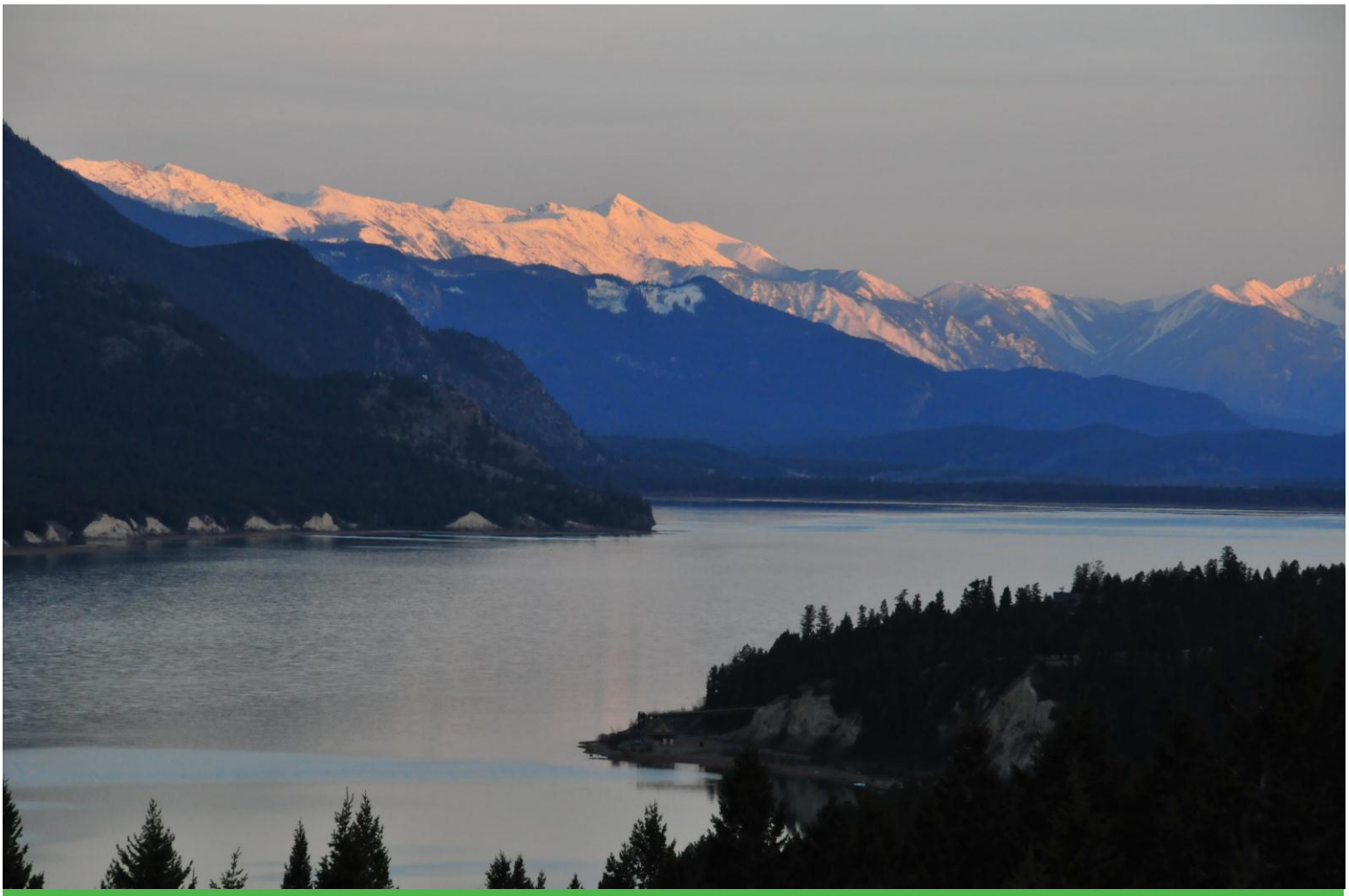

Photo credit: Larry Halverson

FISH AND WILDLIFE
COMPENSATION PROGRAM

COLUMBIA BASIN PLAN
DRAFT

June 2012

BC hydro
FOR GENERATIONS

BRITISH COLUMBIA
The Best Place on Earth

Canada
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Pêches et Océans Canada

Contents

1. Introduction

This Columbia Basin Plan sets forth the strategic direction for the Fish and Wildlife Compensation Program (FWCP) in the Columbia Region.

It begins by briefly outlining the vision, principles, policy context and strategic objectives that form the foundation of the FWCP. A short description of the Columbia Basin landscape includes an overview of the hydro-electric facilities and footprint impacts created by those facilities.

The priority setting process is then described, followed by a short synopsis of the priority Action Plans. Taken together, this Basin Plan and the accompanying Action Plans present the FWCP priorities for investments in compensation activities within the Columbia Basin.

1.1 Fish and Wildlife Compensation Program

The Fish and Wildlife Compensation Program: Columbia Basin (FWCP:CB) was originally created in 1995 when a fund was established to provide money in perpetuity to offset the footprint impacts of BC Hydro dams and reservoirs on fish and wildlife in the basin (MacDonald 2009; Utzig and Schmidt 2011). An Administrative Agreement was signed in 1999 between the BC Ministry of Environment and BC Hydro to formalize the management of the program, which was developed to satisfy the obligations regarding fish and wildlife attached to the Arrow, Duncan, Mica, Seven Mile and Revelstoke project water licences.

In 2009, the program developed a strategic framework that guides overall planning for compensation investments (MacDonald, 2009). The framework has guided the development of strategic plans for each watershed within the FWCP program area, which are in turn informing action plans that focus on specific priorities within each watershed (Figure 1).

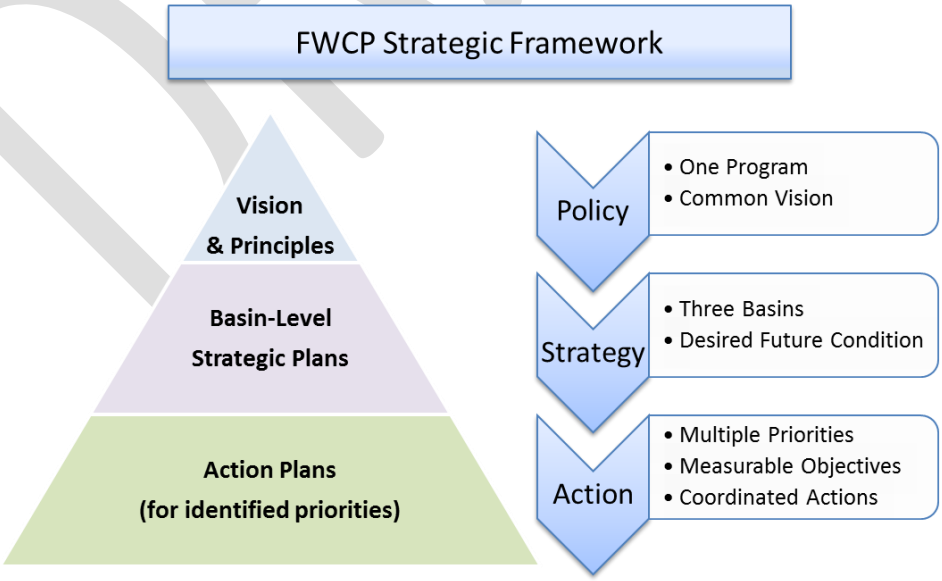

Figure 1: Relationship between the FWCP Strategic Framework, basin strategic plans and action plans.

Delivery of the program as a whole is guided by a vision, set of principles and policy priorities as developed by the program's partners.

Vision

Thriving fish and wildlife populations in watersheds that are functioning and sustainable.

An effective program will support the maintenance of healthy fish and wildlife populations in basins significantly altered by hydroelectric development. Actions taken should satisfy both the conservation and sustainable use objectives and, where possible, restore ecosystem function, making species more resistant to emerging pressures such as climate change.

Principles

Approach – The program has a forward-looking, ecosystem-based approach that defines the desired outcomes and takes actions to restore, enhance and conserve priority species and their habitats.

Decision Making – The program efficiently uses its resources and works with its partners to make informed and consensus-built decisions that enable the delivery of effective, meaningful and measurable projects that are supported by the impacted communities.

Geographic Scope – Within the watersheds, basins and ranges of the populations of species affected by generation facilities owned and operated by BC Hydro.

Objectives – The program defines and delivers on compensation objectives that reflect the partnership's collective goals, and that align with local, provincial and federal fish and wildlife conservation and management objectives in the areas where we work.

Delivery – The program strives to be a high performing organization with skilled and motivated staff and partners delivering efficient, effective and accountable projects.

Partners

The program is a partnership between BC Hydro, the BC Provincial Government, Fisheries and Oceans Canada, First Nations and public stakeholders. Our goal is to have engagement and participation of all the partners in priority setting, approval, review and delivery of the program.

Policy Context

The FWCP addresses the policy requirements and social commitments to compensate for impacts to fish and wildlife associated with the development of BCH's generating facilities. The core responsibilities of the agencies are:

BC Provincial Government

The BC Ministry of Environment (MOE) and BC Ministry of Forests, Lands and Natural Resource Operations (FLNRO) manage and deliver a wide range of programs and services that support the Province's environmental and economic goals[1]. The Ministry encourages environmental stewardship, develops innovative partnerships, engages First Nations, stakeholders and the public and actively promotes the sustainable use of British Columbia's environmental resources. Within this broader context, the Ministry has a number of responsibilities that are particularly relevant to the development and implementation of actions under the FWCP including:

- Management and conservation of the province's biodiversity;
- Protection of fish, wildlife, species-at-risk and their habitats;
- Protection and restoration of BC's watersheds; and,
- Provision and management of fish and wildlife-based recreation.

A number of policies and plans guide the Ministry in delivering on these goals and objectives. The **Conservation Framework**[2] is British Columbia's approach for maintaining the rich biodiversity of the province, providing a set of science-based tools and prioritized actions for conserving species and ecosystems in B.C. **Program Plans for Freshwater Fisheries, Wildlife and Ecosystems**[3] articulate a clear set of strategies supported by actions to achieve both conservation-based outcomes and the provision of recreational opportunity. **Recovery Strategies and Management Plans** continue to be developed to guide the maintenance, recovery and/or use of specific species and ecosystems. These plans may include specific performance measures and targets.

Fisheries and Oceans Canada

Under the federal ***Fisheries Act***, DFO is the primary agency responsible for conserving and managing Canada's fisheries, including pacific salmon. It does so through management and monitoring of fisheries, protection of fish habitat, and pollution prevention. The **Policy for the Management of Fish Habitat** (1986) has an overall objective of 'net gain' of fish habitat and helps guide the implementation of fish habitat protection through collaboration with relevant provincial agencies. The ***Species at Risk Act*** mandates protection of geographically and genetically distinct populations. The principle goal of the **Wild Salmon Policy**[4] is "to restore and maintain healthy and diverse salmon populations and their habitats for the benefit and enjoyment of the people of Canada in perpetuity". This is achieved through

[1] http://www.bcbudget.gov.bc.ca/2011/sp/pdf/ministry/env.pdf (MOE Service Plan)
http://www.bcbudget.gov.bc.ca/2011/sp/pdf/ministry/flnr.pdf (FLNRO Service Plan)
[2] http://www.env.gov.bc.ca/conservationframework/
[3] http://www.env.gov.bc.ca/esd/
[4] Canada's Policy for Conservation of Wild Pacific Salmon, 2005.

safeguarding genetic diversity, maintaining ecosystem integrity and managing for sustainable fisheries.

BC Hydro

BC Hydro is a Crown Corporation committed to producing, acquiring and delivering electricity in an environmentally, socially and financially responsible manner,[5] through managing impacts from its operations, and weighing environmental values with social and economic interests. Where negative impacts cannot be avoided, it will work to mitigate or offset them, enhance affected habitat and sustain resources over the long term. As part of its water licenses to operate its facilities, BC Hydro is required to undertake compensation programs in different regions of the province. Through the compensation program, it is committed to developing positive projects, such as investments to improve fish and wildlife, and building relationships to encourage stakeholder and aboriginal community engagement, particularly where their input can contribute to better decisions.

Program Delivery

The overall vision and common principles above drive the FWCP program and projects, and provide a foundation for determining strategic priorities at the basin level (i.e., this Basin Plan), which are used to develop Action Plans. The bulk of projects undertaken by the FWCP will be delivered under Action Plans that lay out a suite of key actions to achieve specific goals associated with priority species and ecosystems. Actions could include research, implementation activities, monitoring and evaluation activities, and communication mechanisms. Applicants are encouraged to use this Basin Plan and accompanying Action Plans to develop projects that meet the overall objectives of the FWCP program. Technical and steering committees, together with staff, will reference the plans to ensure that investments target the highest priority projects.

A portion of the FWCP program activities will include small-scale, short-duration strategic projects that target specific issues identified by program partners or others (e.g., community members). These could include projects not yet identified in any action plans, as well as lower priority action plan items that require timely response in order to take advantage of an investment or partnership opportunity.

Project Investment Criteria

At the level of individual project investment and implementation decisions, the FWCP applies the following criteria to further define its role and actions within defined program areas:

[5] BC Hydro Social Responsibility Policy.

FWCP does:

- Fund actions to create, restore, or otherwise improve the function of ecosystems that have been impacted by BC Hydro activities;
- Fund actions to create, restore, or otherwise improve the function of alternate ecosystems that provide a better opportunity for investment;
- Participate as a team member in species of interest planning;
- Fund specific management actions for species of interest as identified by recovery teams and action/implementation groups;
- Fund baseline inventory that contributes to the development of habitat or species based actions within Action Plans;
- Fund monitoring programs designed to measure the effectiveness of FWCP funded habitat and species actions; and,
- Contribute to all aspects of managing co-operatively managed conservation lands.

FWCP does not:

- Fund core activities of government or non-government agencies or programs;
- Lead the development of species recovery goals;
- Fund, co-ordinate or lead National Recovery Teams for species at risk;
- Develop policy related to land or wildlife management;
- Administer government regulations;
- Engage in enforcement and compliance activities, except in relation to co-operatively managed conservation lands; and,
- Fund programs designed exclusively to address government harvest objectives.

2. The Columbia River Basin[6]

2.1 Setting

The Columbia Basin is situated in southeastern British Columbia and spans Canada and the United States. The Canadian portion, the focus of this plan, is approximately 100,000 km^2 and contains the Columbia River and the Kootenay River Basins (Figure 2). The Canadian Columbia River is approximately 800 km long, and has an impressive elevation drop of 430 m from its headwaters in Columbia Lake to the point where the river crosses the Canada-US border. The Columbia River initially flows northwest along the Rocky Mountain Trench for about 250 km before emptying into Kinbasket Reservoir behind Mica Dam. The river flows south to Revelstoke Reservoir and Dam, and then south again into Arrow Lakes Reservoir behind Hugh Keenleyside Dam, and finally south across the border to the United States. The Kootenay River flows south to the Koocanusa Reservoir, which spans from British Columbia into the United States where the Libby Dam is situated. It then flows north returning to BC and flows into Kootenay Lake before joining the mainstem of the Columbia River below Arrow Lakes Reservoir.

The Columbia River experiences extremely variable flows. While the Canadian portion of the basin is a little less than 15% of the entire Columbia Basin it supplies approximately 35% of the water for the entire basin, and as much as 50% at flood levels. Precipitation in the basin occurs from the flow of moist low-pressure weather systems that move eastward through the region from the Pacific Ocean. Large snow packs accumulate at middle and upper elevations in the watersheds during the cool winter period. Summer snowmelt is reinforced by rain from both frontal storm systems and local convective storms. More than two-thirds of the annual precipitation in the basin falls as winter snow.

The major source of flow in the Columbia River in the spring and summer months is water stored in large snow packs that developed during the previous winter months. Snow packs often accumulate above 2000 m elevation through the month of May and continue to contribute runoff long after snow pack at lower elevations has been depleted. Runoff begins to increase in April or May and usually peaks in June to early July. Approximately 45 per cent of the runoff occurs in the months of June and July. Severe summer rainstorms are not unusual in the Columbia Basin. Summer rainfall contributions to runoff generally occur as short-term peaks superimposed upon high river levels caused by snowmelt. These rainstorms may contribute to annual flood peaks dealt with under the current Columbia River Treaty operations.

[6] Information in this section is summarized from BC Hydro 2005a, BC Hydro 2005b, Utzig and Schmidt 2011 (and references therein).

First Nations

There are a significant number of First Nations with claimed traditional territories across the Columbia River Basin. Ongoing engagement efforts will help to ensure that First Nations interests are accommodated within the priorities and focus of the FWCP: CB plans.

Major centres and recreation

The largest centres of populations where BC Hydro facilities are located include: Castlegar, Cranbrook, Kaslo, Nakusp, Nelson and Revelstoke. Parks and protected areas near BC Hydro facilities include Mt. Revelstoke and Glacier National Parks, West Arm Park, Purcell Wilderness Area, Goat Range Park, and Lockhart Creek Park. Wildlife Management Areas at Creston, Columbia Wetlands, Midge Creek, Hamling Lakes, East Columbia Lake, and Bummers Flats provide significant environmental, social and some economic value to the area. Fishing and hunting are important social, recreational and commercial pursuits across the region.

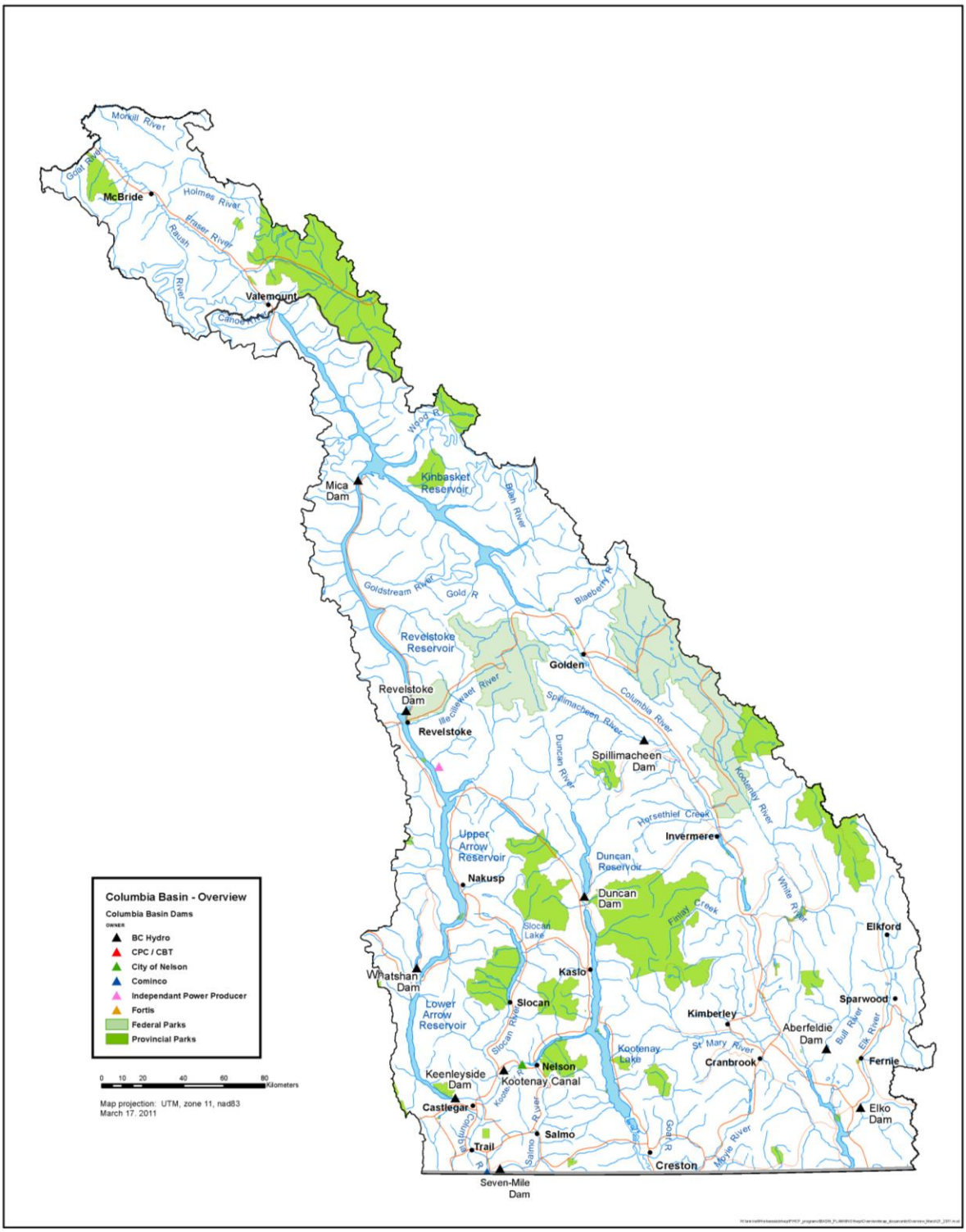

Figure 2 Canadian Portion of the Columbia Basin.[7]

[7] Note that the Upper Fraser area was added to the program based on limited opportunities for wildlife compensation projects in the Canoe Reach.

2.2 Hydro Facilities[8]

The Columbia River Basin spans both Canada and the United States and is the largest producer of hydroelectricity in North America, with 14 hydro-dams on the mainstem alone with the capacity to produce approximately 24,000 MW of power. There are 19 facilities in the Canadian portion, on the mainstem and tributaries, producing about 50% of the total power generated in British Columbia.[9] Eleven of these facilities are operated by BC Hydro.

BC Hydro Dams and the Columbia River Treaty

Flood control and power generation provided the impetus for the Columbia River Treaty (CRT) between Canada and the United States in 1964.[10] The CRT is an agreement between the United States and Canada to develop and operate upstream storage in BC to provide a regulated flow on the Columbia and Kootenay rivers, and optimize flood control and power generation in both countries. Under the treaty, the Hugh Keenleyside, Mica and Duncan dams were constructed. The CRT also provides for the US to compensate Canada (specifically, BC) for the 'downstream benefits' the US could realize (under the assumed conditions); and it permitted the US to construct the Libby dam and associated Koocanusa reservoir, which extends into BC. Revelstoke dam was constructed after the CRT to take advantage of the controlled flow. Other dams controlled by BC Hydro include Walter Hardman, Seven Mile, Elko, Aberfeldie, and Whatshan (Figure 2).

Aberfeldie Dam

The Aberfeldie Dam was originally built in 1922, and was redeveloped in 2009. It is located on the Bull River approximately 10 km upstream of the confluence with the Kootenay River. The Aberfeldie Dam is an in-basin diversion. The generating station is located approximately 1.2 km downstream of the dam and has a capacity of 25MW. The Aberfeldie headpond has an area of 20 ha and a storage capacity of 510,000 m^3. The average drawdown of the headpond is approximately 0.5 m under normal operating conditions.

Columbia River – Mica Dam

Mica Dam is located on the Columbia River about 135 km north of Revelstoke. The dam was completed in 1973 and consists of an earthfill dam, low-level outlets, outlet works and a chute spillway. The generating station was completed in 1977 and contains an underground powerhouse. The Mica Powerhouse has four operating units with a generating capacity of 1805 MW. Two additional generating units with a capacity of approximately 500 MW each are currently under development and scheduled for installation in 2014 and 2017. Kinbasket Reservoir is 216 km long, is 426.5 km^2, and has a

[8] Details in this section are summarized from Water Use Plan reports available at: http://www.bchydro.com/planning_regulatory/water_use_planning/southern_interior.html

[9] See the Columbia Basin Trust's *A Guide to Major Hydropower Dams of the Columbia River Basin* available at: *http://www.cbt.org/newsroom/?view&vars=1&content=Publication&WebDynID=441*

[10] Information available at http://www.em.gov.bc.ca/EPD/COLUMBIARIVERTREATY/Pages/default.aspx

licensed storage volume of 12 million acre-feet (MAF). Of this, 7 MAF is operated under the terms of the Columbia River Treaty. The normal operating range of the reservoir is between El. 754.38 m (2,475.0 ft) and 707.41 m (2,320.9 ft).

Columbia River – Revelstoke Dam

Revelstoke Dam and Generation Station are located on the Columbia River about 5 km upstream from the City of Revelstoke and about 130 km downstream from the Mica Dam. The Revelstoke Dam was completed in 1984, and consists of a concrete gravity main dam with an earthfill wing on the west bank, a gated spillway, a powerhouse and switchgear building. The powerhouse is located directly downstream of the power intakes, and currently has five operating units with a total generating capacity of 2480 MW and space to install a sixth additional unit in the future. Revelstoke Dam impounds Revelstoke Reservoir, which is 130 km long, 114.5 km^2, and is licensed to storage 1.5 MAF. The licensed operating range of the reservoir is between El. 573.02 m (1,880.0 ft) and 554.54 m (1,819.4 ft). The reservoir is normally kept within 1.5 m of the maximum elevation throughout the year to maximize the turbine hydraulic head and maintain a small storage buffer for operational flexibility and short-term variations in inflow.

Columbia River – Hugh Keenleyside Dam

Hugh Keenleyside Dam is located on the Columbia River about 8 km upstream of Castlegar. The facility was completed in 1968, and consists of an earthfill dam, a concrete dam, four spillways, eight low-level outlets (ports) and a navigation lock. The Arrow Lakes Generating Station, operated by the Columbia Power Corporation, is a 185 MW power plant constructed on the north bank about 400 m downstream of Hugh Keenleyside Dam. The reservoir formed by the dam is known as Arrow Lakes Reservoir. The total discharge capacity of Hugh Keenleyside Dam is 10,500 m^3/s when the reservoir is at normal full pool. The mean annual discharge is approximately 1,140 m^3/s. Arrow Lakes Reservoir flooded the former Upper and Lower Arrow Lakes, is about 240 km in length, 512.7 km^2, and has a live storage capacity of 7.1 MAF. The reservoir is licensed to operate between the normal full pool El. 440.1 m (1,444.0 ft) and minimum pool El. 418.64 m (1,374.24 ft).

Duncan Dam

The Duncan Dam is located immediately upstream of the confluence of the Duncan and Lardeau rivers, approximately 10 km upstream of Kootenay Lake and 42 km north of the Village of Kaslo. There are no power generating facilities at Duncan. The Duncan Reservoir is 45 km long when the reservoir is at its full pool El. 1,892 ft and covers an area of 73 km^2.

Elko Dam

The Elko Dam was originally built in 1924 and is located on the Elk River approximately 16 km upstream of Lake Koocanusa, which is the reservoir impounded by the Libby Dam in Montana, USA. The Elko power station generates 12 MW and a discharge capacity of 25 m^3/s. The dam impounds a small headpond with a surface area of 0.1 km^2 and a storage capacity of 600,000 m^3.

Kootenay Canal

The Kootenay Canal Generating Station with a capacity of 580 MW was completed in 1976 and is located between Nelson and Castlegar on the Kootenay River. Water from the Kootenay River enters the canal from the Corra Linn headpond and returns to the river at South Slocan after passing through the canal and powerhouse.

Seven Mile Dam

The Seven Mile Dam and Generating Station are situated on the Pend d'Oreille River, approximately 15 km south-east of the City of Trail. The Dam is 18 km downstream of Seattle City Light's Boundary Dam and 9 km upstream from the Waneta Dam. It has an 848 MW capacity. Seven Mile Reservoir on the Pend d'Oreille River is 4.3 km^2, and is not a storage reservoir in the traditional sense. It has only sufficient capacity for daily pondage and does not affect weekly or seasonal Pend d'Oreille River flows. The Buckley recreational site is located on the Seven Mile Reservoir.

Spillimacheen Dam

The Spillimacheen Dam was completed in 1955 and is located on the Spillimacheen River about 5 km upstream of its confluence with the Columbia River. The dam is a concrete dam and impounds a small headpond of 0.024 km^2, which has an active storage capacity of 58,320 m^3. The Spillimacheen generating station is located about 1.5 km downstream of the dam on the left bank (north side) of the Spillimacheen River and has a generating capacity of 4MW.

Walter Hardman Dam

The Walter Hardman dam was built in 1961 and is located on Cranberry Creek approximately 25 km south of Revelstoke. The facilities consist of a series of saddle dams and the main diversion dam. Tunnels convey water to a power house with a maximum generating capacity of 8MW on the west side of Arrow Lakes Reservoir. The headpond is 0.16 km^2 with a 700,000 m^3 storage capacity.

Whatshan Dam

The Whatshan Dam was first built in 1951 and is located on the Whatshan River near the community of Edgewood. The dam facilities consist of a 12 m high concrete dam and a 7 meter earthfill saddle dam. A 3.4 km partially lined tunnel connects the power intake on Whatshan Lake Reservoir to the 50 MW powerhouse located on the west shore of Arrow Lakes. The reservoir is approximately 17 km long and has an average width of one km and storage capacity of 122 million m^3, and is approximately 17.7 km^2.

2.3 Footprint Impacts Summary

This summary of the primary footprint impacts is derived from the Dam Footprint Impact Summary (Utzig and Schmidt 2011) and detailed supporting reports (Table 1). This comprehensive study involved over four years of work, analyzing, summarizing and mapping impacts to habitat, primary productivity, impacts to specific fish and wildlife species, and the effects on their populations.

Table 1: List of Columbia River basin Dam Impacts Study Reports.

	Component	Reference	Content
1	Pre-dam Aquatic and Terrestrial Habitat Mapping	Ketcheson et al. 2005	GIS dataset of streams, lakes, wetlands and uplands within Columbia Basin reservoir footprints
2A	Impacts on aquatic and wetland primary productivity	Moody et al. 2007	Estimated Net Primary Productivity and Net Ecosystem Productivity changes in wetland and aquatic habitats following dam construction
2B-1	Terrestrial primary productivity modeling	MacKillop and Utzig 2005	Modeled NPP in terrestrial habitats for the basin
2B-2	An evaluation of terrestrial and wetland primary productivity impacts	Utzig and Holt 2008	Determined change in NPP for terrestrial and wetland habitats following dam construction
3A	An assessment of aquatic habitat impacts	Thorley 2008	Summary of aquatic fish habitat loss within and among reservoir units
3B	Impact of BC Hydro dams on Terrestrial and Wetland Habitat	MacKillop et al. 2008	Summary of terrestrial and wetland ecosystem loss within and among reservoir units
4A-1	Fish Species Impacts: Sturgeon	Porto 2008	Species-specific review
4A-2	Fish Species Impacts: Kokanee	Arndt 2009	Species-specific review
4A-3	Fish Species Impacts: Bull Trout	Hagen 2009	Species-specific review
4A-4	Fish Species Impacts: Rainbow Trout	Arndt 2009	Species-specific review
4A-5	Fish Species Impacts: Burbot	Cope 2008	Species-specific review
4A-6	Fish Species Impacts: Biodiversity	Ladell et al. 2009	Multi-species review
4B	Wildlife Species and Population Impacts	Manley and Krebs 2009	Draft Species-habitat assessment of non-fish vertebrates

Habitat Loss: Dam construction inundated large areas of woodlands, wetlands, floodplain, riverine and lake (littoral) habitat. The Arrow (512.7 km^2) and Whatshan (1,770 ha km^2) reservoirs flooded pre-existing lakes and wetlands, whereas the Kinbasket (426.5 km^2), Revelstoke (114.5 km^2), Seven Mile (Pend d'Oreille) (4.5 km^2), and Spillimacheen (0.024 km^2) reservoirs inundated woodlands and large river systems. The Duncan reservoir (73 km^2) inundated a complex mix of lakes, forests and wetlands. The construction of the Kootenay Canal (<0.5 km^2) resulted in the loss of forested areas.

Approximately 1,600 km of riverine habitat was lost affecting a large number of fish species (e.g., kokanee, rainbow, bull trout, white sturgeon, sculpins, dace, minnows, suckers) as well as riverine birds, and cavity nesters. Approximately 126.5 km^2 of wetlands were lost affecting amphibians, birds and fish, primarily in the Kinbasket and Duncan areas.

From an overall aquatic impact perspective, the creation of reservoirs caused a significant shift from highly diverse habitats (e.g., floodplains, wetlands and small lakes) to simpler, less diverse pelagic habitats. Those reservoirs with large fluctuations in level further result in seasonal impacts on tributary stream habitat and littoral area productivity.

From a terrestrial perspective, an estimated total of 266 km^2 of riparian area and 240 km^2 of uplands area were lost, predominantly due to Kinbasket, Arrow, Revelstoke and Duncan dams, which affected a large number of wildlife species (e.g., large mammals, carnivores, bats, flycatchers, warblers, woodpeckers, raptors, owls).

New Habitat: Pelagic lake habitat increased by an estimated 693.5 km^2 with the construction of the dams and reservoirs. Although this type of habitat benefits some pelagic lake species such as kokanee, there have been significant impacts on species that rely on littoral and riverine habitat as noted above.

Experimental revegetation has been conducted in some areas with an aim to create new (compensatory) habitat, most notably around the Arrow Lakes reservoir where native sedge and grass colonization is occurring in the upper drawdown zones. This has been successful, in part, due to an initial program of annual seeding of fall rye to reduce dust.[11]

Migration Barriers: Barriers to migration and habitat fragmentation due to the dams and reservoirs have stopped migration and movement of both fish and wildlife species.[12] Impacts to migration can affect access to traditional spawning and rearing areas and affect genetic diversity of fish populations. For example, Arrow Lakes rainbow trout, bull trout, kokanee and white sturgeon were notably impacted, and the creation of migration barriers was likely a major factor that led to the decline and eventual extirpation of Arrow Lake Yellowfin rainbow trout.

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[11] *Footprint Impact of BC Hydro Dams on Aquatic and Wetland Primary Productivity in the Columbia Basin*, AIM Ecological Consultants, April 2007.

[12] Aberfeldie, Elko, and Spillimacheen dams were built at falls that were natural historic barriers to fish migration.

Migration barriers are not limited to the large reservoirs; for example, smaller reservoirs such as Aberfeldie and Elko have had local impacts on the migration and movement of bighorn sheep and badgers.

Productivity and Nutrient Loss: Basin-wide losses in primary productivity (i.e., the conversion of solar energy into organic carbon) are mainly related to the loss of forested ecosystems in the Kinbasket, Revelstoke and Arrow reservoirs. A complex system of terrestrial (that included trees, shrubs, herbs and micro-organisms), wetland and floodplain primary productivity has been lost In addition, rivers, lakes and tributary streams have been replaced by reservoir aquatic ecosystems that are generally less productive. In sum, it is estimated that there has been an overall reduction of over 800,000 tons of carbon per year in primary productivity as a result of flooding in the basin.

Dams also impact nutrient flows. This is particularly evident in Kootenay Lake and in the Arrow Lakes where upstream dams trap nutrients and result in notable negative impact on kokanee, bull trout and piscivorous rainbow trout. In addition, the complex transfer of carbon and nutrients between floodplain and wetland ecosystems and the aquatic system have been lost or severely disrupted.

Water Quality and Turbidity: Dams often affect water quality both within and downstream of reservoirs. Large reservoirs tend to keep water temperatures warmer in the winter and cooler in the summer. In most situations, reservoirs also block sediment transfer and reduce turbidity which can benefit some species but not others.

Entrainment: Fish entrainment can be considered both a footprint and operational issue as both the existence and design of the water control infrastructure and how it is operated over time influence the level of impact. At two of the larger facilities on the mainstem, Mica and Revelstoke dams, the species identified as having the highest risk of entrainment include kokanee, bull trout and rainbow trout (Mica-Revelstoke FESTC, 2009). A technical and policy planning process is underway to systematically assess the magnitude and nature of entrainment at each facility and to develop and evaluate appropriate mitigation or compensation actions.

2.4 FWCP Accomplishments to date

The FWCP – Columbia Basin program was established in 1995 through the amalgamation of several pre-existing compensation programs related to Arrow, Duncan, Revelstoke, Mica and Seven Mile dams. Over the past 15 years FWCP has spent approximately $3.5 million per year in the Columbia Basin (a total of over $50 million).[13] Some examples of the accomplishments of these investments include:

Restoration:

Large Lake / Reservoir

- A significant portion of overall program funding is directed toward the Aquatic Nutrient Restoration Program on Kootenay Lake and Arrow Lakes Reservoir. The Kootenay Lake program is one of the longest standing programs in the Columbia Basin. Nutrients were added annually to the North Arm of Kootenay Lake starting in 1992 and the program was extended to the South Arm in 2003.[14] The Arrow Lake Nutrient Restoration program was initiated in 1998. The nutrient restoration programs were designed to replace nutrients that are lost as a result of upstream impoundments (Duncan Dam and Libby Dam in the case of Kootenay Lake and Mica and Revelstoke dams in the case of Arrow Lakes), and to restore overall ecosystem productivity in the lakes.

Stream / River

- Spawning Channels: Meadow Creek Spawning Channel was constructed in 1967 to compensate for the loss of kokanee spawning area due to the construction of Duncan Dam. Over the years it has been modified and in particular sedimentation issues have been addressed through upgrading of settling ponds and assessment of sediment movement. Hill Creek spawning channel was constructed to compensate for losses to the Arrow Lakes system incurred by the construction of Revelstoke Dam. The aim is to increase kokanee fry recruitment through provision of high quality spawning habitat and by improving egg-to-fry survival.
- In-stream Habitat Complexing: [15] In 2001 habitat restoration work in Sproule Creek restored access to the creek for rainbow trout spawners, and improved habitat conditions for their spawning and rearing in a straightened section. Stream complexing has also been conducted in the Salmo River, Norns Creek as well as other Columbia River tributaries (e.g., Murphy and Blueberry creeks).
- Gravel Additions: Gravel was placed to enhance kokanee spawning areas in areas such as Boulder Creek in 2008 where subsequent monitoring followed downstream movement.

[13] For a complete list of completed projects see: http://www.fwcpcolumbia.ca/

[14] The Kootenay Lake program is implemented as a partnership with funding from Bonneville Power Corporation and the Kootenay Tribe of Idaho.

[15] Note this is not an exhaustive list.

Wetland / Riparian

- Wetland Restoration: The function in the Yaqan Nuki Wetlands, south of Creston, was restored between 2003 and 2005, along with several other smaller wetlands nearby. In 2007 control structures for the Cranberry Marsh (near Valemount) were replaced and upgraded; wetland enhancement was conducted in the Lower Columbia in 1997.
- Wetland enhancement in Corn Creek Marsh in 2006 and Leach Lake water control structure upgrades in 2009 (Creston Valley Wildlife Management Area).
- Nestbox, cottonwood protection projects that have been conducted in Duncan and Columbia Wetlands;
- Wetland protection and enhancement: Fencing; water management McGinty Lake; City Pasture
- Aquatic Invasive plant control action on Lower Columbia, Kootenay River

Upland/ Dryland

- Through participation on a multi-agency Ecosystem Restoration committee; ongoing investments in restoration and monitoring on sites near: Premier Ridge, Bull River, Newgate, Elk River, Dutch Creek, Stoddart Creek
- Habitat Restoration has occurred in the Lower Arrow area, Pend d'Oreille, Duncan, and Kootenay Lake (3-7 sites/year).
- Wildlife tree recruitment (East Kootenay).
- Invasive plant control projects in both East and West Kootenay, as well as education and awareness building in the Central Kootenay in 2009.

Conservation:

Species of Interest

- White Sturgeon Conservation Aquaculture
- Northern Leopard Frog rearing/release program (2001-2005)
- Badger translocation; highway crossing structures (2009-2010)
- Western Screech Owl Nest Area Protection
- Townsend Big-eared Bat maternity roost protection (2003)
- Painted Turtle nest site protection – enhancement and monitoring at Elizabeth Lake near Cranbrook in 2003; and Red Devil Hill near Revelstoke in 2000.
- Vaux swift nestbox placement.

Land Acquisition

- Worked with Land Trusts to secure valuable habitat along rivers/streams and lakes: Kootenay Lake, Slocan Lake, Slocan River, Columbia River, Salmo River; Robson Valley.
- Wetland Acquisitions: near Pend d'Oreille River, Columbia River, Duncan River, Kootenay Lake, East Kootenay, Robson Valley

- Upland and Dryland Acquisitions: along Arrow Lakes, Pend d'Oreille River, Duncan River, Kootenay Lake, East Kootenay, Robson Valley

Research and Information Acquisition:

- Arrow Reservoir fish stock status information summary up to 1997 (Sebastian et al, 2000).
- Bull trout inventory, monitoring plan for Arrow and Kootenay Lake tributaries (Decker and Hagen 2008, Hagen and Decker 2009)
- Creel surveys were continued in Arrow Lake (2000-2002) to evaluate Hill Creek Hatchery and Spawning Channel (Arndt, 2004) and to evaluate nutrient restoration (Arndt, 2011 in prep); in Lake Koocanusa (1997), Kinbasket (1994-6); Revelstoke reservoir (2001); and in Kootenay Lake (2010-2011).
- Small Lake Assessments to identify potential restoration possibilities, such as Elizabeth Lake (2007) and Bear Lake (2004), amongst others.
- Species at Risk inventories:[16] Great Blue Heron (2003, 2007) , American Bittern (2003), Short-eared Owl (2003), Townsends Big-eared Bat (1997, 2000, 2003, 2004, 2006) Northern Myotis (1998, 2002, 2004), Yellow-bellied racer (2004), Yellow-breasted chat (2006), Yellow Warbler (2006), Tailed Frog (1998, 2002), Selkirk Least Chipmunk (1999 2002), Western Toad (2006, 2002) Wolverine (1993, 1998, 1999), Grizzly Bear(1995-1997), American Badger(1997-2001), Lynx (1998, 2002, 2007), Bighorn Sheep (2000, 2007), and Mountain Caribou (1994, 1999, 2000, 2002, 2005, 2007, 2010),
- Ecosystem Inventories for small wetlands, deciduous forests and specific critical habitat such as mineral licks.
- Dam Impact Analysis was undertaken between 2005 and 2010 to update understanding of the impacts and to determine compensation options in support of on-going strategic planning.

Monitoring and Evaluation:

- Trophic level monitoring is conducted annually in both Kootenay Lake and Arrow Lakes Reservoir to review the effectiveness of nutrient restoration programs.
- Temperature assessments, both as part of the annual assessment of fertilization programs as well as in streams to determine the effect of temperature on salmonids (for example Slocan River 1998-1999).

[16] Note this is not an exhaustive list.

3. Strategic Objectives for FWCP

Strategic objectives for the Fish and Wildlife Compensation Program reflect a synthesis of the core objectives and mandates of the partner agencies as they relate to mitigating impacts associated with hydro-power generation in British Columbia.

Conservation and sustainable use are core objectives for both the BC Provincial Government (MOE, FLNRO) and Fisheries and Oceans Canada. Conservation is addressed in terms of maintaining individual species or habitats both in terms of their importance for diversity (including genetic diversity), as well as their importance for ecosystem functions, integrity and productivity. For example, a species such as White Sturgeon may be important in terms of species diversity, while Pileated Woodpeckers may be important for maintaining ecosystem functioning and integrity by creating habitat for other species. Sustainable use incorporates the human interest in utilizing species for sustenance, commercial, recreational, or cultural needs. Consequently, species such as rainbow trout, moose or bald eagles (wildlife viewing) could be considered important from a sustainable use perspective.

Community engagement is a core objective for BC Hydro under the compensation program and is driven by the corporation's social responsibility policy. It also reflects the 'shared stewardship' goal of the BC Provincial Government and those of Fisheries and Oceans' Stewardship and Community Involvement program. It reflects the importance of incorporating local values and interests in determining and implementing projects.

The FWCP strategic objectives are therefore:

Conservation

- **Maintain or improve the status of species or ecosystems of concern**
  This objective focuses on the conservation goals for ecosystems, habitats or ecological communities, and particular species. Priorities may be identified through the provincial Conservation Framework or at the watershed level based on local conditions.
- **Maintain or improve the integrity and productivity of ecosystems and habitats**
  This objective addresses the concept of ecosystem integrity, resiliency and the functional elements of ecosystems, including efforts to improve or optimize productive capacity.

Sustainable Use

- **Maintain or improve opportunities for sustainable use, including harvesting and other uses**
  This objective focuses on the program's role in restoring or enhancing the abundance of priority species and in providing information to resource management decision makers related to providing opportunities for harvesting and

other uses. Harvesting includes First Nations, recreational, sport and commercial harvests. Other uses may include cultural, medicinal, or non-consumptive uses.

Community Engagement

- **Build and maintain relationships with stakeholders and aboriginal communities**
  This objective stems from BCH's social responsibility policy, the BC Provincial Government's shared stewardship goal and the approach of DFO's Stewardship and Community Involvement Program. This recognizes the importance of engaging aboriginal communities, local stakeholders, and other interest groups to contribute toward making good decisions and delivering effective projects.

4. Priorities

4.1 Introduction

Across all basins and watersheds where the FWCP operates, the general process of identifying priorities involves three basic steps:

Step 1 – Identification (Candidate Priority Species and Ecosystems)

The first step involves identifying and prioritizing the species and ecosystems against the core strategic objectives, and understanding how they have been affected by hydro-power development footprint impacts.

Step 2 – Preliminary Planning

This step consists of identifying action plans based on a review of the prioritized species and ecosystems. The scope of the action plans is defined by logical groupings of species and/or ecosystems. Other key considerations include: limiting factors, exploring the opportunity for multiple benefits, addressing specific local threats, the feasibility of implementing actions, and alignment with existing agency programs.

Step 3 – Final Planning and Prioritization

This step identifies specific actions within each action plan, stratified by focal area (where appropriate). Actions are selected according to cost effectiveness and technical feasibility criteria:

- **Technical Feasibility –** The program should generally seek out investments that are the most technically feasible. Considerations generally include the use of proven methods and availability of technical resources. Innovative approaches should be considered but they must have a credible technical foundation and reasonable expectation of success. The potential interactions with system operations and programs being implemented by the Water License Requirements and other basin programs (e.g., Columbia Basin Trust, Habitat Conservation Trust Fund, etc.) must also be considered.

- **Cost Effectiveness** – The program should generally seek out investments that are the most cost effective. This includes issues or actions that may benefit multiple species, areas where there is an opportunity to leverage additional funds for activities, issues where previous work has been conducted and incremental expenditure may have substantive benefits, actions that are closely related to on-the-ground actions with measurable impacts, amongst others.

4.2 Priority Setting in the Columbia Basin

In the Columbia region of the FWCP, the Dam Footprint Impact Study (Utzig and Schmidt 2011, and references therein) provided the foundation for the priority setting process, by describing how the construction of the BC Hydro dam facilities and reservoirs affected fish, wildlife, and their habitats. Periodic workshops with the fish and wildlife technical committees, supported by information gathering (i.e., reports and interviews) and management reviews guided the priority setting process.

Step 1 – Identification began by assembling lists of candidate priority species covered in the Dam Impacts Study. A Species Rating and Database Tool (FWCP 2011a) was developed to enable each species to be rated on a 5-point scale against each of the FWCP strategic objectives (i.e., conservation, sustainable use, and community / First Nations engagement), as well as an impact rating for the link to footprint. The database allowed for the sorting and grouping of species by guild and identified the primary and supporting ecosystem / habitat affiliation for each species.

Step 2 – Preliminary Planning was guided by the choice to assemble action plans by five major ecosystem categories and one species category (Table 2).

Within each ecosystem category, an initial review of existing information was undertaken to summarize the dam footprint impacts, understand the limiting factors on fish and wildlife, and identify past FWCP accomplishments. Based on this understanding, a set of plan-specific objectives were developed as the basis of identifying potential actions.

Table 2: Action Plans Chosen for the Columbia Basin

Action Plan	Scope
Large Lakes	Large lakes and reservoirs are ecosystems that are greater than 1,000 hectares in size (classification threshold adopted from the *Freshwater Fisheries Program Plan* (MOE 2007)). Many have hydrologic regimes that are dominated by hydropower developments.
Small Lakes	Naturally occurring water bodies that are generally unaffected by hydropower developments. Most are low productivity (oligotrophic) ecosystems.
Streams	Natural watercourses with flowing water. Includes remaining river fragments along the Columbia and Kootenay Rivers mainstem (stream order 9) up to upper basin headwater tributaries (stream order 1).

Riparian and Wetlands	Riparian habitat is the area adjacent to a river or stream that differs from surrounding uplands in the diversity and productivity of its plant and animal species. A wetland is an area of land whose soil is saturated with moisture either permanently or seasonally.
Upland / Dryland	Uplands are ecosystems that are found above the influence of periodic or permanent flooding. Drylands are a subset of these habitats characterized by relatively low rainfall and rapid drainage, which results in vegetation communities dominated by grasses and drought-tolerant shrubs and trees.
Species of Interest.	Defined as species of conservation concern (including species-at-risk) or other regionally important species for management planning process.

Within each broad ecosystem type, the priority rated species were identified using the spreadsheet database. Candidate actions or tasks were then developed and screened in consideration of two factors:

1. The primary ongoing threats and limiting factors identified for the priority species and their habitats, and
2. The management objectives and targets developed within each ecosystem type.

Species of interest were cross-referenced with the ecosystems addressed in other actions plans to encourage projects that leverage both species and ecosystem priorities.

Step 3—Final Planning and Prioritization involved first identifying key geographic focal areas or sub-categories within ecosystems addressed by the action plans (e.g., Kootenay Lake, Upper Columbia Wetlands). Actions were developed for each focal area /sub-category and organized into five action categories (Table 3). Here again the Dam Impact Studies were drawn upon as a primary source of potential management actions at both the species and ecosystem level. After a further round of screening and organization, the final lists of actions within each action plan were assigned a relative priority rating on a scale of 1 to 3.

In overview, given the current commitment of FWCP partners to continue support for past investments that have demonstrated benefits for impacted fish and wildlife species, the Large Lakes and Riparian and Wetlands Action Plans currently have a relative higher priority than the other ecosystem-based action plans. The Small Lakes and Streams Action Plans contain actions to first and foremost improve the information basis for further planning, which may result in the identification of higher priority actions for specific

geographic focal areas or topics over time. The Upland / Dryland Action Plan identifies feasible actions that are currently suitable for implementation.

Table 3 Five Action Categories with Example Actions and Tasks

Action Categories	Example Actions / Tasks
Research and Information Acquisition	Inventory & Analysis Assessments (e.g., to develop implementation targets) Integrated Planning Predator-Prey Interactions Feasibility Studies
Species-based Actions	Translocation / Reintroduction Conservation Aquaculture / Captive Breeding
Habitat-based Actions	Habitat Creation and/or Enhancement Habitat Restoration Restore Connectivity Invasives Control.
Land Securement	Habitat Acquisition Habitat Stewardship
Monitoring & Evaluation	Effectiveness Monitoring Plan Evaluation

Although the bulk of FWCP project investments are expected to be guided by the six action plans, a portion of the FWCP program activities will include small-scale, short-duration strategic projects that target specific issues identified by program partners or others (e.g., community members).

Actions identified in the plans have resource requirements that in aggregate exceed the FWCP's ability to fund; therefore, setting priorities among actions will be required as the program is implemented each year.

5. Action Plan Summaries

The six priority action plans for the Columbia Basin are summarized below. The full plans can be accessed on the FWCP website (http://www.fwcpcolumbia.ca/version2/index.php).

The Large Lakes, Small Lakes, Streams, Riparian and Wetlands and Upland / Dryland Action Plans focus on overall ecosystem health and diversity in support of multiple fish and wildlife species. The objectives and sub-objectives within these plans reflect the overall ecosystem focus, and the plans include primarily habitat-based actions, supported by research, information acquisition, assessments and monitoring actions.

The Species of Interest Action Plan, on the other hand, focuses on species of conservation concern (including species-at-risk) or other regionally important species for management planning purposes. The objectives, sub-objectives and actions within this plan reflect this focus on individual species.

All six action plans in the Columbia Basin provide broad support to the FWCP strategic objectives for sustainable use and community engagement.

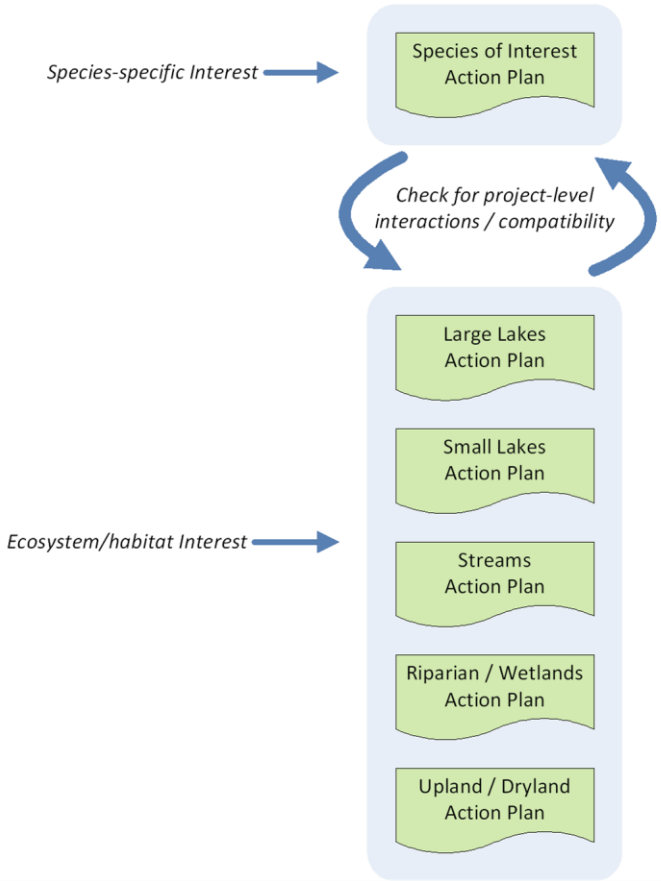

Figure 3: Interactions among Action Plans

FWCP partners and interested parties may examine the action plans with a primary viewpoint stemming from an interest in either individual species or ecosystems and habitats (Figure 3). The action plans contain cross references, such as species-habitat association lists, that help to guide the interactions across action plans. In all cases, there should be a check for potential interactions and compatibility of actions across plans as their projects enter the detailed development stage. This is important for two reasons:

1. *To Achieve Synergy* – For example, actions to protect shoreline and shallow water habitats are noted within the Small Lakes Action Plan. When developing these actions into project proposals for any specific small lake, proponents should refer to

the Riparian and Wetlands Action Plan in order to check for compatible actions such as land securement opportunities or plans to control invasive species.

2. *To Test Compatibility* – For example, broad-based habitat restoration actions like prescribed burning are identified in the Upland / Dryland Action Plan. Specific project proposals for an area should test for compatibility with potential actions identified in the Species of Interest Action Plan, where protection of important habitat features or other critical life history requirements of species of conservation concern are noted.

5.1 Large Lakes Action Plan

Rationale

Large lakes are important in the Columbia Region as they support fisheries for large rainbow trout, bull trout and kokanee. Large Lakes are defined in BC as those bigger than 1,000 hectares and are typically complex ecosystems supporting a more diverse fish/aquatic community than that found in small lakes (MOE 2007). In the Columbia Basin, there are several large lake / reservoir systems that have been significantly altered as a result of dams built for flood control and hydropower development. Large reservoirs have inundated extensive areas of lakes, riverine, riparian and wetland/floodplain habitats resulting in significant impacts to both fish and wildlife species. Some of the most significant limiting factors in the large lake / reservoir aquatic ecosystems include a decline in nutrient inputs due to dam impoundments, a loss of high quality spawning and rearing habitat in stream tributaries, a loss of effective littoral habitat due to reservoir fluctuations, and reservoir aging phenomenon (initial nutrient spike with long term decline after).

Program investments to date include large lake nutrient restoration programs started in 1992 on Kootenay Lake and 1999 on Arrow Lakes Reservoir. These programs have successfully increased productivity at lower trophic levels, although success has been more variable at higher trophic levels (i.e., kokanee and their predators). Early efforts to address dam-related impacts in large lakes also focussed on spawning habitat losses, with investments in both hatchery production for bull trout and rainbow trout and spawning channels for kokanee. These past efforts provide a solid base of experience upon which the future plan direction is developed.

The primary aim of the Large Lakes Action Plan is to take a habitat-based approach to ensuring a productive and diverse aquatic ecosystem capable of providing societal benefits. Implemented in conjunction with species-specific actions to support recovery planning in the Species of Interest Action Plan below, the plan also aims to improve the status of species of conservation concern. The plan recognizes that large lakes in the Columbia Basin support a significant and varied fishery for First Nations, other local residents and tourists. The goal generally is to have a thriving recreational fishery in the region.

Focus

The Large Lakes Action Plan presents a strategy to address compensation for five priority large lake / reservoir systems within the Columbia compensation area: Kootenay Lake, Duncan Reservoir, Arrow Lakes Reservoir, Revelstoke Reservoir and Kinbasket Reservoir (Figure 4). It also includes provision for planning preliminary actions on other large lakes in the Basin. The plan describes fisheries objectives, measures and targets, and the actions required to meet (and revise) the targets over time.

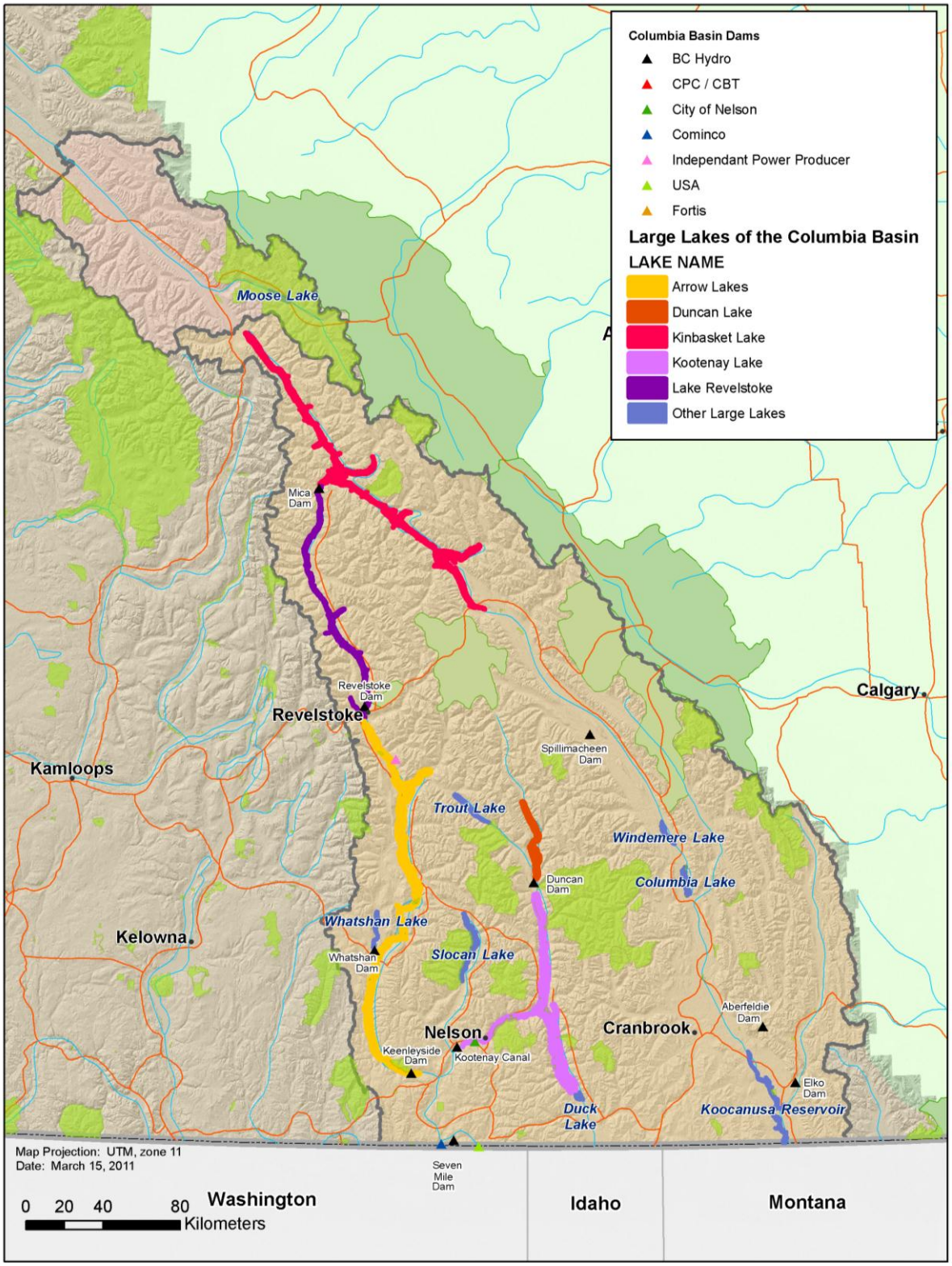

Figure 4: Priority Large Lakes in the Columbia Basin

The Large Lake Plan re-affirms the primary importance of the nutrient restoration program as the primary near-term means to offset the losses of overall aquatic productivity in Kootenay and Arrow lakes due to impoundment and upstream dams. That said, given the high proportion of the current program budget that is allocated to the nutrient restoration programs, it emphasizes the need to evaluate the efficacy of the actions and investments over time. The plan further directs the development and implementation of studies, evaluations and actions aimed at refining and achieving management objectives and targets for priority indicator species within each large lake system. In summary, actions identified in the Large Lakes Action Plan focus on:

1. Habitat Restoration – continued implementation and ongoing adaptation of the nutrient management programs and spawning channels in both Kootenay Lake and Arrow Lakes Reservoir.
2. Assessments – conduct habitat- and species-based biological studies and modelling to inform the development of targets for indicator species in each priority lake system (e.g., piscivorous rainbow trout, bull trout, burbot, and kokanee).
3. Information Acquisition – develop an inventory of habitat restoration and enhancement opportunities for target species in each priority lake system.
4. Monitor the status of multiple ecosystem components relative to fisheries and ecosystem management objectives and targets.

Expected Outcomes

- Sustained abundance and diversity of target fish species;
- Improved targets for each indicator species ;
- Improved understanding of limiting factors for fish and wildlife;
- Better understanding and communication of the costs and benefits of FWCP actions; and,
- Sustained or improved regional angling opportunities.

5.2 Small Lakes Action Plan

Rationale

There are over 220,000 small lakes in British Columbia that support the majority of angling effort in the Province, and are generally recognized as representing the best opportunity for increased growth of the economically important recreational fishery. Small lakes also play a unique role in support of overall aquatic biodiversity in the province, and provide unique habitat for nesting and migrating birds, and rearing and foraging habitat for amphibians, reptiles, and aquatic mammals.

In the Columbia Basin, dams built for flood control and hydropower development have significantly altered the status of small lake habitat. A total of 7 $km^2$of small lake habitat was inundated by creation of the Large Lake / Reservoir systems, while headponds and reservoirs associated with smaller hydro development projects (e.g., Spillimacheen, Walter Hardman, Whatshan, etc.) created a little over half that amount (although with markedly different biophysical features like flushing rates, etc.).

The majority of small lakes in the Basin are naturally low productivity (oligotrophic) systems. Limiting factors for fish and wildlife include biotic factors like predation and competition, which may include effects of invasive species and harvest. Abiotic factors are also important, like habitat quantity and quality, access to habitats (i.e., passage), summer and winter water temperatures, water levels, nutrient levels, length of the growing season and various natural and human-induced disturbances.

Given the extent of footprint habitat losses and ongoing ecosystem pressures, actions to protect and restore existing small lake habitat is a priority for compensation.

The primary aim of the Small Lakes Action Plan is to take a habitat-based approach to ensuring a productive and diverse aquatic ecosystem capable of providing societal benefits. Implemented in conjunction with species-specific actions to support recovery planning in the Species of Interest Action Plan below, the plan also aims to improve the status of species of conservation concern. The plan recognizes that small lakes generally support 70% of freshwater angling activities in the province (BC MOE, 2007). In conjunction with other Provincial programs, the goal generally is to increase the number of angler days and allowable harvest. In the case of small lakes in particular, the program recognizes that there may be conflicting values between sustainable fisheries use and wildlife conservation.

Focus

Since the original small lake habitats have been lost permanently to inundation, and creation of equivalent habitat would be prohibitively expensive, the FWCP will invest in enhancement and protection of naturally occurring small lakes in the region. The initial focus will be on six small lakes identified by the FWCP partners and program staff as

priorities over the next five years: *Summit Lake, Staubert Lake, Box Lake, Bear Lake, Rosebud Lake,* and *Elizabeth Lake.* In addition, the plan incorporates information gathering actions that will help to identify which additional lakes are good candidates for compensation program activities.

There has been little investment in small lakes by the program to date. Therefore, the first priority is to develop a better understanding of the scope of FWCP investment opportunities. Information collection will aim at the identification and evaluation of compensation options.

The plan describes management objectives and an initial set of actions required to develop and manage toward targets over time. For the purposes of management, the plan focuses on two types of small lakes in the Basin: *1) Natural small lakes, with high species conservation value*, and *2) Natural small lakes, with high potential for increased sustainable use (i.e., angling and/or wildlife viewing) with modest FWCP investment in habitats and/or stocking*. In summary, actions identified in the Small Lakes Action Plan focus on:

1. Planning and Assessments – identify fish and wildlife habitat restoration and other compensation options targeting improved fisheries; update and refine the overall plan.
2. Information Acquisition – establish baseline information for priority small lakes. (e.g., habitat / fish population information, conduct breeding waterbird surveys, etc.).
3. Habitat Restoration – restore shallow water habitats and habitat features such as nesting islands, loafing logs, emergent aquatic vegetation, etc.; develop control programs for invasive species.
4. Land Securement – develop shoreline stewardship programs; coordinate other land securement activities with the Riparian and Wetlands Action Plan (see below).
5. Monitor – establish basic shoreline and water level monitoring; effectiveness monitoring of completed works.

Expected Outcomes

- Identification and prioritization of locations and future compensation actions for small lake habitats;
- An updated action-oriented plan detailing specific targets and measures of success;
- Improved small lake ecosystems, including robust fish and wildlife populations; and,
- Improved angling and wildlife viewing opportunities.

5.3 Streams Action Plan

Rationale

The loss of functional stream and riverine habitat stands out as one of the most notable impacts from development of dams and reservoirs in the Columbia Basin. Some 1,600 km of stream systems were lost due to impoundment, and remaining mainstem rivers below dams have highly regulated flow regimes. Fluvial fish populations have been greatly reduced in the basin, and the loss of gravel bars has been noted as a particular concern for some bird species.

Most streams in the Columbia Basin are naturally low productivity (oligotrophic) systems. Limiting factors vary among species, trophic levels and locations. Limiting factors for fish likely include biotic factors like predation and competition, and abiotic factors like habitat quantity and quality, access to habitats (i.e., passage), summer and winter water temperatures, flow regime, nutrient levels and length of the growing season. Some of these limiting factors are also jointly operational in nature.

Given the extent of footprint habitat losses and related ecosystem pressures, actions to protect and restore existing stream habitat is a priority for compensation.

The primary aim of the Streams Action Plan is to take a habitat-based approach to ensuring a productive and diverse aquatic ecosystem. Implemented in conjunction with species-specific actions to support recovery planning in the Species of Interest Action Plan below, the plan also aims to improve the status of species of conservation concern.

Focus

Since the original stream habitats have been lost permanently, FWCP will invest in enhancement and protection of remaining river fragments as well as "off-site" streams in the region. The initial focus will be on fifteen streams identified by the FWCP partners and program staff as priorities over the next five years:[17] *Salmo River, Columbia River downstream of Hugh Keenleyside Dam, Slocan River, Alkolkolex River, Flathead River, Kootenay River mainstem downstream of Kootenay Lake, Kootenay River mainstem upstream of Kootenay Lake, Goat River, Palliser River, White River, Bull River, Elk River, Wigwam River, St. Mary River,* and *Skookumchuck Creek.* In addition, the plan incorporates information gathering actions that will help to identify which additional streams are good candidates for compensation program activities.

[17] In general, streams in the West Kootenay have been impacted by hydropower development to a greater degree than those in the East Kootenay and the remaining streams are a priority; however, there may be more opportunity for cost-effective habitat improvements in the East Kootenay.

Modest FWCP investments to date have included projects such as stream complexing, and fish passage improvements. Moving forward, the first priority is to develop a better understanding of the scope of FWCP investment opportunities. Information collection will focus on the identification and evaluation of compensation options.

The plan describes management objectives and an initial set of actions required to develop and manage toward targets over time. In summary, actions identified in the Streams Action Plan focus on:

1. Planning and Assessments – assess limiting factors and identify stream habitat restoration options for priority streams; contribute to instream flow studies in support of water allocation decisions (e.g., conservation licenses, buy-backs); update and refine the overall plan.
2. Habitat Restoration – apply appropriate techniques (e.g., large woody debris, habitat complexing, stream fertilization, etc.) designed to address site-specific limiting factors; develop control programs for invasive species.
3. Land Securement – coordinate riparian land securement activities with the Riparian and Wetlands Action Plan (see below).
4. Monitor – effectiveness monitoring of completed works.

Expected Outcomes

- Identification and prioritization of locations and future compensation actions for stream habitats;
- An updated action-oriented plan detailing specific targets and measures of success;
- Improved stream ecosystems, including robust fish and wildlife populations; and,
- Improved angling and wildlife viewing opportunities.

5.4 Riparian and Wetlands Action Plan

Rationale

Riparian and wetland habitat in the Columbia River system has been altered significantly by the construction of dams and consequent changes to flood regimes. Basin-wide, nearly 270 km^2 of floodplains (roughly corresponding to riparian habitat) and 130 km^2 of wetlands were inundated by reservoirs resulting from BC Hydro dam construction. Beyond the direct loss in the extent and distribution of riparian and wetland habitats in the Basin, there have been other impacts affecting the productivity of those habitats that remain. Key limiting factors include variable hydrologic conditions that fail to support necessary ecosystem functions (e.g., nutrient exchanges between terrestrial and aquatic systems) and the loss of species-specific habitat features (e.g., dense nesting cover for waterfowl).

In the past, FWCP investments and significant efforts by partner agencies and organizations have led to the creation and maintenance of wetland habitat areas, particularly in the Columbia and Creston valleys. Nonetheless, given the extent of footprint habitat loss, further actions to protect and restore existing wetlands and riparian habitats, and in some cases to create or convert sites into desired habitats remains a high priority for compensation.

The primary aim of the Riparian and Wetlands Action Plan is to take a habitat-based approach to ensuring productive and diverse riparian and wetland ecosystems. Implemented in conjunction with species-specific actions to support recovery planning in the Species of Interest Action Plan below, the plan also aims to improve the status of species of conservation concern.

Focus

The Riparian and Wetlands Action Plan targets the majority of actions toward six priority riparian and wetland habitat focal areas within the Columbia Basin compensation area, including *Creston Valley, Upper Columbia, Canoe Reach and Robson Valley, Lardeau Beaton and Revelstoke Reach, Slocan Valley* and *Elk Valley* (Figure 5). These are the areas where most remaining riparian and wetland habitat occurs, where significant investments have been made by FWCP, or where significant, known opportunities for investment occur.

The plan describes management objectives, measures and targets, and the actions required to meet (and revise) the targets over time. Actions are also organized around three broad habitat categories: 1) naturally functioning habitats, 2) degraded habitats (candidates for restoration) and created (artificial) habitats. In summary, actions identified in the Riparian and Wetlands Action Plan focus on:

1. Land Securement – collaborative efforts to either purchase or otherwise secure (e.g., through covenants) priority habitats.
2. Habitat Restoration and Creation – habitat treatments such as drawdowns and controlled burns to restore habitat, diking to create habitat, installing fencing

(either permanent or temporary as required) to protect existing/restored habitats; develop invasive control programs.

3. Planning and Assessments – develop operational plans for managed wetlands.
4. Information Acquisition – conduct biophysical studies to identify habitat risks and project opportunities in each focal area.
5. Monitor – effectiveness monitoring of completed works; refinement of management targets over time.

Expected Outcomes

- Known distribution, abundance and condition of riparian and wetland habitats throughout the basin;
- The securement of a significant proportion of currently unprotected, naturally functioning riparian and wetland habitat; and,
- Enhanced and maintained productivity of restored and created wetlands, where feasible.

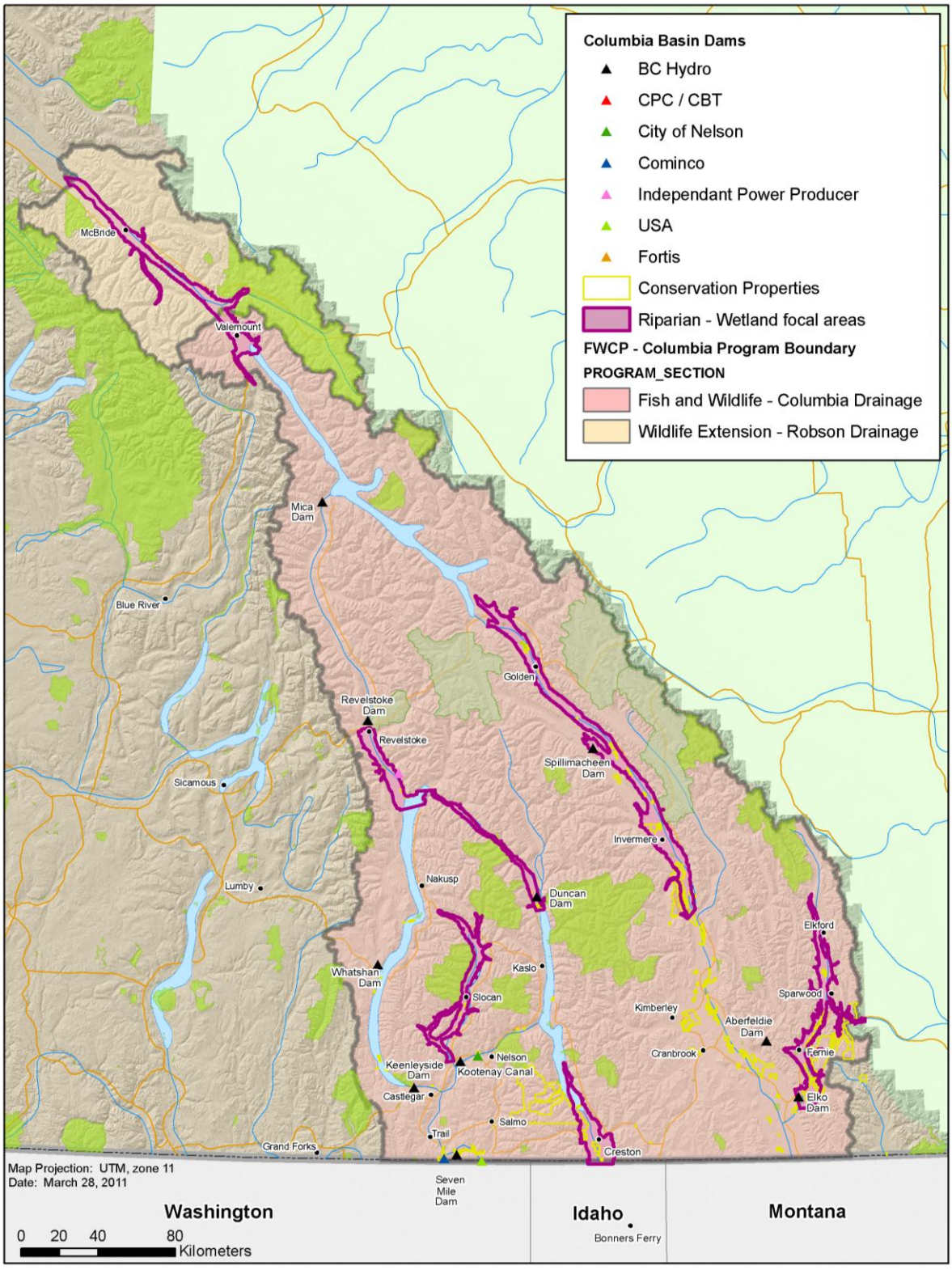

Figure 5: Riparian and Wetland Action Plan Focal Areas.

5.5 Upland / Dryland Action Plan

Rationale

Upland habitats are defined as those ecosystems that are found above habitat influenced by periodic or permanent flooding. Drylands are a subset of upland habitats characterized by relatively low rainfall and rapid drainage, which results in vegetation communities dominated by grasses and drought-tolerant shrubs and trees. Basin-wide, over 24,000 ha of upland / dryland habitat was inundated by reservoirs resulting from BC Hydro dam construction (primarily in the Kinbasket reservoir area). Although the physical extent of habitat loss as a proportion of overall habitat was small, significant impacts have resulted from the loss of connectivity among habitats which has disrupted the dispersal of plants and animals and the seasonal movements of some species. These impacts are further confounded by other human activities in the Basin that limit upland / dryland ecosystem productivity including forest harvesting, livestock grazing and other resource extraction activities. Invasive species, soil erosion and recreation use impacts are also known to follow the expansion of roads and other linear right-of-way developments.

Given the extent of footprint habitat losses and related ecosystem pressures, actions to protect and restore existing upland / dryland habitats are a high priority for compensation. Dryland restoration in particular is noted as a high priority objective for the land management agencies through the Kootenay Boundary Land Use Plan and other strategic initiatives.

The primary aim of the Upland / Dryland Action Plan is to take a habitat-based approach to ensuring productive and diverse terrestrial ecosystems. Implemented in conjunction with species-specific actions to support recovery planning in the Species of Interest Action Plan below, the plan also aims to improve the status of species of conservation concern.

Focus

The opportunity to restore upland habitat directly or indirectly affected by dam impacts is limited. As a result, the FWCP will direct management actions towards the best opportunities for improving the condition and productivity of priority native upland/dryland habitats within the Columbia Basin. These priority habitats include: *1) fire-maintained ecosystems (i.e., NDT 4 classified forest ecosystems), 2) exceptional old-growth forests, 3) deciduous forests (e.g., rare aspen leading stands),* and *4) ungulate winter ranges (designated under the Forest and Range Practices Act)* (Figure 6). Co-management of “conservation properties”, which are fee-simple parcels usually owned by the BC Ministry of Environment or non-governmental agencies and co-managed with the Ministry and land trusts, offer a special opportunity to achieve FWCP objectives in the Basin.

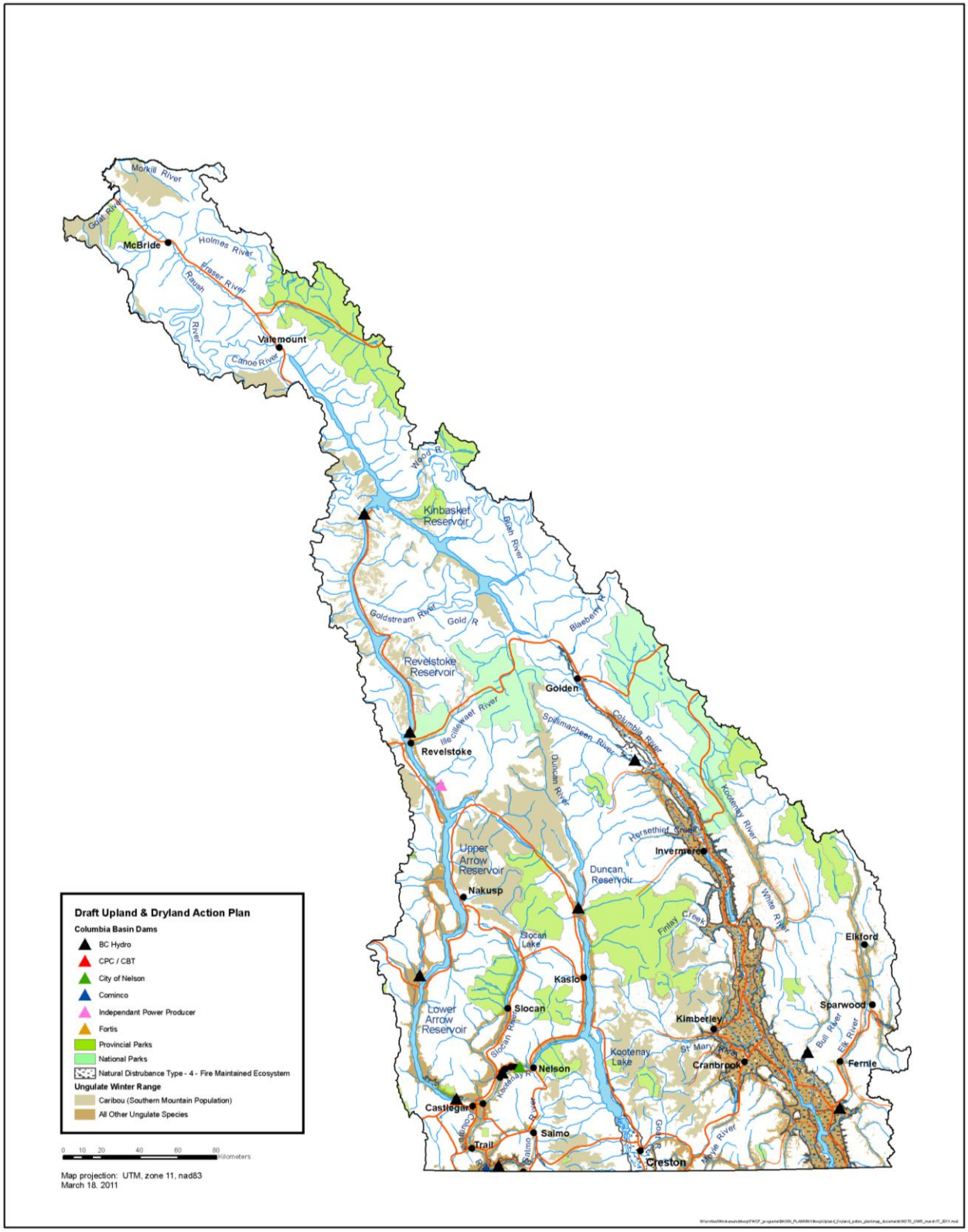

Figure 6: Fire-maintained Ecosystem and Ungulate Winter Range in the Columbia Basin.

The plan describes management objectives, measures and targets, and the actions required to meet (and revise) the targets over time. In summary, actions identified in the Upland / Dryland Action Plan focus on:

1. Land Securement – collaborative efforts to either purchase or otherwise secure (e.g., through covenants) priority habitats.
2. Habitat Restoration – conduct ecosystem restoration projects (e.g., prescribed burning, wildlife tree recruitment, etc.) designed to address site-specific limiting factors; develop invasive plant control programs.
3. Planning and Assessments – develop plans for all conservation properties; contribute to NDT 4 and other restoration planning efforts.
4. Research – develop a framework to identify habitat risks and project opportunities for ungulate range enhancement.
5. Monitor – effectiveness monitoring of completed works; support species monitoring (e.g., ungulates); refinement of management targets over time.

Expected Outcomes

- Improved condition of priority upland / dryland habitats – e.g., fire-maintained ecosystems, ungulate winter ranges – through periodic habitat treatments;
- Securement of currently unprotected priority habitats;
- Identification and prioritization of locations and potential future actions for conservation, protection and restoration; and,
- Completed / updated plans for all conservation properties on a 5-year rotational basis.

5.6 Species of Interest Action Plan

Rationale

Habitat impacts as described above in each of the ecosystem-based action plans translate directly into impacts on species. As habitats are either lost, or their productivity is diminished, the overall carrying capacity for individual species is reduced, resulting in changes in range or abundance. Left unaddressed, individual species impacts can result in local extirpations and overall losses in biodiversity.

In most cases, broad-based habitat restoration and enhancement actions are the preferred means of providing compensation for priority species. In some cases however, additional, complementary species-based actions, directed at niche habitat requirements, are also warranted. The Species of Interest Action Plan provides the avenue for such compensation actions to be developed and implemented.

The primary aim of the Species of Interest Action Plan is to develop species-specific actions to maintain or improve the status of species of interest in the Columbia Basin. These actions will be developed and implemented in conjunction with the habitat-based actions in the ecosystem based Action Plans described above.

Focus

Management for species of interest ultimately rests with the provincial and federal environment Ministries, but FWCP contributes resources towards planning and implementation of management actions that benefit species within its program area, usually based on the outcomes of multi-agency planning processes. FWCP's mandate limits its involvement in species of interest management to activities that meet FWCP objectives.

There are three general categories of species of interest defined for this action plan:

Recovery Species: Recovery species are those of highest priority and conservation concern that have been adversely impacted by dam construction and/or operation. These species have formally been classified as either threatened or endangered by BC or Canada, and recovery plans are either in place or under development by Federal or Provincial management agencies. Actions contained within this plan are directly coordinated with recovery strategies and plans. The seven recovery species addressed in the plan are: *Mountain Caribou, Northern Leopard Frog, American Badger, Western Screech-Owl, Yellow-breasted Chat, Lewis' Woodpecker,* and *White Sturgeon.*

Focal Species: Focal species are defined by having both a high conservation concern (as defined by the BC Conservation Framework and local interest) and a strong linkage to footprint impacts. Actions proposed for species in this category should be developed in the context of the relevant ecosystem-based plans (i.e., wetlands/riparian, upland/dryland, etc.).

Inventory Species: These species also have both a high conservation concern and have been affected by dams, but detailed inventory and/or trend monitoring is required to support the development of more detailed actions. Actions proposed for species in this category should aim to provide the basis for future compensation actions.

The Action Plan has individual actions for each Recovery Species, and provides direction for proponent-led proposals aimed at improving the status of both Focal Species and Inventory Species. In summary, actions identified in the Species of Interest Action Plan focus on:

1. Planning and Assessments – identify key causes of mortality and recruitment failure (e.g., predation, road kill, habitat competition); develop habitat suitability models and maps.
2. Information Acquisition – survey abundance of recovery/focal/inventory and inter-related (e.g., predator) species.
3. Species Recovery – transplant animals to augment a critically low population in an area; support captive breeding and hatchery programs.
4. Habitat Restoration – restore habitat features such as breeding or nesting areas; develop invasive species control programs.
5. Land Securement – contribute toward land securement activities specifically targeting critical habitats; develop stewardship programs for landowners and municipalities.
6. Monitor – abundance and habitat monitoring; effectiveness monitoring of completed works.

Expected Outcomes

- Implementation of key recovery actions to improve the distribution and abundance of priority species.
- Leveraging of compensation investments to simultaneously support both species and habitat improvements.
- Improved information regarding the status of Columbia Basin aquatic and terrestrial species.

6. Conclusion

There has been a significant loss of habitat and other related fish and wildlife impacts in the Columbia Basin as a result of hydro-electric developments. To address these footprint impacts, this *Columbia Basin Plan* sets forth the strategic direction for the Fish and Wildlife Compensation Program (FWCP) in the Columbia Region. It presents an overview of the program and its objectives derived from the mandates of the program partners.

Overall program activities are summarized within six Action Plans, focused on Large Lakes, Small Lakes, Streams, Riparian and Wetlands, Upland and Dryland, and Species of Interest. The entire set of plans are intended to be living documents, updated and revised periodically as new information becomes available and priority projects are completed.

The latest status of all plans can be found on the FWCP: Columbia website (http://www.fwcpcolumbia.ca/version2/index.php).

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