A Border Runs Through It: Exploring Transboundary Institutional Support for Environmental Flows for Ecosystem Function in the Columbia River Basin

by

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Abstract

This study examines the role of institutional cooperation between the United States and Canada under the Columbia River Treaty in supporting flow regimes that sustain the health and function of the ecosystem in the Columbia River Basin. Methods employed include a literature review, a limited set of case studies, and an online survey questionnaire. These methods are used to explore regional perspectives on the existing transboundary cooperative regime in the Basin, to identify key concerns, and to identify institutional alternatives that may meet the identified concerns. This study then presents an analysis of the identified institutional alternatives. This study finds that the environmental flow paradigm and the concept of basin-wide water use planning underpin institutional alternatives that best meet ecosystem function objectives in the Basin. These findings are used to recommend a portfolio of institutional options.

Keywords: Columbia River Treaty; transboundary river management; ecosystem function; institutions; climate change; environmental flows

Dedication

For my husband, my family, and my friends.

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I wish to thank all those who made this capstone possible. I am grateful to the Adaptation to Climate Change Team at Simon Fraser University and to Deborah Harford for introducing me to this issue and supporting my opportunity to work on this subject matter. I also wish to thank the Pacific Institute for Climate Solutions for their support. I owe a debt of gratitude to all who contributed their time and effort to assisting me with this project, including all of the faculty and staff of the MPP program, Dr. Daniel Savas for his thoughtful advice early on, Dr. Nancy Olewiler for her insights, advice, and support of this research, as well as for her useful feedback during my defense, and my supervisor, Dr. Doug McArthur for his advice, guidance, and support as I made my way through the adventure that is completing a thesis. I also wish to thank my husband, Toby, my parents, my parents-in-law, my family, my friends, and my MPP cohort for their constant encouragement and support during the past two years. Thanks to you, Toby, in particular, for you have been unfailingly patient, supportive, and enthusiastic as I undertook this program, and I am so very grateful.

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List of Acronyms

ACTO	Amazon Cooperation Treaty Organization
AOP	Assured Operating Plan
BC	British Columbia
DBDA	Danube Basin Analysis Report
DOP	Detailed Operating Plan
DRBM Plan	Danube River Basin Management Plan
FWCP	Fish and Wildlife Compensation Program
ICPDR	International Commission for the Protection of the Danube River
IJC	International Joint Commission
IWRM	Integrated Water Resources Management
MAF	Million-acre-feet
NTSA	Non-Treaty Storage Agreement
SFU	Simon Fraser University
SAP	Strategic Action Program
SOA	Supplemental Operating Agreement
TDA	Transboundary Diagnostic Analysis (Amazon)
TSR	Treaty Storage Regulation
US	United States
WUP	Water Use Plan

Executive Summary

The United States ("US") and Canada share the Columbia River and the Columbia River Basin. The River flows through a South-eastern portion of the province of British Columbia into the Pacific North-western US where it eventually drains into the Pacific near Portland, Oregon. In order to manage river flows for the purposes of flood control and hydroelectric power generation, the two nations signed the Columbia River Treaty in 1961 (ratified in 1964). Today, the Columbia River Treaty can be described a story of successful collaboration between the nations for its intended purposes. The mighty and highly variable flows of the Columbia are now dam-controlled, which mitigates regional flood risks, and the Columbia has become a vital source of regional hydroelectric power generation.

Yet, the dominant issues that underpinned the nations' interests when the Treaty was reached 1961 are no longer the only issues of concern. One such concern is that the successful management of the Columbia River for flood control and hydroelectric power generation has been achieved at the expense of the River's ecosystems. The construction dams altered a number of ecosystems in the Basin, the operation of dams continues to alter the natural hydrology of the River (which impacts the functioning of Basin ecosystems in various ways), and competition between human and environmental water uses puts pressure upon an already-taxed river system. Further, forecasted climate change may exacerbate existing challenges to ecosystem function in the Basin and give rise to new challenges.

Now is the time to consider how these matters can be addressed by the US and Canada in their management of the River. This year – 2014 – presents the US and Canada with their first opportunity to ask to end the Treaty. This is because 2024 is the first year the Treaty can be unilaterally terminated upon 10 years notice from either party. Further, some Treaty terms, such as those pertaining to flood control, will change in 2024 even if no nation wishes to end the Treaty. In this context, the nations, observers, residents, and academics have been contemplating how the Treaty can best address modern concerns about ecosystem function now and in a future increasingly subject to the impacts of climate change.

Using a literature review, online survey and limited set of case studies, this study aims to contribute to the dialogue on how we – the US and Canada – may structure our international institutions to support flexible and adaptive means of addressing the transboundary issue of ecosystem function in the Columbia River Basin. The literature, survey data, and case analysis is first used to identify a set of objectives that may assist us in crafting institutional arrangements that better balance flows for ecosystem function with other social values, such as flood control and hydroelectric power generation. Then, using multi-criteria analysis, this study assess the status quo and three institutional alternatives against criteria derived from the identified objectives. The alternatives are 1) adding ecosystem function as a third purpose to the Columbia River Treaty, 2) instituting transboundary water use planning, and 3) establishing a transboundary river basin organization.

The final recommendations of this study are a multi-pronged policy approach. The recommendations include the adoption of the identified objectives within the basis of future transboundary water management under the Treaty. Further, transboundary water use planning is identified as an effective and adaptive means of formally placing ecosystem function within the water management regime under the Columbia River Treaty.

It suddenly struck me that that tiny pea, pretty and blue, was the Earth. I put up my thumb and shut one eye, and my thumb blotted out the planet Earth. I didn't feel like a giant. I felt very, very small.

— Neil Armstrong.

Chapter 1. Introduction

1.1. Identifying the Policy Problem

Earth has been called the blue planet with good reason. Water covers about 75 percent of the planet's surface. Freshwater comprises about 2.5 percent of this amount. It is a finite resource subject to the constant and ever-growing demands of the nations through which it flows. In fact, over 260 river basins are shared between two or more countries (Cooley & Gleick, 2011). As countries develop, they often exploit their river systems. This can boost economic outputs, but it can also have detrimental social and environmental consequences. For example, dams built along a shared river alter the river's flow regime, which has myriad impacts on the natural environment that are not constrained by political borders. As nations attempt to address these impacts, they arrive at the major challenge facing transboundary water management today: effectively managing a river while also respecting the sovereign interests of the nations sharing the watercourse (Braga et al., 2011). Such is the case with the Columbia River.

The United States ("US") and Canada share the Columbia River. The River flows through the province of British Columbia ("BC") into the Pacific North-western US. It is the largest river in the Pacific Northwest and the fourth largest river in North America (Cohen et al., 2000; Osborn, 2012). The main stem of the Columbia begins at its headwaters at Columbia Lake in BC's South-eastern interior. From Columbia Lake, the River flows north through the Rocky Mountain Trench for about 250 kilometres before turning and heading south. The River crosses the border into Washington State and then flows past a series of dams before emptying into the Pacific near Portland, Oregon.

This powerful river has been a source of regional interest and concern for many decades. By the middle of the last century, regional focus was not only on rising power demands in the region, but also on a pressing need for flood control. For example, in 1948 a flood on the Columbia destroyed the city of Vanport, Oregon, which spurred

interest in finding a system-wide approach to flood control (CRTRT, 2013a; Osborn, 2012; U.S. Entity, 2013a). The twin desires of harnessing the River's might for hydroelectric power generation and flood control culminated when the US and Canada (the "Parties") signed the Columbia River Treaty (the "Treaty") in 1961 (ratified in 1964).[1]

The Treaty enabled a series of dams and reservoirs to be constructed: three in Canada (Mica, Hugh Keenleyside (also known as Arrow), and Duncan) and one in the US (Libby)(the "Treaty Dams").[2] Canada is obligated to operate its Treaty Dams in accordance with the terms of the Treaty. This includes an obligation to operate the 15.5 million-acre-feet ("MAF") of water storage provided by the three Canadian Treaty Dams (the "Canadian Storage") for optimum power generation downstream, and 8.45 MAF of the Canadian Storage in accordance with flood control operating plans.[3] Further, the US is entitled to downstream power benefits, with Canada being entitled to share equally in those benefits. The downstream power benefits refer to the additional power that can be generated in the US as a result of flow management by the Canadian Storage (CRTRT, n.d.). The US provides Canada with one-half of the downstream power benefits (the "Canadian Entitlement").[4] The Canadian Entitlement is provided to Canada as energy and capacity, averaging about 1320 megawatts of capacity (or about 11 percent of the British Columbia Hydro and Power Authority's ("BC Hydro") total capacity) and approximately 4540 gigawatt hours of energy per year (CRTRT, n.d.). Powerex, a

[1] In practice, it is the province of British Columbia that is responsible for and benefits from management of the River in Canada. This is because the *Canada-B.C. Agreement* made on July 8, 1963 assigned to British Columbia all proprietary rights, titles and interests arising under the Treaty, and obliged British Columbia to construct and operate (or arrange for the construction and operation of) all storage required under the terms of the Treaty (*Canada-B.C. Agreement* of 1963, ss. 2 and 3). Canada must also obtain British Columbia's concurrence before doing a number of things, including terminating the treaty (*Canada-B.C. Agreement* of 1963, s. 4(2)(h)).

[2] While this study focuses upon the Treaty Dams, there are numerous other dams along the main stem and tributaries of the Columbia constructed before and after the Treaty Dams. For example, on the Canadian main stem of the Columbia, the construction of the Treaty Dams enabled the construction of the Revelstoke Dam, which is located between the Mica and Arrow dams. In total, there are 11 dams along the mainstem of the River in the US, three in Canada, and over 400 dams used for irrigation and hydroelectric power on tributaries (McKinney et al., 2010).

[3] Until 2024, when floor control provisions under the Treaty automatically switch to a "called upon" approach to flood control.

[4] BC owns the benefits of the Canadian Entitlement per the 1963 *Canada-B.C. Agreement*.

wholly-owned electricity marketing subsidiary of BC Hydro, sells the Canadian Entitlement at market value to BC Hydro, Alberta, or the US (CRTRT, n.d.). Depending on market prices, the Canadian Entitlement is worth $120 – $300 million per year, and goes into BC's general revenue account (CRTRT, n.d.).

In sum, the storage provided by the Treaty Dams adds flood control capacity to the River system and enhances the River's hydroelectric power generation capacity, both of which provide benefits to the US and Canada. Yet, this successful arrangment has come at the expense of the Basin's ecosystems.

Dams impact the volume, quality, and pattern of flows in a river (Hirji & Davis, 2009). Shifting the pattern of flows includes shifting the seasonal timing of flows, impeding the natural flooding of floodplains, and maintaining high flow levels during periods that traditionally faced lower flows (Bunn & Arthington, 2002). In the Columbia River Basin, these kinds of impacts challenge the natural functioning of the Basin's ecosystems. First, the construction of dams along the Columbia resulted in the flooding of lakes, wetlands, floodplains, and other areas (CRTR, 2012). Second, flow alterations due to the continued presence and operation of the dams can have a host of impacts, including impeding the passage of migratory fish, altering aquatic habitats, changing water temperatures and quality, and impacting wildlife and vegetation.

In this context, many feel that the river management arrangements under the Treaty are insufficient to adequately address challenges to ecosystem function arising from the Basin's altered flow regime. Thus, there is a desire to see the Treaty include improved cooperative measures to address environmental matters. This desire exists across the Basin, yet the environmental priorities in the US and Canada may not be not entirely identical. For example, the volume and quality of river flows for anadromous salmon are a dominant concern in the US portion of the Basin, while the impacts of reservoir operations on resident fish, wildlife and vegetation are common Canadian focal points.[5]

[5] Put simplistically, "anadromous" means migratory (i.e. anadrormous salmon migrate from ocean waters to fresh waters to spawn).

Despite some differences in domestic concerns, there is a common driver behind challenges to ecosystem function on both sides of the border: the River's flow regime. Given the fundamental role of alterations to the River's flow regime in challenging ecosystem function in the Basin, finding ways to support flows throughout the Basin may be desirable. Unfortunately, the Treaty is silent on the needs of the Basin's ecosystems or on environmental matters in general. As a result, there are multiple opinions, but no clear path on how best to address ecosystem function in the Basin. Hence, the US and Canada now face what Braga et al. (2011) identify as the major challenge facing transboundary water management today: how to address basin-wide ecosystem challenges while also balancing sovereign interests. In this context, this study examines the following policy problem:

> **The US and Canada do not have a sufficient understanding of which, if any, transboundary institutional alternatives will enable the two nations to better consider and address ecosystem function in the Columbia River Basin.**

To consider this issue, I explore the status quo, as well as institutional alternatives to the status quo. Through a survey of experts on both sides of the border, and through consideration of what some other transboundary basins are doing to address similar water management challenges, I seek insight into what institutional arrangements could address the unique challenges in the Columbia River Basin. Chapter 2 of this report introduces the background for the policy problem. Chapter 3 discusses research methods. Chapter 4 is a narrative summary of the analysis of survey data (the full survey report is included at Appendix B). Chapter 5 explores three case studies to gain insight into institutional alternatives. Chapter 6 describes the institutional alternatives that are assessed in this report. Chapter 7 sets out a comparative multi-criteria analysis of these institutional alternatives. Finally, Chapters 8 and 9 present my recommendations and conclusions.

1.2. Limits to the Scope of Problem Examination

The Treaty does not have a specific termination date. Rather, if either Canada or the US provides notice by 2014, either party may unilaterally terminate the Treaty (which

unilateral termination can occur no earlier than 2024, subject to 10 years notice by the party seeking to terminate the agreement). The institutional alternatives considered in this report provide an opening to the Parties to negotiate and agree upon ways to cooperate/coordinate on the issue of ecosystem function on the assumption that the Treaty will remain in place, in some form, past 2024.[6]

1.3. Key Terms and Concepts

Before continuing on to the body of this report, a number of terms and concepts need to be defined. These are: ecosystem, ecosystem function, ecosystem services, and environmental flows. The literature indicates that each of these terms can have a number of different definitions; however, Table 1.1 sets out definitions for each of these terms that are sufficient for this purpose of this report.

[6] The reason for this assumption is that US and Canadian official positions to-date have indicated an interest in continuing the Treaty, albeit in different ways. The US position seeks to modernize the Treaty, which can include amendments or other modifications, while the Canadian position seeks improvements within the existing Treaty framework (CRTRT, 2014; U.S. Entity, 2013). Based upon these most recent official positions, assuming that the Treaty will continue, in some form, after 2024 is chosen as a plausible narrowing of the scope of this report.

Table 1.1. Key Terms and Concepts

Term	Definition(s)	Source
Ecosystem	"an interacting system of biota and its associated physical environment"	NRC, 2004, p.7
Ecosystem function	"…a process that takes place in an ecosystem as a result of the interactions of the plants, animals, and other organisms in the ecosystem with each other or their environment."	NRC, 2004, p. 1
Ecosystem Services	"…the tangible benefits people obtain from ecosystems; including human use of products from forests, wetlands and oceans (timber, medicinal plants, food products, etc.) and the functions ecosystems perform that are used and valued by human societies, such as the provision of clean water, pollination of crops, and maintenance of livable (sic) climates and atmospheric conditions…."	Swedish Water House, 2009, p. 10
Environmental Flows	"the water regime provided within a river, wetland or coastal zone to maintain ecosystems and their benefits where there are competing water uses and where flows are regulated."	Dyson et al., 2003, p. 17
	"the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems."	Brisbane Declaration, 2007, n.p.

Chapter 2. Background

2.1. Ecosystem Function in the Columbia River Basin.

2.1.1. An Ecosystem Under Pressure

In many ways, the Columbia River Treaty is a success story. The mighty and highly variable flows of the River are now dam-controlled, which mitigates regional flood risks, and the Columbia has become a vital source of regional hydroelectric power generation. For example, there are 19 hydroelectric facilities in the Canadian portion of the Columbia River Basin alone, generating about 50 percent of BC's hydroelectric power (Utzig and Schmidt, 2011). In addition to the dams on the mainstem, there are over four hundred dams throughout the entire Basin that are used for irrigation and hydropower (McKinney et al., 2010). Ultimately, the entire River system has a generating capacity of more than 21,000 megawatts (McKinney et al., 2010).

Yet, the literature indicates that the successful management of the Columbia River has been achieved at the expense of the River's ecosystems. The Columbia River Basin is under strain from a number of impacts. Fluctuating reservoir water levels impact vegetation and wildlife in the Basin. Shores and banks are flooded and uncovered as reservoirs fill and empty. This impacts shoreline vegetation, which is valuable for a number of purposes, including the provision of food, ground cover to control dust, the maintenance of aesthetic quality, and protection for sites of cultural importance (BC Hydro, 2013g). Further, fluctuating reservoir levels impact terrestrial habitats for wildlife. For example, rising reservoir levels in the spring can have direct impacts on nesting birds (BC Hydro, 2013g). Aquatic species are also under pressure. Four resident fish species in the lower portion of the Canadian portion of the Basin, including White Sturgeon, are considered to be at risk (BC Hydro, 2013j). In the US, a number of species of anadromous salmon are listed as endangered or threatened under the federal

US *Endangered Species Act*.[7] Negative impacts can stem from challenges to ecosystem function caused by, or related to, the presence and operation of dams and reservoirs. As discussed in greater detail below, these challenges include:

- "footprint" impacts;
- changes to the River's natural hydrology due to reservoir operations;
- competing water uses;
- climate change.

2.1.2. Challenges to Ecosystem Function

Footprint Impacts

"Footprint" impacts are caused by the construction and continued physical presence of dams (Utzig and Schmidt, 2011). They include habitat loss/alteration due to flooding, nutrient and contaminant effects, impacts on reservoir water quality, erosion, and sedimentation. Dams also create physical barriers that can impact aquatic species. For example, blocking access to fish spawning grounds can negatively impact species' reproductive success, cause species isolation, and decrease species' genetic diversity (Utzig and Schmidt, 2011, p. 34).

Changes to River Hydrology

Snow and glacier runoff are foundational to the natural hydrology of the Canadian portion of the Basin.[8] Over two-thirds of annual precipitation in the region falls as winter snow, which acts as natural water storage until April or May of each year (Murdock, Fraser and Pearce, 2007). As temperatures warm in the spring, the snow melts, causing runoff into the River to increase until it peaks around June of each year.

[7] These species include chinook (Oncorhynchus tshawytscha), steelhead (Oncorhynchus mykiss), and salmon sockeye (Oncorhynchus nerka)

[8] The natural hydrology of the US portion of the Basin is similar, but not identical. While the Canadian portion is largely snow-dominated, the lower portion of the Basin is comprised of both rain-and-snow-dominated and rain-dominated regions (Miles et al., 2000). Some portions of the Basin – namely those low lying regions west of the Cascade mountain range – are low enough in elevation that winter precipitation falls mainly as rain, with little water stored in snowpack; however, these regions form a small part of the total runoff (Miles et al., 2000; Hamlet & Lettenmaier, 2000).

While snow-melt runoff contributes to spring and early summer flows, glaciers supplement runoff during late spring and summer (Murdock, Fraser and Pearce, 2007; Cohen et al., 2000). For example, glaciers near the Mica basin contribute 25 to 35 percent of stream flows in August and September (Jost et al., 2011). After the natural peak around June, the flows decline through the summer and early fall, with the cycle starting again with winter snow accumulation.

The large number of dams along the Columbia and its tributaries has "flattened out" the River's natural hydrology (Cohen et al., 2000). This means that the Basin's hydroelectric system releases water from storage to produce energy in the winter (which raises river flows above natural winter conditions), and captures high spring flows to prevent floods and to refill the system storage in each year (which decreases natural spring flow conditions) (Hamlet, 2003). Reservoir operations, which drive the flattening of the Basin's hydrology, are associated with changes in the River's water temperatures, altered sedimentation, changes in nutrient composition, impacts to shoreline habitats, and fluctuations in below-dam outflows . All of these elements can have various impacts on the River's ecosystems. For example, they can impinge the quality and availability of aquatic habitat for fish species, such kokanee salmon,[9] trout, whitefish and other freshwater fish species (BC Hydro, 2007). Fluctuating reservoir water levels can also impact vegetation and wildlife in the Basin. For example, each reservoir has areas that may be exposed and re-covered by the rise and fall of reservoir waters. These drawdown areas can support vegetation but, because they are periodically flooded, the depth, timing, and duration of these floods impact where and to what degree vegetation can thrive (BC Hydro, 2013g).

Competing Water Users

Hamlet & Lettenmaier (2000, p. 1620) observe that the water managers along Columbia River also face "increasing and irreconcilable competition for water with no available increase in supply." Human and environmental flow needs compete with each other, as well as with flood control and hydroelectric power generation. For example, water for irrigation is an important water use objective in certain sub-regions of the

[9] Kokanee are a non-anadromous (non-migratory) form of Pacific salmon (*Oncorhynchus nerka*) (Foote, Woode, & Withler, 1989).

Basin, such as the Snake River Basin, the Yakima River Basin, the central Columbia Basin in Washington State, and the Okanagon/Okanagan Basin that runs across parts of BC and Washington State (Hamlet, 2011). Fish species, recreation, and irrigation all require flows of during summer months. This can place them in competition with each other for water flows, but also in conflict with the need to store summer water and release storage in winter months for hydropower and flood control purposes. Further, if populations continue to grow, the region may face increasing demand for both water usage and electrical power (McKinney et al., 2010).[10]

Climate Change

Pressures upon Basin ecosystems from dam operations and competing water uses also face future impacts from climate change and variability. Forecasts indicate that the Basin is facing hotter, dryer summers and warmer, wetter winters. This stands to introduce new ecosystem challenges and to exacerbate existing ones.

Climate change will impact water availability, particularly during the summer months; however, these impacts may not be spatially identical (i.e. they may not be identical in all parts of the Columbia River Basin) (Hamlet, 2011). For example, annual stream flows in the Canadian portion of the Basin may show a net increase by the 2050s (Zwiers, Schnorbus, and Maruszeczka, 2011; Jost and Weber, 2012). This means that summer flows (and therefore summer water availability) may decline, but winter flows may increase (Hamlet, 2011; Jost and Weber, 2012). US models, however, indicate a decline in average annual runoff (Murdock et al., 2007; Cohen et al. 2007).

Changes in water flows due to climate change can negatively impact a host of water uses that compete with Basin ecosystems. For example, climate change is projected to impact when energy is demanded in the Basin and our ability to meet that demand. Lower flows in late summer and fall can result in less firm[11] hydropower production and lower revenues (McKenzie, 2013; Payne et al., 2004). Changes in

[10] For example, McKinney et al. (2010) note population growths of 20 to 40 percent in urban areas in the lower portion of the basin since 1960.

[11] McKenzie (2013, pp. 944-945) provides a concise definition of firm and non-firm: "*Hydropower production falls into two categories: firm power—the minimum that must be produced and delivered under contract—and non-firm power—excess that can be sold*."

temperatures may also impact the seasonality of energy demands. Warming temperatures are expected to increase summer demand for cooling and decrease winter demands for heating. Lower summer flows due to climate change, however, mean that the Basin may face decreased summer hydropower generation capacity at times when summer energy demands are rising (Cohen et al., 2000). These impacts on the timing of and demand for hydropower production will place the water supply needs of the hydropower system in greater competition with other economic and environment water needs, such as agriculture, recreation, and species habitat needs. For example, decreased summer flows due to climate change will compound the existing the strain between maintaining hydropower production or providing water flows for fish (McKenzie, 2013).

From a water management perspective, taking climate change into account will be crucial. As noted by Hamlet & Lettenmaier (2000, p. 1620), early climate simulations for 2025 and 2095 indicated that the hydrologic character of the River will be significantly altered, with the consequence being that “hydrologic changes of this magnitude would require extensive changes in the operation of the Columbia reservoir system to mitigate, even partially, the effects on reservoir system performance.” While we may have time to introduce required changes by the end of this century, a concern is short-to-medium term complacency. Referring to simulations for 2025, Hamlet & Lettenmaier (2000, p. 1620), note that “studies of the Columbia's management system have observed that it will be difficult to make substantive changes in the management system due to the lack of centralized control, transboundary issues with Canada, and competing demands for water which will politicize any attempts to redirect impacts between competing users by changing the operating system.”

One example of future climate related water management challenges in the face of climate change is known as “loss of stationarity” (Osborn, 2012). Stationarity means that “ecosystems function in dynamic equilibrium, fluctuating within a predictable

envelope of variability" (Osborn, 2012).[12] Large infrastructure projects, such as dams and reservoirs, are designed based upon our understanding of historic weather and water conditions, while the operation of reservoirs draws upon both historic data and current year conditions (Osborn, 2012). [13] Indeed, the Columbia River Treaty appears to incorporate a broad reliance on historic stream flow data (Annex B, clause 6).[14]. Reliance on historical stream flow data raises the question of whether the substance of the Columbia River Treaty is flexible enough to enable the adaptive approaches to river governance needed to address future challenges posed by climate change. As Osborn (2012, p. 94) notes, "the need for Columbia River managers to contend with loss of stationarity will challenge the current, relatively stable system of coordinated river operations."

[12] Sandford (2012) summarizes this concept as follows: "Within the broader hydro-climatic context, stationarity is the notion that there will always be approximately the same amount of water available in any given place or region as we have come to expect. Stationarity implies that seasonal weather and long-term climate conditions will fluctuate predictably within established limits.…What is happening now is that increased mean atmospheric temperatures are altering te patterns of movement of water through the global hydrological cycle. This means that the statistics from the past related to how surface, subsurface and atmospheric water will act under a variety of given circumstances are no longer reliable. (Sanford, 2012, p 17-18)

[13] As noted by Hamlet (2011, pp. 1432-1433):

"Until very recently, formal water resources planning in the US and Canada has been based almost exclusively on the use of observed streamflow records. These approaches implicitly assume a stationary climate system, and attempt to construct (and test, e.g. via simulation) water resources systems that are relative robust to observed climate variability represented by observed streamflow records. By extension, these well-tested systems are assumed to be relatively robust to future climate variability…Projections of changing population, water or energy demand, or other factors related to water resources system performance are commonly incorporated in planning studies, but systematic changes (or for that matter even decadal scale variations) in climate that affect hydrologic extremes are not typically considered in planning."

[14] Under the Treaty, the US is entitled to "Downstream Power Benefits."Annex B of the Treaty describes the bases upon which the Downstream Power Benefits are determined. Per Annex B, clause 1, they are:

a) The estimated increase in dependable hydroelectric capacity in kilowatts for agreed critical stream flow periods and

b) The increase in average annual usable hydroelectric energy output in kilowatt hours on the basis of an agreed period of stream flow record.

Per Annex B, clause 6, it appears that these determinations are based upon historic stream flows for a twenty-year period beginning in July 1928.The Treaty provisions indicate that water flow must be sufficient to meet Downstream Power Benefits. In this way, it appears that the requirement for Downstream Power Benefits builds a deliverable into the Treaty that is based to some extent upon historic flows.

2.1.3. Challenges to Coordinated Management: Different Priorities

Despite facing similar challenges to ecosystem function in the Basin (such as altered flows due to dam operations and climate change), Canada and the US have unique domestic interests and concerns. For example, the US portion of the Basin currently struggles to provide adequate stream flows for salmon and other fish species (Cohen et al, 2000). In the future, decreases in summer flows due to climate change are expected to be more severe in the US portion of the Basin than the Canadian portion (Osborn, 2012; Cohen et al., 2000; Hamlet, 2003).). In this context, the US may become increasingly reliant on Canada as a source of water flows during the summer months (McKenzie, 2013; Hamlet, 2011). As noted by Hamlet (2011, p. 1438), "in the US portion of the basin, losses of natural storage as snowpack are likely to create local impacts to summer flow that can only be mitigated by release of Canadian storage."

The implications of this are highlighted by Hamlet and Lettenmaier (2000, p. 1620), who state "it is apparent that if the dominant source of summer inflow to the river moves north into Canada as the climate warms, U.S. water managers will need a more comprehensive and far reaching coordinating mechanism with Canada if impacts to regulated summer stream flow in the lower basin are to be avoided." Yet, despite the US need to secure current and future need to secure summer water flows, some scholars have noted that Canada has little-to-no obligation or incentive to operate its dams in order to support salmon in the US (Osborn, 2012; Hamlet, 2003). The lack of obligation arises from the fact that there is no requirement under the Treaty to address this issue. The lack of incentive arises from the fact that the Grand Coulee Dam in Washington State, built in 1941, effectively blocks anadromous fish runs into Canada. Hence, the literature suggest that Canada and the US may place different priority upon the issue of water flows for anadromous salmon.[15]

Further, a need for summer flows in the lower Basin may give rise to conflicts with the way waters are managed in the upper portion of the Basin. The Canadian

[15] I note that the literature evidences interest amongst residents and First Nations to have anadramous salmon populations returned to historic harvesting and habitat areas in the upper Columbia River. This would require structural modifications to the Grand Coulee, such as the installation of fish ladders. This was not originally done as, historically, it was deemed to be too difficult to include fish ladders in a dam of that size (CRTRT, 2012).

Storage is essentially operated as a lake ecosystem (Hamlet, 2011). Thus, while a concern for water availability seems to underpin much discussion of ecosystem challenges in the US literature, Canadian publications focus heavily on ecosystem challenges from reservoir operations and releases (Utzig and Schmidt, 2011; BC Hydro, 2007). [16] This operation of the Canadian Storage as a lake ecosystem "presents a fundamental conflict with potential releases of water to mitigate losses of summer flow in the US portion of the basin" (Hamlet, 2011, p. 1438).

2.1.4. The Benefits of Coordinated Management

The discussion above highlights negative impacts to ecosystem function in the Columbia River Basin that stem from challenges to river flows posed by the presence and operations of dams and reservoirs. That both the River and the negative impacts to the River are not constrained by the border raises the question of whether a basin-wide approach to managing waters for ecosystem function would be beneficial. As Sadoff et al. (2008) explain, managing rivers at the basin level is widely seen as a best practice in water resource management:

> It is widely accepted that best-practice water resources management is undertaken at an integrated basin-wide scale. Managing the river basin as a whole is the best way to ensure the integrity of the ecosystem. It is also the best way to leverage productivity and increase the total sum of benefits because it allows planners to find the best possible locations for different activities (e.g., fisheries, food and fibre production, hydropower generation, recreation and navigation) and manage activities' interactions and trade-offs.
>
> (Sadoff et al., 2008, p.16)

Achieving basin-wide management requires cooperation between nations, but nations will only cooperate with each other when they feel it is in their interest (Sadoff et al., 2008). In the case of the Columbia River, the literature suggests that finding a basin-

[16] Recall that the Treaty required three dams to be built in Canada, which nearly doubled the reservoir storage capacity in the river system (U.S. Entity, 2013b). Drafts and refills of the reservoirs are required to meet Treaty obligations, which influence fluctuations in the volume, quality and flow of water in the Canadian portion of the River.

wide approach to managing ecosystem function can benefit both nations. From a Canadian perspective, possible benefits are both environmentally and economically pragmatic.

First, the literature shows that the operation of reservoirs has environmental impacts in the Canadian portion of the Basin. The Treaty, however, does not contain provisions that address any Canadian desire to prioritize ecosystem function in the operation its reservoirs. It is important to note this does not wholly prevent Canada (namely, BC) from taking steps to try and mitigate these environmental impacts. First, under the Treaty, BC can operate the Treaty Dams "as a whole," which enables BC Hydro to move water between the reservoirs of the Canadian Treaty Dams as long as doing so does not impact Treaty obligations (Davidson & Paisley, 2009). This does give BC some flexibility to establish storage operations that can contemplate non-power interests, such as fisheries and recreation (Davidson & Paisley, 2009). Thus, there are certain programs and initiatives extant in the Canadian portion of the Basin that aim to study or mitigate impacts from dam operations. For example, the Fish and Wildlife Compensation Program (FWCP) was established in 1995 to offset the ecological impacts of BC Hydro dams.[17] In 2012, the FWCP undertook the Dam Impacts Project, which recommends options that target reservoir operations and stream flow management for the benefit of habitats and species in the Canadian portion of the Basin. The presence of programs, such as those funded by the FWCP, is positive for BC ecosystems; however, these efforts are not without their costs. For example, the FWCP confirmed a $4 million budget for projects funded in 2012-2013, including nutrient restoration in Arrow Lakes Reservoir and Kootenay Lake, contributions to the Upper Columbia White Sturgeon aquaculture program, ecosystem enhancement programs for wildlife (BC Hydro, 2012a).

Yet, even if funding were unlimited and all desired options could be pursued, domestic efforts in BC are ultimately subject to the overriding obligations and objectives of the Treaty. For example, Article IV(5) of the Treaty prohibits any water resource development in Canada from adversely affecting the stream flow in a way that reduces

[17] The FWCP is a partnership between BC Hydro, the BC Ministry of Environment, Fisheries and Oceans Canada, First Nations and public stakeholders.

flood control and hydroelectric power benefits that the Canadian Storage would otherwise produce. Also, except as provided by Article XIII(1), neither Canada nor the US can, without the consent of the other, divert for any use, other than consumptive use,[18] any water in a way that alters the flow across the border. In other words, even if a change in river flows would address a particular matter of ecosystem function in the Canadian system, the ability of Canada (i.e. BC) to take actions that would alter the flows of water across the border may be constrained by the need to obtain US consent. Non-treaty storage agreements and supplemental agreements to the hydroelectric operating plans that govern the management of the Treaty Dams do show that this consent can be obtained; however, these agreements are limited in scope and duration. They do not constitute long-term approaches that give Canada broad discretion with respect to river flows for ecosystem function in or around reservoirs. A commitment between the US and Canada to take a basin-wide approach to supporting ecosystem function implies a commitment to consider impacts throughout the entire system. This could include consideration of reservoir impacts, the solutions to those impacts, and their related costs. As such, a transboundary commitment to supporting ecosystem function could provide Canada with a more consistent and flexible framework in which to develop its domestic efforts to mitigate impacts from reservoir operations.

Second, Canada and the US may not share an identical perspective regarding the volume of water flows in the River; yet, the literature suggests that benefits can accrue to both nations if this issue is addressed. For example, anadromous fish in the US portion of the Basin can benefit from secured summer flows. Hamlet (2003) notes that the evolving climate and, therefore, hydrology of the Basin also presents new incentives for Canada. Specifically, potential access to the growing market for cooling demands in California during the summer months may make commitments to release water to the US more palatable to Canada as these releases may coincide with a time when energy is increasing in value (Hamlet, 2003).

[18] ""Consumptive use" means use of water for domestic, municipal, stock-water, irrigation, mining or industrial purposes but does not include use for the generation of hydroelectric power" (Treaty Article 1(1)(e)).

Third, the means by which both nations address specific issues, like summer water flows, can also be a vehicle through which the nations can address broader concerns about the equitable use of resources. BC has expressed a concern that the value of all benefits experienced in the U.S. portion of the Basin, such as flood risk management, hydropower, ecosystem support,and predictable water supply, should be accounted for and shared equitably between the nations (CRTRT, 2014, n.p.). The US Entity has stated that the "health of the Columbia River ecosystem should be a shared benefit and cost of the United States and Canada" (US Entity, 2013, p. 3). Also recall that BC receives the Canadian Entitlement under the Treaty. The US Entity has expressed dissatisfaction with the way the Canadian Entitlement is currently assessed (feeling it is too high), while BC takes that view that that the Canadian Entitlement does not account for the full range of benefits experienced by the US benefits or impacts felt in BC under the Treaty (US Entity, 2013, CRTRT, 2014). These are clearly not identical views, but they do evidence a common desire to understand and negotiate Basin-wide costs and benefits. Committing to cooperatively support basin-wide ecosystem function implies a need to first understand water usage and flow needs throughout the Basin. Gaining this kind of understanding could help both nations arrive at water management choices, such as how to address summer flows or impacts from reservoir operations, in a manner that both find fair and equitable.

Finally, there is the overarching benefit of preventing or mitigating the social and economic costs of ignoring environmental flows in the Basin. Ignoring the need to support environmental flows can have grave consequences for a river basin. For example, environmental flows have not been given significance in the management of the Rio Grande- Rio Bravo transboundary river, much of which flows along the border of Mexico and the State of Texas before emptying into the Gulf of Mexico (Sandoval-Solis & McKinney, 2014). The flows of that river have been modified over time by the construction of dams and reservoirs for flood storage and hydroelectric power generation, as well as water withdrawals for irrigation, drinking water, and industrial uses.

As a result of these various pressures on the river's flow regimes, the Rio Grande- Rio Bravoriver is now heavily over-allocated. Water use and demand often outstrips supply, and environmental needs receive that lowest water allocation priority

(Sandoval-Solis & McKinney, 2014). For example, a report by the US-Mexico Binational Council notes that "no water is officially allocated to support downstream ecosystem needs, and instream flow below the Amistad is often reduced to a trickle during irrigation season" (US-Mexico Binational Council, 2003, p. 14). In this context, there have been impacts upon fish, plant, and wildlife species in the river basin. For example, 85 species of plants and animals on the Mexico side of the border were in danger of extinction as of 2003 (US-Mexico Binational Council, 2003). The number of native fish species has declined by 70 percent in recent decades and more than 40 percent of native fish species in the middle Rio Grande being either completely or locally extinct (Lacewell et al., 2010; Barrens, Ganderton, Silva, 1996). Further, pristine environmental reserves in the US and Mexico are threatened by the lack of environmental support in the existing water management regime (Sandoval-Solis & McKinney, 2014).

Today, there are increasing efforts to restore the Rio Grande-Rio Brava. Notably, the US and Mexico have agreed to an action plan that includes, among other things, the goals of restoring the ecosystem of the Rio Grande-Rio Bravo and restoring the silver minnow population (The Department of the Interior of the United States of America, 2010). Such initiatives will not be without costs. For example, a 2007 report from the US Fish & Wildlife Service estimates total costs to recover the Rio Grande silvery minnow at $114 million USD (U.S. Fish & Wildlife Service, 2007).

One cannot assume that what goes for the Rio Grande-Rio Bravo is what will go for the Columbia. Yet, although the environmental statuses of the basins are not identical, the example of the Rio Grande serves as a cautionary example of how ignoring environmental flows can lead to serious problems.

2.2. Ecosystem Function and the Current Treaty Regime

The preceding sections illustrate the need for the US and Canada to coordinate in order to address ecosystem function in the Columbia River Basin. One problem, however, is that the Columbia River Treaty does not offer a clear path on how to accomplish this goal. To explain why this is the case, this section considers how environmental concerns, such as ecosystem function, do or do not fit within the Treaty.

This section first describes how the current Treaty regime is arranged. This section then explores the extent to which this arrangement allows the Parties to deal with environmental concerns.

2.2.1. The Current Treaty Regime

The current institutional arrangements are complex. To simplify the discussion, this section describes the current arrangement as being comprised of two parts, or frameworks. The first framework is comprised of the Columbia River Treaty and a number of arrangements that are enabled by the Treaty (the "Treaty Framework"). The second framework exists external to the Treaty and includes commercial agreements between hydroelectric power authorities in the US and Canada (the "External Framework"). Together, these two frameworks make up the main parts of the existing cooperative arrangement between Canada and the US. As these frameworks work together and inform each other, this report refers to the two frameworks collectively as the "Treaty Regime."

The Treaty Framework

The Columbia River Treaty

The Treaty establishes storage capacity requirements for the Canadian Treaty Dams, establishes the purposes for which the dams are to be operated, and establishes how storage objectives are to be implemented by the US and Canada. The Treaty requires Canada and the US to designate entities that are "empowered and charged with the duty to formulate and carry out the operating arrangements necessary to implement the Treaty" (Art. XIV(1))(the "Entities"). The US Entity is the Administrator of the Bonneville Power Administration and the North-western Division Engineer of the U.S. Army Corps of Engineers. The Canadian Entity is BC Hydro. The Entities have established two committees: the Columbia River Treaty Operating Committee and the Columbia River Treaty Hydro Meteorological Committee (CRTOC, 1991). Both committees have a US section and a Canadian section, with membership in the Operating Committee being limited to four members from each country (CRTOC, 1991). Canada must operate the Canadian Storage in accordance with "hydroelectric operating plans" and flood control plans (Treaty, Article IV(1); Annex A, s.5). The Entities are

responsible for these hydroelectric operating plans, which are prepared by the Operating Committee (CRTOC, 1991).[19]

Treaty-Enabled Plans and Agreements

The aforementioned flood control plans and the hydroelectric operating plans are the foundation for river management operations at reservoirs in the Basin. The hydroelectric plans ensure optimum power generation (subject to the constraints of any flood control plans). There are two types of hydroelectric operating plans: assured operating plans ("AOP") and detailed operation plans ("DOP").

The Entities must prepare and agree on an AOP for the use of the Canadian Storage and any resulting downstream power benefits six years in advance of the actual year of operation (CBT1, n.d.). An important outcome of the AOPs is agreement between the Entities on various applicable rule curves. The rule curves are the operating criteria that govern the flow of the Canadian Storage. The rule curves provide technical guidance to dam managers regarding when and to when extent water is to be released from reservoirs, as well as reservoir refills.

The Treaty also permits the Entities to agree upon DOPs, which may produce results that are more advantageous to the Parties than those that would result from use of the AOPs (Treaty, Article XIV(2)(k)). To date, the Entities have agreed each year to the preparation of a DOP for the immediately succeeding operating year (CRT-Entities, 2008). The actual operation of the Canadian Storage is guided by the DOPs and any other supplementary agreements (CRTOC, 1991). DOPs are implemented through the use of Treaty Storage Regulation ("TSR") studies. TSR studies use the operating criteria

[19] In addition to the US and Canadian Entities, the Treaty also establishes a Permanent Engineering Board ("PEB") and places limited authority in the International Joint Commission. The PEB consists of four members. Two are appointed by the US and two by Canada. The main duties of the PEB are maintaining records of cross-border river flows, monitoring for substantial deviations from the hydroelectric and flood control plans, reporting to Canada and the US on the status of Treaty objectives, and dealing with any technical or operational disagreements between the Entities (Treaty, Article XV(2)). Other disputes between Canada and the US can be referred to the International Joint Commission, which is a transboundary river basin organizing existing pursuant to the terms of the 1909 by the *Boundary Waters Treaty* between the US and Canada. Disputes under Columbia River Treaty can be referred to the Commission or to independent arbitration for adjudication. Any decisions rendered by the Commission are binding (Treaty, Article XVI).

for both Canadian and U.S. dams set out in the DOP in order to determine the monthly storage rights and obligations for the three Canadian Treaty dams (Hearn 2008; CRT-Entities, 2008).

External Framework

Commercial agreements have also been used to address non-power water uses. They apply to certain waters stored in Canada that are not governed by the Treaty. These commercial agreements are called Non-Treaty Storage Agreements

BC constructed the Mica dam with an additional 5 MAF of storage capacity beyond that which was required by the Treaty. This means that there is an additional 5 MAF of storage available for use at Mica. This extra storage is referred to as Non-Treaty Storage. BC cannot unilaterally use all of the Non-Treaty Storage as doing so risks conflicting with the Treaty's discharge requirements (CRTR, 2013). As such, this volume of storage has been managed under a succession of Non-Treaty Storage Agreements (NTSA). The most recent NTSA was signed in April 2012 and expires at midnight on September 15, 2024 (NTSA, 2012, s. 1).

The NTSA is separate and distinct from the Treaty (CRTR, 2013). It is not a treaty in its own right and nothing in the NTSA supersedes or amends the Columbia River Treaty. Rather, the NTSA is a commercial agreement - Contract No. 12PG-10002 - between BC Hydro and the Bonneville Power Administrator. The agreement enables the use of the 5 MAF of Non-Treaty Storage to be operated by their mutual agreement (CRTR, 2013). Rather than imposing strict rules upon the parties, the NTSA allows the parties some flexibility in using the Non-Treaty Storage for both power and non-power objectives (CRTR, 2013). For example, a 0.5 MAF release right to the Bonneville Power Administrator is available for use in May/June to support salmon migration in the lower Columbia River during low flow years (CRTR, 2013)

2.2.2. The Ecosystem Under the Current Treaty Regime

To understand the extent to which the Columbia River Basin ecosystem does or does not fit within the Treaty Regime described above, we can start by first considering the overarching purpose of the Regime. This purpose informs current river management

objectives and, therefore, operational decisions. It is the Columbia River Treaty that establishes the purpose of transboundary management of the Columbia River.

Some international agreements have sections that explicitly state the purpose or objectives of the agreement (for example, a particular section of a treaty may be entitled "objectives"). The Columbia River Treaty does not have such a section. It is, however, possible to discern the intended purpose of the Treaty from its preamble – the words following the title and preceding the terms – and its terms. A preamble is not binding in the same way as the terms of a treaty, yet it still plays an important role. A preamble functions as an aid through which the terms of a treaty are interpreted.[20] The preamble to the Columbia River Treaty establishes that the US and Canadian governments entered the agreement in the context of having recognized "that the greatest benefit to each country can be secured by *cooperative measures for hydroelectric power generation and flood control*…."Given the focus upon hydroelectric power and flood control, we may ask where ecological water uses fit within the existing regime. A number of terms are relevant to this issue.

The Entities are empowered "to formulate and carry out the operating arrangements necessary to implement the Treaty" (Treaty, Article XIV(2)(k)). One of these powers is the "coordination of plans and exchange of information relating to facilities to be used in producing and obtaining the benefits contemplated by the Treaty" (Treaty, Article XIV(2)(a). These operating plans include the AOPs and the DOPs discussed above. The point preparing a DOP is that it may produce "results that are more advantageous to both countries than those that would arise from" operations under an AOP (Treaty, Article XIV(2)(k)). The word "results" is not defined in the Treaty. No

[20] This view of the function of treaty preambles is codified in the *Vienna Convention on the Law of Treaties* of 1969, entered into force January 27, 1980 ("Vienna Convention"). Canada acceded to the Convention on October 14, 1970. While a signatory to the Convention, the United States has yet to ratify the agreement. Yet, both nations may view the Vienna Convention as binding upon them as a codification of customary public international law of treaties (Bankes & Cosens, 2012; U.S. Department of State, n.d.; Government of Canada, 2011). Article 31 of the Vienna Convention establishes the basic rules for treaty interpretation. Article 31(1) notes that "A treaty shall be interpreted in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose." Article 31(2) notes that this "context" includes a treaty's text, preamble and annexes.

arbitral or International Joint Commission ("IJC")[21] decisions interpret the meaning of "results more advantageous" or "any other matter coming within the scope of the Treaty," nor have I found interpretations of similar or analogous treaty provisions in other international forums. Yet, we do have some indication of how the Parties interpret "results" that are more advantageous to both nations.

Canada and the US appear to view flows for fish spawning and habitat protection as mutually beneficial results under DOPs and SOAs. For example, the 2013-2014 DOP acknowledges that the operation of the Canadian Storage is to be in accordance not only with the Treaty and its related agreements, but also with any SOAs applicable to the operating year (CRT-Entities, 2013). Such SOAs must consistent with objectives set out in the DOP and must be for the mutual benefit of the Parties (CRT-Entities, 2013, section IV(A)). The non-power objectives set out in the 2013-2014 DOP include flows for "whitefish and trout spawning downstream of Arrow, dust storm avoidance upstream of Arrow, and recreational objectives [while] potential U.S. non-power objectives may include… storage of water up to 1.233 km3 (1 MAF) for anadromous fish flow augmentation, minimum flows at Bonneville dam and at Venita bar for fish spawning, and recreation needs…." (CRT-Entities, 2013, section IV(C)(2)).

An example of an SOA adhering to such objectives is the 2012-2013 Non-Power Use Agreement between the US and Canadian Entities (non-power agreements dated after July 2013 do not appear to be publicly available). Among other things, the 2012-2013 Non-Power Use Agreement enables flow management for trout and whitefish in the lower part of the Canadian portion of the Basin and flow augmentation for legislative fish management requirements in the US portion of the Basin. The Agreement goes beyond the DOP statement of objectives by outlining month-by-month procedures to meet the desired flow management objectives from January through July 2013. In sum, it appears that the Parties see such coordination to achieve results – however limited – that include ecologically-related non-power uses as falling within the scope of their authority under the Treaty.

[21] The IJC is a transboundary river basin organizing existing pursuant to the terms of the 1909 by the Boundary Waters Treaty between the US and Canada. Disputes under Columbia River Treaty can be referred to the IJC or to independent arbitration for adjudication.

Aside from what may be gleaned from the Parties' behaviour, there are other sources that can assist in interpreting the Treaty. Article 32 of the Vienna Convention provides that one can refer to the "preparatory work" of a treaty (i.e. the background documents generated in the process of reaching the agreement) as a supplementary means of interpreting the objectives and purposes of a treaty. But, this can only be done in the unique circumstance where the interpretation of a treaty's text leads to ambiguous, obscure, manifestly absurd, or unreasonable results (Vienna Convention, Article 32).

The only statement in the Columbia River Treaty that approaches a statement of objectives is in the Treaty's non-binding preamble. The preamble only speaks hydroelectric power and flood control. Yet, the actions of the Entities to-date indicate they do not see themselves as acting outside of their jurisdiction by addressing other matters in operating agreements. Thus, what is or is not within the scope of the Treaty may be ambiguous based upon the text of the Treaty documents alone.

If there is ambiguity as to the scope of the Treaty, "preparatory work" may clarify the concerns Canada and the US wished to address cooperatively by reaching this agreement. For example, in 1944, prior to forming the Treaty, Canada and the US sent a reference to the IJC requesting that the Commission investigate and report on the possibility of the two nations cooperatively developing the Columbia River (Government of Canada, 1964a).[22] Part of that reference states as follows:

> 2. It is desired that the Commission shall determine whether in its judgment further development of the water resources of the river basin would be practicable and in the public interest from the points of view of the two Governments, having in mind (a) domestic water supply and sanitation, (b) navigation, (c), efficient development of water power, (d) the control of floods, (e) the need for irrigation, (f) reclamation of wet lands, (g) conservation of fish and wildlife, and (h) other beneficial public purposes.
>
> (Government of Canada, 1964a, p. 17)

[22] Article IX of the *Boundary Waters Treaty, 1909* allows references to the IJC for advice in relaion to their rights, obligations, or interests. The Commission can examine and make recommendations on such references, but the Commission's recommendations are not binding.

In response to the reference, the IJC founded the Columbia River Engineering Study Group to assess the best use of the River. In their report to the IJC, the Columbia River Engineering Study Group noted that, while the initial request was for the IJC to examine an overall plan of development that considers a number of interests, they had found that hydroelectric power generation would be the most valuable use of the river's water resources; hence, they focused on hydroelectric power generation as a primary goal (Government of Canada, 1964b). The IJC was not silent on the other issues included in the reference. Rather, the IJC determined the following:

> At present there is no urgent need for cooperative development in reclamation of wetlands and no reason for cooperative development in the fields of domestic water supply and sanitation, navigation, or conservation of fish and wildlife.
>
> (Government of Canada, 1964b, p. 37) (Emphasis Added).

The information in these documents arguably cuts both ways. From one perspective, it is clear that hydroelectric power and flood control were not *initially* the sole concern of the Parties. On the other hand, one could also argue that, despite initial intentions, the Parties consciously and purposefully limited their agreement to only those concerns found to be most valuable by the IJC (the implication being that the Parties were well aware of their other concerns but elected not to include them in the agreement).

At the end of the day, there is a lack of clarity as to where ecosystem function fits. The Treaty is silent on the issue, yet, as discussed above, it is not clear that environmental matters fall entirely outside the scope of the Treaty. To that end, it appears that the Entities do not interpret including some ecological non-power issues in operating plans as being outside their scope of authority. Ultimately, however, the Treaty provides no clear foundational and coordinated regime to address basin-wide concerns that fall outside of the primary purposes of hydroelectric power generation and flood control.

2.3. Institutional Support for Ecosystem Function

As discussed above, there are both shared and differing interests and concerns regarding ecosystem function in the Basin, all of which are connected by impacts to river flows from dam operations, as well as factors external to the management regime, such as climate change. The problem is that the current Treaty Regime offers no obvious path to addressing these interests and concerns in a cooperative manner. This brings us to a discussion of the Treaty's role as a transboundary institution. This institutional role informs why the Treaty should be a starting point for addressing ecosystem function in the Basin.

2.3.1. The Role of Institutions

Although the term has long been used in the social sciences, there is no consensus on the meaning "institution" (Hodgson, 2006). A simple definition is that institutions are ""systems of established and prevalent social rules that structure social interactions (Hodgson, 2006, p. 2). International environmental institutions are "sets of international regulations and organizations that were intentionally established by pre-existing actors (states) through explicit, legally or politically binding, international agreements in order to regulate anthropogenic sources of negative externalities affecting the natural environment" (Bernauer, 1995, p. 352). Put very simply, international environmental institutions constrain or enable behaviour (Hodgson, 2006).

It is through their institutional arrangements that states can establish how they will address their interests, as well as how they will navigate trends, rights or obligations that exist in international law or policy. Consequently, the design of institutions can influence whether successful collaboration on environmental issues can be achieved (Bernauer, 1995). When dealing with a transboundary resource, however, collaboration is complicated by the concept of state sovereignty.[23] Yet, as discussed below, there are

[23] State sovereignty is fundamental concept in international law and international relations. The basic concept of state sovereignty is that "supreme authority is vested in the State over the territory it occupies to the exclusion of other States" (Agius, 1998, p. 270).

tools in international law and policy that can assist nations in designing institutions to meet this challenge.

First, while state sovereignty is a peremptory norm governing states' rights and obligations to each other, international law can redefine states' rights and obligations (Agius, 1998). For example, principles of international environmental law that apply to relationships between basin states include the principle of equitable and reasonable use and the principle of harm prevention (Newton, 2013).

The 1941 decision of the arbitral tribunal in the Trail Smelter case (between the US and Canada)[24] is an early confirmation of the principle of harm prevention; namely, the principle that one state's activities must not injure the environment within another state, and that states have an ongoing duty not to harm to the territory of another state (Agius, 1991, p. 273). In addition to principle of harm prevention, international environmental law has introduced the notion that states are obligated to share resources (and benefits derived from their exploitation) in an equitable and reasonable way. As Agius (1998, p. 282) explains:

> Equity in international environmental law implies that States should utilise resources and the environment in such a way that all States can use them as well or at least obtain a reasonable and equitable share, and that States must cooperate for the optimum use of resources and prevent appreciable transboundary damage.

The principle of equitable use is reflected in international case law,[25] and in modern international agreements such as 1997 *United Nations convention on the Law of Non-navigational Uses of International Watercourses.* The Convention is the only global treaty that addresses uses of rivers for purposes other than navigation (Swedish Water House, 2009). It requires the use of international watercourses in an equitable and reasonable manner. There are also emerging global policy paradigms on transboundary water management that, in addition to legal norms, influence how different river basins in

[24] Trail Smelter Arbitral Decision (United States v. Canada) (1939) 33 American lournal of International Law 182; Trail Smelter Arbitral Decision (United States v. Canada) (1941) 35 American lournal of International Law. 684

[25] Gabèíkovo-Nagymaros Project (Judgment,I.C.J. Reports 1997)

other regions of the world are structuring their institutional arrangements pertaining to water management. Two dominating paradigms are sustainable development and integrated water resource management (IWRM).

IWRM focuses on the coordinated development and management of water, land, and related resources in a way that maximises economic and social welfare without compromising ecosystem sustainability (Swedish Water House, 2009). IWRM is premised on the idea that water is one resource in a connected system of terrestrial and aquatic environments (Swedish Water House, 2009). As such, as a management concept, IWRM seeks to balance different water users and to balance uses over the short and long term (Forslund, 2010).

The sustainable development paradigm originates with the definition for sustainability established by the 1987 World Commission on Environment and Development. The Commission defined the concept as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This idea informs the concept of sustainable river basin management, which Lorenz, Gilbert, and Vellinga (2001, p. 41) define as follows:

> …sustainable management is more sophisticated that a search for an implementation of thresholds. Management needs knowledge of cause-effect relationship and of socio-economic and environmental effects of policy measures in order to maximize the total amount of human, human-made, natural and social capital. Trade-offs have to be made between environmental, social and economic goals, being ultimately a societal choice…

The *United Nations convention on the Law of Non-navigational Uses of International Watercourses* has yet to be ratified and brought into force. The management paradigms of sustainable development and IWRM are equally non-binding. However, the instruments and paradigms discussed above are illustrative of emerging norms and are evidence a growing recognition of the importance of environmental flows (Forslund, 2010). Further, these instruments are offered to illustrate that institutional arrangements function not only to balance sovereign interests, but also to import global values and norms into governance regimes.

To recap, we can summarize the role of transboundary environmental institutions as follows:

- They can constrain or prompt states' behaviour in ways that
- Allow states to identify and reconcile their sovereign interests while also
- Taking into consideration both binding and non-binding global norms and values.

2.3.2. Possible Institutional Responses

A dominant theme in the literature is a concern that the Treaty does not allow Canada and the US to sufficiently address current and future ecosystem challenges. For example, Hamlet (2011) observes that institutional constraints play a key role in determining the ability of water management systems in the region to adapt to climate change. To this end, our ability to respond to droughts in the Columbia River Basin is constrained by "institutional fragmentation, lack of centralized authority, and conflicted water management objectives in times of scarcity" (Hamlet, 2011, p. 1433). The literature raises parallel considerations for identifying possible alternatives to the status quo; namely 1) *what* should a new institutional arrangement address and 2) *how* should a new institutional arrangement address it.

What Do Institutional Arrangements Need to Address?

The literature indicates that a key cause of various ecosystem challenges in the Basin is the status of the River's flow regime. A flow regime is a key driver of a river's ecosystem (Bunn & Arthington, 2002) and is comprised of the "magnitude, frequency, duration, timing, and rate of change of river flow" (Swedish Water House, 2009, p. 12). As discussed, all of these elements can be compromised in rivers regulated by dams. Thus, when we discuss supporting ecosystem function in the Columbia River Basin, we are largely discussing support for the quality, quantity and timing of a river's flow regime in a manner that can support ecosystem function.

The literature presents the concept of *environmental flows* as a way to think about flows regimes in heavily regulated rivers. The concept of environmental flows can be viewed as having two components: the 'what' and the 'why'. The 'what' can be parsed from the common definitions; namely, the concept of environmental flows is concerned

with the adequacy of a river's *flow regime*. The 'why' points to the paradigmatic lens through which the concept of environmental flows contemplates the adequacy of water flows. In general, the concept of environmental flows has come to refer to the adequacy of the quantity, quality, and timing of water flows for the purpose of supporting the function of an aquatic ecosystem and the services it provides (Dyson et al., 2003).

Environment flows can be integral tool to achieving institutional arrangements premised on either sustainable development and IWRM principles. This is because environmental flows are not commonly considered as waters required to maintain an ecosystem in pristine condition, but, rather, as waters that may be allocated to an ecosystem based upon environmental, social and economic choices (Dyson et al., 2003, p.17). In this manner, while environmental flows can approximate natural flow regimes, they can also deviate significantly depending on the end result of the societal choice to allocate flows as between a river's ecosystem and human development needs (Hirji & Davis, 2009).

How Can Institutions Address Environmental Flows?

The Treaty provides the institutional backbone for coordinated management of reservoirs along the Columbia for hydroelectric power generation and flood control. There is a lack, however, of coordinated management systems to address matters such as low flows (Hamlet, 2011). There are a limited number of institutional alternatives proposed in the literature aimed at addressing river flows and ecosystem function. Some propose focusing on domestic, sub-basin, approaches to addressing future challenges, with the hopes of avoiding institutional gridlock at the basin level (Hamel, 2011). Others propose introducing changes at the basin level in order to change the framework upon which water use planning is undertaken. Consideration of this latter focus appears particularly timely given the pending the modernization or renegotiation of the Treaty in light of the possible 2024 deadline.

A limited number of authors have proposed basin-level institutional alternatives. For example, McKenzie (2013) proposes a revised (or new) Treaty that includes a transboundary water management organization. McKenzie finds that this sort of organization would be the most effective means of incorporating new environmental and water use concerns into the Treaty, as well as bring the Treaty in line with international

legal norms (such as the principles of equitable use and harm prevention). Others argue for the elevation of ecosystem function to a co-purpose of the Treaty, along with flood control and hydroelectric power (Cosens, 2012). Including ecosystem function as a new co-purpose in the Treaty is also the position of the US Entity in its final recommendation to the U.S. Department of State (U.S. Entity, 2013).

Both of these options are intuitively appealing. The Treaty is entirely silent on the environment, so adding the environment into the Treaty is not an idea that is far afield. Rather, it is perhaps the most obvious option to consider. Yet, the literature is unclear as to how (or why) an amendment of Treaty purposes can best serve basin-wide environmental objectives. In fact, the literature is silent on what, exactly, the basin-wide objective are in the Columbia River Basin. McKenzie (2013) provides a thorough argument for the general merits of basin-wide water management and, more specifically, of creating a transboundary water management organization; however, the article does not explore how we know that such as organization would be the *most* effective institutional solution for the Columbia River Basin. In short, there is a lack of comparative analysis in the literature on what, if any, alternatives to the current institutional arrangement can best improve the Parties' ability to cooperatively address ecosystem function in a manner suited to the needs and objectives of the Basin.

It is in this context that this study addresses the policy problem : *the US and Canada do not have a sufficient understanding of which, if any, transboundary institutional alternatives will enable the two nations to better consider and address ecosystem function in the Columbia River Basin*. In addressing this problem, this study researches the following questions:

1. What objectives should any institutional alternatives seek to address in order to support a framework of US/Canadian cooperation that can effectively address ecosystem function challenges in the Basin?
2. Assuming the Treaty continues after 2024, is the status quo able to enable the parties to meet these objectives?
3. If not, what institutional alternatives are there to the status quo that may enable the parties to meet their objectives?

Chapter 3. Methods

3.1. Preliminary Research Methods

A review of literature, reports, and other documents were used to identify the scope and key components of the policy problem. The literature review also identified some of the policy options assessed in this report. A set of research questions where developed from the results of the literature and background review. These questions informed the focus of the survey and case studies.

3.2. Survey

An online survey was used to follow up areas of inquiry raised in the literature Namely, I sought to assess regional perspectives on challenges to ecosystem function in the Basin, and regional perspectives on role of the Treaty in addressing ecosystem function. I also sought to assess these perspectives against a primary independent variable: country of residence. I chose this variable in order to investigate the intimation in the literature that the US and Canada may have subtle, but relevant, differences in perspectives on ecosystem concerns and the role of the Treaty.

3.2.1. Survey Design

I collected primary data using an online survey. As the Treaty is under review in both nations, and as it is possible that potential respondents may have interests or concerns unknown to me in either review process, I sought to employ a survey method that permitted minimal intrusion, discretion, and promoted honest participation. I selected an online survey method for ease of distribution, administration, and ensuring the anonymity of survey responses. The survey questionnaire was designed and administered using Qualtrics.com, which is a web-based survey software. Using the

Qualtrics platform, an anonymized link to the survey questionnaire was generated for distribution via email to survey recipients. The link was anonymized in that it was programmed so that individuals' identities were not connected to any responses. This means that I was not able to track any response provided by any specific respondent.

I designed the survey to collect both quantitative and qualitative data. As such, the survey consists of a mix of closed and open-ended questions. The participant consent statement and survey instrument are attached at **Appendix A**.

3.2.2. Survey Population and Recruitment

The survey population was a non-random sample of experts comprised of academic and water management professionals. I identified these individuals through the literature review and background materials, as well as a through a limited number of suggested contacts obtained from survey recipients. Publicly available email information for the survey population was obtained through online searches using www.google.ca.

The survey was distributed via email in two main tranches on December 30, 2013 and January 18, 2013, as well as with a limited number of additional releases via emails sent between December 30, 2023 and February 7, 2013 to individuals not included in the two main tranches. The survey was emailed to a total of 103 individuals. A total of 4 emails bounced and 3 emails failed, indicating that the survey was successfully delivered to 96 individuals. To encourage responses, follow up emails were sent out between January 15, 2014 and January 23, 2013.

I advised survey respondents that they did not have to complete all questions, they were able to skip any questions they did not wish to answer, and they were able to stop the survey at any time. As such, there is variation in the completeness of survey responses that were received. I received 24 recorded survey responses, while response rates for each question range from 15 to 21 respondents.

3.3. Case Studies

Case studies were derived from the literature review and survey results. The case studies focus on multiple river basin management institutions. These cases were picked on the basis that they all deal with various water use demands and environmental pressures, and a body of monitoring reports and/or commentary exists for each case. The case study analysis is used to identify the common principles and structural components of institutional alternatives.

3.4. Multi-Criteria Option Analysis

Following an analysis of preliminary, survey, and case study data, I identified key objectives for institutional arrangements seeking to foster cooperation between the US and Canada for supporting environmental flows for ecosystem functions. These objectives informed the development of a set of criteria and measures. These criteria and measures were used to assess the policy options against the status quo and against each other. In order to evaluate the options, high/medium/low scores (with corresponding 3,2,1 values) where assigned to each measure for each criterion.

3.5. Limitations

There is limited comparable cost information available on the institutional alternatives I assessed. Therefore, while I acknowledge that each option has a cost, I excluded cost as an assessment criterion.

A technical issue arose concerning surveys completed and submitted on or before January 21, 2014. As a result of this issue, surveys that were fully completed and submitted by respondents on or before January 21, 2014 were being received, but then automatically erased by the system from the survey database. The issue was dealt with immediately upon discovery, and the survey population was advised and invited to re-take the survey. It is possible that responses rates were impacted by this.

Chapter 4. Survey Results

4.1. Survey Objectives

The first research question asked in this study is: *what objectives should any institutional alternatives seek to address in order to support a framework of US/Canadian cooperation that can effectively address ecosystem function challenges in the Basin*? I employed an online survey to investigate this question further. To do so, I structured survey questions around four issues that stem from the research question.

> Issue 1: is there is a common desire to prioritize ecosystem function in the Columbia River Basin? By "common" I mean a sense of concern shared throughout the entire Basin. The entire Basin includes the US and Canadian portions.
>
> Issue 2: are there any differences in the nature or scope of concern for ecosystem function as between the US and Canada?
>
> Issue 3: what are perceived trade-offs that may result from taking cooperative action to address ecosystem function in the Basin?
>
> Issue 4: is the Treaty perceived or not perceived as a barrier to addressing ecosystem function, and why?

As management of the Columbia River is a complex topic that draws upon many fields of expertise, I wished to elicit expert perspectives. In this case, I defined an expert as an individual having an informed understanding of the subject matter based upon a technical, professional or academic interaction with the Treaty and/or environmental issues in Columbia River Basin. This qualification narrowed the field on potential respondents to persons I identified in my literature review as likely having published, written, or otherwise substantive engaged with the subject matter.

The survey data gathered from respondents is outlined in detail at **Appendix B** of this report. In the two next sections I provide a narrative summary of the survey findings and I discuss key lessons drawn from the analysis.

4.2. Survey Findings

My findings in relation to the four issues that are the focus of my survey are as follows:

1. Is there a common desire to prioritize ecosystem function throughout the Basin?

Survey results confirm, as the literature suggests, that there is general desire to see importance given to ecosystem function by the US and Canada in their management of the Columbia River. This includes a desire to see a balancing of priority with hydroelectric power and flood control. Despite these shared concerns, however, there may be some disparity in terms of interest in a new type or level of agreement. For example, the majority of US respondents wished to see a new agreement, while only half of Canadian respondents felt the same.

2. Are there differences in the nature or scope of concern for ecosystem function as between the US and Canada?

Survey results indicate similar US and Canadian perspectives on sources of concern (i.e. sources of impacts that may be detrimental to the Basin's ecosystems). To that end, reservoir operations (for both flood and hydro purposes) and impacts from warming temperatures are viewed as the top challenges to ecosystem function in the Columbia River Basin.

However, US and Canadian respondents have somewhat different perspectives about the extent to which competing water uses and environmental flows are understood and being addressed (both in the transboundary regime and domestically in each nation). In terms of understanding competing water uses, the majority of survey respondents feel that Canada and the United States are not doing enough to understand this issue. There is less unanimity in terms of efforts to address competing waters uses and demands in the Basin. The majority of respondents who feel not enough is being done are US respondents. Canadian respondents are divided in their perspective on whether enough is being done to address competing water uses and demands in the Basin.

There are also differing US and Canadian perspectives in terms of the level of understanding of environmental flow needs in the Basin. The majority of US respondents disagree with the claim that enough is being done by both nations to understand these needs. Conversely, the majority of Canadian respondents feel that enough is being done to understand environmental flow needs in the Basin. In terms of addressing environmental flow needs, the majority of all survey respondents perceive that Canada and the US are not doing enough to address the issue now, and that the joint management of the Columbia River will not adequately support environmental flows in the future. Looking deeper into the results indicates that US respondents feel strongly in this regard, while the Canadian respondents more divided.

US and Canadian perspectives also differ on the adequacy of domestic efforts to address environmental flows now and in the future. US respondents perceive domestic measures in their country of residence to be insufficient to address environmental flows now and in the future. The majority of Canadian respondents shared the opposite perspective, seeing current domestic measures as sufficient to address environmental flow needs now and in the future

3. What are perceived trade-offs that may result from taking cooperative action to address ecosystem function in the Basin?

Trade-offs in relation to prioritizing ecosystem function are a concern. Possible losses/disadvantages identified by respondents (a number of whom felt that ecosystem function should be prioritized nonetheless) include:

- Loss of hydroelectric power production capacity
- Loss of revenues from power production
- Loss of funding derived from power revenues
- Decrease of flood control capacity
- Decreases of water flows for other economic and consumptive uses
- Lower water levels for navigation
- Lower water levels for recreation

Respondents also offered a number of general perspectives on how to consider advantages and disadvantages of prioritizing ecosystem function. A few respondents

warned against taking an overly narrow view of the issue (either by assuming that trade-offs would indeed result from prioritizing ecosystem function, by assuming that trade-offs cannot be mitigated, or, by thinking only in terms of trade-offs). For example, one respondent suggested the better approach is to think in terms of finding outcomes that support system-wide resilience based on a shared perspective of ensuring community and ecosystem resilience. Other respondents raised the need to properly understand the impact that prioritizing ecosystem function can have on different facets of human life. Some noted that new conflicts of interest may come to the fore if ecosystem function is further prioritized. Examples include potential tensions between those who seek floodplain restoration and those who may have to give up land along the River to meet that objective, as well as new or exacerbated conflicts between water users or between nations. This latter concern was linked to a need to properly understand and define ecosystem function in any new institutional arrangement as the term can pertain to different/competing interests in different parts of the basin.

4. Is the Treaty perceived or not perceived as a barrier to addressing ecosystem function, and why?

The majority of respondents view the Treaty as a hindrance to cooperative management that can support ecosystem function; however, results are nuanced when considered by country of residence. Of the six Canadian respondents to this question, three (50 percent) feel that the Treaty hinders such management to some degree, two (34 percent) feel that the Treaty enables such management to some degree (as some flows can be provided for ecological purposes and the Parties can agree on compensation for resulting power losses), and one was neutral. The majority of US respondents feel that the Treaty hinders such management to some degree. No US respondents perceive the Treaty to be an enabling instrument.

Much of the concern centers on the degree to which the focus on only two purposes impacts the parties' abilities to address new/evolving concerns or initiate large scale actions. Further, the current Treaty arrangement is perceived by some to subordinate matters that are not of priority to dominant interest groups and the agencies represented by the Entities. The Treaty is seen to promote a myopic approach to river management that is focused on short-term gains. It also does not incentivize both parties to give equal consideration to all ecological issues in the Basin, such as flows for anadromous fish.

Respondents were also able to provide additional comments on the subject matter of supporting environmental flows for ecosystem services. Concerns emerging from this data include a desire for better/expanded public participation in the Columbia River treaty regime, better participation/consultation with First Nations and US Tribes; improved adaptability and flexibility in the Treaty to address climate change, and the lack any mechanism in the current Treaty Regime to determine how economic and ecological uses of the basin interact.

4.3. Lessons Learned

The results of the survey indicate some possible discrepancies between the nations in terms of how current and future environmental flow and water use issues are perceived. While there is an overarching desire to give greater priority to ecosystem function, US and Canadian respondents did not share the same level of urgency or concern over a number of matters, including the status of basin-wide knowledge of water uses and environmental flows, basin-wide steps to address environmental flows, and the sufficiency of domestic measures to address environmental flows now and in the future. Guarding against extrapolating too conclusively from the limited data set, one consideration this data raises is whether there is a discrepancy in the degree to which each nation may wish to prioritize issues in the transboundary management regime. Hence, one consideration is that, in order to foster political willingness to address problems from a basin-wide perspective, any future institutional responses may need acknowledge and find a way to negotiate and balance different interests and domestic priorities.

The survey results also indicate a perceived need to enable consideration not only of ecological impacts, but also social and economic interests in the Basin. Striving for a broader, shared understanding of Basin -wide needs and impacts is desirable, as is better stakeholder engagement and systemic transparency. Finally, the qualitative survey responses yielded two recommendations for alternative institutional options. These are:

- “Ecosystem Function must be elevated as a primary purpose of the Treaty in order to ensure all ecosystem needs are considered and addressed in flow management planning”
- “Development of a common water use plan would be beneficial for the ecosystem function and environmental flows”

The first resonates with literature in that it reflects a desire to see ecosystem function included as a new purpose of the Treaty. The second recommendation, water use planning, is not absent from literature on transboundary water management *per se*, but does not appear to have been given consideration in literature specifically discussing the Columbia River Basin.

Chapter 5. Case Studies

The literature and survey results indicate a regional desire to explore new ways to include considerations of ecosystem function in the management of the Columbia. Two possible alternatives that emerge in the literature are adding ecosystem function as a co-purpose in the Columbia River Treaty and the formation of a new transboundary river basin organization. The additional suggestion of a common water use plan emerged from the survey.

To inform a comparative analysis of these options, I looked to various jurisdictions to get a sense of what others are doing. I examined three cases in detail. The first case explores what British Columbia does domestically under its water use planning regime. The remaining two cases are the Danube River Basin and the Amazon River Basin.

5.1. British Columbia

The water use planning process in British Columbia aims to improve water management at hydroelectric power facilities in the province. The main instrument of BC's water rights system is the *Water Act*, RSBC 1996, c. 483 This *Act* vests in the provincial Crown all rights to "the use and flow of all the water at any time in a stream in British Columbia for all purposes" (*Water Act*, s. 2(1)). In order for private entities to divert, store or otherwise use provincial surface waters, they have to apply for a license or approval (under the *Water Act* and relevant regulations, such as the *Water Regulation*, BC Reg. 204/88. In 1998, under the *Water Act*, the province requested that BC Hydro undertake a process of developing water use plans ("WUP") in order to review operating conditions at its hydropower facilities (Quadra Planning Consultants Ltd et al., 2004.). The operating requirements established in WUPs are taken into account by the province's Comptroller of Water Rights in the terms of licenses/amended licenses

applicable BC Hydro hydroelectric power generating facilities in the province (Quadra Planning Consultants Ltd et al., 2004.). The intention is for the WUPs to become part of the water licenses and, thus, become binding statutory instruments (Quadra Planning Consultants Ltd et al., 2004, p. 51).

5.1.1. The Water Use Planning Process

WUP processes are undertaken in accordance with BC's *Water Use Plan Guidelines*. The *Guidelines* require the engagement of regulators, licensees and stakeholders in a multi-stage process. The initial stages are consultative and iterative, meaning they rely upon engaging with stakeholders and upon the analysis of data/information. The objectives of public consultation include: identifying various interests in water resources, balancing local and regional water use concerns with provincial priorities for water management, developing an understanding of water use impacts, exploring operational alternatives, and, seeking compromises with respect to water uses (British Columbia, 1998, p. 49).

Responsibility for plan development falls upon the water use license holder/applicant (British Columbia, 1998). Stakeholders are engaged by the license holder/applicant to identify issues of concern and define objectives that relate to these issues. The objectives are also used to understand trade-offs when comparing operating alternatives in terms of their water use impacts (British Columbia, 1998). The process results in the preparation of 1) a consultation report and 2) a draft WUP. The consultation report sets out the consultation methods used to engage stakeholders, the identified interests and objectives, any technical data used, the operating alternatives considered, the results of the trade-off assessment, and areas of consensus and disagreement (British Columbia, 1998, p. 28). The goal of the WUP process is to reach consensus on a preferred operating alternative for a hydroelectric power facility (British Columbia, 1998, p. 28). The draft WUP also sets out monitoring measures and the timing for plan review (British Columbia, 1998, p. 29).

Upon review of consultation report and draft WUP, the Comptroller of Water Rights may or may not require changes to the WUP, may engage in further consultative inquiry with interested parties under the *Water Act*, and ultimately will issue a decision

regarding the WUP (British Columbia, 1998). If the Comptroller authorizes the draft Plan, it is then subject to federal review by the Department of Fisheries and Oceans for its input and any required approvals. Once the Comptroller's approval is obtained and federal review complete, the WUP may be implemented. Water licenses then operate subject to the WUP parameters. The objectives established in each WUP are implemented through operating orders for hydroelectric facilities (British Columbia, 1998).

5.1.2. Examples of Provincial Water Use Plans

This section considers the Jordan River WUP as a general example of the WUP process, and then considers the Columbia River WUP, which is uniquely constrained by, among other things, the Columbia River Treaty.

Jordon River Water Use Plan

As one of the first WUPs completed in the province, the Jordan River Water Use Plan provides a relatively simple example the WUP process. The Jordan River is located on southern Vancouver Island. There is a hydroelectric power system on the river owned by BC Hydro. The consultative stage of the WUP process regarding this system took nineteen months. Engaged participants comprised a Consultative Committee, which included BC Hydro and fourteen representatives of various interests including fish, wildlife, water quality, socio-economic issues, recreation, culture and heritage sites (BC Hydro Project Team & the Jordan River WUP Consultative Committee, 2002). The committee identified water use objectives. They also identified performance measures for each objective. Dam operating alternatives where then generated, modeled by BC Hydro, and tested against the chosen performance measures. The results were provided to and assessed by the Committee. The outcome of this process was the identification by the Committee of recommended operating constraints for the WUP. The WUP also requires monitoring and technical studies to be undertaken with respect to the plan objectives, and for the Plan to be reviewed no later than six years after implementation.

Columbia River Water Use Plan

The WUP process for the Canadian portion of the Columbia River was completed in 2004 and implemented in 2007. The Consultative Committee for the Columbia River WUP was comprised of thirty-nine representative, including BC Hydro, various government agencies, municipal governments, industry, First Nations, and other local stakeholders. Similar to the Jordan River WUP, the Consultative Committee identified interests and related objectives for the operation of the Mica, Revelstoke and Hugh Keenleyside dams along the main stem of the Columbia.[26] It should be noted that the Columbia River WUP was uniquely constrained. It was not only guided by BC's *Water Use Plan Guidelines*, but also by transboundary flow obligations under the *Columbia River Treaty* and provincial policy that places a high value on the generation of hydroelectric power in the Columbia and Peace rivers (BC Hydro Project Team and the Columbia River Consultative Committee, 2005). Subject to these constraints, the WUP consultative process proceeded to reach final objectives and gather technical data regarding flow-related impacts. The process was particularly challenging due to the large geographic scope of the Basin, the complexity of the issue, and the limited resources with which to scope water use issues (BC Hydro Project Team and the Columbia River Consultative Committee, 2005). The Consultative Committee Report notes that, because of these limitations, data uncertainties arose regarding how to effectively address certain water use issues. To address this hurdle, the Consultative Committee proposed that data continue to be gathered and included in Information Plans and Management Plans. As a result, a number of Information and Management Plans are in place for the Canadian dams along the Columbia. These Plans recommend both hard and soft constraints relating to specific concerns at each dam. Broadly speaking, environmental constraints focus on maximizing the abundance, diversity, and condition of wild fish populations, vegetation, and wildlife (BC Hydro Project Team and the Columbia River Consultative Committee, 2005, p. 3)

[26] Hydroelectric facilities not owned by BC Hydro were not included in the Columbia River WUP.

5.2. Danube River Basin

Table 5.1. Danube River Basin Summary

Danube River Basin					
Continent	**Countries**	**Ecosystem challenges**	**Basin Agreement(s)**	**Basin organization(s)**	**Basin plan(s)**
Europe	Austria Albania Bosnia & Herzegovina Bulgaria Croatia Czech Republic Germany Hungary Italy Macedonia Moldova Montenegro Poland Romania Serbia Slovakia Slovenia Switzerland Ukraine	Heavily regulated – altered flows Water quality Warming temperatures Decrease/increase in precipitation (lower/upper portion of basin Changing precipitation (from snow to rain) Glacier retreat	Danube River Protection *Convention*, 1994 EU Water Framework Directive.	International Commission for the Protection of the Danube River (ICPDR)	ICPDR River Basin Management Plan

5.2.1. Background

Covering 817,000 km^2 and impacting nineteen countries, the Danube River Basin is the second largest river basin in Europe (Roy et al., 2011). Prior to the 1980s, the main focus of river management along the Danube was navigation. By the mid 1980s, environmental issues, such as water quality, were emerging, as were conflicts between nations on water use. For example, after the 1960s, the ecosystem of the Black Sea suddenly collapsed (Giosan et al., 2012). The catastrophe was linked, in part, to agricultural, waste water and industry pollution in Danube, which flows into the Black Sea (Giosan et al., 2012). This situation contributed to drawing attention to the status of the waters of the Danube at the time, which set the tone for an overhaul of river basin

management. In terms of water use conflicts, the dispute over the Gabèíkovo-Nagymaros hydroelectric projects is illustrative. Under a 1977 agreement, Hungary and Czechoslovakia (now Slovakia) decided to build dams on the Danube near the towns of Gabèíkovo and Nagymaros (Deets, 2009). This project originated without much public debate but, during the 1980s, drew increasing public opposition (Deets, 2009). This public pressure, as well as changing political and economic circumstances, resulted in Hungary suspending construction efforts in 1989 (Eckstein & Eckstein, 1998). Over Hungary's objections, Slovakia responded by diverting the Danube upstream from the Hungarian-Slovak border (Eckstein & Eckstein, 1998). This had serious impacts in Hungary, such as decreased water levels, dried wells, fish kills, and decreased flows to wetlands. (Eckstein & Eckstein, 1998). In 1992 Hungary renounced the 1977 agreement. In 1994 the two nations moved their dispute to the International Court of Justice. In 1997 the Court ruled that Hungary had not had grounds to abandon of the 1977 agreement, but also that Slovakia had not had the right to divert the waters of the Danube (Eckstein & Eckstein, 1998).

The Black Sea and the Gabèíkovo-Nagymaros examples to illustrate serious water quality and water use concerns coming to the fore in the Danube region by the 1980s. In 1985 riparian nations along the Danube signed the Bucharest Declaration, an early instrument targeting water management the basin. This ushered in an era of agreement formation including the establishment of the following cooperative transboundary legal frameworks and related institutional arrangements.

5.2.2. Basin Governance

A complex collection of agreements and conventions make up the water management regime in the Danube. Two key agreements are:

- The Convention on Cooperation for the Protection and Sustainable Use of the Danube River of 1994 (entered into force 1998) ("**Danube River Protection Convention**"), and
- Directive 2000/60/EC adopted by the European Union in 2000 (***EU Water Framework Directive***)

The *Danube River Protection Convention* establishes a legally binding commitment to cooperative water management. The purpose of the *Convention* is to ensure that

surface and ground waters are used sustainably and equitably (Article 2(1)). The *EU Water Framework Directive* is the guiding legal framework for transboundary water management of the Basin. Relative to the *Danube River Protection Convention*, the terms of the *EU Water Framework Directive* are more specific, being focussed on various requirements to achieve a "good status" for surface and ground waters in the basin (*EU Water Framework Directive*, Recitals 25 and 33).

River Basin Organization

The International Commission for the Protection of the Danube River (ICPDR) implements the *Danube River Protection Convention* and the *EU Water Framework Directive*. Founded in 1998, the ICPDR is run by a permanent secretariat located in Vienna, Austria. The Secretariat is headed by an Executive Secretary, who is supported by technical and administrative support staff (ICPDR, 2006). The ongoing costs of the ICPDR relate to the secretariat, which include salaries and operational costs (Swedish Ministry of Foreign Affairs, 2001). These costs are largely born by the signatory countries to the *Danube River Protection Convention*, with some funds coming from the European Union and multi-lateral agencies (Swedish Ministry of Foreign Affairs, 2001).

The Commission does not have any legal, regulatory, or administrative powers (Swedish Ministry of Foreign Affairs, 2001). Rather, the ICPDR functions as a forum to promoting cooperation between riparian nations. It is a forum for discussion between members (via twice yearly meetings of high-level government representatives from each nation), public engagement, and cooperative efforts regarding data gathering, analysis, and other activities. Public engagement is also strong focus of the ICPDR. Twenty-two organizations hold observer status with the ICPDR, including non-governmental organizations (NGO), private industry organizations, and intergovernmental organisations (ICPDRc, n.d.). The ICPDR can also take specific actions. For example, a Trans-National Monitoring Network (TNMN), which is a basin-wide system monitoring trends in surface and ground water, was set up under the umbrella of the ICPDR (Sommerwerk, 2010). Another example is the Joint Danube Survey (JDS). The JDS was also carried out under ICPDR. The JDS collected data from laboratories throughout the Basin on pollution in the waters of the Danube.

River Basin Plans

In 2009, parties to the *EU Water Framework Directive* developed the first Danube River Basin Management Plan ("DRBM Plan"). The DRBM Plan is based on input from stakeholders and the public, an assessment of environmental pressures, and an economic analysis of water uses. The DRBM Plan must be up updated every six years, with the current Pan set for renewal in 2015, and then every six years thereafter (ICPDR, 2012).

Prior to developing the DRBM Plan, the parties adopted a common strategy for plan development. Guidance Document No. 11 - Planning Process: Common Implementation Strategy for the Water Framework Directive (2000/60/EC) ("Guidance Document No. 11") sets out the river basin planning cycle (European Commission, 2000). The goal of Guidance Document No. 11 is to establish a common understanding of the planning process. To that end, Guidance Document No 11 sets out principles that are integral to water planning in the basin. The process involves a planning, implementation, and monitoring stage.

The initial planning stage involves identifying the geographic scope of concern, competent authorities, administrative processes, and current water status (European Commission, 2000). A key component of the planning stage is setting environmental objectives for Basin waters. These objectives are based on the Danube Basin Analysis Report ("DBDA")(ICPDR, 2005). The DBDA studied the characteristics of the surface and ground waters of the basin, took an inventory of protected areas, included economic analysis and information on public participation, and offered key conclusions and outlooks (ICPDR, 2009). The Analysis resulted in the identification of four significant water management issues facing the basin: hydro-morphological alterations, as well as pollution by organic substances, nutrients, and hazardous substances (ICPDR, 2009).

The DRBM Plan is also intended to include conclusions addressing climate adaptation (ICPDR, 2012). Indeed, part of the underlying rationale for water planning in the Danube region is that "integrated approaches to water and ecosystem management, combined with the cyclical review of progress achieved, are consistent with the basic principles of adaptive management" (ICPDR, 2012, p.2). This rationale includes incorporating a focus on basin-wide planning for climate change; namely, the region has

established the 2012 ICPDR Strategy on Adaptation to Climate Change (ICPDR, 2012). This Strategy reviews the existing knowledge base on predicted impacts, uncertainties, and vulnerabilities relating to regional climate change and variability, an overview of possible basin-wide adaptive measures, and possible ways to integrate climate change into the ICPDR planning process (ICPDR, 2012). For example, the ICPDR Strategy on Adaptation to Climate Change identifies future stresses on key competing water users and ecosystems. The Strategy notes that "future mean annual and mean summer hydroelectric power generation is likely to decrease in the DRB, although increases can occur in winter due to changes in water availability" (ICPDR, 2012, pp. 17). The Strategy also notes that changes in precipitation, water availability, water quality and increasing extreme events like floods, low flows and droughts may result in higher stress on ecosystems in parts of the basin (ICPDR, 2012, pp. 17).

Addressing the issues identified in the DBDA and the ICPDR Strategy on Adaptation to Climate Change is the objective of the DRBM Plans. As the current DRBM Plan is set for review and updating in 2015, a number of its measures must be in place by then. Measures to be carried out by 2015 include new migratory fish passages, and reductions in organic pollution (Weller and Liska, 2011). A number of other measures, however, will need years, or decades, past 2015 for full implementation. The ICPDR Strategy on Adaptation to Climate Change is intended to guide the full integration of climate change adaptation into the next (2015) iteration of the DRBM Plan (ICPDR, 2012).[27] This means consideration of climate impacts on water resources when considering possible conflicts and tradeoffs, as well as when assessing other stressors/pressures like population growth and changes in consumption patterns (ICPDR, 2012).

[27] This strategy does caution that while there are issues that can be planned at the basin scale, this does not detract from the need for detailed planning at the sub-national and national levels (ICPDR, 2012).

5.3. Amazon River Basin

Table 5.2. Amazon River Basin Summary

Amazon River Basin					
Continent	**Countries**	**Ecosystem Challenges**	**Basin Agreement(s)**	**Basin Organization(s)**	**Basin Plan(s)**
South America	Bolivia Brazil Colombia Ecuador Guyana Peru Suriname Venezuela	Increasing economic and social development Increasing Temperature Decreasing Precipitation	Amazon Basin Co-operation Treaty, 1978 Protocol of Amendment of the Treaty for Amazonian Cooperation, 1998	Permanent Secretariat/Amazon Co-operation Treaty Organization (ACTO)	Strategic Action Programme (SAP) for the Amazon Basin Global Environment Facility (GEF) Amazon Project

5.3.1. Background

At 6,100,000 km^2, the Amazon River Basin is the world's largest river basin (Braga et al., 2011). The Basin is shared by eight South American countries - Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela - all of which have varying political systems and development priorities. The river is important to these nations for a multitude of reasons. The River has tremendous hydroelectric power generating capacity and is home to a variety of plant and animal species. The Basin's ecosystem also faces a number of pressures related to social and economic development in the region. These include deforestation, agricultural water uses, water pollution, mining impacts, as well as forecasted impacts from climate change (OAS, 2013; Braga et al., 2011).

5.3.2. Basin Governance

The Amazon nations recognized early on the need to cooperate in order to protect the environment. This is illustrated by the *Amazon Cooperation Treaty* of 1978 (entered into force in 1980)(the "*ACT*"), which establishes a legal framework for water

management in the Amazon River Basin. The purpose of the *ACT* is cooperative regional development that balances economic growth and the conservation of the environment (*ACT*, Article 1).

River Basin Organization

The *ACT* and the *Protocol of Amendment of the Treaty for Amazonian Cooperation of 1988 (the "Protocol")* establish the Amazon Cooperation Treaty Organization ("ACTO"). The ACTO is comprised of a Permanent Secretariat, headed by an elected Secretary General. The ACTO's Permanent Secretariat is responsible for implementing cooperative actions, preparing regional plans and activities, as well the budget for ACTO (Paisley, n.d; *Regulations of the Permanent Secretariat of the Amazon Cooperation Treaty Organization*, arts. 1 &5.). The ACTO is a political forum, but it can also enter into binding agreements with the signatories of the ACT and with third parties, such as other states (ACT, Article 1). Agreements reached by the ACTO have resulted in the implementation of a number of scientific or environmental projects (Braga et al., 2011).

Permanent National Commissions support the ACTO in each member nation. These commissions are comprised of high level government representatives (such as vice ministers) with portfolios including economic matters, science and technology, health, the environment, indigenous affairs, tourism, transportation, education, and social affairs (ACTO/PS, 2004). These Commissions seek to implement treaty-related decisions in a manner that takes into consideration the domestic priorities of each nation. They are also tasked with promoting "the active participation of civil society to face the complexity of the challenges of the Amazon region" (ACTO/PS, 2004, p. 77).

River Basin Plans

2004-2012 Strategic Plan

The ACTO's 2004-2012 Strategic Plan was approved during the 8th Meeting of Ministers of Foreign Affairs held in September 2004 in Manaus (ACTO/PS, 2012). The Strategic Plan sets out the organization's broad goals for the Basin. One of the broad goals in the ACTO's 2004-2012 Strategic Plan is the "formulation and development of a Regional Program for the Integrated Management of Water Resources" (ACTO/PS, 2004, p. 39). ACTO is pursuing this goal with the help of funding from the Global Environmental Facility (the "GEF").

GEF Amazonas Project

One of the most ambitious projects initiated through the ACTO is named "Integrated and Sustainable Management of Transboundary Water Resources in the Amazon River Basin Considering Climate Variability and Change" (the "GEF Amazonas Project"). This is a detailed water management planning process supporting by the GEF, the United Nations Environment Program, and the Organization of American States.

The goal of the Project is the development of a consensual Strategic Action Program ("SAP") among the eight Amazonian nations based on the principles of IWRM that will enable coordinated water use in the Amazon Basin. The creation of the SAP is unfolding in three stages over six years. The first stage consists of strategic planning and capacity building over 1.5-2 years. Over the following four years, the second stage will focus on implementation of the measures identified in the first stage. The final stage will follow-up on and strengthen the measures taken.

The focus to-date as been on the first stage of the project, which includes stakeholder engagement, data gathering and analysis. Technical studies are to be undertaken as part of a basin-level Transboundary Diagnostic Analysis ("TDA"). The TDA will focus on challenges to sustainable water use in the basin by identifying current and future risks and threats. The TDA will also analyze socio-economic drivers in the region. Although there is no specific strategy in place yet, a focus on adaptation to climate change is intended to be woven throughout the SAP (ACTO/PS, 2013). A broad goal of the Project is to "introduce climate variability and change considerations into

Basin management policies and practices, thus reducing the vulnerability of peoples and ecosystems to extreme events" (GEF Amazonas, n.d., p.1). A comprehensive monitoring and evaluation plan will also be created during the SAP preparation stage. The end goal of the SAP is the consolidation of a "shared vision" for the Basin that will enable joint water management initiatives and activities (UNEP GEF, n.d., p. 12).

5.4. Comparative Observations

5.4.1. River Basin Organizations.

The Amazon and the Danube offer examples of river basin organizations charged with enabling cooperative efforts that are required under their respective transboundary agreements. The organizations function according to the terms of these agreements, which set up the powers, duties, and organizational structure for each commission.

Membership in each commission is through high-level bureaucratic or diplomatic representatives. Each commission is administered through a small bureaucracy. The ICPDR and the ACTO are administered by permanent secretariats in Vienna and Brasilia, respectively. These secretariats are supported by staff and experts sub-commissions/working groups. The ACTO has the added operational layer of the Permanent National Commissions, which work at implementing plans and policies at the domestic level.

The mandates of the ICPDR and the ACTO are similar. The ICPDR's mandate is one of oversight, supporting dialogue, promoting cooperation, enabling data collection and monitoring (Swedish Ministry of Foreign Affairs, 2001). The ACTO's mandate is focussed on implementing cooperative actions, preparing regional plans and activities. There is, however, a difference in autonomous authority between the two bodies, with the ICPDR having no legal personality or powers, while the ACTO has legal personality and can, therefore, enter into binding agreements with others. Further, the ICPDR functions pursuant to agreements that specifically target water use, while the enabling agreement for the ACTO is broader in scope and focussed more on sustainable use of

resources (not simply water). Hence, the ACTO addresses a broader swath of concerns that range from the terrestrial to the aquatic.

Public engagement is a feature of both organizations. The agreements establishing the ACTO lack specific terms on stakeholder consultation. There is evidence, however, the consultation with stakeholders is a priority. For example, the Permanent National Commissions play a consultative role within each nation. The ICPDR's engages stakeholders by offering groups "observer" status. These groups do not have carte blanche access to the Commission. Rather, the ICPDR's interaction with observers is largely restricted to meeting and stakeholder conferences (Sommerwerk, 2010). There may be an imbalance in the political influence amongst NGO observers with the ICPDR. Specifically, NGOs in the upper Danube basin are long-established and internationally influential, while NGOs in the lower basin are still gaining presence and influence (Sommerwerk, 2010).

The commissions have had success in fostering high-level dialogue and cooperative actions. Both function as forums for diplomatic relations. Further, the functioning of both commissions has translated into deliverables aimed at addressing environmental challenges. For example, this is evidenced by support for improved river monitoring in the Danube Basin developed under the ICPDR. The ACTO has also implementing measures aimed at sustainability and conservation, which are resulting in positive outcomes. These outcomes include a sustainable economic development plan and a rainforest programme that has protected millions of hectares in the region (Braga et al., 2011). The table below summarizes key features that the ACTO and the ICPDR share:

Table 5.3. Comparison of River Basin Organization Features

International Commission for the Protection of the Danube River (ICPDR)/	Amazon Cooperation Treaty Organization
Members are high level country representatives (member nations have one representative)	Members are high level government officials or bureaucrats
Organization is forum to make transboundary policy decisions for whole basin	Organization is forum to set high-level policy direction for the basin
Has working groups that work on various treaty concerns	Has special commissions that work on various treaty concerns
Main task is implementing transboundary agreements	Main task is implementing treaty objectives
Coordinate studies, meetings, and other joint actions between nations	Coordinate studies, meetings, and other joint actions between nations
Promotes communication between nations	Promote communication between nations
Promotes engagement with public – Observer system - Unclear as to specific level of consultation in the assessment and formation of activities and policies. May vary by activity or policy.	Some level of engagement with public is important, - Unclear as to level of consultation in the assessment and formation of activities and policies. May vary by activity or policy.
Promote cooperative actions between nations	Promote cooperative actions between nations
Promote scientific inquiry between nations	Promote scientific inquiry between nations
Support program planning, monitoring and evaluation	Support program planning, monitoring, and evaluation

5.4.2. Water Use Planning

Compared to the transboundary basin organizations, the planning processes in the cases manage specific resources and target specific outcomes through the adherence to known steps and processes. The processes share a number of common attributes.

All three planning processes specifically target water management. They do in a way that contemplates competing interests and various pressures in a three-stage process. Broadly speaking, in each case the first stage consists of data gathering/analysis and stakeholder engagement, the second stage is implementation, and the third stage is monitoring and review.

In addition to sharing this overall format, the first stage in each process shares key elements. These include scoping interests/uses, the identification of objectives, and the assessment of measures to achieve those objectives. The end goal of the first planning stage is similar in each case, with BC seeking consensus amongst stakeholders and license holders, and the Danube and the Amazon processes seeking shared visions between stakeholders and the member nations.

The water use plans have had success in enabling cooperative actions that address specific environmental concerns. For example, an early assessment of the impacts of BC WUPS found that the process had generally improved the level of fish habitat protection in the province, and has served to identify uncertainties, data gaps, and to establish a framework for adaptive management of fish flow issues (Quadra Planning Consultants Ltd et al., 2004). This assessment also notes areas of dissatisfaction with the WUP process, however, including the concern that the level of consultation under the WUP may not rise to the level of consultation with First Nations as constitutionally mandated (Quadra Planning Consultants Ltd et al., 2004). There was also a concern that, while the process of identifying trade-offs is fruitful, the BC Guidelines may not sufficiently clarify how trade-offs between operating alternatives are to be identified and assessed in the provincial process (Quadra Planning Consultants Ltd et al., 2004). The procedural concerns identified in the BC WUP process may not be barriers to substantive ecological impacts. Continued monitoring shows that measures implemented under the WUP are having some positive impacts in the Jordan River. For example, measures included increasing base flows in lower Jordan river in order to benefit rainbow trout. These measures have had some positive impacts on fish density and habitat continuity (BC Hydro, 2012). In the Columbia, while it appears that many conclusive results have yet to be established, there is some evidence of positive impacts due to modifications to dam operations. For example, BC Hydro studies of minimum flow targets (water releases at or above 142 cubic feet per second) below Revelstoke Dam are shedding light on the conditions in which such flows may be most effective in supporting fish species (Ecoscape, 2012).

One of the procedural concerns identified within the BC context was with imprecision in the Guidelines as to how to undertake the identification of water use trade-offs. To the end, I note that in the two international basins examined, both

established procedures specifically targeting the assessment of basin-wide water uses and impacts. In the Danube this was the Danube Basin Analysis Report and in the Amazon this was the Transboundary Diagnostic Analysis. It appears that by identifying impacts, existing water uses, and data gaps, these detailed processes enable the nations of the two basins to identify and choose between desired measures. In terms of effect, in the Danube, for example, efforts are still underway to address the significant water management issues facing the Danube River Basin; however, a 2012 report on the measures being implemented under the DRBM Plan indicate that nations are taking steps to implement a number of water quality measures identified in the Plan (ICPDR, 2012a). Further, work is being undertaking to identify gaps in data regarding water management issues and to monitor the impacts of measures addressing hydrological alterations, such as impoundments (ICPDR, 2012a). Finally, an important aim of the transboundary planning processes examined is to be adaptive in the face of climate change and variability. This is reflected in the Danube region's ICPDR Strategy on Adaptation to Climate Change and in the GEF Amazonas Project.

The table below summarizes key features that the water use planning processes share.

Table 5.4. Comparison of Water Use Planning Features

BC Water Use Plan	ICPDR River Basin Management Plan	GEF Amazonas Project (Strategic Acton Plan)
Focus on water use (concern is balance between water users)	Focus on water use (concern is water quality and use)	Focus on water use (concern is sustainable use)
Defines the operating parameters to be imposed on specific works or water control facilities	Defines measures to ensure health and sustainable use of river	Defines measures to ensure sustainable development in river basin.
Goal is to recognize and balance multiple water use objectives	Goals is to balance environmental, economic and social uses of river	Goals to guide future development in the region in a sustainable manner
Has document outlining planning process (BC Water Use Planning Guidelines)	Has documents outlining planning process (Guidance Document No. 11 and Strategic Paper)	Has document outlining planning process (GEF project details).
Multi-step process of WUP development • Consultative Committee phase • Implementation • Monitoring and review	Multi-step process of RBMP development • Consultative preparation phase • Implementation • Monitoring and review	Multi-step process of SAP development • Consultative planning and capacity building • Implementation • Follow-up and strengthening
Preparation phase is consultative and iterative	Preparation phase is consultative and iterative	Preparation phase is consultative and iterative
Early and ongoing stakeholder involvement	Stakeholder engagement about issues and options	Stakeholder engagement about issues and options
Strive for consensus	Develop common objectives	Develop shared vision
Gather/analyze available data on water uses	Gather/analyze basin wide current water status, pressures and impacts, and economic analysis of water uses (Danube Basin Analysis Report)	Technical and socio-economic studies undertaken to define the root causes of shared transboundary problems in the basin (Transboundary Diagnostic Analysis)
Identify objectives	Identify objectives	Identify objectives
Identify various options to meet objectives	Identify various measures to meet objectives	Identify various measures to meet objectives
Implementation by water license holders	Implemented by each state through state ministries	Details of implementation are yet to be established
Monitoring and evaluation	Monitoring and evaluation	Monitoring and evaluation
Review and updating	Review and updating	Review and updating

Chapter 6. Policy Options

The policy problem explored in this report is that *the US and Canada do not have a sufficient understanding of which, if any, transboundary institutional alternatives will enable the two nations to better consider and address ecosystem function in the Columbia River Basin.* Institutional alternatives considered in this study must respond to this problem in a manner that accounts for the challenges to ecosystem function and potential barriers to cooperative action identified in the literature review and the survey. Based on the literature, survey results, and the three cases, I have identified three institutional alternatives to the status quo for analysis. These alternatives are:

- Adding ecosystem function as a co-purpose under the terms of the Treaty,
- Basin-wide water use planning, and
- A new basin-wide river management organization.

Each of these alternatives are institutional in nature as they are systems of politically or legally binding rules designed to influence the behaviour of states regarding transboundary environmental challenges. This section provides a brief description of each of the three alternatives, as well as the status quo.

6.1. Status Quo

The status quo is the continuation of current institutional arrangements under the Treaty Regime, which are described in detail in Chapter 2. The Treaty, being the institutional foundation, establishes a system in which the Treaty dams are operated by the US and Canadian Entities. Hydroelectric power generation and flood control are the explicit purposes for which these dams are operated. River management for these purposes is implemented via flood control and hydroelectric power operating plans (the

AOPs, DOPs, and SOAs). These plans specify when and how much water can be drafted or refilled over the course of each operating year.

6.2. Ecosystem Function as Co-Purpose of the Treaty

Adding consideration for ecosystem function to the Columbia River Treaty has emerged as an alternative to the status quo in recent years. This alternative is most commonly characterised as adding ecosystem function as a third co-purpose in the Treaty alongside hydroelectric power generation and flood control (Bankes & Cosens, 2012; Cosens, 2012; Blumm, 2013). This option incorporates the status quo. What is different is the addition of new wording to the text or preamble of the Columbia River Treaty that describes ecosystem function as a co-purpose under the Treaty ("co-purpose" meaning that ecosystem function becomes a third purpose of the Treaty, in addition to hydroelectric power generation and flood control).

6.3. Transboundary Water Use Planning

This option proposes a transboundary water use planning process for the entire Columbia River Basin. This option could target the coordinated operation of Treaty reservoirs and dams in the Basin through a multi-step planning process. This could be implemented using existing protocol procedures under the Treaty to expand the duties and powers of the Entities to cooperatively administer the transboundary water use planning process.

The planning process could commence with a consultative/iterative phase. As in the case studies, a priority of this phase could be arriving at a shared vision between the US and Canada for managing the River in a way that supports ecosystem function throughout the Basin. This shared vision could be informed by public input about pressures on the Basin's ecosystem, as well as about water uses and demands in the Basin. Those engaged can include local governments, residents, Native Americans, First Nations, stakeholders, civil society, and the private sector. This phase can also require scientific and economic analysis, including the gathering and analysis of data and

technical information on flow needs and pressures to ecosystem function in the Basin, including current climate modelling and forecasts.

The goals of this process could include identifying ecosystem function objectives, measures to meet the objectives, advantages and disadvantages of each measures, and reaching agreement on which measures to implement in order to meet the identified objectives. After the plan is developed and implemented, monitoring and evaluation methods should be in place to track progress under the plan. There could also be a deadline by which the plan would be reviewed and updated by the Parties.

6.4. Transboundary River Basin Organization

This option proposes the formation of a new transboundary river basin organization for the entire Basin. Assuming the Treaty continues to exist post-2024, this new organization could be introduced to the Treaty Regime through new wording in the text of the Treaty. This change to the Treaty would establish the structure, mandate, powers, and duties of the new organization.

The policy direction of the organization would be set through its membership, which, as in the case studies, can include representatives of US and Canadian interests. This membership should meet no less than once a year. The new organization could be administered by a limited bureaucratic corps comprised of an equal amount of Canadian and US personnel. This personnel should have technical or professional backgrounds relevant to the management of river flows. This corps could be supported by expert working groups/committees that specialise in various matters, such as fish species or climate change.

The mandate of the organization could include identifying, developing and implementing cooperative actions that support ecosystem functions throughout the Columbia River Basin. The organization wouild draw from the ACTO model in the Amazon in that it will have legal personality. In this way, not only would the organization be able to undertake its own work, but it would, if desired, by able to enter into agreements with third parties for the purposes of research, analysis or any other activities identified by the organization as being in furtherance of its mandate.

Chapter 7. Option Analysis

Bernauer (1995, p.351) states "if the degree of success in international collaboration can be influenced by the institutions we establish and operate, we can be more successful if we know how to design institutions that produce the desired effect." The key words here are *desired effect*. In order to assess possible institutional alternatives for the Columbia River Basin, we need to know what it is we hope to achieve. In this section, based on the literature review, case studies, and survey results, I identify key objectives that ought to underpin future institutional arrangement for transboundary river management in the Columbia River Basin. This chapter then develops a multi-criteria analysis framework to consider whether institutional alternatives can assist in meeting the identified objectives. Finally, this chapter applies the multi-criteria framework to institutional alternatives drawn from the literature and survey results.

7.1. Policy Objectives

7.1.1. Objective 1: Support for Environmental Flows and Ecosystem Function within the Governing Institution

The literature indicates that ecosystem function is a general problem in the Columbia River Basin and that there is a link between negative impacts to ecosystem functions and alterations to the Basin's hydrology and flow regime. The literature reviewed in Chapter 2 shows that the concept of environmental flows can be useful considering ways to address ecosystem function in the context of rivers that are heavily regulated and are facing competing water uses. The concept of environmental flows recognizes that the allocation of water flows involves trade-offs between water users and, therefore, seeks to equitably balance water between users while maintaining ecosystem sustainability (Swedish Water House, 2009; Forslund, 2010). Further, the

literature advises the flexibility and adaptability are key components of sustainable water treaties.[28] In order to support ecosystem function in the Columbia River Basin, the Parties can consider crafting an adaptive institutional arrangement that fundamentally supports environmental flows. In light of these considerations, one objective should be to incorporate both a broad consideration of ecosystem function as well as a specific focus on understanding basin-wide flow needs and demands now and in the context of future climate change and variability.

7.1.2. Objective 2: Identify Water Use Interests and Concerns

Best practices identify management at the basin level as an accepted method to meet transboundary ecosystem challenges; however, managing a basin as a unit implicates the varying interests in basin resources held by stakeholders and sovereigns. The literature and data in this study indicate that the US and Canada have somewhat dissimilar perspectives on 1) which challenges to ecosystem function are priority concerns, 2) the sufficiency of the nations' joint understand of and ability to address environmental flow needs and 3) the manner by which these needs should be jointly addressed. To this end, to mitigate lack of political will, or political inertia, institutional arrangements should strive to identify the full scope of interests, including possible conflicts of interest in the basin.

7.1.3. Objective 3: Identify Trade-offs and Balance Interests

The survey results reveal a concern that choosing and prioritizing amongst water uses may involve trade-offs. These are not just environmental, but also social and economic. Trade-offs that impinge on national priorities again bring to the fore the issue of political willingness to cooperate. Thus, it is not only important to identify the field of

[28] Recent literature pertaining to international water governance advocates that treaties should be crafted to incorporate mechanisms that will permit governance regimes to adapt to uncertain circumstances, such as uncertain river variability and extreme weather events related to climate change (Fischhendler, 2004; Cooley and Gleick, 2011; De Stefano et al, 2010; Osborn, 2012). Kistin and Ashton (2004) define flexible water treaties as those that "anticipate the possibility of gradual and sudden changes in shared basins and incorporate mechanisms to allow parties to adjust management practices to changing circumstances" (p. 390).

interests and concerns in the basin, but also how those interests interact and how different measures may impact them. In this context, an objective should be to incorporate consideration of social, economic, and environmental trade-offs relating to different flow management options.

7.1.4. Objective 4: Public Participation

The Treaty Regime lacks fulsome public engagement mechanisms. The literature and the survey results evidence a desire for this kind of engagement. The cases show that public participation not only informs an understanding of possible water use interests, but makes river management decisions transparent and inclusive. In this context, an objective should be meaningful engagement with stakeholders and residents about water interests and ecosystem challenges, as well as about measures to address those challenges.

7.2. Criteria & Measures

The four institutional options will be evaluated against three criteria. The objectives identified above are the foundation for these criteria. They are:

1. **Effectiveness**:

   The objectives identified above collectively strive for an institutional response that is effective in two ways: 1) by being truly equitable and cooperative in nature and 2) by giving meaningful consideration to environmental flows for ecosystem function now and in the context of future climate change and variability. This criterion considers whether an option enables parties to the institutional arrangement to cooperatively address environmental flow challenges to ecosystem function. Six measures are used to assess the degree to which each institutional option meets the criterion. A high/medium/low scale is used to describe how each option meets each measure (with the degree to which each option scores high, medium, or low being based upon evidence in the case studies and/or literature and background material).

2. **Ease of Implementation:**

This criterion considers the likelihood of the option facing political resistance or inertia, and whether it will be possible to implement the option under current Treaty terms. Two measures are used to assess the degree to which each institutional option meets the criterion. As above, a high/medium/low scale is used to describe how each option meets each measure.

3. **Public Acceptability**:

This criterion considers the degree to which institutional alternatives mandate an engagement process with stakeholders. Three measures are used to assess the degree to which each institutional option meets the criterion. As above, a high/medium/low scale is used to describe how each option meets each measure.

Each of these criteria and their measures are described in detail in the matrix below**.**

Table 7.1. Index of Criteria and Measures

Criterion	Meaning	Measure	Index	
Effectiveness	Does the option enable parties to the institutional arrangement to cooperatively address challenges to ecosystem function?	Measure 1: Does the institutional arrangement include terms that mandate or enable consideration of the transboundary ecosystem?	High	Terms include broad references, such as to the river basin, the ecosystem, the aquatic ecosystem, ecosystem function, or the natural environment *per se.*
			Medium	Terms are limited in scope (e.g. references limited to specific concerns for or components of the ecosystem, such as water quality or fish species).

Criterion	Meaning	Measure	Index	
			Low	There are neither broad nor specific references to ecosystems or components of ecosystems in the terms.
		Measure 2: Do the terms of the institutional arrangement enable the parties to the arrangement to identify domestic and transboundary interests or concerns regarding ecosystem function?	High	Measures are in place, or enabled, through which the parties to the arrangement can identify interests or concerns regarding ecosystem function.
			Medium	Measures are in place, or enabled, though which the parties to the arrangement can identify limited interests or concerns, such as water quality or fish species.
			Low	There are no measures in place, or enabled, through which the parties can identify interests or concerns.

Criterion	Meaning	Measure	Index	
		Measure 3: Does the institutional arrangement enable the parties to gather technical data and other relevant information on the flow or hydrological needs of their identified water use interests, and how different water management options can impact the viability of their identified water use interests?	High	Measures are in place through which the parties can assess the flow needs for ecosystem functions, as well as impacts upon those ecosystem functions under water management alternatives.
			Medium	Measures are in place through which the parties assess only limited or specific ecosystem components.
			Low	No such measures are in place.
		Measure 4: Does the institutional arrangement enable the parties to identify water management options?	High	Clear provisions to identity options.
			Medium	Limited or unclear provisions in place.
			Low	No such measures are in place.
		Measure 5: Does the institutional arrangement enable the parties to identify trade-offs and/or work to a common goal (or goals)?	High	Measures are in place through which the parties can identify water management objectives and reach an agreement.
			Medium	There is limited consideration of options and objectives
			Low	No such measures are in place.

Criterion	Meaning	Measure	Index	
		Measure 6: Has the operation of the institution yielded positive results for target ecosystem objectives?	High	Literature, reports, studies or other sources indicate a high degree of success in meeting objectives.
			Medium	Literature, reports, studies, or other sources indicate some degree of success in meeting objectives.
			Low	No reported success in literature, reports, studies, or other sources.
Ease of Implementation	Would the option face political resistance or inertia?	Measure 1: Has either sovereign given an indication of their position vis-à-vis the option?	High	Literature, reports, studies or other sources indicate silence on or support for the option.
			Medium	Literature, reports, studies or other sources indicate uncertainty, possible risk, or no statement of support or opposition.
			Low	Literature, reports, studies or other sources indicate clear opposition.
	Is it possible to implement the option under current Treaty terms?	Measure 2: Could the option be implemented or exist under current Treaty	High	It appears likely that the option could be implemented or exist under current Treaty terms.

Criterion	Meaning	Measure	Index	
		terms?	Medium	It is unclear-to-possible that the option could be implemented or exist under current Treaty terms.
			Low	It appears unlikely-to-impossible that the option could be implemented or exist under current Treaty terms.
Public Acceptability	Does the option strive for a public or stakeholder engagement?	Measure 1: Does the institutional arrangement mandate or enable engagement processes with stakeholders with respect to interests or concerns regarding ecosystem functions and/or ecosystem services (e.g. interests in various water uses)?	High	There is a formal or structured engagement process in place.
			Medium	No formal engagement process is in place, but there is evidence of come level (e.g. occasional or ad hoc) of stakeholder engagement.
			Low	There is no evidence of any engagement process, either formal or informal.
		Measure 2: Does the intuitional arrangement mandate or enable engagement processes with stakeholders regarding trade-offs as between possible water allocation or management options?	High	There is a formal or structured engagement process in place.
			Medium	No formal engagement process is in place, but there is evidence of some stakeholder engagement.

Criterion	Meaning	Measure	Index	
			Low	There is no evidence of any engagement process, either formal or informal.
		Measure 3:	High	Information or data sharing is required.
		Does the institutional arrangement mandate or enable the sharing of data/ information on identified interests as between the parties to the arrangement and other stakeholders?	Medium	Information or data sharing is optional or there is evidence that it is undertaken to some degree
			Low	There is no evidence of any required or optional information and data sharing.

7.3. Policy Evaluation

7.3.1. Option 1: Status Quo

Effectiveness

Measure 1 (Focus on Ecosystem Function): Medium

Despite the lack of explicit provisions in the text of the Treaty, mechanisms such as flow requirements for fish species in the DOPs and SOAs indicate that the Treaty Regime is currently incorporating some considerations for certain components of the Basin's ecosystem. The considerations, however, are limited in their scope and application (e.g. limited in terms of being directed only at certain species or habitats, certain times of year, and/or limited in application to the duration of the governing agreement).

Measure 2 (Identify Interests): Medium

Canada and the US have interpreted their ability to expand operational considerations under DOPs in ways that are more mutually advantageous than would occur under the AOPs. By implication, it is assumed that there must be some minimal level of identifying of interests in order to negotiate specific concerns, such as flows for aquatic species.

Measure 3 (Flow Data and Technical Information): Low

The Treaty Regime does not include a mandate to assess the flow needs of the Basin ecosystem. While domestic efforts in the US and Canada provide domestic sources of information on flow needs for specific components of the ecosystem (e.g. anadromous and non-anadromous fish species), there is no indication that the transboundary regime requires basin-wide study or assessment. The Treaty Regime contains no terms requiring the study or assessment of competing water uses. There is no requirement for a basin-wide understanding of ecosystem flow needs.

Measure 4 (Identify Options): Low

Negotiating supplemental agreements on water flows for aquatic species on a year-by-year basis does not equate to identifying and assessing different operational strategies that take basin-wide ecosystem needs into account.

Measure 5 (Identify Trade-offs and Agree on Objectives): Low

The Treaty Regime shows some ability to compensate for decreases in power generation due to the provision of flows for fish. This, however, does not meet the standard of engaging in an assessment of the advantages and disadvantages of different alternatives or measures.

Measure 6 (Meet Objectives): Medium

Although results may be mixed, the literature does indicate that the current flow provisions contribute to meeting some of the needs of some ecosystem functions (namely, fish species under the SOAs and Non-Treat Storage Agreements).

Ease of Implementation

Measure 1 (Sovereign Support or Opposition): Low

US and Canadian positions are not aligned on a number of issues as they currently exists within the Treaty Regime (e.g. ecosystem function, restoration of salmon to the upper Columbia, the calculation of the Canadian Entitlement, and, possibly, flood control post-2024). It appears both nations will wish to see the Treaty improved/modified, although in different ways (the US favours modernization, which can include amendments, while Canada favours working within the existing framework). The desire to see improvements/modification indicates lack of support in both nations for maintaining the status quo exactly as is.

Measure 2 (Implementable under Treaty Terms): High

The status quo is already implemented.

Public Acceptability

Measure 1 (Public Engagement re Interests): Low

While there is evidence of some domestic stakeholder engagement in both nations (particularly on issues relating to fish), there is no mechanism to fulsomely identify and consider the interests or concerns of non-state stakeholders into transboundary operational decision making.

Measure 2 (Public Engagement re Trade-offs): Low

There is no evidence of substantive stakeholder engagement under the Columbia River Treaty for the purpose of assessing trade-offs as between river management alternatives.

Measure 3 (Information Availability): Medium

No formal information sharing with stakeholders is required under the *Treaty*, but there is evidence of the publication of information (e.g. the Entities' websites make plans and reports available).

7.3.2. Option 2: Ecosystem Function as Co-Purpose in Treaty Terms

Effectiveness

Measure 1 (Focus on Ecosystem Function): High

This option would explicitly bring consideration of the ecosystem into the Treaty Regime.

Measure 2 (Identify Interests): Medium

The addition of a term making ecosystem function a co-purpose of the Treaty speaks more to the weight or priority explicitly given ecosystem concerns rather than a mandate to identify all pressures on or concerns about the basin ecosystem.

Measure 3 (Flow Data and Technical Information): Medium

As a change in the Treaty's purpose would impact the context in which the Treaty terms are interpreted and implemented, it is possible that existing terms that enable data collection and analysis for the purposes of hydro power and flood control could be interpreted to also enable analysis for other flow needs and water uses.

Measure 4 (Identify Options): Medium

The addition of ecosystem function as a co-purpose does not, in and of itself, require or enable the identification of different operational alternatives that benefit ecosystem function. There is a question, however, of whether this new co-purpose would impact the purpose for which the operating plans are drafted. At present they focus upon optimal power generation, subject to constraints of flood control provisions. It is possible that the introduction of a new purpose may add another constraint or another focus for hydroelectric operating plans.

Measure 5 (Identify Trade-offs and Agree on Objectives): Low

As with the fourth measure, the addition of ecosystem function as a co-purpose does not, in and of itself, mandate cooperation between the US and Canada to identify and negotiate the positive and negative impacts that operational alternatives may have on sovereign and stakeholder interests.

Measure 6 (Meet Objectives): Medium

There is no basis for comparison, but I have no foundation upon which to conclude that this option could lead to worse results than the status quo. Further, the cases examined indicate that including the environment in a governing agreement can lead to political and legal commitments intended to benefit river basin ecosystems.

Ease of Implementation

Measure 1 (Sovereign Support or Opposition): Medium

There is some reason for concern that this could be an area of disagreement or impasse. While the US Entity's final recommendation is keen to see this concept included in a modernized Treaty, the Canadian Entity's position on ecosystem function in the Treaty is circumspect. The final draft of the BC recommendation is silent on BC/Canada's position on the concept of making ecosystem function a co-purpose, but it does note that residents are "big proponents of enhancement to environmental values within the Basin…by adjustments to hydro system operations to balance ecosystem needs with those of flood protection and power generation" (CRTRT, 2014).

Measure 2 (Implementable under Treaty Terms): Low

This measure considers whether the current Treaty can accommodate the option under current Treaty terms, or whether amendments would be required. Introducing a new purpose to the Treaty would require a change to the terms themselves. This option likely would require an amendment to the Treaty. Amendments may not require opening the whole treaty for re-consideration (McKinney, 2010), but they still need to be formally endorsed by federal authorities in each nation. Each nation has its own amendment policies.

The recent Canadian policy on new treaty's has been to table the new arrangements with Parliament for approval; however it is not clear how this policy would apply to amendments to existing treaties (Bankes & Cosens, 2012). The literature indicates that Recent practice suggests that the policy may extend to significant amendments of existing treaties (Bankes & Cosens, 2012). A change to the very purpose of an agreement is arguably a significant amendment. It is less clear how US ratification policies would handle amendments to the Columbia River Treaty. Prior to

1950, US practice was to ratify amendments dealing with transboundary waters by obtaining the advice and consent of Senate; however, more recent cases have varied with the advice and consent of the Senate required in some cases, but not others (Bankes & Cosens, 2012).

There is evidence in the literature that US and Canadian stakeholders would like to avoid having to involve federal levels of government make changes to the Treaty (Bankes & Cosens, 2012). The official US position on modernization includes a willingness to consider amendments (US Entity, 2013). In contrast, the Canadian recommendation clearly states that the desired outcome are improvements within the existing Treaty framework (CRTRT, 2014). Also, from a Canadian perspective, the federal and provincial crowns will have a constitutional duty to consult and accommodate First Nations if their interests may be affected by a Treaty amendment (Bankes & Cosens, 2012). In sum, there is a question of whether political willingness to engage in substantive amendments may be dampened by the complexities of having to engage in domestic amendment procedures and related processes.

Public Acceptability

Measures 1-3: Low

The addition of ecosystem function as a co-purpose does not, in and of itself, address this issue and changes nothing from the status quo.

7.3.3. Option 3: Transboundary Water Use Planning

Effectiveness

Measure 1 (Focus on Ecosystem Function): High

The cases suggest that river basin water use plans can bring explicit consideration of a transboundary ecosystem into the governing institutional arrangement.

Measure 2 (Identify Interests): High

The cases indicate that a key principle of water use planning is to foster a cooperative environment by enabling interested parties to participate in identifying ecosystem pressures, concerns, and interests.

Measure 3 (Flow Data and Technical Information): High

The cases show that water use planning can be designed to be evidence-based and iterative; namely, in terms of identifying flow needs and water pressures/uses.

Measure 4 (Identify Options): High

The cases place emphasis on considering river management measures and considering their impacts on desired objectives.

Measure 5 (Identify Trade-offs and Agree on Objectives): High

The cases include steps where the positive and negative impacts of options, or trade-offs, are considered in an effort to agree on how to proceed.

Measure 6 (Meet Objectives): Medium

Each planning system examined in the cases focussed on establishing scientifically-based understanding of ecosystem function in each basin. As such, each case evidences a growing knowledge base in each basin. There are also indications that measures taken are translating into improvements for identified challenges. However, despite the level of optimism in each basin, there is not yet enough information to confirm that basin planning leads to high degree of success in supporting ecosystem function. On the other hand, there is no evidence to suggest the basin planning regimes have no impact or lead to negative outcomes; rather, there is evidence of positive impacts and developments with respect to ecosystem function.

Ease of Implementation

Measure 1 (Sovereign Support or Opposition): Medium

Water use plans do not appear to be a concept that has been considered in the context of the Columbia River Basin. The level of support the sovereigns would give this option is unknown.

Measure 2 (Implementable under Treaty Terms): Medium

The medium score is due to the uncertainty surrounding whether water use planning can be introduced using existing Treaty mechanisms. The Treaty contains mechanisms to expand what is done by the Entities, but any such expanded powers still have pursuant to the terms of the Treaty. There is no clear mandate for addressing ecosystem function in Treaty, but the Entities already interpret negotiating non-power uses that are mutually beneficial as including operations management for limited ecosystem functions This suggests, but does not confirm, that there may be room to incorporate transboundary water use planning for ecosystem purposes into the existing framework through an expansion of the Entities' mandate.

Public Acceptability

Measure 1 (Public Engagement re Interests): High

The cases demonstrate that water use planning is a tool that can that requires a high degree of stakeholder involvement in identifying concerns and priorities.

Measure 2 (Public Engagement re Trade-offs): High

The cases show that water use planning can incorporate a consideration of impacts on concerns raised by all involved stakeholders.

Measure 3 (Information Availability): High

The measure considers whether the option enables information sharing on ecosystem concerns between the parties to the arrangement and other stakeholders. The cases demonstrate that water use planning can incorporate information exchanges as between nations and stakeholders.

7.3.4. Option 4: Transboundary River Basin Organizations

Effectiveness

Measure 1 (Focus on Ecosystem Function): High

The cases show that transboundary river basin organizations can incorporate mandates that focus on basin-wide ecosystem issues, like sustainable development and river protection.

Measure 2 (Identify Interests): High

The cases show that river basin organizations can enable a high level communication and coordination between nations in order to identify shared concerns.

Measure 3 (Flow Data and Technical Information): Medium

The cases indicate that river basin organizations can function as forums in which flow needs can been discussed. The basin organizations examined lack specific mandates in this regard, but they do evidence broad authority to enable the parties to pursue this type of analysis. However, the cases also show that something more than the mere existence of the organization is required for the research to take place, such as the establishment of a plan, strategy, or project.

Measure 4 (Identify Options): Medium

The organizations in the cases enable high level decision-making for the purposes of implanting treaties. The organizational arrangements themselves are not focussed on the specifics of river flow management, but their broad scopes of authority to enable the parties to take actions for the purpose of identifying options.

Measure 5 (Identify Trade-offs and Agree on Objectives): High

The river basin organizations examined in this report do not appear to have such an explicit mandate, but it is assumed that the requirement for unanimous decision-making in the Danube and the Amazon basin organizations implies that the balancing of sovereign interests must get meaningful consideration.

Measure 6 (Meet Objectives): Medium

The organizations examined were able to initiate studies, monitoring, research, and planning efforts. There is evidence in that these actions are having some positive results in both the Danube and the Amazon (such as on aspects of water quality in the Danube and the establishment of a hydro-meteorological database in the Amazon).

Ease of Implementation

Measure 1 (Sovereign Support or Opposition): Medium

Neither Canada nor the US have expressed a position on the concept of a river basin organization.

Measure 2 (Implementable under Treaty Terms): Low

This option could be the most cumbersome to implement. An entirely new organization would require substantive additions to the terms of the *Columbia River Treaty* in order to establish its mandate, objectives, composition, and functions. This would require amendments to the terms of the Treaty, which prompt the same concerns as option 2 for this measure.

Public Acceptability

Measures 1-3: Medium

While stakeholder engagement features in both the Amazon and Danube basin organizations, both cases are unclear as to exactly when and how stakeholders are involved in high-level, planning, and implementation decisions. Yet, there is evidence that the organizations at least broadly consider the need to address stakeholders, such as indigenous groups, as a part of transboundary river governance.

7.3.5. Summary

The matrix below provides an illustrative aggregate of the relative scores, as well as the advantages and disadvantages of each option. The pale green, pale yellow, and pale red/textured colours correspond, respectively, with the high, medium, and low scores.

Table 7.2. Summary of Multi-Criteria Analysis

Criteria		Status Quo	Co-Purpose in Treaty	Water Use Planning	River Basin Organization
Effectiveness	Measure 1:	Medium (2)	High (3)	High (3)	High (3)
	Measure 2:	Medium (2)	Medium (2)	High (3)	High (3)
	Measure 3:	Low (1)	Medium (2)	High (3)	Medium (2)
	Measure 4:	Low (1)	Medium (2)	High (3)	Medium (2)
	Measure 5:	Low (1)	Low (1)	High (3)	Medium (2)
	Measure 6:	Medium (2)	Medium (2)	Medium (2)	Medium (2)
	Subtotal	9	12	17	14
Ease of Implementation	Measure 1:	Low (1)	Medium (2)	Medium (2)	Medium (2)
	Measure 2:	High (3)	Low (1)	Medium (2)	Low (1)
	Subtotal	4	3	4	3
Public Acceptability	Measure 1:	Low (1)	Low (1)	High (3)	Medium (2)
	Measure 2:	Low (1)	Low (1)	High (3)	Medium (2)
	Measure 3:	Medium (2)	Medium (2)	High (3)	Medium (2)
	Subtotal	4	4	9	6
	Total (out of 33)	**17**	**19**	**30**	**23**

Option 1, the status quo, is the lowest scoring of the four institutional alternatives. Despite the lack of explicit provisions in the text of the Treaty, flow provisions for fish in the operation plans and supplement agreements do show that the Treaty regime is currently incorporating some considerations for a limited set of components of the basin ecosystem. The considerations, however, are limited in their scope and application (to certain species and only for the duration of the contracts). The Treaty Regime does not include a clear mandate to assess or address the flow needs of the Basin ecosystem. Further, negotiating supplemental agreements on water flows for certain aquatic species on a year-by-year basis does not equate to identifying and assessing different operational strategies that take basin-wide ecosystem needs into account. Lastly, the status quo lacks mechanism to identify and consider the interests or concerns of non-state stakeholders.

Option 2, the ecosystem-function-as-co-purpose alternative, receives a higher overall score than the status quo for effectiveness as it introduces explicit recognition of ecosystem function. This would change to the way existing Treaty terms are interpreted and implemented, which leads to improve scored for measures 3 and 4. However, the co-purpose option does little to improve upon the status quo in terms of identifying ecological concerns or understanding of how operating alternatives impact the basin ecosystem as a whole. Further, while adding a mandate to consider ecosystem function, Option 2 may also introduces uncertainty as to the parties' rights and obligations because what is meant by ecosystem function is undefined. Further, the feasibility of implementing this option may be lower due to uncertain support and the possible desire by the US and Canada to avoid alternatives that require domestic ratification. Lastly, this option does nothing to improve stakeholder involvement.

In theory, Option 4, a new transboundary river basin organization, has a lot to offer. A basin organization can place clear emphasis on ecosystem function and can enable considerations of basin-wide interests, concerns, pressures on environmental flows, and alternatives to benefit the same. This option has a heightened focus on stakeholder engagement relative to the status quo. Yet, the creation of a new organization could add the costs and complexities of a new mandate, personnel, and processes. Some of these functions may be redundant in the Columbia River Basin as we cannot overlook the existing implementation arrangements via the Entities and related boards and committees. Also, this could be the most cumbersome option to implement, given the substantial additions to Treaty terms that would be required to establish an entirely new basin organization. In addition to adding administrative complexity, a basin organization is still a step removed from taking specific action to identify and assess different ways to manage the river flows.

Option 3, water use planning, is the highest scoring option. It shows marked improvement over the status quo for each of the three criteria. While it is the recommended option, it should be recognized that these options are not mutually exclusive, as will be discussed below.

Chapter 8. Recommendations

8.1. Recommendation 1: Institutional Objectives

I have identified four institutional objectives that the parties should adopt to address the challenge of cooperative ecosystem management in the Basin. The objectives are to:

1. Incorporate both a broad consideration of ecosystem function and a specific focus on understanding basin-wide flow needs and demands into the Treaty Regime. This consideration should include current needs and demands, as well as implications of future climate change and variability.
2. Incorporate a means to better understand water uses and interests in the basin, how they impact each other, and river management alternatives that can address/balance the flow requirements for these uses.
3. Incorporate consideration of social, economic, and environmental trade-offs relating to different river management alternatives or measures.
4. Incorporate meaningful engagement with stakeholders and residents about water interests and ecosystem challenges, as well as about measures to address those challenges

I find that these four key objectives can provide a general foundation for institutional arrangements seeking to support environmental flows for ecosystem function in the Columbia River Basin. This is not an exhaustive list of all possible goals or objectives. These are simply those objectives that respond to the concerns most prevalent in the literature and reflected in the survey results. They are intended to contribute to the dialogue on how the Basin can think about better including ecosystem in the Treaty Regime.

As discussed below, the recommended means of adopting these objectives is through the establishment of a transboundary water use planning process.

8.2. Recommendation 2: Transboundary Water Use Planning

8.2.1. General Recommendation

I recommend the Parties adopt a transboundary water use planning process. In this section I first explain the recommendation. I then present two scenarios for this recommendation: a Best Case and a Second Best Case.

A transboundary water use plan is a means of formally placing ecosystem function at the centre of water management in the Columbia River Basin. It is a way of identifying and negotiating US and Canadian interests in a manner that keeps support for ecosystem function as a guiding objective. To the extent the Parties agree, new developments in international law and policy can be reflected in this iterative method of considering and addressing basin-wide ecosystem challenges. This option incorporates stakeholder input and technical data into the process of developing basin-wide objectives. It identifies measures to achieve desired objectives and assess those measures in light of possible economic, social, and environmental trade-offs. By incorporating scientific data and analysis into the planning process, water use planning can also bolster the flexibility of the Treaty Regime. Further, the iterative and review-based process may assist in incorporating adaptability into the Treaty framework in the face of future climate change and variability. Requiring analysis of flow regimes for long-term planning will move the Treaty Regime away from reliance on historical stream flow data. Measures that are mutually beneficial and responsive to changing conditions can be identified from a long-term basin-wide planning perspective, rather than a year-by-year set of negotiations.

I recommend that any water use planning process instated in the Basin follow a similar format to those in the cases. A guidance document establishing how the planning process should unfold should be drafted upon consultation with both nations and stakeholders. The basic structure of the process should consist of a number of steps, the basic steps being consultative, implementation, and monitoring phases. The consultative phase is crucial and should include the following:

1. Engagement with stakeholders and interested parties (e.g. NGOs, civil society, Native Americans/First Nations).
2. Available data on basin-wide hydrology, climate forecasts, and environmental challenges. I note that the literature indicates that private entities and academic institutions in the Pacific Northwest are already engaged in a fair amount of research in these areas.
3. Challenges and interests must be identified from initial consultations with stakeholders and data analysis
4. Gaps in data or information should be identified and addressed over the course of this phase.
5. The Parties to the Treaty and the various stakeholders should strive to reach a common understanding of basin-wide challenges, how they relate, and how they might be addressed.

8.2.2. Best Case

The Best Case version of this recommendation includes both the introduction of ecosystem function as a Treaty purpose (Option 2) and the introduction of water use planning (Option 3).

Based on the results of the multi-criteria analysis, I cannot recommend introducing Option 2 – ecosystem function as a co-purpose to the Treaty – as a stand alone institutional reform. While this option does result in improvements to the status quo by inserting a clear mandate to address environmental issues into the Treaty, this option, on its own, cannot meet the remaining objectives identified in this report. Further, a simple re-purposing of the Treaty, absent transparent mechanisms to cooperatively agree upon basin-wide environmental flow needs, objectives, and interests, risks introducing uncertainty about flow rights and obligations as between Canada and the US.

Introducing a co-purpose amendment *in tandem with* a requirement to implement that purpose in accordance with a transboundary water use plan could remedy much of the uncertainty that arises from the co-purpose option on its own. This scenario would not detract from the advantages to be gained from water use planning . Rather it would result in an institutional framework that explicitly balances ecosystem function, hydroelectric power generation, and flood control, while also ensuring room for equitable

societal choices to be made based on a full understanding of potential trade-offs and impacts.

8.2.3. Second Best Case

The Best Case scenario is premised on both nations being amendable to a new co-purpose under the agreement. The evidence in the literature and survey results, however, suggests that this may not be the case. If so, this would be a barrier to achieving a co-purpose amendment and, therefore, to the Best Case scenario.

I recommend that a transboundary water use planning process can be implemented even without any amendment to the purpose of the Treaty. In terms of feasibility, as discussed in Chapter 2, the terms of the Treaty suggest that ecosystem issues fall within the scope of the Entities' authority under the Treaty. Thus, implementing a water use planning process directed at ecosystem function simply formally expands and builds upon what is already ongoing to a very limited extent. This expansion may be achieved under the existing terms of the Treaty. Specifically, the Treaty enables the Parties to add substantively to the agreement in some cases – without needing to go through amendment procedures – by creating Protocols that can be confirmed by an exchange of notes. Refining the Treaty is this way is not unprecedented. For example, a Protocol annexed to an exchange of notes between the nations dated January 22, 1964 added to the Treaty's flood control provisions and a second exchange of notes on that same date allowed the sale of the Canadian Entitlement to the US.

I recommend that Article XIV(4) of the Treaty, which is the term that allows for an expansion of the powers of the Entities via protocol, be employed to add water use plans to the sphere of planning already undertaken by the Entities. The proposed protocol can set out the basic requirements to establish a guiding policy document and the basic structures that must be incorporated into the process (as described in section 8.2.1, above). Further, article XIV(1) permits Canada and the US to designate one or more entities, meaning that the Entities need not be limited to the current agencies. Thus, if necessary to carry out the new planning mandate, additional parties (such as agencies or ministries) could be incorporated.

Chapter 9. Conclusions

This report presents an analysis of institutional alternatives addressing how the US and Canada can cooperatively manage the Columbia River in a manner that supports environmental flows for ecosystem function. I used a literature review, survey and case study analysis to identify and then assess the status quo, an amendment to include ecosystem function as a co-purpose in the Treaty, transboundary water use plans, and transboundary river basin organizations. The portfolio of recommendations includes 1) a set of objectives that the Parties should adopt as foundational for future coordination efforts to address ecosystem function and 2) the recommendation to adopt these objectives by implementing a transboundary water use planning process in the Columbia River Basin.

Going forward, the US and Canada would have to consider whether a water use planning process is the place for the US and Canada to agree on the manner of calculation and quantum of benefits, such as the Canadian Entitlement and any other benefit sharing arrangement that may be desired. Right now, the Canadian Entitlement is calculated as part of the preparation of AOPs. If this remains the process of choice, it is possible that the water use planning process could provide Canada and the US information about the value ecosystem benefits and costs in the Basin. This could inform the calculation of future benefit arrangements. The issue of how and where to determine those values and any related benefits requires detailed consideration.

Implementation also warrants further study. Article XIV(4) of the Treaty allows Canada and the US to “empower or charge the entities with any other matter coming within the scope of the Treaty.” As such, the constraint is that the matter must be “within the scope of the Treaty.” Legal opinion should be obtained to confirm the viability of Article XIV(4) for purposes recommended here. Such analysis falls beyond the scope of this report, but would have to be determined in order to proceed as recommended in the Second Best scenario.

Lastly, although the survey population is small, the results raise a question as to the urgency with which Canadians perceive the need to address environmental flows. Yet, this is also not a non-issue for Canadians; the results align with what is suggested in the literature, which is a general desire on both sides of the border to see ecosystem function given greater consideration in river management. Considered together, this indicates that getting a basin-wide approach to addressing environmental flows for ecosystem function on the agenda for Treaty negotiations is desirable, but will not be easy. To induce the Parties to put this on their agenda, further study of basin-wide interests and concerns is necessary to enable the Parties to understand magnitude of basin-wide challenges, how challenges may be interconnected, and how both parties can be incentivized to assist each other in maintaining ecological health throughout the region.

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Appendix A.

Participant Consent Form & Survey Instrument

Consent Form

PARTICIPANT CONSENT STATEMENT

This research is being conducted under the permission of the Simon Fraser University Research Ethics Board (ethics application number 2013s0822). If you have any questions or concerns with respect to your participation in this research study as a research participant, please direct them to Dr. Jeffrey Toward, Associate Director, Office of Research Ethics at [redacted] or [redacted]

The results of this study will be reported in a graduate thesis and the main findings may be published in academic journal articles or presented at conferences.

If you have any questions or wish to inquire about research results you may contact the Principal Investigator, Melissa Kruger, at [redacted]. You may also contact the Principal Investigator's capstone supervisor, professor Doug McArthur, at [redacted]

Who is the Principal Investigator?

The Principal Investigator is a graduate student at Simon Fraser University in Vancouver, British Columbia, Canada. As part of the academic requirements for the Masters of Public Policy (MPP) degree, students are required to complete a capstone research project. The purpose of the Principal Investigator's capstone project is to investigate the role of institutional cooperation between the United States and Canada, including such cooperation via the Columbia River Treaty, in supporting environmental flows to sustain the health and function of the ecosystem in the Columbia River. The project is currently entitled "Transboundary Institutional Support for Environmental Flows for Ecosystem Function in the Columbia River."

This questionnaire is designed to elicit your perspective on the issue of environmental flows and ecosystem function in the Columbia River. The questionnaire also seeks your perspective on the role that institutional cooperation/coordination between the US and Canada (including international coordination via the Columbia River Treaty) may or may not play in supporting environmental flows for ecosystem function in the Columbia River Basin. The survey will take approximately 10-15 minutes to complete. Survey respondents will not be paid for their participation. For this study, the only subsequent contact the Principal Investigator may initiate with you is one reminder email with respect to this survey.

What are the Benefits of Participating in this Study?

Your participation in the study may not benefit you directly; however, the study results may be of use or benefit to others. Further, your responses will assist in deepening the quality of this research. The Principal Investigator will use the information you contribute via this questionnaire in her consideration of policy options that address and/or support the ecosystem health and function of the Columbia River, as well as the role of international arrangements, including the Columbia River Treaty, in supporting these options.

What about Risks?

You have the right to refuse to participate and your refusal to participate will not have any personal adverse effects. If you decide to take part in the survey, you may still choose to withdraw at any time without any negative consequences. With the exception of questions eliciting very limited demographic information, the questions are not personal in nature and are not intended to generate any discomfort. However, if you feel uncomfortable with any question, you do not have to answer it. Responses received will not be reported individually, but only in combination with those of other respondents.

How is Privacy being Addressed?

This questionnaire is being administered using Qualtrics.com, which is a web-based survey software. Qualtrics is a websurvey company located in the USA and is subject to US laws, in particular, the US Patriot Act, which allows authorities access to the records of internet service providers. If you choose to participate in the survey, you understand that your responses to the survey questions will be stored and accessed in the USA. The security and privacy policy for the websurvey company can be found at the following link:

http://qualtrics.com/security-statement/

All data downloaded by the Principal Investigator from Qualtrics.com will be stored on a password protected personal laptop and backed up on a password protected USB key, which will be housed in a secure locker for 2 years from the date of this study, after which time all such data will be destroyed.

Your participation in this questionnaire is **voluntary.** The link to the Qualtrics.com survey that the Principal Investigator is employing is **anonymized**, meaning that the link is programmed so that your identity will not be connected to the responses you provide. In other words, the Principal Investigator will not be able to track any response to any specific respondent.

Participant Consent

You are under no obligation to participate in this survey. If you decide to participate, you may choose to stop the survey at any time without giving a reason and without any negative impact on you. If you are not comfortable with a question, you do not have to answer it. **Please note that by filling out this survey, you are consenting to participate in this study and to the use of your of answers in the study**.

To proceed with the survey questionnaire, please click **YES**

If you do not wish to proceed with the survey questionnaire, please click **NO**

Thank you very much for your time and your participation in this research.

Do you wish to proceed to the survey questionnaire?

- ○ YES
- ○ NO

Block 1

You may already have some knowledge about the Columbia River and its management by the United States and Canada; however, this page provides some succinct background information for your review.

The **Columbia River** runs through the Columbia River Basin. The Columbia River Basin includes a portion of the Canadian province of British Columbia and portions of several US states, including Washington and Oregon.

The **Columbia River Treaty** is an agreement finalized in 1964 between the United States and Canada. Under the Treaty, Canada and the United States coordinate the management of flood risks and hydroelectric power generation along the Columbia River and some of its tributaries.

2024 is an important year for the Treaty. If either Canada or the United States gives notice by 2014, the first opportunity for either party to unilaterally terminate the Treaty is 2024. A limited number of aspects of the Treaty's implementation are also set to change in 2024. As such, Canada and the United States are currently considering possible futures for the Treaty and for their management of the Columbia River.

A wide range of issues and interests has emerged in relation to the future of the Columbia River. Among other things, some individuals, groups, communities, and levels of government on both sides of the border have expressed an interest in the ecological health and functioning of the environment in the Columbia River Basin.[1] This interest varies in scope and focus, but can include concerns for the health and sustainability of terrestrial and aquatic environments, as well as concerns about various impacts upon these environments relating to matters such as reservoir operations, climate variability, climate change, and competing water uses.

In this context, institutions that enable the current and future coordinated management of the River by the United States and Canada, and the role these institutions may or may not play in addressing the ecological health and functioning of the River Basin, are one area of discussion. 'Institutions' can be thought of as systems of accepted rules that structure social interactions, which systems can include laws and organizations.[2] For example, the Columbia River Treaty is such an institution.

In examining this area of discussion, this survey uses the terms "**environmental flows**" and "**ecosystem function**." You do not need to have expert knowledge of the concepts of "environmental flows" and "ecosystem function" to participate in this survey. There is no single definition for these terms, and their meaning can vary by context or discipline. For the specific context of this survey these concepts are defined as follows:

Ecosystem Function:
Ecological interactions and processes of living and non-living parts of an ecosystem. In other words, the general working of an ecosystem. For example, this can include the biological and physical interactions of fish species with their aquatic environment.

Environmental Flows:
Water flows that are of the timing, quality and quantity required to maintain Ecosystem Function.

1 Columbia River Treaty Review . (2012). *Environmental Discussion Paper November 2012*. Retrieved from http://blog.gov.bc.ca/columbiarivertreaty/files/2012/11/CRT-Environmental-Discussion-Paper_-Revised1.pdf; Columbia River Treaty 2014/2024 Review . (December, 2013). *CRT Stakeholder Comment Summary – March 2013*. Retrieved from http://www.crt2014-2024review.gov/CRTComments.aspx

2 Hodgson, G. M. (2006). What Are Institutions? *Journal of Economic Issues*, *XL*(1), 1–25 referencing Knight, J. (1992). *Institutions and social conflict*. Cambridge [England]: Cambridge University Press

Section 1

The two questions below ask you for some general information.

What is your primary country of residence?

- ○ USA
- ○ Canada
- ○ Other (please specify)

Which of the following best describes your occupation?

- ○ Academic (e.g. university or research institution)
- ○ Legal (e.g. law firm, legal advocacy, legal research)
- ○ Utility/Energy Management
- ○ Water Management
- ○ Government (national/regional/local/municipal)
- ○ Student (graduate/undergraduate)
- ○ Other (please specify)

Section 2

The next questions ask you about issues pertaining to the management of the Columbia River. These questions include the terms “Ecosystem Function” and “Environmental Flows.” Recall that these terms are defined as follows:

Ecosystem Function:
Ecological interactions and processes of living and non-living parts of an ecosystem. In other words, the general working of an ecosystem. For example, this can include the biological and physical interactions of fish species with their aquatic environment.

Environmental Flows:
Water flows that are of the timing, quality and quantity required to maintain Ecosystem Function.

Block 4

There are a number of issues that may be contemplated when discussing the management and use of the Columbia River by Canada and the United States. A number of these possible issues are listed below.

How do you think the general importance of each issue <u>is currently</u> rated by Canada and the United States in their management and use of the Columbia River?

	Not at all important	Very unimportant	Somewhat unimportant	Neither Important nor Unimportant	Somewhat Important	Very Important	Extremely Important
Navigation	○	○	○	○	○	○	○
Other (Please Specify)	○	○	○	○	○	○	○
Recreation	○	○	○	○	○	○	○
Hydroelectric Power Generation	○	○	○	○	○	○	○
Ecosystem Function	○	○	○	○	○	○	○
Flood Control	○	○	○	○	○	○	○

How do you think the general importance of each issue <u>should be</u> rated by Canada and the United States in their management and use of the Columbia River?

	Not at all important	Very unimportant	Somewhat unimportant	Neither Important nor Unimportant	Somewhat Important	Very Important	Extremely Important
Other (Please Specify)	○	○	○	○	○	○	○

Hydroelectric Power Generation	○	○	○	○	○	○	○
Ecosystem Function	○	○	○	○	○	○	○
Recreation	○	○	○	○	○	○	○
Navigation	○	○	○	○	○	○	○
Flood Control	○	○	○	○	○	○	○

Block 6

One of the issues listed in the previous question was Ecosystem Function. What do you see as the top two challenges to Ecosystem Function in the Columbia River Basin over the next century?

Please select only two

- ☐ Reservoir operations for flood control purposes.
- ☐ Impacts from warming temperatures on Environmental Flows (e.g. changes in the seasonal timing and volume of instream flows).
- ☐ Increase in competing demands for non-hydropower water use (e.g. irrigation, municipal water supplies).
- ☐ Reservoir operations for the purpose of hydroelectric power generation.
- ☐ Other (please specify)
- ☐ I do not know.
- ☐ I do not see any challenges to Ecosystem Function.

Block 8

Please indicate to what extent you agree or disagree with each of the following statements:

	Completely Agree	Largely Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Largely Disagree	Completely Disagree
Canada and the United States, jointly, are doing enough to understand Basin-wide Environmental Flow needs along the Columbia River.	○	○	○	○	○	○	○
Canada and the United							

States, jointly, are not doing enough to address Basin-wide Environmental Flow needs along the Columbia River.	○	○	○	○	○	○	○
Canada and the United States, jointly, are not doing enough to understand competing water uses and demands along the Columbia River.	○	○	○	○	○	○	○
Canada and the United States, jointly, are doing enough to address competing water uses and demands along the Columbia River.	○	○	○	○	○	○	○

Block 10

Please indicate to what extent you agree or disagree with each of the following statements:

	Completely Agree	Largely Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Largely Disagree	Completely Disagree
The current approach to the management of the Columbia River by the United States and Canada adequately supports Environmental Flows for Ecosystem Function **right now**.	○	○	○	○	○	○	○
The current approach to the management of the Columbia River by the United States and Canada will support Environmental Flows for Ecosystem Function adequately **in the future**.	○	○	○	○	○	○	○
Current domestic measures in your country of residence are sufficient to address the issue of Environmental Flows for Ecosystem Function **right now**.	○	○	○	○	○	○	○
Current domestic measures in your country of residence will be sufficient to address the issue of Environmental Flows for Ecosystem Function **in the future**.	○	○	○	○	○	○	○

Block 11

The previous questions refer to coordination by the United States and Canada in managing Environmental Flows and Ecosystem Function in the Columbia River Basin.

One current area of discussion concerns whether Canada and the United States should prioritize Ecosystem Function in their management of the Columbia River. "Prioritize" in this case means giving Ecosystem Function equal status with other river management objectives. Right now, the predominant objectives under the Columbia River Treaty are flood control and hydroelectric power generation.

One issue that may be considered is whether Canada and the United States formally and permanently prioritizing Ecosystem Function in the management of the Columbia River could give rise to some conflicts or require some choices (trade-offs) as between different river management/use priorities. For example, and while not representative of all possible trade-offs, one may consider whether prioritizing Ecosystem Function may impact water availability for other uses, such as maximum hydroelectric power generation capacity; or, may impact water availability in some portions of the Columbia River as opposed to other portions of the Columbia River during the same times of year (e.g. during the summer months).

Based upon your knowledge and experience, what do you view as a key trade-off that could arise if Canada and the United States were to formally and permanently prioritize Ecosystem Function in their management of the Columbia River? Please be as specific as possible.

Block 9

There are a number of views on the degree to which Canada and the United States should coordinate their efforts to address Ecosystem Function in the Columbia River Basin. While not representative of all views on the issue, two possible positions are the following:

VIEW 1: A new type or level of formal (e.g. binding) agreement is needed between the United States and Canada to address the issue of Ecosystem Function in the Columbia River Basin because the issue is not adequately addressed and coordinated by the United States and Canada right now.

VIEW 2: A new type or level of formal (e.g. binding) agreement is not needed between the United States and Canada to address the issue of Ecosystem Function in the Columbia River Basin because the issue is adequately addressed and coordinated by the United States and Canada right now.

With which view do you generally agree the most?

- View 1
-

View 2

I do not know

Neither View 1 nor View 2

Block 13

Based on your knowledge and experience, do you think the current Columbia River Treaty **enables or hinders** the coordinated management of the Columbia River by the United States and Canada for the purpose of supporting Environmental Flows for Ecosystem Function?

Strongly enables

Very much enables

Somewhat enables

Neither enables nor hinders

Somewhat hinders

Very much hinders

Completely hinders

Why do you think the Columbia River Treaty enables the coordinated management of the Columbia River by the United States and Canada for the purpose of supporting Environmental Flows for Ecosystem Function ?

Please be as specific as possible.

Why do you think the Columbia River Treaty hinders the coordinated management of the Columbia River by the United States and Canada for the purpose of supporting Environmental Flows for Ecosystem Function?

Please be as specific as possible.

Block 14

If you would like, feel free to share anything you wish to add on the issue of the United States and Canada working together to address Ecosystem Function and/or Environmental Flows in the Columbia River Basin.

Appendix B.

Survey Data

Survey Questions 2 and 3: Demographics

24 respondents followed the survey link to the survey questionnaire. 21 respondents answered the demographics questions regarding their primary country of residence and occupation.

Table B.1. Respondent Characteristics

Characteristic	Category	n(%)
Country of Residence	USA	13 (62%)
	Canada	8 (33%)
	Other	0
Occupation	Academic	11 (52%)
	Government	3 (14%)
	Legal	0
	Other	5 (24%)
	Student	0
	Utility/Energy Management	2 (10%)
	Water Management	0

13 respondents (62 percent) listed the US as their country of primary residence and eight (33 percent) listed Canada as their country of primary residence. Thus, the ratio of US to Canadian respondents to the demographics question is roughly 60:40, meaning that the majority respondents list the US as their primary country of residence. This ratio remains similar for the other quantitative questions in the survey despite variation in the number of respondents for each question.

11 respondents (52 percent), categorized their occupation as Academic, two (10 percent) as Utility/Energy Management, three (14 percent) as Government, and five (24 percent) as "Other." The "other" occupations listed are: "Non-profit environmental organization"; "research consultant"; "resource management consultant"; "non-profit

environmental conservation"; and "legal, but for government agency, plus academic side." Considered by country of residence, US respondents predominantly list Academic as their occupation, while Canadian respondents are predominantly comprised of an assortment of occupations with one Academic respondent (12.5 percent of Canadian respondents), two Utility/Energy Management respondents (25 percent of Canadian Respondents), three Government respondents (37.5 percent of Canadian respondents), and two "other" respondents (25 percent of Canadian Respondents).

Survey Questions 4 and 5: Perspectives on River Management Priorities

Respondents were asked for their perspectives on how the general importance of a number of issues is currently rated by Canada and the US in their management and use of the Columbia River, and then how they think the general importance these same issues should be rated by the US and Canada. The responses give a sense of how respondents feel certain issues are/should be prioritized by the nations. 17 respondents provided their views on how they see the issues as being currently rated by the US and Canada in their management and use of the Columbia River. Their responses are as follows:

Table B.2 All respondents' views of how water management issues are currently rated by the US and Canada in their management and use of the Columbia River

Issue	Not at all important	Very unimportant	Somewhat unimportant	Neither Important nor Unimportant	Somewhat Important	Very Important	Extremely Important	Total Responses
Navigation	0	0	1	3	4	7	2	17
Recreation	1	1	3	4	6	2	0	17
Ecosystem Function	1	0	4	1	8	3	0	17
Hydroelectric Power Generation	0	2	0	0	0	3	12	17
Flood Control	0	1	2	0	0	2	11	16
Other (Please Specify)[29]	0	1	0	0	0	0	2	3

[29] Respondents were provided space to add and rank how they feel one other, non-listed issue is being considered by the US and Canada in the use and management of the River. Three individuals added issues. US respondents added two issues. Fish productivity and fishing rights (especially for Indians/First Nations) are listed together as an issue that one respondent perceives as being rated as *very unimportant* to the US and Canada in their management of the River. Another US respondent perceives irrigation as being *extremely important* to the current system. Canadian respondents added one issue. Flood protection was added as currently being *extremely important.*

17 respondents also provided their views on how they feel the issues should be rated. Their responses are as follows:

Table B.3 All respondents' views of how water management issues should be rated by the US and Canada in their management and use of the Columbia River

Issue	Not at all important	Very unimportant	Somewhat unimportant	Neither Important nor Unimportant	Somewhat Important	Very Important	Extremely Important	Total Responses
Navigation	0	0	2	3	8	4	0	17
Recreation	0	3	2	0	11	1	0	17
Ecosystem Function	0	2	0	0	0	7	8	17
Hydroelectric Power Generation	0	1	1	0	3	9	3	17
Flood Control	0	2	1	0	2	7	5	17
Other (Please Specify)[30]	0	1	0	1	1	0	1	4

Comparing respondents' perceptions on how all issues are being prioritized, as compared to how respondents feel they should be prioritized, indicates which issues are perceived as priority issues for the Basin.

[30] Respondents were provided space to add and rank how they feel one other issue *should* be considered by the US and Canada in the use and management of the River. Four individuals added issues. US respondents added three issues. Fish productivity and fishing rights (especially for Indians/First Nations) were listed together as an issue that one respondent felt should be rated as *very unimportant* to the US and Canada in their management of the River. Another US respondent added irrigation as an issue that should be rated *extremely important*. A third US respondent indicated agriculture should be an issue that is *somewhat important*. A fourth US respondent indicated an issue that was neither important nor unimportant, but did not write out what the issue is. Canadian respondents added one issue; namely, iincreased climate variability was added as an issue that should be rate as *extremely important* by the US and Canada

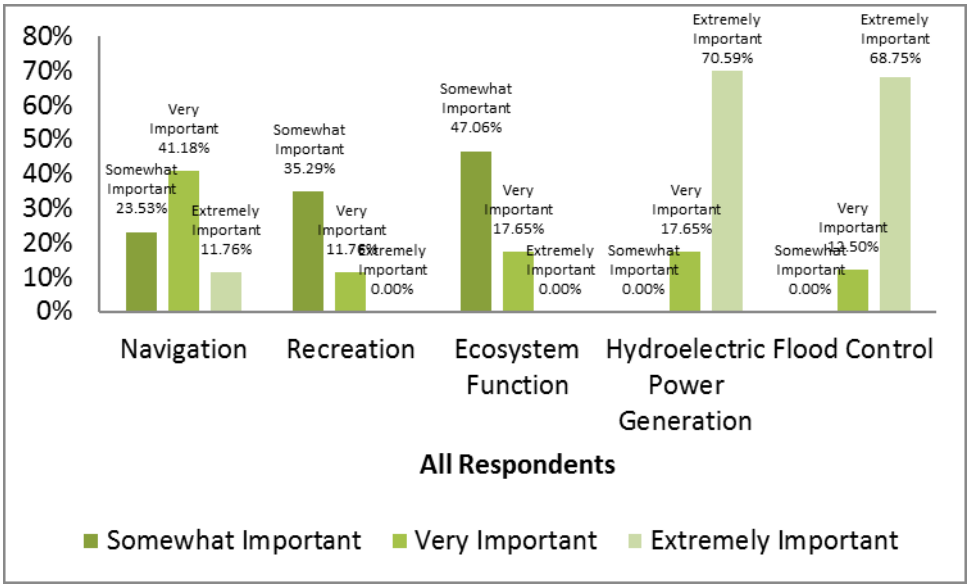

Figure B.1: Percentage of <u>all</u> respondents who view each issue as <u>currently</u> seen as important by Canada and the United States in their management and use of the Columbia River

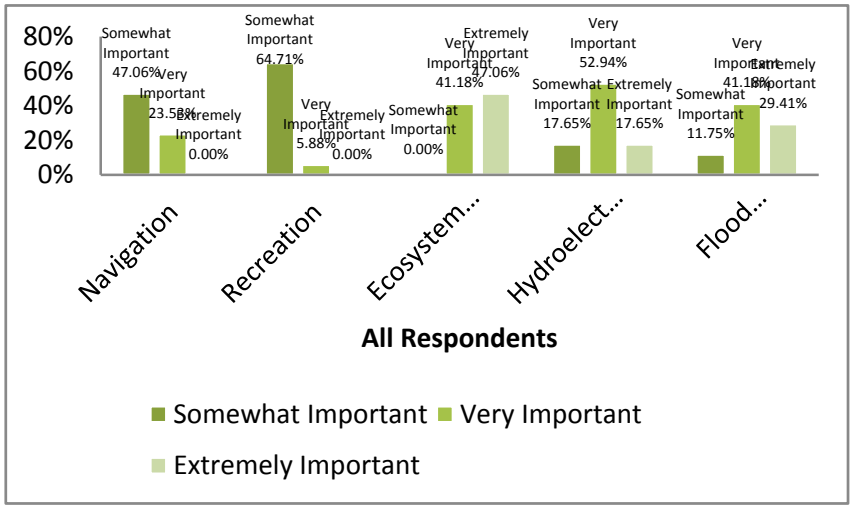

Figure B.2: Percentage of <u>all</u> respondents who view each issue as they <u>should be</u> seen as important by Canada and the United States in their management and use of the Columbia River

Figure B.1, above, illustrates how all respondents view the level of importance *currently* ascribed to the various issues by the US and Canada in their management of the Columbia. Figure B.2, above, shows how all respondents feel importance *should be* ascribed to the various issues. Considering Figure B.1, the majority of respondents

perceive that the current system of river management and use by the US and Canada as already giving some importance to each of the issues listed (except for recreation where a narrow majority feel this is currently an unimportant issue). Hydroelectric power and flood control are seen as having great importance under the current regime. By contrast, Figure B.2 suggests an overall desire for a balancing of river management priorities in the Basin, with increased importance placed on some issues. There is relative continuity in the percentage of respondents who feel hydroelectric power and flood control should remain as important priorities for river management (roughly 88 percent and 82 percent of respondents, respectively), but there are some subtle differences. First, Figure B.2 suggests a general desire to see ecosystem function balanced with hydroelectric power generation and flood control. Second, there is a shift in the degree of importance that respondents ascribe to each of these three issues. For example, about 88 percent of respondents feel that both ecosystem function and hydroelectric power should be issues of importance. The majority of these respondents, however, feel ecosystem function should be *very* or *extremely* important, while about 53 percent feel hydropower should be *very important* (the remaining 47 percent being split between *somewhat important* and *extremely important*).

If we focus solely on the issue of ecosystem function, we can get a sense of how all respondents perceive the issue, as well as how perceptions on the issue may vary as between US and Canadian respondents. As illustrated in Figure B.3, below, the data indicate that the majority of respondents perceive ecosystem function an issue that is *currently* of some importance in the management of the Columbia River. Figure B.4, below, illustrates an increase in the percentage of all respondents who feel ecosystem function *should be* treated as an issue of importance.

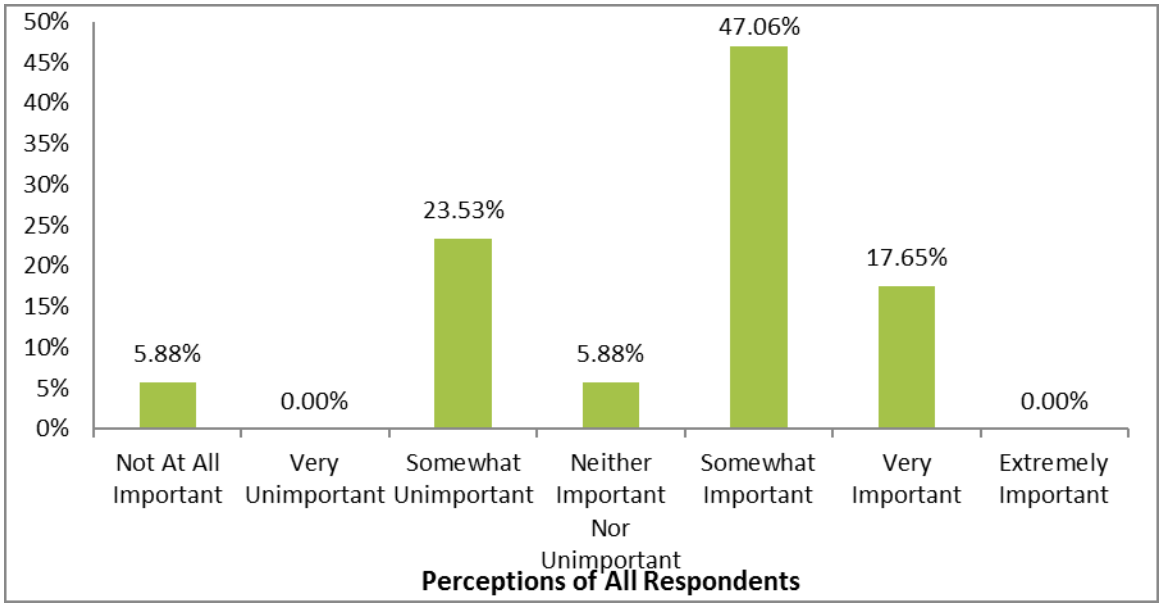

Figure B.3: Percentage of <u>all</u> respondents who view ecosystem function as <u>currently</u> seen as unimportant or important by Canada and the United States in their management and se of the Columbia River

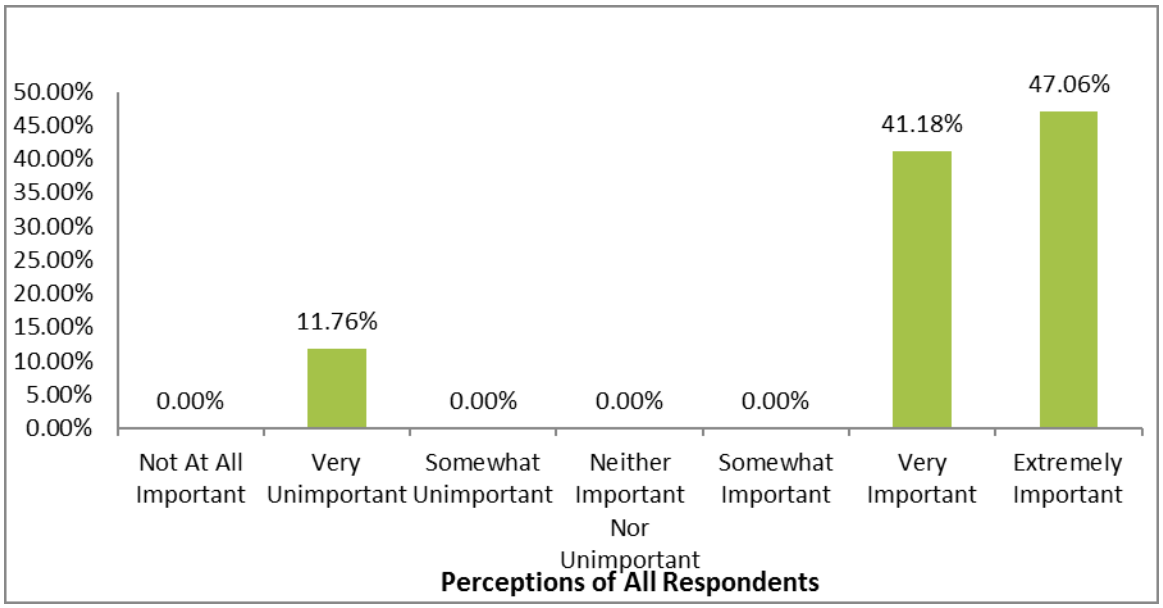

Figure B.4: Percentage of <u>all</u> respondents who view ecosystem function as it <u>should be</u> seen as unimportant or important by Canada and the United States in their management and use of the Columbia River

We can also consider perceptions based upon country of residence. The cross tabs below show how the responses regarding how ecosystem function is currently rated are distributed between US and Canadian respondents.

Table B.4 Respondents' views of how ecosystem function is currently rated by the US and Canada in their management and use of the Columbia River

	Not at all important	Very unimportant	Somewhat unimportant	Neither Important nor Unimportant	Somewhat Important	Very Important	Extremely Important	Total
US	1	0	3	0	6	1	0	11
Canadian	0	0	1	1	2	2	0	6
Total	1	0	4	1	8	3	0	17

The cross tabs below show how the responses regarding how ecosystem function should be rated are distributed between US and Canadian respondents.

Table B.5 Respondents' views of how ecosystem function should be rated by the US and Canada in their management and use of the Columbia River

	Not at all important	Very unimportant	Somewhat unimportant	Neither Important nor Unimportant	Somewhat Important	Very Important	Extremely Important	Total
US	0	1	0	0	0	3	7	11
Canadian	0	1	0	0	0	4	1	6
Total	0	2	0	0	0	7	8	17

Figures B.5 and B.6, below, narrow in on the results for the percentage of US and Canadian respondents who feel ecosystem function *should* be an issue of importance.

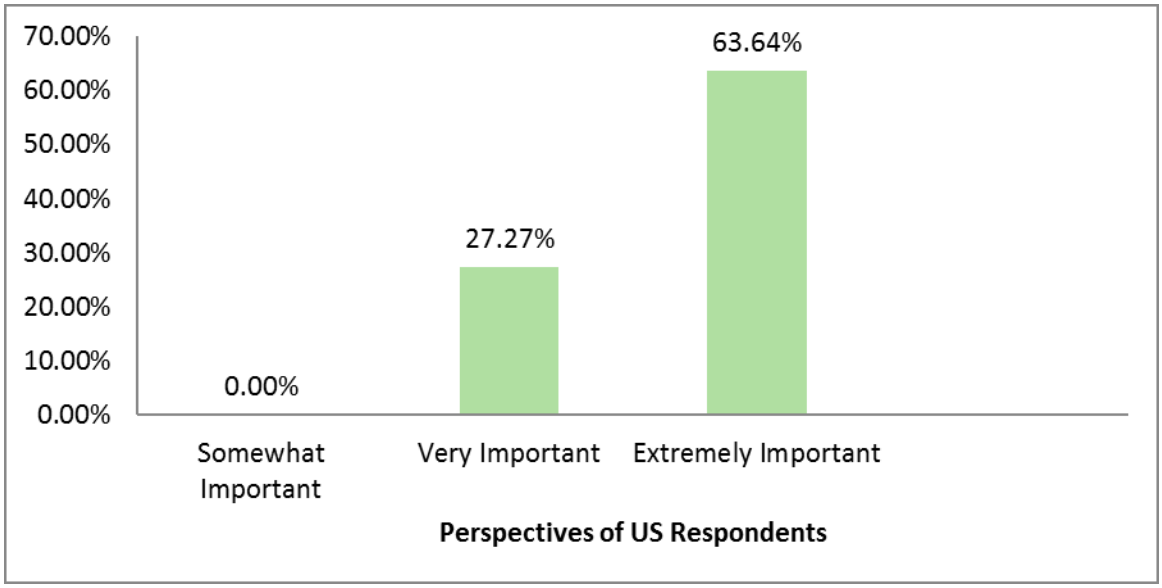

Figure B.5: Percentage of US respondents who view ecosystem as an issue that should be seen as important by Canada and the United States in their management and use of the Columbia River

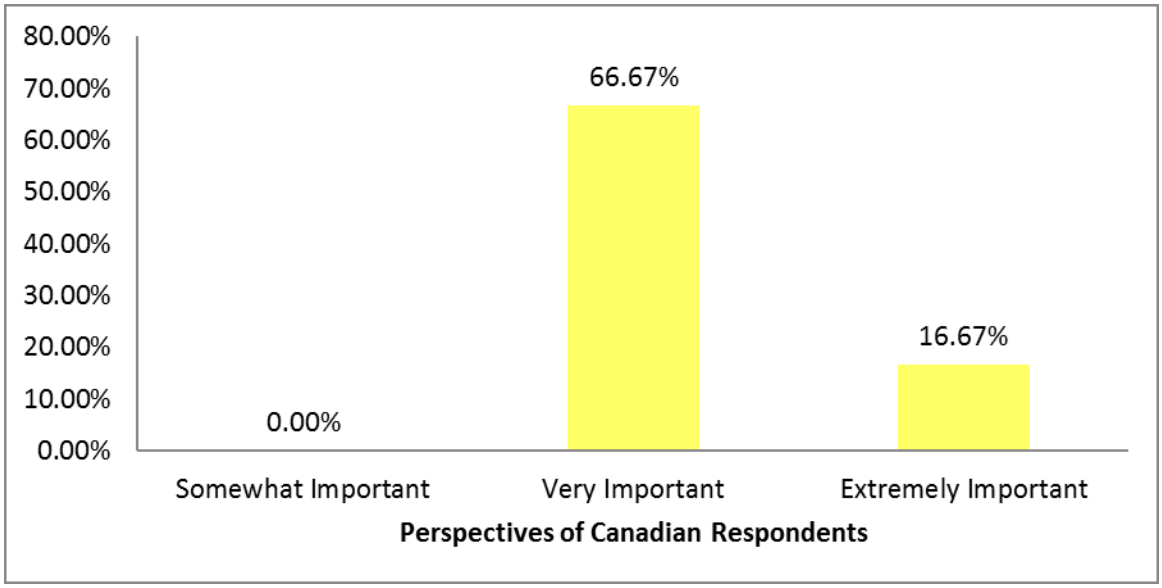

Figure B.6: Percentage of Canadian respondents who view ecosystem as an issue that should be seen as important by Canada and the United States in their management and use of the Columbia River

We can see that a majority of respondents on this issue (about 91 percent of US respondents and 83 percent Canadian respondents) see ecosystem function as an issue that should be rated as important by the US and Canada in their use and management

of the Columbia River. Interestingly, the majority of the US respondents in Figure B.5 feel the issue should be *extremely important* and the majority of Canadian respondents in Figure B.6 feel the issue should be *very important*.

Survey Question 6: Perceptions on Challenges to Ecosystem Function

Respondents were asked to select from a list of options what they perceive to be the top two challenges facing ecosystem function in the Columbia River Basin over the next century. Responses are summarized in Figures B.7 and B.8, below.

#	Answer		Response	%
1	Increase in competing demands for non-hydropower water use (e.g. irrigation, municipal water supplies).		6	35%
2	Reservoir operations for the purpose of hydroelectric power generation.		10	59%
3	Impacts from warming temperatures on Environmental Flows (e.g. changes in the seasonal timing and volume of instream flows).		9	53%
4	Reservoir operations for flood control purposes.		6	35%
5	Other (please specify)		3	18%
6	I do not know.		0	0%
7	I do not see any challenges to Ecosystem Function.		0	0%

Figure B.7: Perceived challenges facing ecosystem function in the Columbia River Basin over the next century.

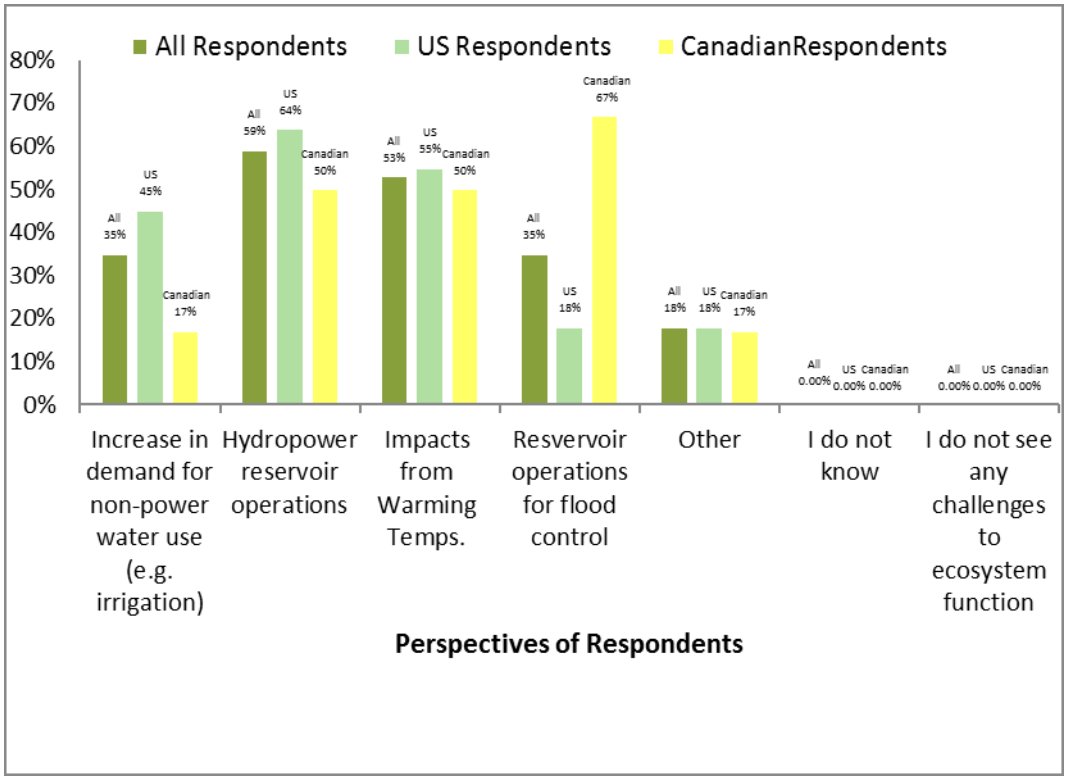

Figure B.8: Perceived challenges facing ecosystem function in the Columbia River Basin over the next century.

The top two challenges to ecosystem function identified by all respondents are:

1. Reservoir operations for hydroelectric power generation, and
2. Impacts from warming temperatures

Other challenges selected by respondents include:

- Competing water demands for non-hydropower uses, and
- Reservoir operations for flood control purposes are concerns next in priority.

The answers to this question can be examined based on the country of residence of respondents The results show that the top two challenges identified by US respondents are:

1. Reservoir operations for hydroelectric power generation, and
2. Impacts from warming temperatures on environmental flows.

By contrast, the top two challenges identified by Canadian respondents are:

1. Reservoir operations for floor control purposes, and

2. A tie between:
    a. Reservoir operations for hydroelectric power generation, and
    b. Impacts from warming temperatures on environmental flows.

Respondents also identified "other" issues that they perceive as challenges to ecosystem function in the Basin over the next century.

Two US respondents raised issues related to the existence of dams, including:

- The loss of natural river form, function and dynamics, which is not solely reservoir operations, but also the way existence of dams and reservoirs change river environments to lake environments, block connectivity, and block/alter fluvial-geomorphic processes so they can no longer create and renew habitat;
- Another lists the issue of selective main stem dam removal.

One Canadian respondent raised the issue of competing water users; namely,

- balancing interests within ecosystem function. The examples given are reservoir species versus riparian species, and birds versus fish.

Survey Question 7: Perspectives on Efforts by the US and Canada to Understand and Address Water Uses and Environmental Flows Needs

Question seven explores respondents' perspectives on whether Canada and the US, jointly, are doing enough to understand and address environmental flow needs and competing water uses along Columbia River. The following responses were received:

Table B.6 Respondents' views of whether Canada and the US, jointly, are doing enough to understand and address environmental flow needs and competing water uses along Columbia River

Question	Completely Agree	Largely Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Largely Disagree	Completely Disagree	Total Responses
Canada and the United States, jointly, are not doing enough to understand competing water uses and demands along the Columbia River.	1	4	7	0	1	2	0	15
Canada and the United States, jointly, are doing enough to understand Basin-wide Environmental Flow needs along the Columbia River.	0	2	1	0	4	4	3	14
Canada and the United States, jointly, are not doing enough to address Basin-wide Environmental Flow needs along the Columbia River.	5	4	4	0	1	0	1	15
Canada and the United States, jointly, are doing enough to address competing water uses and demands along the Columbia River.	1	0	1	1	6	6	0	15

Perspectives on Joint Efforts to Understand Competing Uses and Environmental Flow Needs

Two statements in question seven elicit perspectives on efforts by Canada and the US to understand competing waters uses and demands, as well as environmental flow needs. One statement says: "*Canada and the United States, jointly,* ***are not*** *doing enough to understand competing water uses and demands along the Columbia River*." Responses were received from fifteen individuals. As illustrated in Figure B.9, below, 80 percent (12) of all respondents agree to some extent with this statement, while 20 percent (three) disagree to some extent.

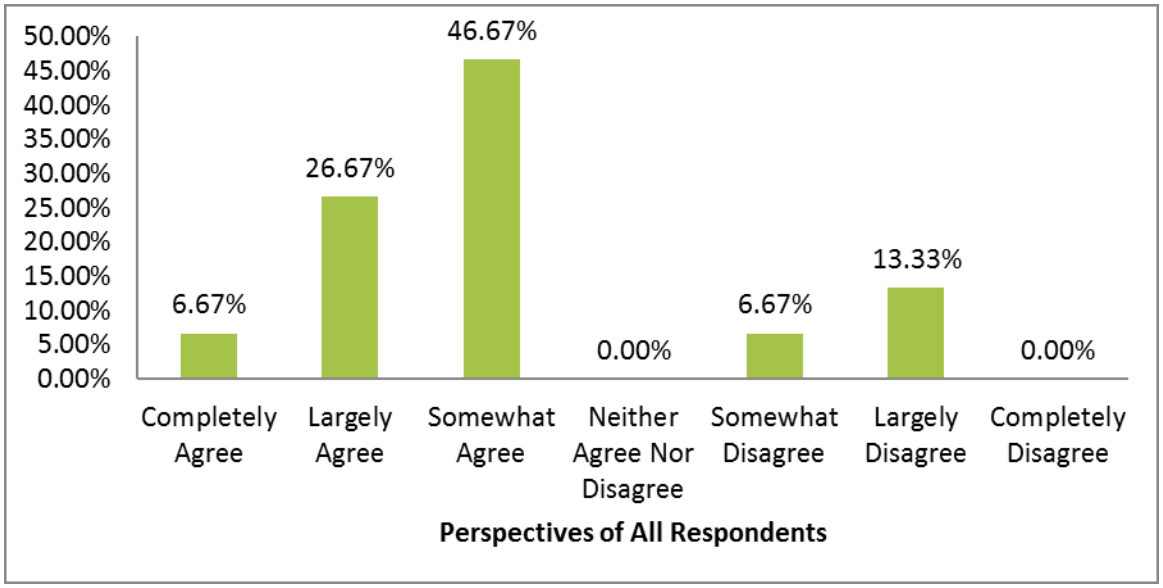

Figure B.9: Percentage of <u>all</u> respondents who agree or disagree with the statement *Canada and the United States, jointly, are not doing enough to understand competing water uses and demands along the Columbia River*

US and Canadian perspectives on this statement are also considered. As illustrated in Figures B.10 and B.11, below, of the majority of both US and Canadian respondents agree with the statement to some extent.

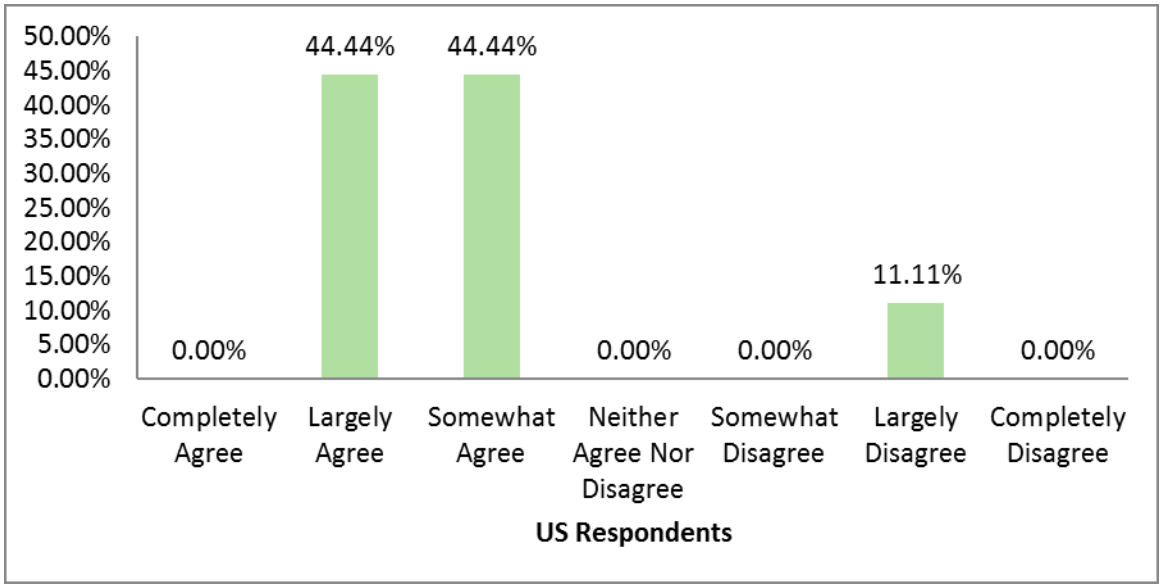

Figure B.10: Percentage of <u>US respondents</u> who agree or disagree with the statement *Canada and the United States, jointly, are not doing enough to understand competing water uses and demands along the Columbia River*

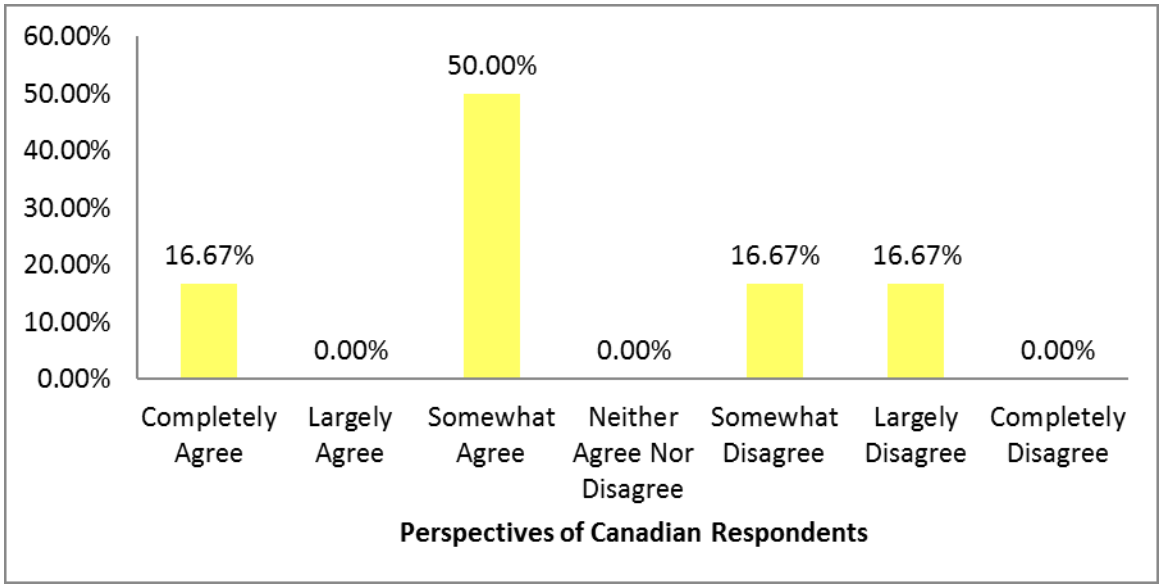

Figure B.11: Percentage of <u>Canadian respondents</u> who agree or disagree with the statement Canada and the United States, jointly, are not doing enough to understand competing water uses and demands along the Columbia River

The other statement in question seven says: "*Canada and the United States, jointly, **are** doing enough to understand Basin-wide Environmental Flow needs along the Columbia River.*" Responses were received from 14 individuals. As illustrated in Figure B.12, below, about 79 percent (11) of all respondents disagree to some extent with this statement, while about 21 percent (three) agree to some extent.

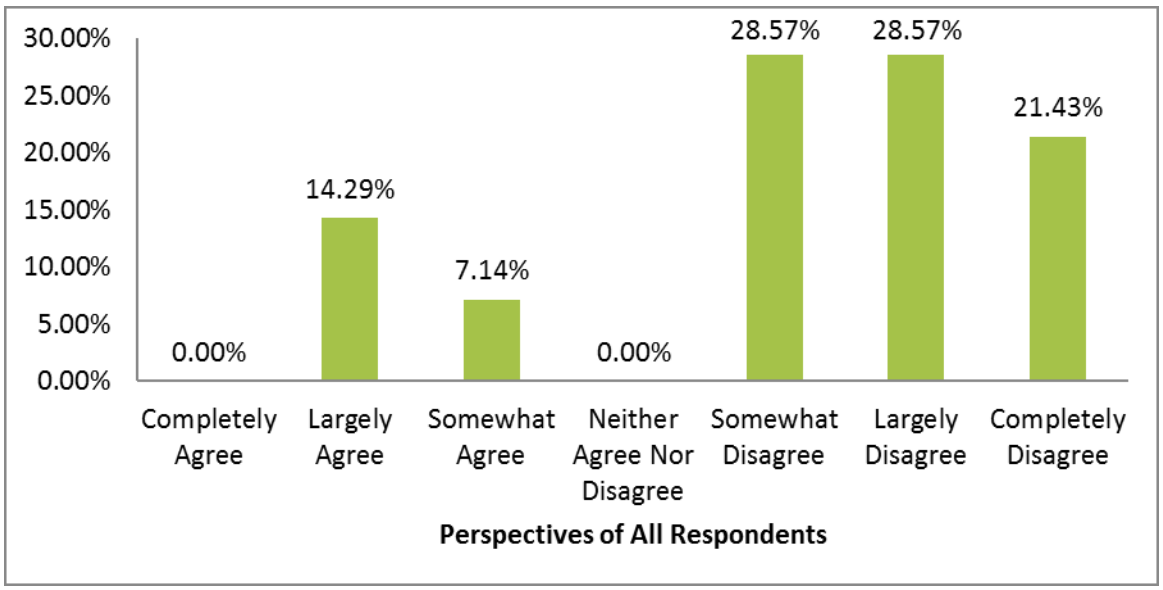

Figure B.12: Percentage of all respondents who agree or disagree with statement Canada and the United States, jointly, are doing enough to understand Basin-wide Environmental Flow needs along the Columbia River

US and Canadian perspectives on this statement are also considered. As illustrated in Figure B.13, below, all of the US respondents to this statement disagree with it to some extent. By contrast, as illustrated in Figure B.14, below, the Canadian responses are not unanimous in their agreement or disagreement and the majority of Canadian respondents agree with the statement to some extent.

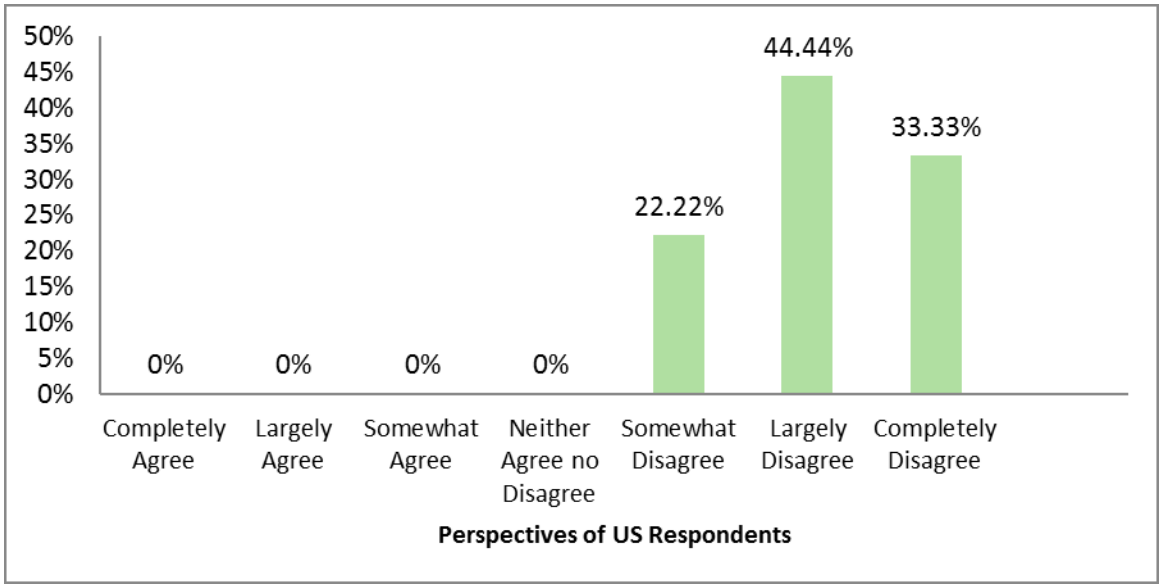

Figure B.13: Percentage of <u>US respondents</u> who agree or disagree with the statement Canada and the United States, jointly, are doing enough to understand Basin-wide Environmental Flow needs along the Columbia River

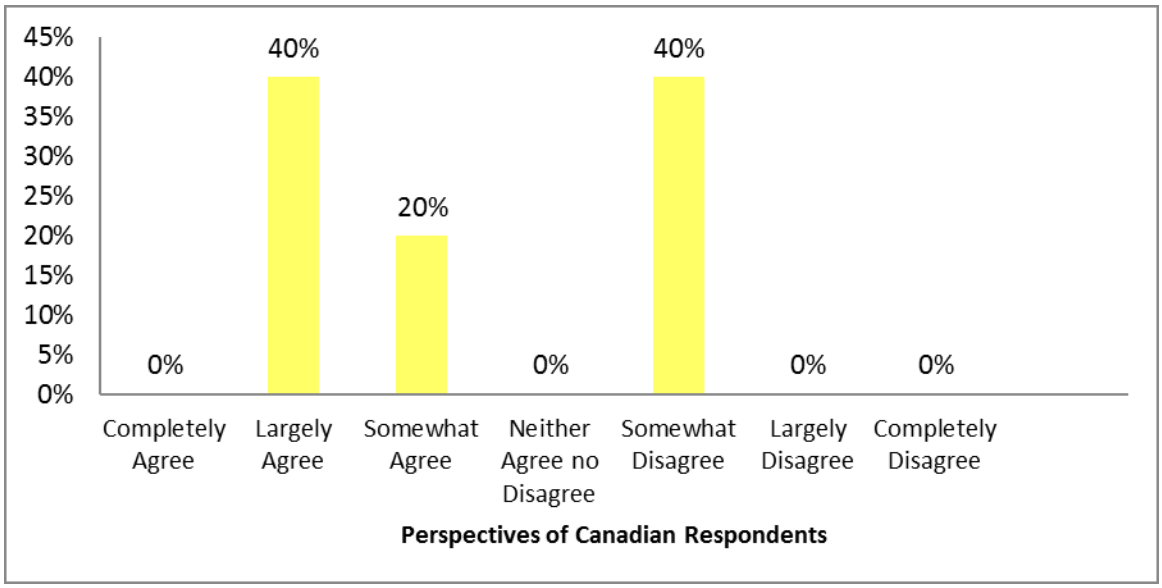

Figure B.14: Percentage of <u>Canadian respondents</u> who agree or disagree with the statement Canada and the United States, jointly, are doing enough to understand Basin-wide Environmental Flow needs along the Columbia River

Perspectives on Joint Efforts to Address Competing Uses and Environmental Flow Needs

The remaining two statements in question seven of the survey elicit perspectives on efforts by Canada and the US to address competing waters uses and demands, as well as environmental flow needs. One statement says: "*Canada and the United States, jointly, **are** doing enough to address competing water uses and demands along the Columbia River*." Responses were received from 15 individuals. As illustrated in Figure B.15, below, 80 percent (12) of all respondents disagree with this statement.

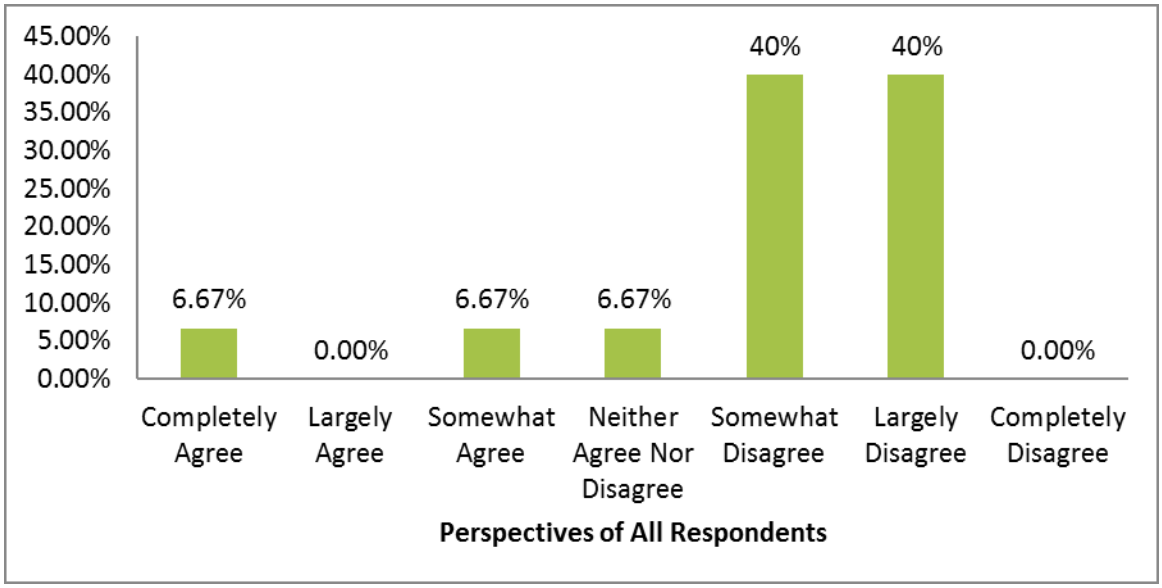

Figure B.15: Percentage of all respondents who agree or disagree with statement: Canada and the United States, jointly, are doing enough to address competing water uses and demands along the Columbia River.

As illustrated in Figure B.16, below, all US respondents disagree to some extent with the assertion that the US and Canada are doing enough to address competing water uses and demands. By comparison, Figure B.17 shows that Canadian perspectives are divided. Two Canadian respondents agree to some extent and two disagree to some extent, with the remaining respondent neutral on the issue.

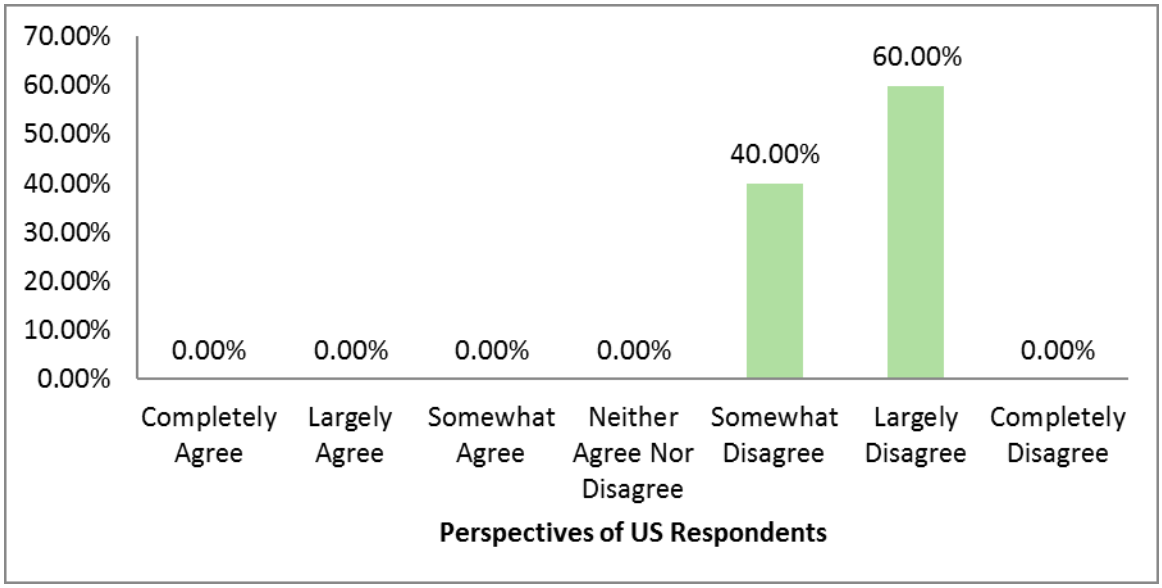

Figure B.16: Percentage of <u>US respondents</u> who agree or disagree with the statement Canada and the United States, jointly, are doing enough to address competing water uses and demands along the Columbia River

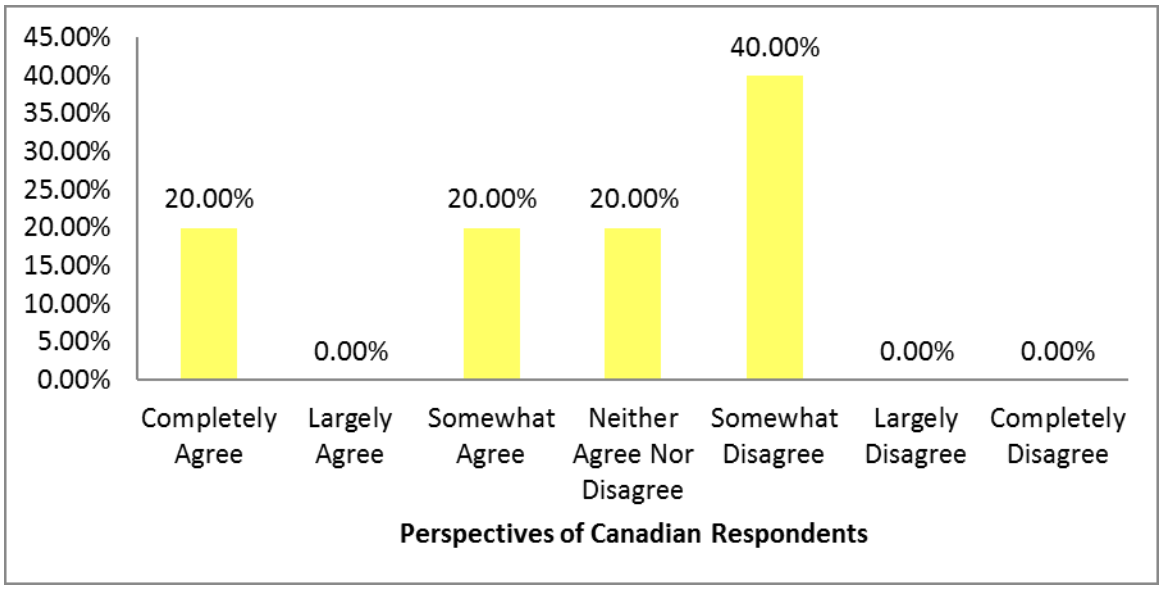

Figure B.17: Percentage of <u>Canadian respondents</u> who agree or disagree with the statement Canada and the United States, jointly, are doing enough to address competing water uses and demands along the Columbia River

The remaining statement from Question seven of the survey states: "*Canada and the United States, jointly, are **not** doing enough to address Basin-wide Environmental Flow needs along the Columbia River*." Responses were received from 15 individuals. As illustrated in Figure B.18, below, the majority of all respondents agree to some extent with this statement.

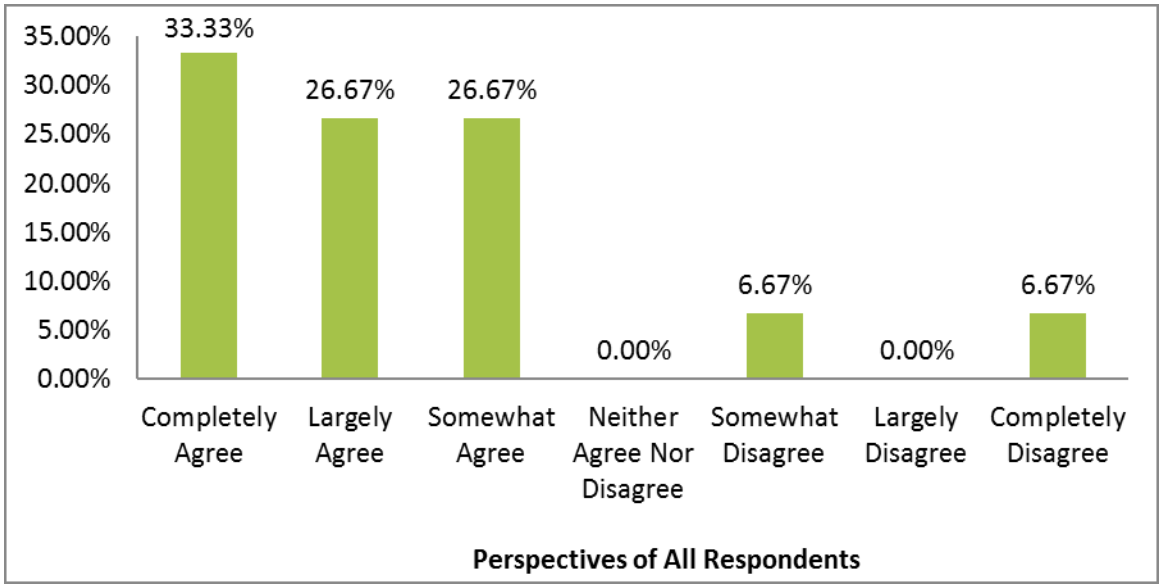

Figure B.18: Percentage of all respondents who agree or disagree with statement: Canada and the United States, jointly, are not doing enough to address Basin-wide Environmental Flow needs along the Columbia River

As illustrated in Figure B.19, below, all US respondents agree to some extent with the assertion that the US and Canada are not doing enough to address basin-wide environmental flow needs. Figure B.20, however, illustrates that there is somewhat less unanimity amongst the Canadian respondents. The majority (four of six) of Canadian respondents do agree to some extent with the assertion, and two disagree with the assertion that the US and Canada are not doing enough to address basin-wide environmental flow needs.

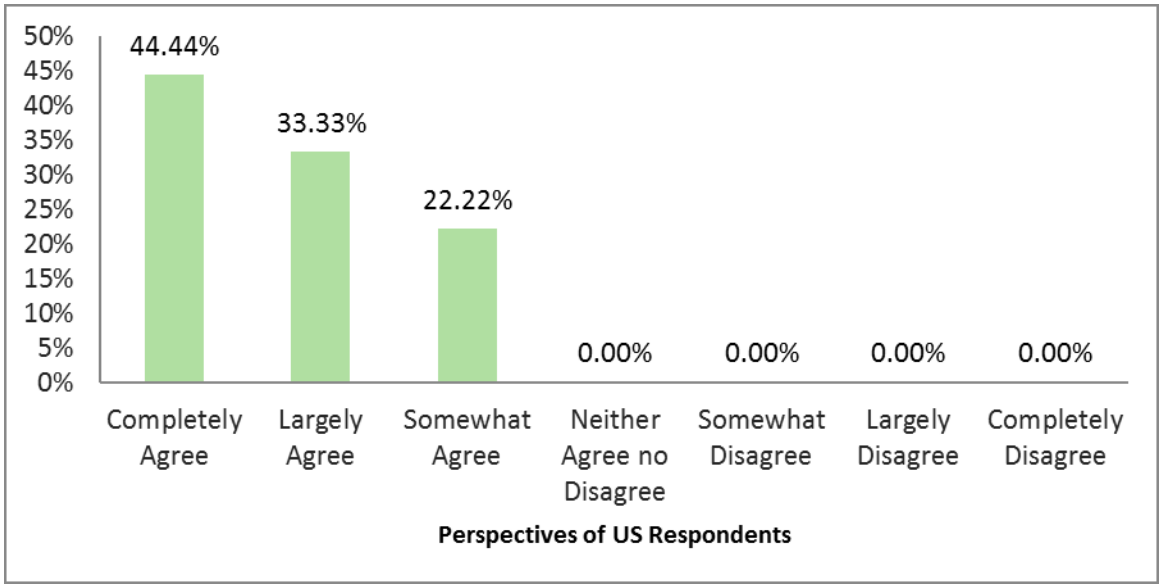

Figure B.19: Percentage of <u>US respondents</u> who agree or disagree with the statement Canada and the United States, jointly, are not doing enough to address Basin-wide Environmental Flow needs along the Columbia River

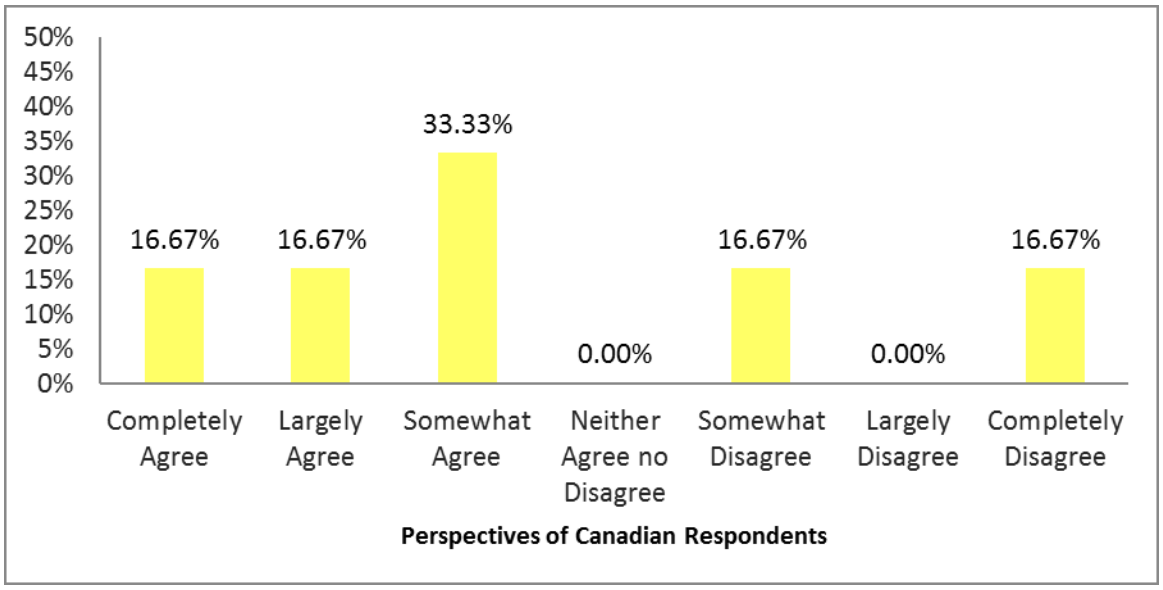

Figure B.20: Percentage of <u>Canadian respondents</u> who agree or disagree with the statement Canada and the United States, jointly, are not doing enough to address Basin-wide Environmental Flow needs along the Columbia River

Question 8: Perspectives on Sufficiency of Joint and Domestic to Support Environmental Flows Now and in Future

Question eight presents statements that explore respondents' perspectives on the whether or not joint and domestic measures are sufficient to support environmental flows for ecosystem function now and in the future. The following responses were received:

Table B.7 Respondents' views on the whether or not joint and domestic measures are sufficient to support environmental flows for ecosystem function now and in the future

Question	Completely Agree	Largely Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Largely Disagree	Completely Disagree	Total Responses
The current approach to the management of the Columbia River by the United States and Canada adequately supports Environmental Flows for Ecosystem Function right now.	0	2	1	0	2	4	6	15
The current approach to the management of the Columbia River by the United States and Canada will support Environmental Flows for Ecosystem Function adequately in the future.	0	2	1	2	2	3	5	15

Question	Completely Agree	Largely Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Largely Disagree	Completely Disagree	Total Responses
Current domestic measures in your country of residence are sufficient to address the issue of Environmental Flows for Ecosystem Function right now.	0	4	1	1	0	5	4	15
Current domestic measures in your country of residence will be sufficient to address the issue of Environmental Flows for Ecosystem Function in the future.	0	3	0	1	1	6	4	15

The majority of all respondents disagree to some extent with the first assertion, that the management of the Columbia River adequately supports environmental flows for ecosystem function *right now*. As illustrated in Figure B.21, below, all US respondents disagree to some extent with the assertion. In contrast, Figure B.22 indicates that Canadian respondents are divided in their perspective on the statement with three agreeing to some extent and three disagreeing to some extent.

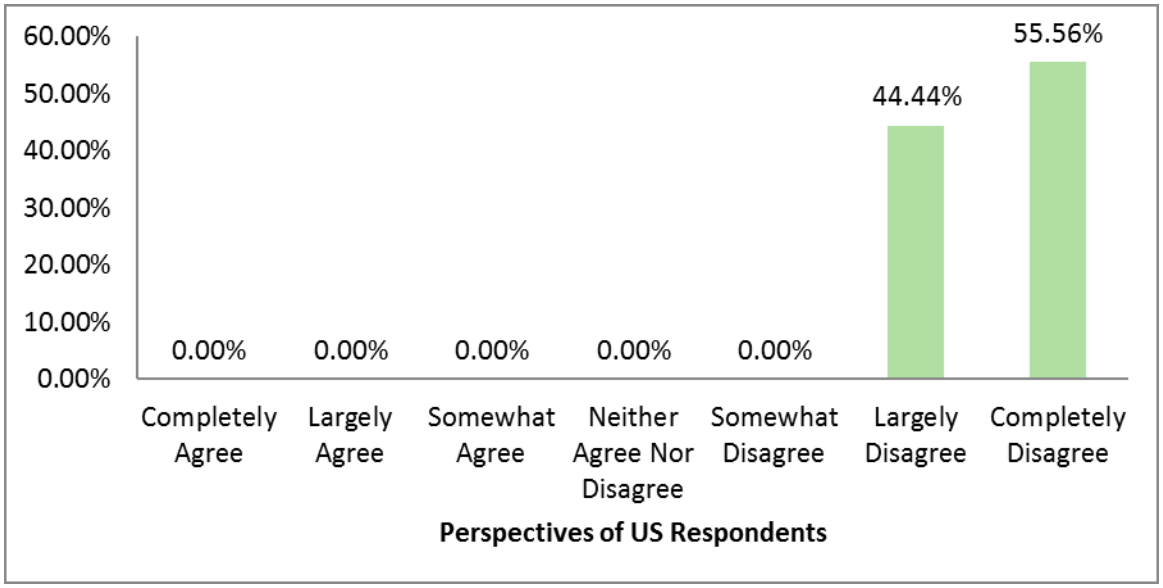

Figure B.21: Percentage of US respondents who agree or disagree with the statement The current approach to the management of the Columbia River by the United States and Canada adequately supports Environmental Flows for Ecosystem Function right now

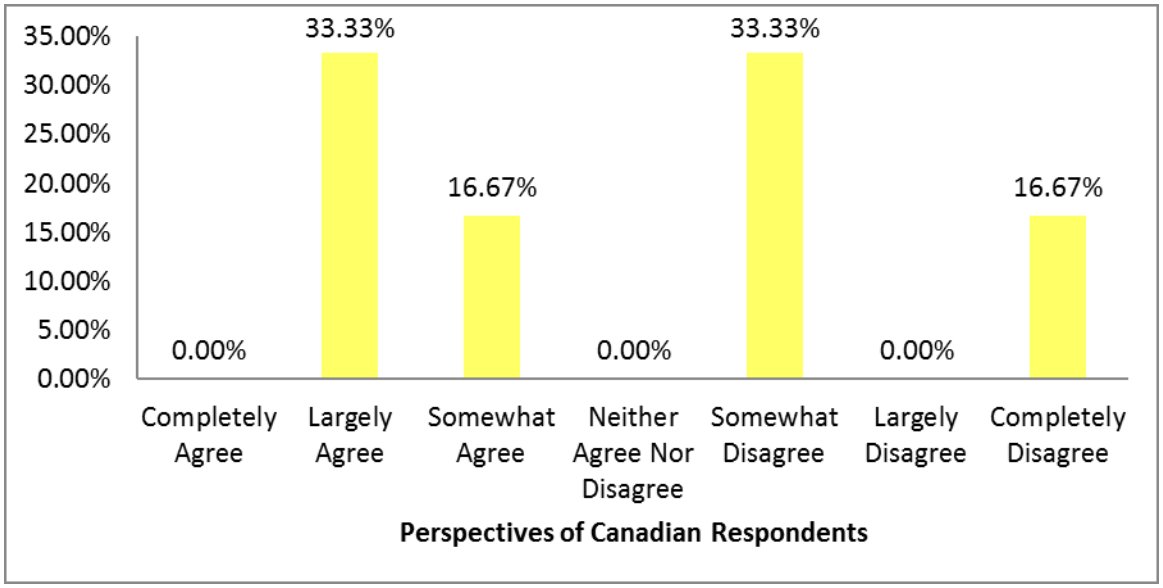

Figure B.22: Percentage of Canadian respondents who agree or disagree with the statement The current approach to the management of the Columbia River by the United States and Canada adequately supports Environmental Flows for Ecosystem Function right now

The second assertion says: *The current approach to the management of the Columbia River by the United States and Canada will support Environmental Flows for Ecosystem Function adequately in the future*. A majority (10 or 67 percent) of all respondents disagree with this statement. The majority of US respondents disagree with the statement to some extent. Canadian respondents are once again less unanimous. Of the six responses received from Canadians, only two disagree with the statement, one is neutral, and three agree with the statement to some extent. The differences in the distribution of US and Canadian perspectives are illustrated in Figures B.23 and B.24, below.

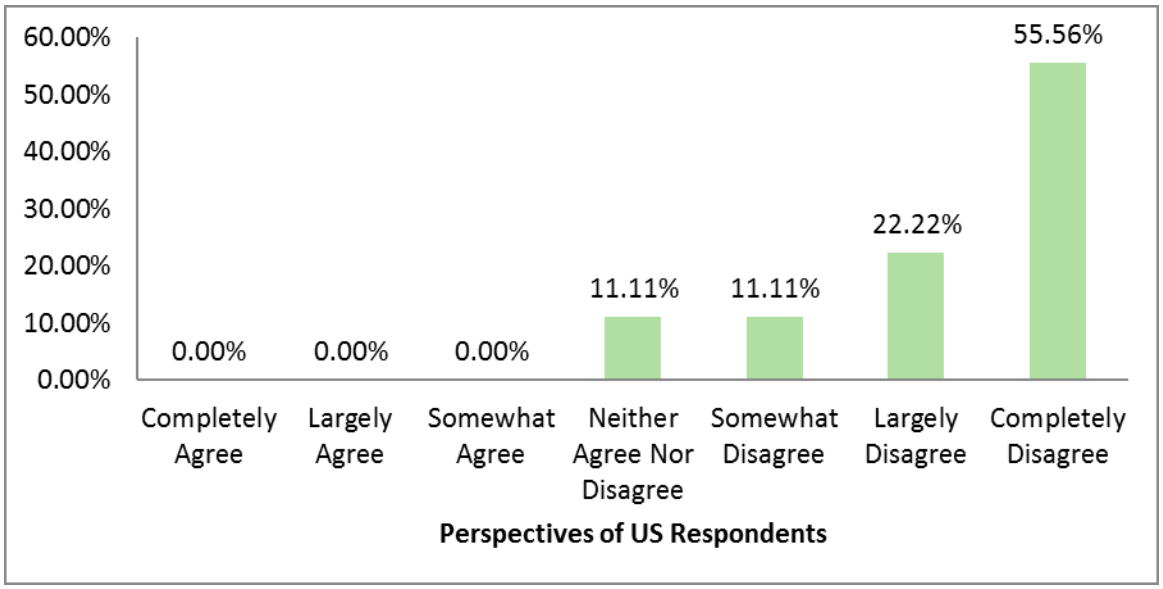

Figure B.23: Percentage of <u>US respondents</u> who agree or disagree with the statement The current approach to the management of the Columbia River by the United States and Canada will support Environmental Flows for Ecosystem Function adequately in the future

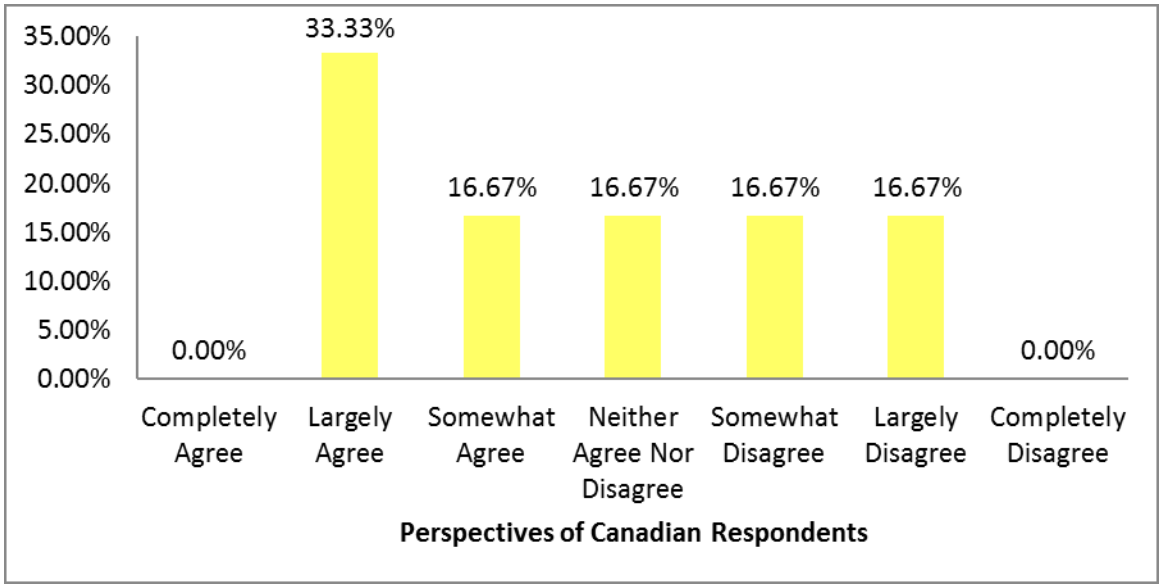

Figure B.24: Percentage of Canadian respondents who agree or disagree with the statement The current approach to the management of the Columbia River by the United States and Canada will support Environmental Flows for Ecosystem Function adequately in the future

The last two statements of question eight seek to elicit perspectives on the adequacy of *domestic* measures in respondents' country of residence support environmental flows for ecosystem function.

The third statement says: *Current domestic measures in your country of residence are sufficient to address the issue of Environmental Flows for Ecosystem Function right now*. The majority of all respondents (nine or 60 percent) disagree with this statement to some extent. Responses were received from nine US respondents, of whom eight (or 53 percent of US respondents) disagree with this statement to some extent. The majority of Canadian responses, however, fall on the other end of the spectrum, with the majority (four or about 67 percent) largely agreeing with the statement that current domestic measures in Canada are sufficient to address the issue of environmental flows for ecosystem function right now.

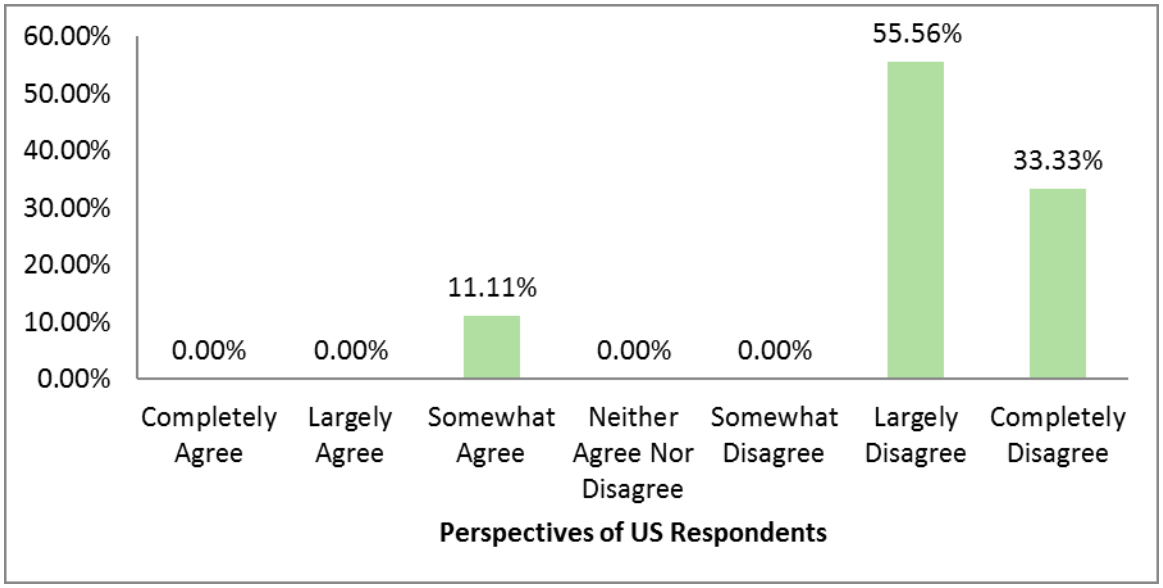

Figure B.25: Percentage of <u>US respondents</u> who agree or disagree with the statement Current domestic measures in your country of residence are sufficient to address the issue of Environmental Flows for Ecosystem Function right now

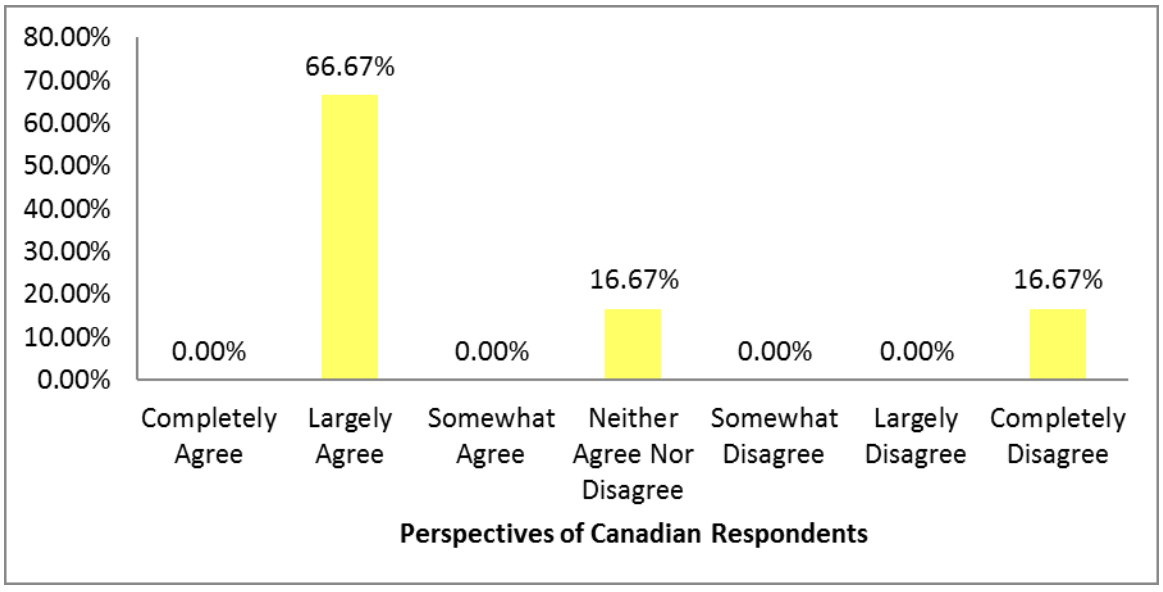

Figure B.26: Percentage of <u>Canadian respondents</u> who agree or disagree with the statement Current domestic measures in your country of residence are sufficient to address the issue of Environmental Flows for Ecosystem Function right now

The fourth statement in Question eight says: *Current domestic measures in your country of residence will be sufficient to address the issue of Environmental Flows for Ecosystem Function in the future*. The majority (11 or 73 percent) of all fifteen respondents disagree with this statement. Responses to this fourth statement were received from nine US respondents, the majority of whom disagree with the statement to some extent (Figure B.27). As illustrated by Figure B.28, however, the six Canadian respondents are evenly divided on this issue.

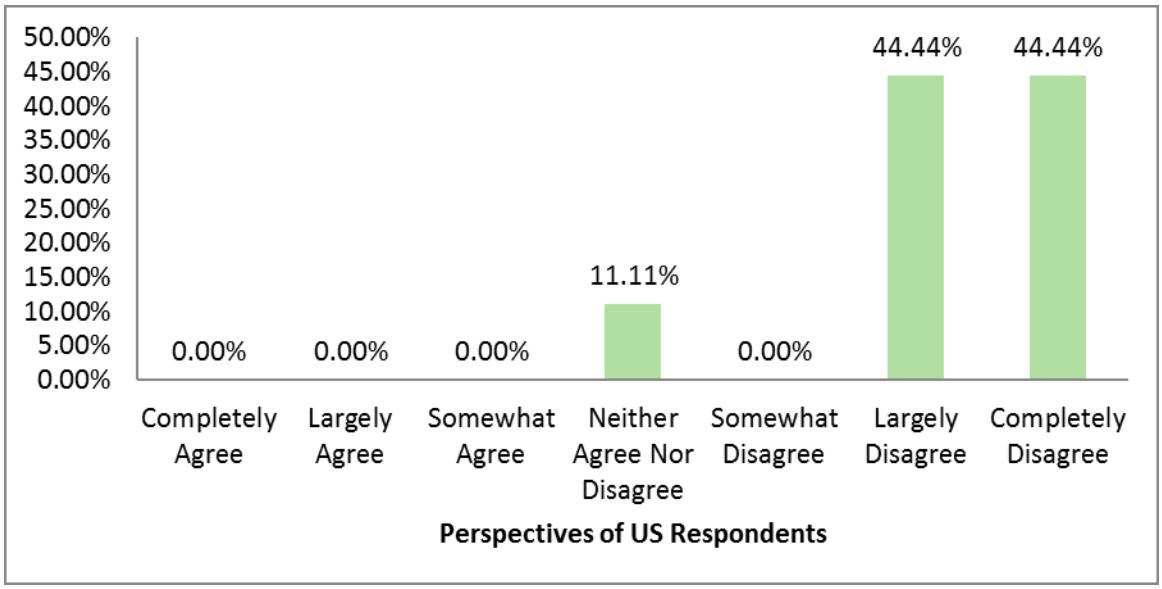

Figure B.27: Percentage of US respondents who agree or disagree with the statement Current domestic measures in your country of residence will be sufficient to address the issue of Environmental Flows for Ecosystem Function in the future.

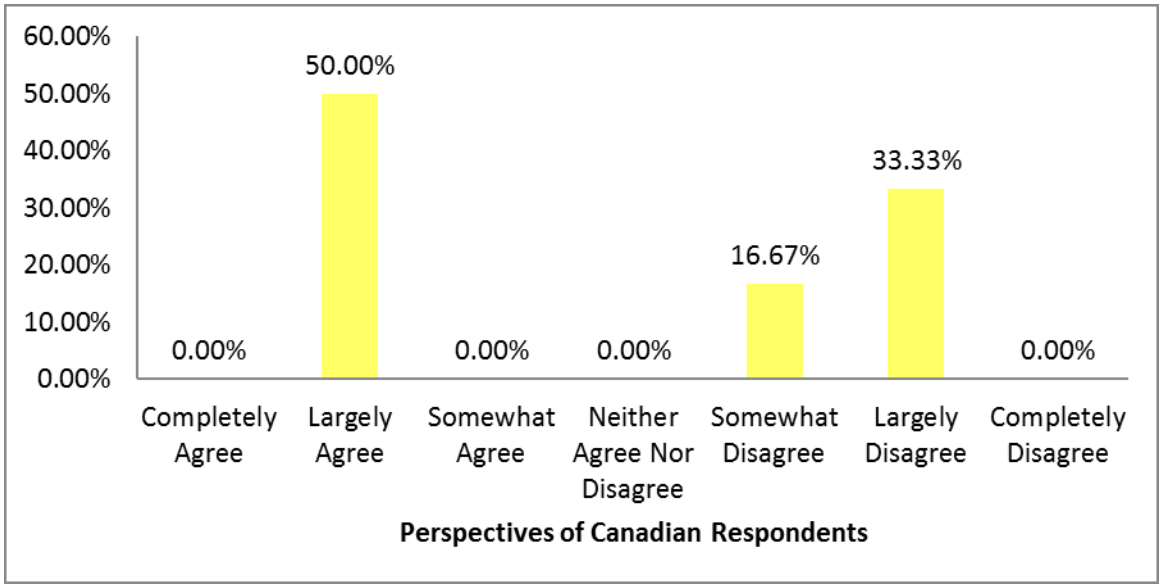

Figure B.28: Percentage of Canadian respondents who agree or disagree with the statement Current domestic measures in your country of residence will be sufficient to address the issue of Environmental Flows for Ecosystem Function in the future.

Question 10: Perspectives on the Need for a New Agreement

Question ten presents respondents with two views on the degree to which Canada and the US should coordinate their efforts to address ecosystem function in the Columbia River Basin. Respondents were asked to identify with which view they generally agree the most. Fifteen respondents answered the question. The majority (73 percent or 11) agreed with view one, which is that "*a new type or level of formal (e.g. binding) agreement is needed between the United States and Canada to address the issue of Ecosystem Function in the Columbia River Basin because the issue is not adequately addressed and coordinated by the United States and Canada right now*." Of the nine US respondents, the majority (eight or 89 percent) agreed with view one and a single respondent agrees with neither view one or two. Of the six Canadian respondents, half (three) agree with view one, one with view two, one did not know, and one with neither view.

Question 11: Perspectives on the Columbia River Treaty

Respondents were also asked for their views on whether the Treaty enables or hinders coordinated management that supports environmental flows for ecosystem

function. The majority of all fifteen respondents (10 or 67 percent) felt that the Treaty hinders such management to some degree, two (14 percent) felt that the Treaty enables such management to some degree, and three (20 percent) respondents were neutral on the issue. Of the six Canadian respondents, three (50 percent) felt that the Treaty hinders such management to some degree, two (34 percent) felt that the Treaty enables such management to some degree, and 1 was neutral. The majority (seven or 77 percent) the nine US respondents felt that the Treaty hinders such management to some degree, and two were neural. No US respondents perceive the Treaty to be an enabling instrument.

Questions 9, 12-14: Qualitative Responses

The limited volume of data received for qualitative responses did not require coding in order to identify themes, or commonalities. This section summarizes the qualitative data.

Respondents provided views on possible trade-offs to consider in terms of prioritizing ecosystem function. Possible losses/disadvantages identified by respondents are:

- Loss of hydroelectric power production capacity
- Loss of revenues from power production
- Loss of funding derived from power revenues[31]
- Decrease of flood control capacity
- Decreases of water flows for other economic and consumptive uses
- Loss of an ability to compensate for the loss of snow storage due to climate change
- Impact water levels for navigation[32]
- Lower water levels for recreation

[31] One respondent noted that this could impact actions or agencies funded by these revenues. Identified agencies were those working on environmental issues, such as the Columbia Basin Trust, the Bonneville Power Administration, the NW Power and Conservation Council, and other agencies that receive Bonneville Power Administration funding)

[32] One respondent noted that increasing spring flows and reducing fall flows to create a more natural hydrograph would do two things in regards to navigation: a) increase sedimentation input and the need for costly dredging and b) lower fall water levels, which will present a challenge for large ships

Respondents also identified possible gains from prioritizing ecosystem function:

- More and better fish habitat
- Equalization of the system.[33]

Respondents also raised a number of concerns regarding the issue of trade-offs, such as:

- one should not presume there will be tradeoffs - it is possible there will not be any
- prioritizing ecosystem function in River management will not necessarily result in the restoration of all critical ecosystem functions. The example given is a potential conflict between interests in floodplain restoration and the amount of land that public/private landowners would be willing to release for floodplain restoration.
- thinking in terms of trade-offs is a narrow perspective; rather, we should think in terms of outcomes that support system-wide resilience based on a shared perspective of ensuring community and ecosystem resilience.
- prioritizing ecosystem function will create new conflicts between non-power water users, such as between agriculture and fish.
- a basin-wide assessment of flood risk management operations, flood control infrastructure and updated run-off forecasting modeling could identify outcomes under which both flood risk management and ecosystem function options can be supported.
- any agreement on ecosystem function will need to carefully define what the term means, as it may pertain to different/competing interests in different parts of the basin.

Those respondents who offered a perspective on the degree to which the Columbia River Treaty enables or hinders transboundary river management that supports ecosystem function were also asked to explain their position.

The two Canadian respondents who see the Treaty to be enabling share a similar perspective. In their view, the US and Canada can already mutually agree on and make-tradeoffs with respect to flows for non-power uses (i.e. fish flows in lieu of

[33] The respondent defined this as "the ability to meet and react to equal reservoir levels and flows throughout the entire system of the Columbia River at peak freshet, and environmentally predictable, or non predictable occasions." This option appears to contemplate a system in which the management of reservoir levels and releases considers the needs throughout the basin in a manner the does not assume the presence of political borders.

hydropower production). One respondent notes that the question is not whether a new treaty is needed, but, rather, how the current treaty can be enhanced. They view the Treaty as already having the mechanisms needed to address the issue but "it is political will and understanding that needs change."

Common themes amongst those who see the Treaty as a hindrance are as follows:

- The limitation of the Treaty purposes to hydropower and flood control
    - Means that addressing other issues essentially require a caveat
    - Makes managing for other concerns, such as ESA flow requirements, more difficult
    - Impedes the ability to manage issues through a large scale approach
    - Means that ecosystem function is not sufficiently considered in flow management planning
    - Means the Treaty does not focus on environmental flows
- The Treaty Entities only represent agency interests
- The Treaty contributes to the dominance of hydro and agriculture (and those who represent these interests)
- No incentives are provided to Canada to prioritize ecosystem function (e.g. no incentive for salmon as they are blocked in the US portion of the Basin)
- The focus is on short-term economic benefits. Ecological benefits and costs are generally ignored

As this topic is complex, respondents were also offered space to add any additional comments they wished on the subject of transboundary management for ecosystem function. The major issues and concerns arising from this discussion include:

- There needs to be better/expanded public participation in the Columbia River treaty regime
- There needs to be better participation/consultation with First Nations and US Tribes
- Climate Change
    - The Treaty must incorporate adaptability/flexibility in the face of climate change
    - Will result in a smaller snowpack, earlier snowmelt, and an earlier spring freshet. This increases flood risk and exacerbates conflicts

- The Treaty must incorporate openness and transparency
- There is reluctance to open the whole Treaty for renegotiation.
- Natural flows and the natural ecosystem need to be considered

    Eg. the reservoirs have created a series of lakes that are hostile to the natural ecosystem

    Reservoir levels and flows need to be considered on a basin-wide level

- Potential for future disagreements

    between the US and Canada on environmental benefits to consider and emphasize (e.g. interest in dam removal and reduced storage capacities versus flows for salmon)

    between various water users

    over restoring fish passage into Canada

- Tradeoffs

    There is no mechanism to determine how economic and ecological uses of the basin interact

    No system to assess tradeoffs

- Some view the Treaty as having all the needed mechanisms to achieve improvements