Army Corps of Engineers aims to have the reservoir about 10 to 15 ft below full-pool on June 30. The reservoir then typically peaks within the top 5 to 10 ft in mid July. In low water years the reservoir won't reach this range. During August and September, the Libby operation is designed to continue protecting bull trout in the Kootenay River and to assist downstream salmon migration in the lower Columbia River in the US. In the top 80% of runoff years, the reservoir level target is 10 ft from full on September 30. In the lowest 20% of runoff years, the reservoir level target is 20 ft from full on September 30.

The above seasonal description of Libby operations demonstrates how the U.S. operation of Libby is highly constrained by U.S. fish operations under the Biological Opinion that is required by US domestic law and that benefits fish in the Canadian portions of the river. Essentially the reservoir is operated as high as possible (limited by the VARQ flood control curve) during the period between late December and April to provide maximum water for sturgeon, bull trout, and salmon.

Duncan Reservoir

The Duncan Dam began operations in 1967. As a Columbia River Treaty dam, the 1.4 MAF of storage in the reservoir is operated to meet Treaty requirements; however, Canadian flex under the Treaty is utilized to adjust the operation of Duncan for maximum Canadian benefits. Duncan dam does not have power generation at the facility, but the storage operation provides power benefits for the Canadian dams downstream on the Kootenay River as well as flood control benefits for areas along the Duncan River between the dam and Kootenay Lake, Kootenay Lake, Kootenay River, and the Columbia River from the Kootenay confluence downstream.

BC Hydro owns Duncan Dam and the water license to store and divert water. As part of license requirements, BC Hydro undertook the Duncan water use planning process from 2000 to 2004, involving government agencies, First Nations, local residents and other interest groups. The goal was to find a better balance between competing uses of water, such as domestic water supply, fish and wildlife, recreation, heritage and electrical power generation. The process developed recommendations on how incremental changes to operations at Duncan might have positive impacts on a variety of different interests.

Operating conditions agreed to during the water use planning process include the following:

- "Reach full pool if water conditions permit, between 1 and 10 August. After full pool is reached or after 10 August, decrease reservoir elevation and maintain within a defined range until 5 September. The reservoir elevation targets do not take priority over maintaining minimum flows in the Lower Duncan River;
- Year-round minimum discharge;
- Normal maximum year-round discharge; and
- Maximum flow targets in the Duncan River downstream of the Lardeau River confluence that vary throughout the year"

The normal operating range for Duncan Reservoir is between 546.87 m (1794 ft) and 576.68 m (1892 ft).

Kootenay Lake

Operation of the Kootenay River system and the resulting water levels in Kootenay Lake is complicated as it is administered by several different jurisdictions and the hydroelectric facilities are owned by different agencies/companies. Changes in the discharge requirements from these hydroelectric facilities over time further complicates the Kootenay Lake operational regime.

Regulated Upstream Inflows to Kootenay Lake

The US Army Corps of Engineers operates Libby Dam in Montana, with regulated flows from this dam as well as unregulated flows between the dam and Kootenay Lake flowing into the south end of the lake at Creston. BC Hydro operates Duncan Dam which regulates flows from the Duncan River, but not the Lardeau River or Meadow Creek which join the Duncan River below the dam These flows enter the north end of the lake. Approximately 60% of the total annual inflows into the lake are regulated by Duncan

Dam (~16%) and Libby Dam (~44%). Unregulated inflows originating from Lardeau River (~10%) and local inflow between Libby Dam and Kootenay Lake and along Kootenay Lake (~30%) make up the balance. During freshet, when Duncan dam flows are usually regulated to meet minimum flows only, the greatest portion of the inflows is unregulated.

International Joint Commission Kootenay Lake Order

Water levels in Kootenay Lake are regulated by the International Joint Commission (IJC) Kootenay Lake Board of Control under the "Kootenay Lake Order." The IJC is a bi-national organization established by the Boundary Waters Treaty of 1909. After reviewing representations from Canada and the U.S., the order governing storage in Kootenay Lake was issued in 1938 to West Kootenay Power and Light Company to operate Corra Linn dam, which regulates the lake levels when the flow is not restricted at Grohman Narrows, at the outlet on the West Arm of the lake. The IJC formed the Kootenay Lake Board of Control to monitor adherence to the order and resolve any problems relating to the order.

This Order is now held and administered by FortisBC, the current owner of Corra Linn Dam. FortisBC also holds the water licence for one-half of Kootenay Lake storage. The other half is held by Brilliant Power Corporation (a Columbia Power Corporation/Columbia Basin Trust joint venture that owns the Brilliant Dam, located near the confluence of the Kootenay River with the Columbia River near Castlegar).

Kootenay Lake Operations

The 1938 IJC Order specifies upper operating limits for the elevations of Kootenay Lake throughout the year. It stipulates the following:

- An orderly drawdown of Kootenay Lake in preparation for the spring runoff such that the elevation does not exceed 1739.32ft (530m) on or about April 1.
- During the high spring/summer flows, the allowable lake elevation is calculated using a lowering formula from the natural lake elevation that would have occurred under original outlet conditions existing before the excavation of Grohman Narrows in the 1930s. Grohman Narrows is a hydraulic constriction that limits discharge from the lake. In spring and throughout the summer the Corra Linn forebay is lowered to maximize the discharge from the lake.
- At the end of the summer, for agricultural interests, the 1938 Order also specifies that once the lake elevation falls below 1743.32ft (531m), as measured at the Nelson gauge, it should be held below this elevation until August 31.
- Between September 1 and January 7, the maximum elevation is 1745.32ft (532m).

The Columbia River Treaty requires that the operation of Libby be consistent with the Kootenay Lake IJC Order. Prior to 2007, it was normal practice for the Treaty entities to reduce discharges from Duncan and/or Libby in March-April if needed to allow Kootenay Lake to draft below its IJC Order level of 1739.32ft (530m). However, in some years, this practice "trapped water" in the upstream reservoirs which then reduced their ability to provide flood risk management for Kootenay Lake during the spring freshet. The current agreed operation allows BC Hydro and the US Army Corp of Engineers to draft the upstream reservoirs as needed for flood control and other purposes and this operation has been shown to reduce flood peaks for Kootenay Lake. The IJC and Kootenay Lake Board of Control have confirmed that the IJC Order for Kootenay Lake governs only the operation of Corra Linn dam and does not constrain the operation of the upstream Libby and Duncan dams.