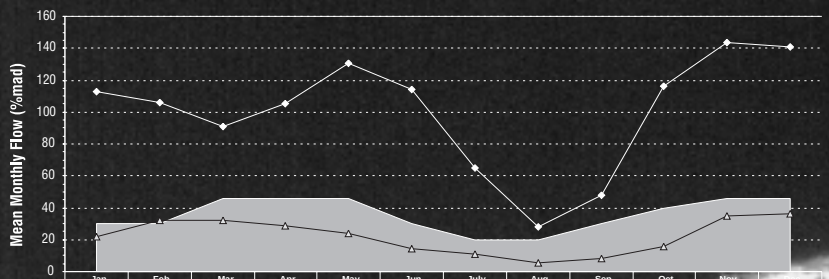
Preliminary Review of Fisheries Conservation Gains within BC Hydro's Water Use Planning Process

Annual hydrograph for the Coquitlam River at Port Coquitlam (WSC Station 08MH002), British Columbia

Naturalized mean annual discharge = 27 cms or 954 cfs. Regulated since 1902



	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Consvr Q	30	30	46	46	46	30	20	20	30	40	46	46
Present Q	21.9	31.8	32.0	28.9	24.2	14.3	11.1	5.6	8.5	15.8	35.2	36.5
Nat Q	113	106	91	105	130	114	65	28	48	116	144	141

Watershed Watch SALMON SOCIETY

Prepared for: Watershed Watch Salmon Society

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Funded by: The Bullitt Foundation May 2004

PREFACE

THE SUCCESSFUL MANAGEMENT OF BRITISH COLUMBIA'S freshwater resources requires overcoming a wide range of obstacles. In their superb yet sobering examination of adaptive capacity and challenges to policy within three dozen management agencies, systems ecologists Buzz Holling and Lance Gunderson have identified a remarkably predictable "management pathology." With few exceptions, management agencies, in their drive for efficiency, and to preserve (initially) successful policies and development, become progressively more myopic and rigid. This occurs, so say Holling and Gunderson, as a consequence of efforts to constrain the 'adaptive cycle' in both the ecosystem and in the management agency.

In cases of extreme and growing rigidity, all systems become "accidents waiting to happen." A triggering event—perhaps a flood or fire or pest outbreak for an ecosystem, or a critic or audit or failed policy for an agency—can now provoke crisis and transformation within the ecosystem or agency. At this point, accumulated resources can be "released from their bound, sequestered, and controlled state, connections are broken, and feedback regulatory controls weaken," thus setting the stage for adaptive reorganization.

The 'release phase' in the lives of such systems is also known as "creative destruction." It is called creative destruction, as opposed to a collapse, because resources from the previous system—people, skills, nutrients, capital, seeds, ideas that were suppressed—now become available for reorganization purposes. Novel ideas, experimentation, learning, and inventions are also more likely to be encouraged and incorporated than under previously rigid conditions. As a consequence, solutions to policy challenges are more likely.

In light of this surprisingly predictable scenario, it should come as no surprise that the BC Hydro Corporation has undergone it own periods of high rigidity, creative destruction, and reorganization. The following report examines one such period in Hydro's recent history. Its focus, however, is not so much on the overly rigid Hydro policies of the early to mid-'90s, in which water was viewed as a resource to be used almost exclusively for the propagation of power—not fish. Nor does it detail the two main triggering events—a review of Hydro's water storage licences, and a complaint to NAFTA about Canada's mistreatment of fish—that precipitated creative destruction by prompting the government of the day to reorganize how BC Hydro does business, relative to fish, and other non-power values. Instead, this report describes some lessons and outcomes from the large-scale reorganization phase we know as the "provincial water use planning (WUP)" process.

Though the government sponsored provincial water use planning process (WUP) is not yet complete (it's now in its fifth and final year), and though the full benefits of the labor- and cash-intensive ($25 million by government alone) process won't be known for years, Watershed Watch believes it is time to report on the 24 water use plans that have been completed or are near completion.

Since Watershed Watch supports legitimate processes that improve our measuring and management of water, Watershed Watch has been extremely active in the past four years, participating in the Coquitlam-Buntzen water use planning consultative committee, the Coquitlam fish technical committee, the First Nations water use planning committee, the fisheries advisory team on water use planning, the green hydro working group, and numerous other academic, technical, and informal meetings.

In 70-some meetings, Watershed Watch advocated for fish and the public interest, provided and received technical advice, made presentations, asked questions, learned a whole new suite of acronyms, and took a lot of notes. It looked for and found evidence of innovation, capacity building, community buy-in, cross-cultural learning—within all WUP participants. It also saw progress in restoring fish flows and public values—at least, in certain WUPs—along with pockets of rigidity, and dubious tradeoffs.

Watershed Watch's involvement in WUPs, however, is mainly as a catalyst, not an analyst. Despite attending so many meetings, Watershed Watch has experienced first hand only a small part of the entire WUP process. Its closeness to the process and its push for fish values might also be seen by some as a challenge to objective reporting.

Watershed Watch thus commissioned Quadra Planning Consultants to prepare the main part of the following report—which, it should be noted, is the first independent assessment of the largest water restoration project ever undertaken in BC. The report focuses on the fish conservation gains that stem from the water use planning initiative. Quadra also examined how successfully the water use plans incorporate First Nations' traditional ecological knowledge.

In addition, Watershed Watch hired environmental lawyer Linda Nowlan to determine whether the WUP process satisfies the expectations set out in NAFTA's "factual report" dated June 2000, and whether the WUPs do or do not meet two contentions: that water use plans are "a step in the right direction towards achieving greater protection of fish and fish habitat from the harmful impacts of hydroelectric operations," and that "the WUP process holds promise as an enforcement strategy." Nowlan's contribution begins on page 47.

Watershed Watch thanks The Bullitt Foundation for funding this report; members of the First Nations Water Use Planning Committee, particularly Fred Fortier, Bill Green and Marilyn Mura for insightful contributions; and the Vancouver, Henry. P. Kendall, David and Lucile Packard, and Tides Canada foundations for making it possible for Watershed Watch to attend so many meetings on water and fish.

Craig Orr, Executive Director, Watershed Watch, May 2004

References:

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ACKNOWLEDGEMENTS:
The authors wish to thank Watershed Watch Salmon Society and the First Nations Water Use Planning Committee for their support, particularly Craig Orr who supervised the project. Various Federal and Provincial government staff and First Nations participants in WUP kindly provided responses to our questions and we appreciate their efforts in contributing to the report. We wish to acknowledge the inputs from Geoff Clayton, Randall Lewis, Rod Louie, Steve McAdam, Steve McFarlane, John Munro, Craig Orr, Ron Ptolemy, John Werring, and Craig Wightman.

Report design & production: Eye Design Inc.

EXECUTIVE SUMMARY

WATER USE PLANS (WUPs) HAVE NOW BEEN completed at most of BC Hydro's hydroelectric facilities in British Columbia. Watershed Watch, in collaboration with the First Nations Water Use Planning Committee, received funding from The Bullitt Foundation to undertake an independent review of fish conservation gains within WUP. This report is an overview analysis of the results to date of the WUP process from a fish conservation perspective, including First Nations expectations and interests related to fisheries. The study focussed on review of certain key aspects – fisheries outcomes, the use of performance measures, the trade-offs associated with fisheries conservation, and the extent to which First Nations fisheries concerns were addressed. It also evaluated the extent to which WUP has addressed the issues raised in the NAFTA Commission for Environmental Cooperation report of May 2000, including: reduced flows, rapid flow fluctuation, adequate flushing flows, altered water quality, fish entrainment, and flow diversions.

The study was organized around the following key objectives:

- Assess the achievement of objectives related to fish and fish habitat conservation.
- Assess the effectiveness and limitations of the performance measures used to determine acceptable fish and fish habitat conservation standards.
- Assess the trade-offs of fish and fish habitat objectives and values with other uses.
- Assess the results of WUP relative to First Nations expectations for fisheries conservation.

Seven of the 24 WUPs were selected for review: Cheakamus, Coquitlam, Alouette, Stave, Bridge, Shuswap and Ash River, although discussions occurred on other WUPs as well. These WUPs were chosen to represent a range of key fish conservation concerns and First Nation interests. As well, there were available reports for these WUPs.

Achievement of Objectives

The outcomes to date for fish conservation have, overall, been generally positive, although not without some level of compromise on fish objectives and a lack of full consensus at several facilities. The recommended flow alternatives were sometimes, although not always, the best choice for fish conservation, but they were usually better than the status quo. Even when the selected alternative was best for fish, it may not have met the particular performance standard set for fish at that facility. Based on the consultative committee reports, fish conservation stakeholders (DFO, WLAP and conservation organizations) endorsed the recommended operating alternative(s) at six of the seven study WUPs.

One of the more important contributions of WUP has been to identify critical uncertainties and data gaps and to establish the framework and parameters for ongoing monitoring and adaptive management of the key fish flow issues. WUP has resulted in some significant advances in understanding the interactions between hydroelectric operations and fish conservation, and improving the methods for balancing competing objectives. In many cases, these advances led to important efficiencies and net gains in both power and fish production potential – results that were generally not anticipated. For example, in the case of Bridge River, by withdrawing the constraints that existed on the separate reservoir operations, operating efficiencies and power revenues were improved while providing greater flexibility to accommodate multiple objectives.

Some constraints in the scope of the WUP process terms of reference limited the range of possible outcomes. More flexibility in addressing all fish flow issues could have contributed to more room for innovative solutions and agreements (e.g., Cheakamus WUP).

Performance Measures

Valuable experience was also gained in the use of performance measures, which was a key focus of the WUP model. The type and detail of performance measures varied between WUPs and over the course of the process. While a long list of performance measures were often developed, the comparative analysis of flow alternatives usually focussed on only a few selected measures that represented the key variables and indicators (e.g. steelhead parr habitat as a "keystone indicator") that captured requirements of several species. It is

apparent that some performance measures were useful for the initial analysis of requirements but not necessarily for distinguishing detailed differences between alternatives. In some cases, major changes occurred in the use of performance measures at various stages of the review. In other cases, the reluctance to change performance measures appears to have constrained the ability to reach consensus. This may reflect differences in views by WUP participants as to in whether these measures were meant to be used as dynamic tools to assist analysis, or normative criteria to guide decisions.

The reliability of performance measures depended on the fish-flow complexity of the particular system, the availability of field data on previous fish impacts, and the risk tolerance of participants to make professional judgements under certain information, time and process constraints. There was considerable potential for measurement and modelling error and subjective expert judgement. In most of the WUPs, the analysis focussed on flow effects on habitat suitability and quality. It proved more difficult to estimate the biological impacts. These were largely derived from professional judgement. Technical uncertainty was therefore typical of the WUPs and many of the assumptions and predictions will need to be tested in the subsequent monitoring phase.

Trade-Offs of Fish & Fish Habitat Objectives & Values with Other Uses

The nature of the trade-offs associated with fish conservation varied widely between WUPs. A comparison of the recommended flow alternatives with the 'fish friendly' alternatives or similar 'conservation ideals' (that were not selected) revealed some definite trade-offs to fish values at some facilities, although these were comparatively small. The opportunity costs of fish conservation turned out to be less than originally anticipated. An analysis of the effects of the recommended alternative(s) on power and fish compared to the status quo showed that the WUP outcomes resulted in estimated changes in annual power revenues from –21% at Coquitlam River to +6 % at Ash River, and positive changes in fish indicators in the range of + 10-30% at the study facilities. Restoring flows to a pattern that reflects some elements of pre-regulation conditions (i.e., mimicking the shape of the natural hydrograph) was often but not always the best overall solution for fish. Components of a naturalized flow regime need to be assessed in terms of species life cycle requirements.

First Nation Perspectives

First Nations accepted the recommended operating alternatives at five of the seven study WUPs, primarily because they were better than the status quo. Their inputs focussed mostly on the effects on archaeological resources and traditional uses. Some significant concerns remain about the process, including (i) the lack of a First Nations mechanism to address the historical footprint impacts of hydroelectric development, which in many cases overwhelm the operational impacts, (ii) the inadequate acknowledgement of First Nations' status, rights and entitlements in water management rather than simply the ascribed role within WUP as one of many stakeholders in water use decisions, and (iii) a lack of resources to support First Nations' participation in the technical aspects of the fisheries assessment and monitoring. These remain unresolved issues for First Nations.

Concluding Observations

There has been substantial progress in reaching consensus on the appropriate operating alternatives for fish conservation, and/or defining the specific uncertainties that need to be addressed to better determine the appropriate flow regimes. The technical solutions generated by the fisheries technical committees and BC Hydro's project teams tended to drive the process and set the frame of reference within which value-based inputs from stakeholders were solicited. Where the process failed to reach full consensus was generally in situations where a lack of flexibility was available to adjust the process to accommodate the particular expectations, perceptions, performance standards and risk sensitivities of the participants. There are some important lessons from the WUP experience to date, including:

- technical analysis and consultation can generate significant water use efficiencies and benefits;
- stakeholder agreement on the process and flexibility to address a range of interests is essential;
- performance measures need to maintain adaptability to the issues that emerge in the process;
- there is a close relationship between historical 'footprint' impacts and contemporary operational impacts which are often inseparable; and
- there are limitations of a multi-stakeholder process in meeting the consultative needs of First Nations.

1. INTRODUCTION

IN 1998, THE GOVERNMENT OF BC, UNDER THE *Water Act,* requested that BC Hydro (BCH) undertake a Water Use Planning process to review the operating conditions of BC Hydro's power generation facilities. A Water Use Plan (WUP) was to be produced for each of the facilities and approved by the Provincial Water Comptroller. Based on each WUP, it is expected that the Water Comptroller will amend the water licences for each of BCH's facilities taking into account the WUP recommendations pertaining to the operation of the facilities. Monitoring of the licence requirements is expected to be an important component of the implementation of a Water Use Plan. For some facilities, the Comptroller has issued interim orders under the *Water Act* which require immediate changes to operations for the benefit of fish.

The Water Use Planning process is a public process that follows a 13-step procedure as outlined in the Water Use Plan Guidelines, Province of BC, 1998:

Step 1 Initiate a WUP process for the particular facility.

Step 2 Scope the water use issues and interests.

Step 3 Determine the consultation process to be followed and initiate it.

Step 4 Confirm the issues and interests in terms of specific water use objectives.

Step 5 Gather additional information on the impacts of water flows on each objective.

Step 6 Create operating alternatives for regulating water use to meet different interests.

Step 7 Assess the tradeoffs between operating alternatives in terms of the objectives.

Step 8 Determine and document the areas of consensus and disagreement.

Step 9 Prepare a draft WUP and submit it to the Comptroller for regulatory review.

Step 10 Review the draft plan and issue a provincial decision.

Step 11 Review the authorized WUP and issue a federal decision.

Step 12 Monitor compliance with the authorized WUP.

Step 13 Review the plan on a periodic ongoing basis.

The WUP process involves 30 BC Hydro facilities within 27 watersheds. WUP does not address the historical ('footprint') impacts of hydroelectric development but focuses on the contemporary regulation of stream flows and reservoir operations. The process is open to the public, including the involvement of the general public, First Nations, provincial and federal agencies, environmental organizations, and communities affected by hydro facilities. For each WUP a consultative committee is usually established which represents various interests, including the general public. The consultative committee is usually divided into a number of subcommittees to address specific issues such as fisheries, recreation, wildlife, etc. These committees are usually assisted by technical resource specialists drawn from federal and provincial agencies, BCH, and consultants. Since 1998, 24 WUPs have been completed or are in the final stages of completion.

Several committees have been established to oversee and assist the WUP process. These include a Management Committee, First Nations Water Use Planning Committee, and Fisheries Advisory Team (FAT). These committees provide direction and overall coordination for the WUP process. They are comprised of senior staff from provincial and federal agencies, BC Hydro, First Nations and other key stakeholders. Watershed Watch sat as a member of the First Nations Water Use Planning and FAT Committees.

During the initial planning stages for WUP, the BC Aboriginal Fisheries Commission and several environmental groups submitted a request to the NAFTA Commission on Environmental Cooperation (CEC) pursuant to Article 14 of the North American Agreement on Environmental Cooperation requesting the Secretariat to consider whether Canada is failing to enforce its environmental legislation, namely the *Fisheries Act*, in regard to BC Hydro's operations. [1] The 'NAFTA complaint' argued that the Department of Fisheries and Oceans was allowing BC Hydro to degrade fish habitat at the expense of power exports and in violation of the *Fisheries Act.* The Commission's Secretariat issued a report in May 2000, presenting the 'factual record' of its findings.

Watershed Watch Salmon Society and BC First Nations have been centrally involved in water use planning through the committees outlined above and participation on several WUP consultative committees. Recognizing the need to review the performance of WUP in resolving the original

1 – Submission SEM-97-001, by BC Aboriginal Fisheries Commission, BC Wildlife Federation, Trail Wildlife Association, Steelhead Society, Trout Unlimited (Spokane Chapter), Sierra Club (US), Pacific Coast Federation of Fisherman's Associations, Institute for Fisheries Resources, represented by Sierra Legal Defence Fund and Sierra Club Legal Defense Fund, April 1997.

concerns about fish and hydroelectric operations, Watershed Watch, in collaboration with the BC Aboriginal Fisheries Commission, and its First Nations Water Use Planning Committee, applied to The Bullitt Foundation for funding to undertake an independent review of the WUP process, focusing on fish conservation requirements and how they have been handled in BC Hydro WUP processes.

In December 2003, Watershed Watch contracted with Quadra Planning Consultants Ltd. and Regional Consulting Ltd. to undertake this preliminary review of WUP. The purpose of the study was to assess the effectiveness of the completed and near-completed water use plans, and to examine the appropriateness to fish conservation of the WUP performance measures, trade-offs, and operating plans. The study addresses, in a preliminary manner, the central question of whether the public process supported by WUPs does (or will) eventually lead to substantially increased conservation and production of fish and the degree of acceptance of the WUP recommendations by conservation interests, including First Nations. This preliminary review also examines whether the water use planning process satisfies the conditions laid out in the May 2000 CEC "Factual Record" on water use planning and the original NAFTA complaint.

Table 1 identifies the 24 WUPs either completed or in the final stages of completion.

Table 1: BC Hydro Draft Water Use Plans

WATERSHED	REGION	WATERSHED	REGION
Completed – as of March 2004		Clayton Falls	Central Coast
Jordan River	South Vancouver Island	Shuswap Falls	Central Interior
Campbell River	Central Vancouver Island	Spillimacheen	Central Interior
Puntledge	Central Vancouver Island	Aberfeldie	East Kootenays
Ash	Central Vancouver Island	Elko	East Kootenays
Coquitlam/Buntzen	Lower Mainland	Whatshan	West Kootenays
Alouette	Lower Mainland	Seven Mile	West Kootenays
Stave/Ruskin	Lower Mainland	Peace River	Northeast
Clowhom	Sunshine Coast	***Incomplete – as of March 2004***	
Cheakamus	Lower Mainland	Columbia	West Kootenays
Whaleach	Lower Mainland	Water Hardman	West Kootenays
Bridge/Seton	Southern Interior	Duncan	West Kootenays
Falls River	North Coast	Kootenay Canal	West Kootenays

2. APPROACH & METHODOLOGY

THIS REPORT IS AN OVERVIEW LEVEL ANALYSIS OF the results to date of the WUP process from a fisheries conservation perspective, including First Nations expectations and interests related to fisheries. The main source of information has been the Consultative Committee Reports and final WUP reports. Limited interviews with key stakeholders (non-BC Hydro) have been used to supplement the analysis. A detailed comprehensive evaluation or audit was not undertaken. Rather, the review has focussed on review of certain key issues – fisheries outcomes, the use of performance measures, the trade-offs associated with fisheries conservation, and the extent to which First Nations fisheries concerns were addressed.

This review concentrated on a sample of WUPs at seven facilities where fisheries conservation issues were determined to be among the key issues discussed by the consultative committees. (The Alouette River water use plan is not always considered a formal WUP but we have nevertheless included it in the study projects.) The WUPs that were reviewed also represent a range of hydroelectric operating systems. However, comments were invited on WUP experiences at other facilities and these are incorporated into the report where available. It is important to recognize that each WUP is somewhat unique, based on the issues to be addressed, the composition of the consultative committee, and the performance measures and approaches used to determine tradeoffs. The following objectives, questions and indicators have been used to guide the review.

EVALUATION OBJECTIVES & KEY QUESTIONS

1. Assess the achievement of objectives and outcomes related to fish and fish habitat conservation.

To what extent did the WUP process resolve the major fish and fish habitat issues and concerns?

a. What agreements were reached on the recommended flows and mitigation measures and how significant were the outstanding areas of disagreement?

b. Did the WUP process adequately address the issues identified in the original submissions and the 1999 NAFTA complaint-CEC Factual Record related to water allocation and hydroelectric operations?

c. What effect did the process eventually have on the scale and timing of water releases from the hydroelectric facilities?

d. What key information deficiencies or scientific uncertainties may have affected the ability to reach agreement on fisheries issues?

EVALUATION INDICATORS

- Proposed fish flows in relation to previous flows (before and after hydrographs where available).
- Type and scale of proposed mitigation measures to reduce operational impacts.
- Level of agreement by consultative and technical committees on measures to address:
  - Reduced flows
  - Rapid flow fluctuation
  - Adequate flushing flows
  - Altered water quality
  - Entrainment of fish
  - Flow diversion
  - Reservoir drawdown
  - Changes in BC Hydro operating rules due to WUP recommendations
  - WUP processes and issues that were constrained by limited information and technical knowledge.

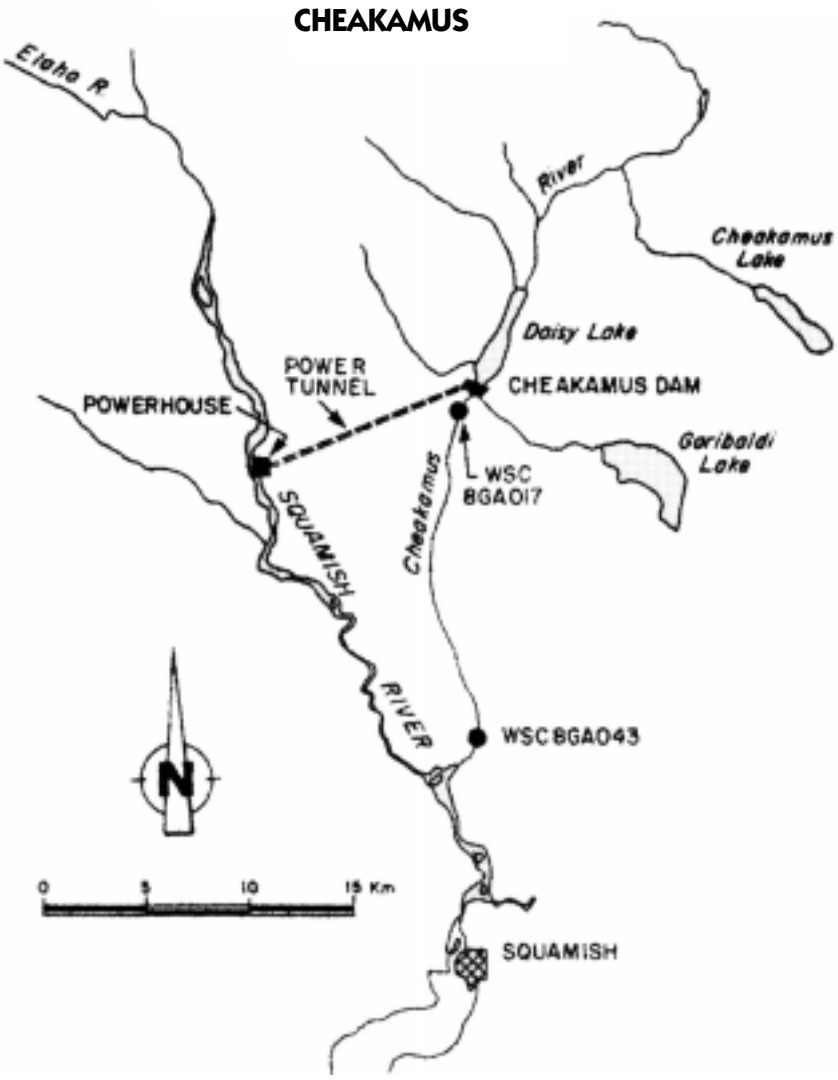
EVALUATION OBJECTIVES & KEY QUESTIONS	EVALUATION INDICATORS
2. Assess the effectiveness and limitations of the performance measures used to determine acceptable fish and fish habitat conservation standards. *To what extent did the WUP process reach agreement on the framework and measures for determining acceptable impacts on fisheries and how effective were these in meeting fisheries conservation requirements and regulations?* **a.** What performance measures were adopted in each WUP and did they accurately represent all of the major fish and fish habitat issues and concerns? **b.** How reliable and effective were the performance measures as indicators of adequate impact mitigation and fisheries conservation? **c.** What thresholds within the performance measures were used to determine acceptable impacts (losses/gains)? **d.** What lessons have been learned about the use of performance standards?	■ Performance measures used in the various WUPs. ■ Quantification and application of the performance measures in WUP documents. ■ Robustness of the performance measures under different flow scenarios. ■ Criteria or rationale used for determining acceptable thresholds within performance measures. ■ Participants perceptions of the efficacy of the performance measures in achieving the fisheries objectives.
3. Assess the trade-offs of fish and fish habitat objectives and values with other uses *To what extent were fisheries conservation priorities adjusted in order to satisfy competing water uses?* **a.** What trade-offs of fisheries objectives and values were required in order to reach agreement on the recommended flows and mitigation measures? **b.** What were the ratios or approximate scales of the trade-offs between fish and other uses (power, flood control, drinking water, etc.)? **c.** How well did fisheries fare in the trade-off process? Were the trade-offs between fish and other uses reasonable and consistent with mitigation standards? **d.** What lessons have been learned about the trade-off process?	■ Initial requirements for fisheries conservation as presented by WUP reps. ■ Changes in fisheries conservation requirements (foregone restoration of productive capacity) in order to achieve agreement with other committee members. ■ Estimates (where available) of potential effects of these changes on fish habitat and populations. ■ Participant views of the trade-off process and the results for fisheries conservation.
4. Assess the results of WUP relative to First Nations expectations for fisheries conservation. *To what extent were First Nations fisheries interests addressed in the WUP processes?* **a.** What key interests or requirements were presented by First Nations representatives in WUP? **b.** How were these addressed within WUP? **c.** How do First Nations representatives rate the WUP fisheries outcomes from their perspective?	■ Traditional ecological knowledge studies undertaken for WUP. ■ Statements and submissions by First Nations provided to the WUP process. ■ Final recommendations recognition of, or response to, these statements or submissions. ■ Participant assessment/rating of WUP outcomes.

3. FISH CONSERVATION ISSUES

THE STUDY UNDERTOOK A BRIEF REVIEW of the Key Issues at seven facilities where Water Use Planning has been completed. Drawing on the available documents, this chapter describes the regulated flow impacts on fish and other issues that were identified prior to and during the Water Use Planning process.

3.1 Cheakamus

The Cheakamus hydroelectric development, constructed in 1957 and later redeveloped in 1981 and 1988, involved flooding of Daisy Lake and diverting flows to Shadow Lake on then 11 km to a power house on the Squamish River. Total original lake area was 21 ha and another 374 ha was inundated to create the present reservoir. Most of the Cheakamus reservoir has traditionally been diverted for power production, although interim orders now limit this to about 55% of flows. The diversion results in marginally increased flows in the Squamish River and significantly decreased flows in the Cheakamus River. The mean annual flow at the dam was reported in 1996 as 33% (19.1 m^3/s) of the original flow and minimum daily flows as 0.82% (0.5 m^3/s) of pre-project mean annual flow.[2] An Interim Flow Agreement was established in 1998 and had the effect of increasing fish flows and decreasing power production. The water use planning process was completed in 2002.



CHEAKAMUS KEY ISSUES:

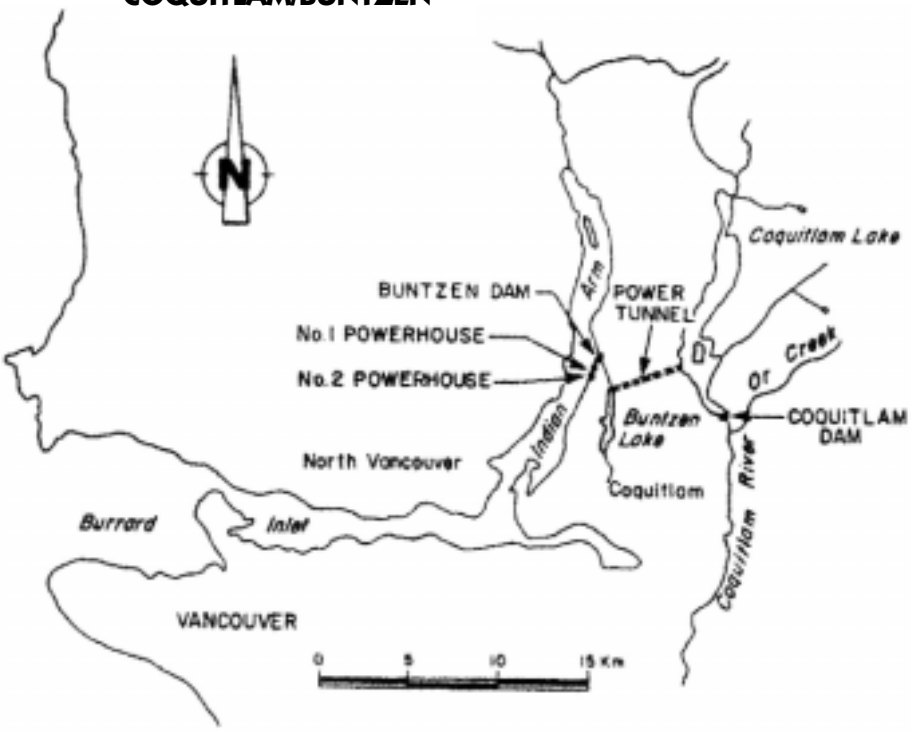
- Decreased mainstem flows in the lower Cheakamus River and their effects on fish and fish habitat.
- Differing views on the importance of engineered side channels and their sensitivity to mainstem flows.
- Effect of operations on the quantity and quality of mainstem rearing habitat for fry and parr, and mainstem spawning habitat.
- Effect of operations on benthic biomass and fish food sources and related juvenile fish growth and survival.
- Effect of operations on upstream migration of adult salmon and steelhead.
- Reduction in sediment transport to the lower river effect on river morphology considered marginal.

3.2 Coquitlam/Buntzen

Coquitlam Lake development began in 1903 and was redeveloped in 1951. It involved flooding 194 ha around the original lake and diverting water west to Buntzen Lake and then to a powerhouse on Indian Arm. Annual reservoir inflows (1992-1997) have historically been three times the flow in Coquitlam River immediately below the dam, with about two-thirds of the water being diverted to Buntzen Lake. These diversions and the extraction of water for GVRD water supply have significantly reduced flows and habitat area in the Coquitlam River. The dam also blocked migration of salmon into Coquitlam Lake. The water use planning process was completed in 2002.

2 – Lewis A.F., et.al., Fish Flow Overview Report, March 1996, P. 93.

COQUITLAM/BUNTZEN



COQUITLAM/BUNTZEN KEY ISSUES:

- Deviation from the Coquitlam River natural hydrograph: instream flow needs for fish.
- Degree of fish accessibility to key tributaries during critical seasons (river and reservoir).
- Quality and quantity of spawning and incubation habitats in relation to flows.
- Quality and quantity of summer rearing habitats in relation to flows.
- Provision of passage for adult fish in the mainstem.
- Substrate quality and sedimentation processes.
- Productivity of the effective littoral zone in the reservoir.
- Habitats for invertebrates in the river.
- Water temperature and impacts of discharges into Indian Arm.

3.3 Alouette

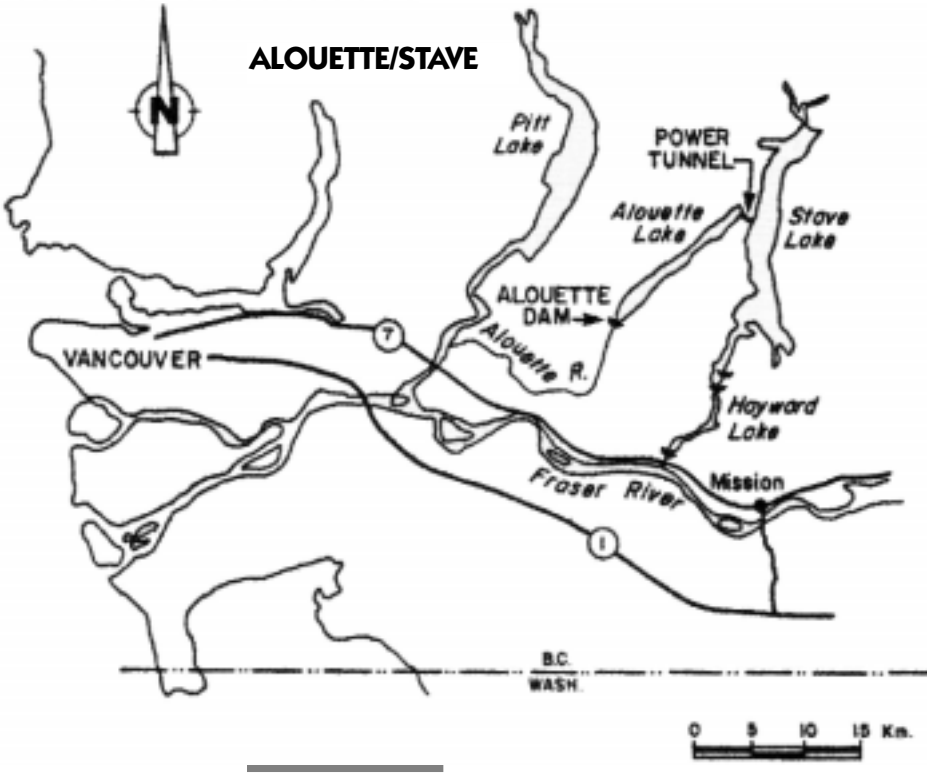
Alouette Lake was originally two smaller inter-connected lakes ('Upper and Lower Lillooet Lakes'). Development in 1928 and later in 1984 resulted in an additional 373 ha land area being flooded, transformation of the lakes into a reservoir, and diversion of water outside of the watershed to Stave Lake. The diversion left only minor flows in the Alouette River. It has significantly reduced flows in the river, a distance of about 20 km downstream to its outlet at the Pitt River. Riparian and instream habitat downstream has therefore been substantially affected by reduced flows.

The water use planning process was completed in 1997.

ALOUETTE KEY ISSUES:

- Inadequate flows to protect fish stocks.
- Loss of downstream transport of gravel and large woody debris.
- Lack of flushing flows.
- Effects on water temperature in Alouette River.
- Ecosystem health and biological productivity.

ALOUETTE/STAVE



3.4 Stave

Stave reservoir, and the downstream Hayward reservoir, operate with additional water diverted from Alouette reservoir. A generating station produces power at the inflow to Stave reservoir. Two downstream power plants at Stave Falls and Ruskin generate power from the Stave system. The Alouette diversion and the series of dams on the Stave River flooded 2612 ha around the original Stave Lake and Hayward Lake.

The flows are diverted for 3 km below Stave Falls Dam to the confluence with Fraser River. With additional water diverted into the watershed and two operating reservoirs, significant changes in the natural hydrology have occurred. The water use planning process was completed in 1999.

STAVE KEY ISSUES:

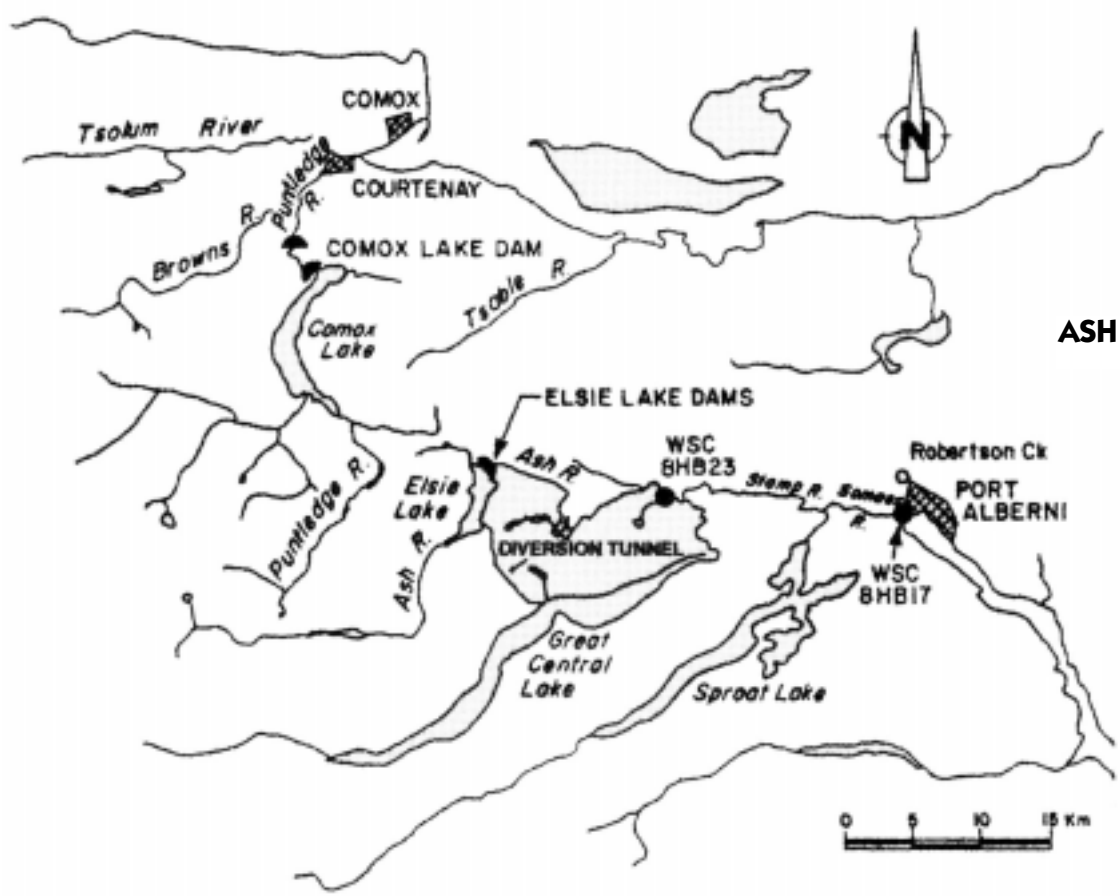
- Maintaining habitat conditions downstream, particularly targeting chum salmon and critical periods of spawning, rearing and egg incubation.
- Low flows have led to exposure of incubating chum salmon eggs in the lower river.
- Limited area of cutthroat spawning and rearing habitat in the reservoir.
- Reservoir operations effects on 'effective littoral zone' and related productivity.

3.5 Ash

Elsie Lake dams, created in 1957, provide storage for diversion of water and discharge through a power tunnel into the north shore of Great Central Lake, located west of Port Alberni. The original Elsie Lake was 271 ha in area; current size of the reservoir is 672 ha. Licensed diversions historically allowed for one-half of the total reservoir inflow to be diverted. However, the actual flows in recent years are substantially higher than the licensed flows. The diversion makes up a major portion of the total streamflow of Ash River and this has reduced riparian habitat in the 30 km downstream before its outlet at Great Central Lake, and also restricted steelhead migration over the falls downstream. Water temperature may have also been adversely affected. The water use planning process was completed in 2002.

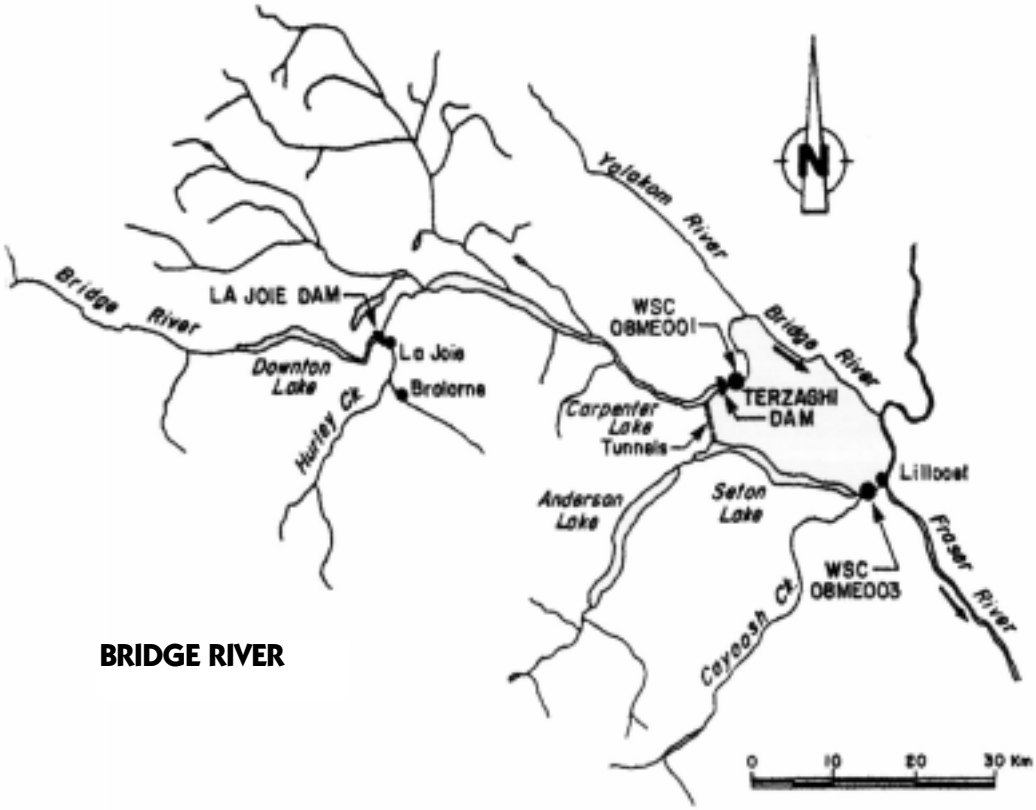
ASH KEY ISSUES:

- Effects of reservoir operations on trout access to 20 tributaries including upper Ash River, flowing into the reservoir.
- Primary food production, spawning and rearing habitat limitations on trout populations in the reservoir.
- Managing flows for steelhead and coho spawning and rearing habitat during the critical stream flow period (August to September).
- Low flows during the summer and early fall when returning steelhead and salmon migrate upstream and the need to provide flows for migrating fish to surmount natural barriers.
- Coordination of BC Hydro operating practices and the NorskeCanada dam on Great Central Lake in order to manage habitat in the lake and Stamp River.



3.6 Bridge River

The Bridge River system involves Carpenter Lake (4669 ha) behind Terzaghi Dam, Downton Lake (2234 ha) behind LaJoie Dam, and diversion of water into Seton Lake. The original Mission Dam on Bridge River was constructed in 1934 but major development occurred in 1948 and Seton River development was added in 1956. Over 1200 ha of mainstem channel habitat was flooded, along with 283 ha of wetland and 80 km of tributary.



BRIDGE RIVER

The project significantly reduced flows in the downstream Bridge River, marginally increased the level of Seton Lake, and significantly reduced flows in Seton River where a power canal diverts Seton Lake water to a powerhouse at the Fraser River. Cayoosh Creek is also diverted into Seton Lake near the outlet. Bridge River flows are, at times, reduced to almost zero except for small local inputs, downstream of Terzaghi Dam to Yalakom River, 12.5 km, and reduced to less extent for another 37 km downstream to the Fraser River. Prior to hydroelectric development, Bridge River provided 200-400 m^3/s to the Fraser River; post development it provided 90 m^3/s, so major reduction in flows have occurred in the lower Bridge River during the past 50 years. The water use planning process was completed in 2002.

BRIDGE RIVER KEY ISSUES:

- The shape of the hydrograph and uncertainty about fish responses to high flows versus low flows.
- Pelagic and littoral reservoir productivity related to flow regulation and the effects on fish populations.
- Risk of dewatering and fish stranding due to rapid flow variations.
- Entrainment of fish in power intake and turbines.
- Effect of turbidity in Seton Lake on fish populations.

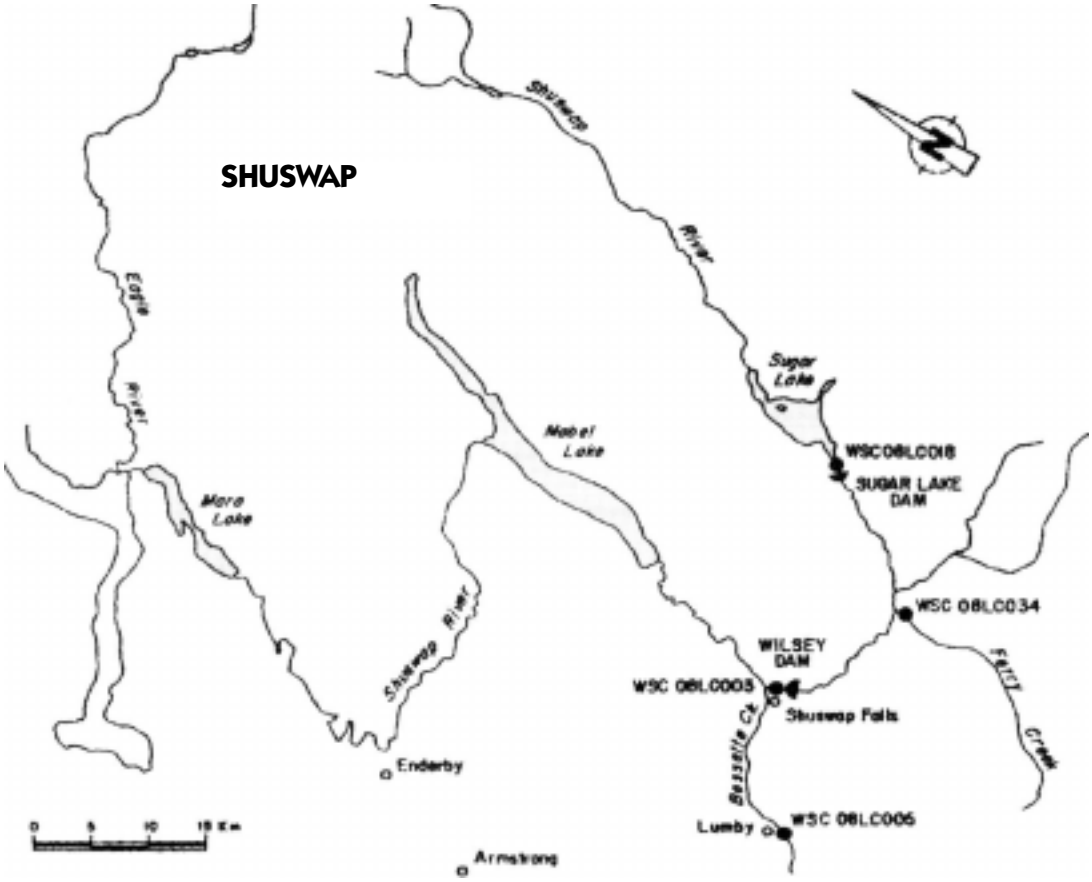
3.7 Shuswap

In the Shuswap system, water is impounded at Sugar Lake (Peers Dam) and to a lesser extent at Shuswap Falls (Wilsey Dam). Sugar Lake was flooded as a result of hydroelectric development in 1929, creating a reservoir of over 2200 ha. The river is diverted for only a short distance from Wilsey Dam to the powerhouse outlet downstream. The minimum flows required have been only about 13% of pre-impoundment mean annual flow. BC Hydro has negligible influence over river flows during freshet (mid-April to mid-June) and has only limited control over daily flows as freshet recedes (mid-June to August). Outside of freshet, Hydro has relatively more control over the ramping rates. Assessing different flows during salmon spawning, incubation, and rearing formed the major source of inquiry during this WUP. Disruptions to power generation and flow disruption also present a problem for downstream aquatic life. The extent of impact and the species affected are highly dependent on the seasonal timing, the magnitude, and the duration of the flow disruption. The water use planning process was completed in 2002.

SHUSWAP KEY ISSUES:

- Low escapements for the Middle and Upper Shuswap River, and the potential for reservoir operations and flow discharges to affect kokanee abundance. Conservation concerns also exist with chinook and coho populations in the Middle Shuswap.

- The impact of sudden flow disruptions arising from unplanned outages at Wilsey Dam create risks for fish populations in terms of mortality to alevins, juvenile and adult fish directly through freezing, asphyxiation and predation and indirectly through stress.
- Retention of some of the runoff, and its gradual release until the next spring allows BC Hydro operations to have an influence on the spawning and incubation of salmon and on the life stages of other fish during the fall and winter months.



4. WUP FISHERIES OUTCOMES TO DATE

THE REPORT OF THE NAFTA COMMISSION FOR Environmental Cooperation (CEC, Final Factual Record for Submission SEM-97-001, BC Aboriginal Fisheries Commission et al., May 2000) provides a summary of the major concerns expressed by First Nations and environmental NGOs. The seven key issues outlined in the report are used to review the fisheries-related outcomes to date from WUP. These issues are:

- Reduced flows
- Rapid flow fluctuation
- Adequate flushing flows
- Altered water quality
- Entrainment of fish
- Flow diversion
- Reservoir drawdown.

This chapter describes the results of WUP to date for the fisheries conservation concerns identified in the NAFTA report. A brief summary of the general extent of agreements in each of the selected WUPs is presented below. The following lead question served to guide the review:

To what extent have the NAFTA CEC issues been addressed by the WUP process and how significant are the areas of agreement and disagreement?

Table 2 summarizes the general conclusions and key issues related to fisheries conservation based on Consultative Committee reports. There was generally a substantial level of agreement about fish flows and conservation requirements at most of the seven study WUPs.

The WUP process resulted in a variety of levels of agreement on the preferred hydroelectric operating alternatives. Where no consensus was reached on a single operating alternative (e.g., Cheakamus, Coquitlam), active monitoring and adaptive management was initiated to test alternative flow regimes. The process was able to focus on the key scientific uncertainties and knowledge gaps associated with system regulation and fish conservation. The preferred alternatives generally resulted in improvements in the selected fish performance measures over the status quo, but further monitoring will determine whether this will also lead to positive biological responses to the new flow regimes. Sections 4.1-4.7 present the statements of concern from the NAFTA CEC report and the general WUP responses to these issues.

Table 2: Summary Conclusions of WUP Consultative Committees

AREAS OF GENERAL AGREEMENT	KEY CONCLUSIONS/ISSUES
Cheakamus 1. No consensus on the preferred operating alternatives – one group preferred maintaining the existing Interim Flow Agreement, and another preferred an alternative with lower flows that was supported by the performance measures 2. Adaptive management agreement reached on the monitoring plan to reduce uncertainties about operational effects on fish	■ Exclusion of engineered side channels from the performance measures was a source of contention ■ Uncertainty about whether flows were sufficient to maintain groundwater flow to engineered side channels ■ Significant differences of view about the importance of engineered side channels vs mainstem, chum versus other species and the reliability of fish impact models
Coquitlam 1. Two of the six final operating alternatives were accepted as the range within which final operating flows would be determined; both provide for increased flows for fish 2. There is a need to reduce uncertainty associated with fish performance measures 3. There is a need to increase certainty for power production and drinking water objectives 4. Adaptive management is proposed to test the two flow alternatives over a 15 year period	■ Both domestic water supply and fish will apparently be better off than under the current operating flows ■ There is insufficient water to satisfy all domestic water supply and fish objectives during dry years, regardless of power production ■ There remains considerable uncertainty about the effects of different operating alternatives on fish and fish habitat
Alouette 1. Flushing flows should be implemented 2. Full-pipe flows year round through the LLO which will increase fish habitat availability during the winter 3. Ongoing involvement of local stakeholders 4. Operating plan should include provisions for ramping rates	■ Insufficient certainty on benefits to fish to justify increasing the capacity of the low level outlet (LLO) to provide more flows ■ Specific ramping rates were not suggested ■ Additional recommendations (non-WUP) related to fisheries were presented ■ Consider the development of a water budget to allow management committee flexibility to modify fish flows
Stave 1. Consensus was reached on a modified Combo 5 option [3] with additional monitoring to reduce uncertainties related to reservoir productivity and First Nations heritage objectives	■ Fish conservation results are largely related to reservoir productivity rather than downstream fish concerns ■ There is uncertainty about the extent to which increased reservoir stability will affect fish productivity

(continued)

3 – Involves a soft target of 80-81.5 m reservoir elevation from May 15-Sept 7 to accommodate recreational interests, and 6 week drawdown one year in three (on average) for heritage interests, plus a monitoring program to assess changes in reservoir productivity and generate understanding of reservoir productivity processes, a program to study effects on First Nations interests, and commitment to re-visiting the WUP based on monitoring findings.

Table 2: Summary Conclusions of WUP Consultative Committees (continued)

AREAS OF GENERAL AGREEMENT	KEY CONCLUSIONS/ISSUES
Ash 1. Alternative C was endorsed, and is expected to result in improved fish habitat in Ash River, increased riparian habitat around Elsie Lake, and increased licensed minimum flows in Ash River 2. WUP led to a process to address the issues related to coordinated operation of Ash River and Great Central Lake systems in low flow periods 3. A passive adaptive management monitoring program is adopted to assess the performance of the one recommended operating regime	■ Increased likelihood of minimum base flows during dry years ■ Downstream fish conservation depends on coordination with NorskeCanada regulation of Great Central Lake ■ Since flows in recent years have been significantly higher than licensed flows and higher than the 3.5 m^3/s recommended flow, it will be difficult to detect significant changes in the biological response of fish and wildlife to the proposed operating regime
Bridge 1. Consensus, with one abstention, on the base operating strategy – N2-2P: reduced reservoir constraints, minimum flows in Middle Bridge R. and reservoir wildlife enhancement 2. Flow trials of 3 to 6 m^3/s in Lower Bridge River over an 11 year adaptive management monitoring program 3. Recommended further studies on Seton generation facilities upgrading.	■ The recommended alternative was strongly endorsed over others ■ Significant uncertainties occurred in understanding whether increased flows in the lower Bridge River would be better or worse for fish ■ Environmental benefits could be derived from increased generation capacity at Seton facility that would reduce the current effects of uncontrolled spilling
Shuswap 1. Agreement reached that Sugar Lake Dam should be operated subject to the constraints associated with the Status Quo alternative. 2. The Committee could not reach consensus on operations at Wilsey Dam.	■ There remains some uncertainty about the impact of sudden flow disruptions

4.1 Reduced flows

NAFTA CEC Report: *A reduction in the flow released downstream of a facility can result in decreased habitat quantity due to a reduction in stream volume and total wetted area in the stream. Reduced flows may also cause a change in stream temperature, depending on the depth of outflow to the reservoir thermocline and the exchange rate in the river.*

The Department of Fisheries and Oceans response to this statement noted that there are other possible impacts of reduced flows including: a) less flushing of fines from downstream gravels; b) reduced velocities for smolt downstream migration; c) magnified surface and substrate ice build-up; d) altered suitability of velocities and depths for spawning; and e) less waste dilution. It also noted however, that in certain circumstances, reduced flows can provide some benefits, e.g. improved over winter survival and early fry rearing under stabilized flows.

Table 3 summarizes the major changes in fish flows (or recommended flows) before and after the WUP process (pre-WUP flows derived from a 1996 study). The WUP process generally resulted in a much more complex and risk-conscious set of recommended flow regimes, and a greater recognition of uncertainties about effects on fish. Target flows, timing and ramping rate specifications have become much more important in flow regulation than just average flow volumes.

The pre-WUP fish flow agreements and arrangements involved a patchwork of requirements and guidelines from original water licences, operating orders and other agree-

ments, many of which were based on no or limited knowledge of the effects of hydroelectric operations on fish and fish habitat. The extent of flow improvements for fish therefore depended on the status of the pre-WUP operating conditions. WUP has clearly provided the technical studies and inputs necessary to identify the key variables and information gaps for developing a longer term program to determine the optimum flows. In some cases, WUP has resulted in increased base flows; in others, it has set minimum and maximum flows during sensitive migration and spawning periods in exchange for more flexibility in non-sensitive periods. For example, in the Coquitlam River base flows have approximately doubled and attributes of a natural hydrograph have been introduced as a result of WUP. At Alouette River WUP, flow volumes have increased 350% over pre-WUP historical levels (20 cfs/0.57 m^3/s) and 50% over the 1995 Interim Flow Agreement minimum (from 70 to 105 cfs). At Shuwap River WUP, minimum flow releases from Wilsey Dam have doubled. These significant increases in flows are nevertheless only a portion of the pre-development natural flows of these rivers. Also, many unknowns remain about the biological effects of the increased flows. In Bridge River WUP, for example, it was uncertain whether increased flows in the lower river would be positive or negative for fish, an issue that is to be addressed in the monitoring program.

Table 3: Responses to Flow Issues

PRE-WUP FISH FLOWS[4]	WUP RECOMMENDED FISH FLOWS
Cheakamus **Agreement:** ■ Mean annual flow = 19.1 m^3/s; min. daily flow = 0.5 m^3/s ■ Minimum flow release required: 5% of mean annual flow [1 m^3/s] ■ Orders do not specify timing of volume flow release ■ Instream Flow Agreement: median flow of 23 m^3/s	■ No recommendation; main choice between IFA median flow of 23 m^3/s or alternatives with flow of 20 m^3/s during Sept 1 – Apr 30 non-freshet period ■ Maintain Interim Flow Agreement and undertake further studies
Coquitlam **Agreement 1993:** ■ 0.23 – 0.85 m^3/s fish flow release depending on time of year ■ 4.28 million m^3 to be released on an 'as required' basis to augment flows in dry periods	■ Flows are to be constrained within alternatives 4FVN & STP5 (10-12% of Mean Annual Discharge [5]) ■ 4FVN: minimum release of 1.1 m^3/s and monthly river target flows (1.1 – 4.88 m^3/s) ■ STP5: monthly target flows (2.9 – 4 m^3/s) to optimize each performance measure ■ Opportunistic flushing flows to be tested
Alouette **Agreement:** ■ Minimum flow release of 0.06 m^3/s at Alouette Dam & 0.7 m^3/s at Maple Ridge ■ BCH maintains a minimum release of 0.7 m^3/s at Alouette Dam ■ Historical flow release is 20 cfs (0.57 m^3/s) , while ideal fish flows are in the order of 250 cfs (7.1 m^3/s) during summer ■ 1995 IFA set minimum flows at 70 cfs (2m^3/s)	■ Year-round full-pipe operation (90-105 cfs or 2.6-3.0 m^3/s) was endorsed, subject to flexibility in providing flushing flows. Flows are limited by capacity of low-level outlet. An increase to 105 cfs (3.0 m^3/s) would increase habitat to 79-99% of optimum habitat (with no low level outlet expansion) ■ Expanding the capacity of the low level outlet was not considered cost-effective

4 – Source of data: Adam F. Lewis, Gerry J. Naito, Shawn E. Redden & BCH Safety & Environment Dept., Fish Flow Overview Report, BC Hydro Report EA 95-06, March 1996.

5 - 4FVN: equivalent of 4 fish valves in volume with the shape of the hydrograph modified by use of an adjustable Low level Outlet to optimize flow release for fish; STP5: 'share the pain' #5; designed to provide target flows to both the river and GVRD water supply on a monthly basis to satisfy optimal conditions where reservoir operations allow with minimum river flow to provide more opportunities for fish in low flow years.

Table 3: Responses to Flow Issues (conintued)

PRE-WUP FISH FLOWS	WUP RECOMMENDED FISH FLOWS
Stave	
Agreement: ■ Ruskin block loading flows of 84 m^3/s during chum spawning and 28 m^3/s during chum incubation ■ Minimum release of 38 m^3/s from Oct 1 –14; weekly block release of 38-127 m^3/s during spawning period mid-Oct-Nov, and minimum flow release of approx. 38 m^3/s during Dec-May incubation and rearing period	■ Limited weekly block loading during Oct 15-Nov 30 chum and coho spawning period; maintain a minimum flow of 100 m^3/s ■ Peaking operations allowed above the 100 m^3/s threshold ■ Weekly block loading constraints at Ruskin Dam for the fall spawning period; load and flow changes are allowed only once per week; flows not to exceed 130 m^3/s during the spawning season
Ash	
Agreement: ■ Minimum average monthly flow release of 3.54 m^3/s at Moran Creek ■ Minimum flow must not be < 0.71 m^3/s during June – Aug and not less that 0.29 m^3/s during Sept – May ■ Median flows during the Critical Stream Flow Period between 1996-99 ranged from 4.27 to 9.43 m^3/s (existing licence requires a minimum release of 0.29 m^3/s)	■ Minimum 3.5 m^3/s from Elsie Dam from May 1-Oct 1-31 ■ Minimum 5.0 m^3/s from Elsie Dam from Nov 1- April 30 ■ Minimum 10.0 m^3/s at Moran Creek for 2 x 48hr migration pulse flows between Aug 1 – Sept 30
Bridge	
Agreement: ■ Minimum release of 42.5 m^3/s from LaJoie Dam at all times, except in maintenance period ■ No minimum flows from Terzaghi Dam	■ Lower Bridge: maintain flows above 3 m^3/s; this will be refined by an 11 year adaptive management testing of 3, 1 and 6 m^3/s flows ■ Middle Bridge River: max flow of 850 cfs (24.1 m^3/s) during whitefish spawning and minimum flow of 650 cfs (18.4 m^3/s) year round ■ Minimum flow of 25 m^3/s in Seton River to minimize fish entrainment
Shuswap	
Agreement: ■ Minimum flow of 5 m^3/s from Sugar Lake Dam ■ Sugar Lake gate discharge changes not to exceed 14 m^3/s in a 24 hr period ■ Minimum flow of 8.5 m^3/s from Wilsey Dam at all times ■ Flow release guideline for Wilsey Dam: minimum release of 22.7 m^3/s during Sept 15 – Nov 15 and 15 m^3/s at all other times	Status quo recommended as per IFA: ■ Minimum 18 m^3/s discharge below Wilsey Dam from August 15 to January 1 for fish (weekly min flows) ■ Minimum 15 m^3/s discharge below Wilsey Dam from January 1 to April 1 for fish (weekly min flows) ■ The first 31.6 m^3/s of flows are routed into the penstocks. All flows above that go down the spillway (The capacity of the generators is 31.6 m^3/s)

4.2 Rapid Flow Fluctuation

NAFTA CEC Report: *The rate of change of flow through a dam is known as the ramping rate. A ramping rate that is too high during flow increase may displace fish from favored habitats, while a rapid decrease in flows can leave fish and benthic invertebrates (food sources) out of water or trapped in isolated pools. Rapid changes in flow can also disrupt fish spawning activity.*

Table 4 summarizes the major ramping issues and the actions proposed by WUP Consultative Committee.

Table 4: Responses to Flow Fluctuations and Ramping Issues

RAMPING ISSUES FOR FISH	ACTIONS PROPOSED
Cheakamus ■ Flow ramping effects on fish have been documented ■ Not explicitly discussed but incorporated into flow release alternatives	■ To be finalized as a part of the monitoring program.
Coquitlam ■ Ramping effects on fish stranding and dewatering were a concern but there was a lack of field data	■ To be finalized as a part of the monitoring program. Target ramping rates based on DFO's suggested maximum water level changes in the river of 5 centimeters per hour. Until an accurate stage/flow relationship is established, the following three-step ramping rate protocol is proposed as a starting point: • Above 7.1m^3/s, ramp down at 9.5m^3/s (cubic metres per second/hour) • Below 7.1m^3/s, ramp down at 0.71m^3/s per every half hour • Below 2.8m^3/s, ramp down at 0.42m^3/s per every half hour • Ramping up rates are currently at 9.5m^3/s per hour
Alouette ■ Previous discussions and experiments suggested an elevation change rate of no more than 5 cm/hr at the Dam plunge pool gauge	■ Agreed to include provisions for specific ramping rates
Stave ■ Significant issues on the Stave system; questions posed by WUP: • Does partial peaking succeed in deterring spawning at high elevations? • How much adult stranding occurs? • How much fry stranding occurs? • Is high velocity a deterrent to mid-channel spawning? • Could partial peaking be optimized given daily patterns of fry out-migration?	■ Ramping rates not directly discussed but will be influenced by block loading rules ■ Combo 6 is proposed along with the monitoring program, based on Combo 5 alternative plus an assessment of effects on reservoir productivity and further consideration to modifying the operations based on the results of the monitoring
Ash ■ Discussed but not pursued by the Consultative Committee; current ramping rates are considered conservative relative to natural rates of changes in flows	■ The committee recommended that the current ramping rate be adopted.

Table 4: Responses to Flow Fluctuations and Ramping Issues (continued)

RAMPING ISSUES FOR FISH	ACTIONS PROPOSED	ACTIONS PROPOSED
Bridge	■ Lower Bridge River and Seton River effects of rapid fluctuations and large spill events ■ Maximizing objectives for the reservoirs requires some trade-offs with spill boundaries in the Lower Bridge and eferred natural hydrograph in Seton River	■ Consultative Committee set some approximate upper limits for spilling: • not to exceed 20m^3/s 50% of time • not to exceed 50m^3/s 10% of time ■ Ramping rates to be determined within the adaptive management program
Shuswap	■ Discussions within the Fish Technical Committee also focused on ramping rates, and it was agreed that constraints on flow changes from gate operations should be based on the lower range of the current guidelines used by BC Hydro for ramping down limits	■ Sugar Lake maximum ramp rates at gauge: • 01 April – 31 July, Fry Emergence, Down ramp: 2.5 cm/h; Up ramp: 5 cm/h • 01 August – 1 October Rearing, Down ramp: 2.5-5 cm/h; Up ramp: 5 cm/h • 2 October – 31 March Winter Rearing, Down ramp: 2.5-5 cm/h; Up ramp: 5 cm/h • Max daily change: 15 cm; except winter rearing period where it is 25% of current flow • Above 7.1m^3/s, ramp down at 9.5m^3/s

Ramping rates were a concern at facilities that are subject to rapid load changes, such as the Stave, Bridge River and Shuswap facilities. Fish stranding has been a major concern at Shuswap, for example, and WUP provided an opportunity to analyze the issue and to set more precise restrictions on changes in flows. Although the WUP process highlighted various fish stranding occurrences and discussed certain target rates for ramping, it was also apparent that there is limited information on the specific effects of ramping rules on fish and ongoing monitoring of these effects is needed.

4.3 Inadequate Flushing Flows

NAFTA CEC Report: *Inadequate flushing flows can reduce productivity by permitting sediment buildup. At higher discharges, a river reconditions its natural channel, and flushes out accumulated sediment. The limited and regulated flow regimes at many of Hydro's dams do not incorporate flushing flows.*

Table 5 summarizes the issues and actions related to flushing flows. In watersheds where sediment levels are naturally low, this is less of a concern.

In the study WUPs, flushing flows were only considered on the Coquitlam River and Alouette River. The risks associated with potential flooding and erosion from such releases is a significant constraint, as is the additional cost of water releases. At Coquitlam, it was recommended that flushing flows be designed to (a) minimize damages in non-target reaches (reach 4) (b) be released from the dam under current conditions, and (c) mobilize fines from the upper layer in reaches 2 and 3. No final conclusion about the feasibility of flushing flows was provided although test flows are to be experimented with. At Alouette River, flushing flows were proposed on a 4-year cycle, with flexibility for BC Hydro to determine preferred timing (in exchange for agreeing to full open operation of the low level outlet). Although the benefits of flushing flows for fish are well recognized, there remains considerable uncertainty about their cost-effectiveness in improving habitat conditions and managing flooding risks.

Table 5: Responses to Flushing Flows to Reduce Accumulated Sediment

FLUSHING FLOW ISSUES	ACTIONS PROPOSED
Cheakamus ■ Not an issue	■ None
Coquitlam ■ Substrate quality is considered a limiting factor for fish ■ Opportunistic short-term releases were reviewed to assess benefits to fish and invertebrates ■ Flushing flows should (a) minimize damages in non-target reaches (reach 4) (b) be released from the dam under current conditions, and (c) would mobilize fines from the upper layer in reaches 2 and 3 ■ Significant concerns existed related to flooding risks from significant flushing flows ■ There are also significant costs associated with flushing flows (estimated up to $1.4 M per yr)	■ Interim flushing flows are to be tested as a one time experiment and other options for substrate maintenance are to be considered. The regime is based on: • 1-day 200m^3/s flow would disturb the upper 30-50cm • 1-day 110m^3/s flow would penetrate as much as 30cm • multi-day 50m^3/s release may provide cleaning in the upper 10cm, all in terms of reach 2 and 3
Alouette ■ No existing arrangement for flushing flows	■ Flushing flows should last 3 days between Sept 15 –Dec 31, with flexibility in timing, during year 1 (670 cfs) and year 3 (1000 cfs) of a 4-year cycle
Stave ■ Not an issue	■ none
Ash ■ Not considered in WUP	■ none
Bridge ■ Not discussed in WUP but possibly an issue for Seton R.	■ Adaptive management program to assess detailed effects on habitat
Shuswap ■ Not considered in WUP	■ none

4.4 Altered Water Quality

NAFTA CEC Report: *When water is impounded, water temperature, dissolved oxygen content, total gas pressure, sediment and nutrient levels, pH and dissolved metal concentrations can all change. Aquatic organisms that depend on physical water parameters, including both fish and the species they feed on, can be adversely affected by these changes in water quality.*

Table 6 summarizes water quality issues and actions.

Table 6: Responses to Water Quality Concerns

WATER QUALITY ISSUES	ACTIONS PROPOSED
Cheakamus ■ Potential temperature effects of flow discharges and hence emergence times of incubating salmonids, summer growing conditions and overwintering survival	■ Temperature effects included in monitoring plan
Coquitlam ■ Many water quality concerns were not related to WUP and therefore not considered ■ TGP not considered likely under normal operations ■ Data suggest that river temperatures are dominated by Or Creek inputs and climatic influences ■ Effects of Buntzen discharges on marine water quality in Indian Arm Temperature effects included in monitoring plan	■ Temperature effects included in monitoring plan
Alouette ■ Ecological health concerns and likely temperature stress on fish during low flows	■ Ongoing involvement of a local Management Committee
Stave ■ Spillway releases at Stave Falls and Ruskin Dams are known to generate TGP levels in excess of guidelines	■ TGP performance measure established as part of a weighted normalized index of fish impacts ■ Monitoring program and fisheries management plan to consider TGP risks
Ash ■ Influence on water temperatures downstream in upper Stamp River was considered but not thought to be significant because of the distance and dissipation of cool reservoir outflows within Great Central Lake	■ Efforts made to ensure adequate flows during dry years to manage the potential higher temperatures
Bridge ■ Elevated levels of metals and contaminants exist in reservoir sediments and fish ■ Studies of concern about high sediment loads discharged into Seton reservoir indicated no apparent adverse effects on water quality ■ Uncertainties exist about diversion effects on aquatic productivity in Seton Lake	■ Water and sediment sampling to be done at 10-15 stations in Bridge – Seton watersheds
Shuswap ■ No initial evidence of TGP or water temperature problems; the fish group chose not to consider these in evaluating alternatives	■ Post-WUP study found a difference in water temperatures through the vertical water profile; an opportunity may exist to release cooler water from the lower gates at Sugar Lake Dam

Water quality was not a significant factor in comparing operating alternatives. Reservoir water quality, while potentially an issue at some of the facilities, was generally considered not to be affected by the flow regime. However, the role of reservoir levels and stream flows in mitigating water quality concerns was not addressed in detail and there may well be local issues. Some discussion occurred on Total Gas Pressure levels below dams on the Stave River system that are to be further monitored. Downstream concerns mostly focused on temperature effects, particularly for those watersheds where flows were diverted. This was especially apparent at Bridge River WUP, where the diversion of colder Bridge River water into Seton Lake is thought to have some adverse effect on aquatic productivity.

4.5 Entrainment

NAFTA CEC Report: *Fish that inhabit waters in the proximity of power intakes or spillways run the risk of being drawn into turbines or over spillways. For fish that become entrained in turbines, mortality or severe wounding may result from contact with rudder blades. In addition, death may result from the sudden water pressure drop as water passes through the turbine, which can result in impacts similar to those of gas bubble disease.*

Table 7 summarizes issues and actions related to entrainment of fish in dams facilities.

Fish being entrained in power turbines or being swept over spillways was discussed in only a few of the facilities. A clear connection between flow regulation and entrainment

Table 7: Responses to Entrainment

FISH ENTRAINMENT ISSUES	ACTIONS PROPOSED
Cheakamus ■ Not considered in WUP	■ None
Coquitlam ■ Not addressed; considered difficult to develop performance measures related to WUP decisions	■ To be addressed separately from WUP
Alouette ■ Not considered in WUP	■ None
Stave ■ Not considered in WUP	■ None
Ash ■ Investigated but not pursued; entrainment is thought to be more of a problem during low reservoir levels when fish concentrate in a small volume of water	■ None
Bridge ■ Fish stranding and entrainment are key issues that were correlated at Downton and Carpenter reservoirs ■ Entrainment of fish at Seton Lake Reservoir turbines is a key issue	■ Minimum and maximum elevations were targeted to mitigate entrainment risks in Downton reservoir ■ Minimum 25 m^3/s release at Seton established for peak sockeye smolt outmigration period
Shuswap ■ Not considered in WUP	■ None

was established at Bridge River and Ash River. But at other facilities this issue was not directly addressed, in part because of inadequate information on the extent of the problem. Setting minimum and maximum reservoir elevations and limiting spilling events were considered the appropriate mitigation measures from a flow regulation perspective. Entrainment was mostly considered as a separate issue outside of WUP.

4.6 Flow Diversion

NAFTA CEC Report: *Diversion of water from one stream for use in power generation in another basin can cause the harmful lowering of flows and interfere in the ability of fish to identify and return to home streams when spawning.*

Table 8 summarizes the general issues and actions associated with diverting water from one watershed and into another.

Water is diverted from one watershed to another at Cheakamus, Alouette, Ash, and Bridge River facilities. This was a key focus in WUP. For example, at Ash River, lower flows due to diversion have historically increased the natural barriers to fish migration; the WUP recommended increased flows to overcome some of these migration barriers. Providing minimum base flows and enhanced flows during spawning, incubation and rearing periods was an essential part of the flow alternatives that were evaluated.

Table 8: Responses to Effects on Diverted Streams

DIVERSION ISSUES FOR FISH	ACTIONS PROPOSED
Cheakamus ■ Issues focussed on four hypotheses: • disruption of flows causes changes in geomorphology and habitat in the mainstem (rejected) • dam operations affect the quantity and quality of mainstem rearing and spawning habitat (accepted with refinements) • dam operations affect the fish food supply and hence juvenile fish growth and survival (accepted) • dam operations affect upstream migration and spawning distribution of adult salmonids and timing of smolts out-migration (rejected)	■ Monitoring plan to address the major uncertainties about downstream effects on fish from diversion of Cheakamus River water into Squamish River
Coquitlam ■ About 70% of reservoir inflows are diverted to Buntzen Lake and Indian Arm; no input diversions from other systems	■ See Table 2; minimum releases will increase by at least 29% and monthly target releases will be established
Alouette ■ Over 80% of reservoir inflows are diverted to the Stave system ■ Historic operation: 20 cfs (0.57m^3/s) release ■ Post 1995 operation: 70 cfs (2 m^3/s) release	■ See Table 2; an increase in water releases by 50% to 105 cfs (3.0 m^3/s) would increase habitat to 79-99% of optimum habitat (with no LLO expansion)
Stave ■ Diversion effects are on the Alouette River	■ Not applicable
Ash ■ Lower flows due to diversions have increased downstream barriers to migrating fish and reduced area and quality of spawning and rearing habitat in the river ■ Releases from Elsie Dam are the only source of flow supporting fish habitat in the first 800m of the Ash River directly below the dam	■ Recommended alternative includes pulse flows (10 m^3/s at Morgan Creek) to enable migrating steelhead to pass obstructions in the Ash River, and provides a base minimum flow to offset concerns during the low water periods and dry years

Table 8: Responses to Effects on Diverted Streams (continued)

DIVERSION ISSUES FOR FISH	ACTIONS PROPOSED
Bridge ■ Middle and Lower Bridge River habitats have been significantly affected by major diversion of flows ■ Increased flows and spilling at Seton River has disrupted fish migration patterns ■ Minimum flow release 25 m^3/s established at Seton River	■ Minimum and maximum flow levels set for Middle Bridge (650-850 cfs or 18.5-24.2 m^3/s) ■ Reduction in spill frequency and duration expected in Lower Bridge; flow trials underway to determine optimum requirements
Shuswap ■ Diversion occurs only within the Shuwap River for a very short distance	■ Minimum flows established below Wilsey Dam

4.7 Reservoir Drawdown

NAFTA CEC Report: *Drawdown of a storage reservoir typically reduces productivity in the shallow, littoral areas of the lake by periodically drying out these areas. This results in mortality of aquatic vegetation and bottom-dwelling organisms that comprise the aquatic food chain. In lakes with fish species that spawn along the shorelines, reservoir drawdown may either prevent spawning or result in the stranding of eggs depending on the extent and timing of the drawdown. Many fish species depend on tributary habitat for spawning and/or rearing, and decreased lake levels may inhibit tributary access for these species. Finally, reservoir drawdown may reduce water quality due to wave-induced mobilization of sediment in the drawdown zone.*

Table 9 summarizes issues and actions related to reservoir drawdown impacts on aquatic productivity and fish access to reservoir tributaries.

Littoral productivity and to a less extent, pelagic productivity, were considered in relation to reservoir operations and levels. There were many questions about measuring reservoir aquatic effects and whether effective littoral zone (1m secchi disk) or littoral productivity (gms carbon) of fish conservation values were meaningful measures. In most cases, the recommended flow alternative involved a more stable operating regime, which is also expected to improve aquatic productivity. The WUP process highlighted the limited empirical data on the reservoir productivity – operations relationships, so in general there remains considerable uncertainty about drawdown impacts. Further measurement of effects on aquatic productivity is required. Fish access to tributaries was easier to address and was more fully considered in the study WUPS.

Table 9: Responses to Reservoir Drawdown Effects

RESERVOIR PRODUCTIVITY AND TRIBUTARY ACCESS	ACTIONS PROPOSED
Cheakamus ■ Not considered because fishing and recreation are not permitted in the reservoir	■ Reservoir productivity was not a high concern but is to be considered in the monitoring
Coquitlam ■ Effective littoral productivity has been reduced ■ Only 3 fish bearing streams known to have barriers to migration in the drawdown zone	■ Reservoir productivity was not a high concern ■ Tributary access for fish to be included in monitoring

Table 9: Responses to Reservoir Drawdown Effects (continued)

RESERVOIR PRODUCTIVITY AND TRIBUTARY ACCESS	ACTIONS PROPOSED
Alouette ■ Not considered in WUP	■ Ongoing involvement of a local Management Committee
Stave ■ Impact on 'effective littoral zone' was a key focus of WUP	■ More stable operating regime is expected to enhance reservoir productivity; effects to be monitored
Ash ■ Both tributary access and reservoir productivity (euphotic zone and effective littoral zone) were considered in detail in the WUP ■ The operating alternatives had a direct effect on fish migration barriers to steelhead and possibly/questionably coho	■ The preferred operating alternative addresses both productivity and tributary access issues
Bridge ■ Rainbow trout in Downton Reservoir rely on littoral production which is adversely affected by operations ■ Uncertainties over littoral productivity (carbon production) and fish abundance and diversity relationships ■ Access of trout to tributaries of Downton and Carpenter Reservoirs during spawning was a concern	■ The preferred operating alternatives addresses both of these issues (productivity and tributary access) ■ Removal of reservoir licence constraints improved the ability to enhance riparian values and productivity ■ Effects on fish habitat to be assessed in the adaptive management program
Shuswap ■ Reservoir productivity was linked to changes in reservoir levels and a more stable littoral zone was the focus of attention ■ Reservoir levels were determined to be high enough in late May to provide for trout spawning in tributaries	■ Status quo regime endorsed, but changes in ramping rate may improve littoral zone conditions

4.8 Interview Comments

In most cases, the participants interviewed were generally pleased about the improvements for fish, although this was tempered by the fact that the end results did not offset the loss in natural flows and conditions that once existed in these rivers. The following comments and quotes were provided during interviews with a sample of government, non-government organizations and First Nations participants in the process.

PROCESS OUTCOMES

"The fact that most WUPs resulted in consensus agreements and that the parties were generally able to show improvement in their areas of interest was unexpected and shows the value of these processes..... The intent of WUPs was not to turn back the clock to pre-dam conditions but to provide at the very least incremental improvements."

"I think it is important to get some of the monitoring done in order to confirm the accuracy of some of the decisions prior to evaluating the decision making structure."

A majority of those interviewed expressed satisfaction with the conservation outcomes because of improvement over the status quo. This was qualified by the concern about funding of the recommended monitoring programs that are to address issues where there was insufficient information. But a few were disappointed in the process and the highly structured and managed aspects of WUP – particularly as it related to confining the discussion to a limited set of flow operation questions.

EFFECTS ON FISH

"Every WUP is unique; the outcomes need to be seen in context. For example, Elk Falls flows changed from zero flow release to some modest release."

"We have seen a persistent [positive] response in steelhead smolt counts since interim flow improvements have occurred."

It was noted that every system is different and the fish conservation requirements must be defined by species life history needs and the specific mechanisms that affect fish responses to flow regimes. It was also emphasized that even modest increases in flows can make a substantial difference. Increased interim flow releases since the mid 1990s have had a measurable, consistent benefit for fish (e.g., it was stated that increased releases since 1996 in Alouette River has clearly improved steelhead parr). In cases where no or low releases existed, such as the lower Campbell River canyon, restoring a constant base flow was considered a major improvement over the pre-WUP status quo.

PERFORMANCE MEASURES

"Our understanding of fish flow performance measures is still evolving. For example, measuring area of spawning habitat is often not sophisticated enough; it's not just habitat area but windows of opportunity for spawning and number of days required for fish to spawn. ...by changing the flow regime, are we getting more water at the right time, and how is it linked to life history requirement."

The WUP experiences highlighted the complexity of the fish flow mechanisms. For example, the area of available spawning habitat under different flow regimes may be less important than the type and timing of flows and the minimum number of days per year when spawning conditions/opportunities are optimum for selected species.

An array of watershed factors affects the optimum fish flows. For example, restoring summer base flows in the Coquitlam River needed to be balanced with periodic flushing flows to address sediment constraints. This was a significant aspect of WUP – shifting the focus from simply calculating changes in physical habitat to considering the broad range of ecosystem functions and biological effects.

ACCURACY AND UNCERTAINTY

"Performance measures presented a problem tied to understanding what habitats limit populations ...and how well we understand the mechanisms that determine fish responses to flows."

"... a number of PMs supplied by BCH (particular PMs for power and greenhouse gases, where used) used the marginal effect rather than the absolute effect (i.e. the amount due to base case was subtracted from the amount for each alternative). In addition the low MSIC (min significant increment of change) (e.g. 1%) was then applied to marginal impact rather than the total impact. This lead to a PM which was much more sensitive than for other issues."

One of the consistent comments of most participants was that much of the modelling and related technical analysis adopted assumptions and data that had various degrees of uncertainty in their accuracy and reliability. The variations in reliability of performance measures across the sectors were also a concern. It was also noted that implementation programs often fail to undertake effective monitoring and that this is a critical aspect of the potential results from WUP. This review consequently highlights the key role for monitoring and adaptive management.

The Peace River and Columbia River WUPs appeared to have more information deficiencies and were apparently less effective in using the performance measures approach. Columbia River Treaty obligations also imposed limitations that may reduce the potential for optimum fish flows. While the structured approach used in WUP was generally endorsed, there was a concern that selected proxies of fish performance measures sometimes mask the inherent complexity of the situation.

THE NATURAL HYDROGRAPH

"...While I certainly don't disagree with the philosophy that natural hydrographs are preferred, there are problems when it is incorporated into a PM structure. It isn't at all clear to me what shape the PM response should have, e.g. is it linear or convex? PM representation gives the impression of a linear response, but I am not at all clear that half of a natural hydrograph yields half of the benefit. In fact I think it is highly unlikely. In such cases the PM needed to address the function of different hydrograph components (e.g. flushing flows, rearing flows), and when we did so I think it was more informative and more accurate."

The dynamics of the WUP process reflected the parallel technical analyses and stakeholder consultations. Information deficiencies had an important effect on the planning process and many of the performance measures and flow alternatives were developed and adjusted based on short-term field studies and modelling results that were initiated during the planning process. There was some feeling that a more efficient process would have been to complete the technical analysis in advance of the stakeholder consulta-

tions so that there would have been more clarity about what is known and unknown before the public discussion begin. It was also emphasized that much of the intensive discussions on fish flows were new to many of the participants and the design of performance measures is still evolving and is watershed-specific.

Single measures, such as the shape of the natural hydrograph, were thought to over-simplify effects of flow changes (e.g., 'it is not clear that achieving one-half of a natural hydrograph yields an equivalent benefit for fish'). Thus the need to delineate the specific benefits of a natural hydrograph for overcoming limiting factors for fish.

MULTI-SPECIES

"The trade-offs between certain species were difficult – increasing the flow for salmon spawning was at the expense of flows for steelhead rearing.... We got significant concessions in the new flow regime in getting better rearing flows for steelhead."

Performance measures also appear to become more important where multi-species trade-offs are involved, such as the balance between more water and flushing flows for salmon spawning habitat and lower water base flows for steelhead rearing. Also important was the ability of WUP performance measures to address the effects of flow ramping and to limit the most damaging spilling events. At Campbell River, for example, formulating a pre-spill release regime and protocol was a key achievement.

The effects of the flow scenarios on restoration activities for various species downstream or off-stream was sometimes outside the WUP process, such as at Cheakamus and Ash River. There were also concerns about how habitat restoration affects flow regulation and vice versa (including channel and habitat forming processes), and the freeze imposed on habitat restoration during the flow testing periods (e.g. Bridge River).

COMMUNICATIONS

"The importance of having a good facilitator was critical because of the complexity of the technical aspects and the many interests involved..... It was a difficult learning process for non-technical people."

"Some of the decision making techniques applied such as swing weighting etc. were critical to the success of some WUPs. I appreciated that these techniques help to remove some of the positioning that inevitably takes place during these types of processes although not completely successfully."

It was noted that communication methods made a difference in helping consultative committee members understand the implications of the technical analyses. Visual presentation of estimated habitat changes was easier to comprehend than the complex outputs of the mathematical models.

Discussion of the ongoing adaptive management and crisis management arrangements was also important to reaching agreement, especially in watersheds where low water/drought conditions occur. At the Puntledge River, for example, a communications process has been established for key interests to review annual inflows and to make in-season allocation/regulation decisions to mitigate or avoid critical situations.

The interviews supported the importance of an active facilitator to guide the WUP process. But there was also some criticism that the process was primarily directed by BC Hydro staff and insufficient time and effort was given to the range of issues that consultative committee members presented outside of the structured performance measures decision framework.

FIRST NATIONS

"Footprint impacts overwhelm the operational aspects for First Nations; had a process been in place to scope out the [footprint] issues, then the First Nations would have been happier, and it would have made it easier to get greater buy-in".

"WUP swallowed up our issues. It did not deal with our First Nations grievance issues. We need to re-engage on the grievance issue."

First Nations expressed concerns about the lack of a process to address the historical effects of hydroelectric development and their specific grievances with BC Hydro, and the lack of resources to fully participate in WUP (see Section 7 below). Further comments on the performance measures and trade-off process are included in the following sections.

5. EFFECTIVENESS OF OBJECTIVES & PERFORMANCE MEASURES

THIS CHAPTER REVIEWS THE VARIOUS OBJECTIVES and performance measures related to fisheries conservation and their effectiveness in addressing impacts of hydroelectric operational scenarios on fisheries. A comparative analysis of the objectives and performance measures is presented. The following lead question is addressed:

Were the objectives and performance measures effective in meeting the requirements and expectations for fish conservation?

Table 10 summarizes the wide range of objectives and their related performance measures used in the study WUPs. These may have been modified over the course of the WUPs.

Table 10: Summary of Fish Objectives and Performance Measures

OBJECTIVES	PERFORMANCE MEASURES (units measured) [6]	COMMENTS ON METHODOLOGY
Cheakamus ■ Maximize wild fish populations ■ Mimic natural hydrograph ■ Maximize area and integrity of aquatic ecosystem	(Measures used for formal comparison of operating alternatives) ■ Rated Usable Area Resident Habitat Rainbow Parr (m^2 x 103) ■ Effective Spawning Area for Chum (m^2 x 103) ■ Resident Riffle Benthic Biomass (g x 106)	■ Fisheries Technical Committee also used a series of performance measures for different species and life stages ■ No performance measure for the reservoir since fishing and recreation are not permitted ■ Performance measures were also linked to impact hypotheses ■ The cumulative weighted useable rearing area measure was relatively insensitive to flows above the 5 m^3/s release
Coquitlam River ■ Mimic natural hydrograph ■ Maximize availability of suitable (fish) habitat ■ Optimize secondary productivity ■ Maximize water quality ■ Minimize direct mortality **Reservoir:** ■ Maximize availability of suitable habitat ■ Optimize secondary productivity ■ Minimize direct mortality **Indian Arm:** ■ Minimize direct mortality ■ Maximize water quality	(Original measures; final measures are more detailed for each objective) ■ Fish habitat suitability (weighted usable area available for steelhead spawning, steelhead parr and Chinook spawning) ■ Invertebrate habitat suitability (weighted usable area m^2) ■ Frequency of Events (effects on flow requirements for various life histories relative to "natural flows") a) short term survival flows (10% MAD, or <2.7 m^3/s at Port Coquitlam) b) rearing flows (20% MAD for steelhead parr, or <5.4 m^3/s) c) spawning flows (46% MAD for steelhead and Chinook, or >12 m^3/s)	■ Objectives and performance measures were changed during the process; only 2 objectives were used in the final analysis of alternatives [7] ■ Some of the original performance measures were insensitive to the alternatives or not useful for decision making ■ Separate objectives were developed for Buntzen Lake and Indian Arm ■ Final performance measures that were mostly used in evaluating alternatives included: a) flow less than short term survival flows for steelhead parr (Mar-Oct) b) flow less than short term survival flow for steelhead parr (Aug. only) c) flow less than short term survival flow for steelhead spawners d) flow less than short term survival flow for salmon spawners e) flow less than the rearing requirement for steelhead parr (Mar-Oct) f) flow less than the rearing requirement for steelhead parr (Aug. only) g) flow less than the rearing requirement for steelhead spawners h) flow less than the rearing requirement for salmon spawners i) flow above the spawning requirement for steelhead j) flow above the spawning requirement for salmon

6 - Note: These are the original performance measures. In some cases, they were revised during the WUP process.
7 - These were availability of suitable habitat and optimizing secondary productivity (see p. 21 of CC report).

Table 10: Summary of Fish Objectives and Performance Measures (continued)

OBJECTIVES	PERFORMANCE MEASURES (units measured)	COMMENTS ON METHODOLOGY
Alouette ■ Promote the ecological health and productivity of South Alouette River and Alouette Lake	■ Hectares of high quality fish habitat in Alouette River ■ Quality of fish habitat in Alouette Lake ■ Shape of river hydrograph	■ Habitat measures were selected as the best indicator of biological health ■ Effects on flow velocity as well as water depth were important ■ Performance measures were not intensively applied; alternatives were organized into a) flushing flows, b) flows to increase habitat in river and c) fish habitat enhancement
Stave **Support viability of fish populations** ■ Increase spawning capacity	■ quantity of spawning habitat (hectares) ■ variability in spawning habitat area from day to day ■ variability in spawning habitat area within-days (this reflects plant peaking operation)	■ 'Influence diagrams' were used to guide thinking about factors affecting the objectives and selection of performance measures ■ Some performance measures had several components which were combined into a weighted normalized index ; e.g. – spawning habitat impacts were combined into a weighted normalized index reflecting the three performance measures ■ A normalized index was calculated for each of the five fish objectives (see Table 11), as assigned by Fisheries Technical Committee ■ Indexed performance measures were ranked between 0 (worst) and 1 (best) for the overall performance of each operating alternative
■ Increase rearing capacity	■ Daily Variability ■ Within-day variability ■ Side channel availability	
■ Reduce stranding	■ Median risk ■ Extreme Risk	
■ Reduce risk of exposure to elevated levels of Total Gas Pressure	■ # of days on which TGP is between 103 and 110% after a period of 28 consecutive days of elevated levels ■ # of days on which TGP exceeds 110% (no threshold)	
■ Increase reservoir productivity	■ Effective Littoral Zone: - area productive at least 80% of year - area productive at least 50% of year - # days cutthroat spawning/ rearing habitat is available ■ Overall Reservoir Productivity - tonnes of carbon	

Table 10: Summary of Fish Objectives and Performance Measures (continued)

OBJECTIVES	PERFORMANCE MEASURES (units measured)	COMMENTS ON METHODOLOGY
Ash **Reservoir:** ■ Maximize euphotic volume ■ Maximize effective littoral zone ■ Maximize trout spawning habitat in tributaries within drawdown zone ■ Maximize trout rearing habitat within drawdown zone **River:** ■ Enable migrating steelhead to pass obstructions ■ Maximize steelhead rearing habitat ■ Maximize steelhead spawning habitat ■ Maximize coho fry rearing habitat ■ Maximize coho spawning habitat	■ Million m^3/days (11m secchi depth) ■ Ha (11m secchi depth) ■ m^3 trout spawning habitat ■ m linear trout rearing habitat (April-Sept) ■ Migration pulse flows of 10 m^3/s over 48 hrs provided during migration period ■ Metres weighted usable width calculated at representative transects	■ 'Minimum significant incremental change' (MSIC) was established for each performance measure, ranging from +/- 10-30%) ■ 'Auxiliary performance measures' were also identified to provide additional information for interpreting the performance measures: - number of days a min flow of at least 3.5 m^3/s is provided during the year - minimum flow released from Elsie Dam - minimum flow during the critical stream flow period during Aug. and Sept. ■ It is recognized that there is some uncertainty between the performance measure (e.g., habitat) and the objective (e.g., fish production)
Bridge ■ Maximize the abundance and diversity of fish in all parts of the system . ■ Spills (weighted index reflecting frequency, magnitude, timing) **Lower Bridge & Seton Rivers:** ■ Spawning habitat (ha by species) ■ Juvenile habitat (ha by species) ■ Spill impacts (index) ■ Passage (Seton River)	**Downton/Carpenter Reservoirs:** ■ Littoral (shoreline) productivity (gms carbon) ■ Pelagic (open water) productivity (gms carbon) ■ Tributary and shore spawning success (index) ■ Entrainment risk (near field velocity index) ■ Strandung risk (hectares of isolated pools) **Seton Lake Reservoir:** ■ Spawning success (tonnes sediment inflow per year) ■ Pelagic productivity (gms carbon) ■ Entrainment risk/mortality **Middle Bridge River:** ■ Adult habitat (ha by species) ■ Juvenile habitat (ha by species)	■ Performance measures were modified after completion of studies and initial discussions ■ As the process progressed, the list of pm's was interactively reduced ■ Factors related to both stranding in isolated pools and entrainment were eventually combined into a single 'enstrainment' value (a function of reservoir volume and discharge rate) ■ There was major uncertainty about fish responses to flows in the lower Bridge River and the reliability of habitat performance measures ■ The spill index was not easy for participants to understand (an upper limit - not exceed 20 m^3/s 50% of the time and 50 m^3/s 10% of the time, was selected beyond which an alternative was unacceptable)

The objectives and performance measures are reviewed in terms of:

- **Representativeness:** did they sufficiently represent fish species life cycle requirements?
- **Reliability:** did they provide clarity and certainty about factors that limit fish abundance and diversity?
- **Responsiveness:** did they effectively measure the incremental effects of alternative flow operations?

Table 10: Summary of Fish Objectives and Performance Measures (continued)

OBJECTIVES	PERFORMANCE MEASURES (units measured)	COMMENTS ON METHODOLOGY
Shuswap ■ Maximize littoral productivity ■ Maximize area of effective spawning habitat in the river ■ Maximize % survival of redds ■ Maximize available rearing habitat	■ "Effective Littoral Zone" or area of suitable reservoir bottom that is reached by sunlight and continuously wetted during the annual growing season (from late spring until fall) ■ Hectares of effective spawning habitat (habitat that provided suitable spawning and remained wetted until the spring) for each of the three species: coho, chinook, and kokanee ■ % survival of redds (sum of the weighted fraction of redds that are effectively wetted during incubation) ■ Area of rearing habitat (Ha) for rainbow trout	■ The PMs also included a threshold for determining "Least Significant Difference"; e.g. for habitat areas, based on analyses of statistical significance, scores that are greater than the following were considered to be different: chinook – 1 ha; coho – 3 ha; kokanee – 0.3 ha ■ Estimated available habitat area during the spawning period and area that remained wetted (to at least 8.0 cm depth) until fry emergence in the spring ■ For each day during the spawning period, the fraction of habitat that remained wetted during incubation was calculated and weighted by the number of spawners modelled to arrive on that day ■ Used the physical habitat model River 2D to estimate the impacts of flow alternatives on available rearing habitat for rainbow trout in the fall, based on a surveyed river section below Wilsey Dam

5.1 Representativeness

The selection of objectives was relatively less important than performance measures because they were mostly generalized statements of intent.

The selection of performance measures was an important aspect of the WUP methodology. The variations in fish issues between WUPs explain many of the differences in performance measures. Several observations can be made:

- In the early years, a small number of performance measures were often adopted but these were later expanded into a more detailed set as the analysis proceeded.
- Detailed performance measures were often used in analysis of the issues but a more narrow consolidated set was subsequently used to compare the final operating alternatives.
- Performance measures were generally more effective in the coastal watersheds where more information about aquatic resources was available, compared to the large interior systems (Peace and Columbia).
- Performance measures usually focussed on incremental and proportional effects relative to the current level of total performance measure output at that facility or watershed, which may not have always been the most important reference scale or limiting factor for fish populations.
- The base case comparison was often not a particular conservation standard but rather the status quo level that existed at the commencement of WUP (so conclusions change somewhat when a reference-based performance measure is adopted, such as the steelhead parr flow threshold measure used in the Coquitlam WUP).
- Comparing performance measures with different measures and scales is a highly qualitative process.

Some of the differences in the selection of and changes over time in the performance measures depended on the particular purpose of the measures – to assess specific impacts or to assist in comparing and eliminating alternatives. The level of precision in representing fish conservation standards or requirements also depended on the particular iterative process and issues that the process determined as important. The WUP experience was therefore a learning process in the use of performance measures for various stages of analysis and decision making.

The dynamics of performance measurement in WUP are evident in the Coquitlam example. Performance measures originally focussed on the three types of measures as outlined in Box 1. Habitat suitability (Measure 1) was the main tool for evaluating flow alternatives for Coquitlam WUP. It was later determined that a wider range of measures was needed and ten objectives were identified along with 16 related performance measures. Some of the measures, notably deviation from the natural hydrograph and effects on aquatic invertebrates (secondary productivity), presented

methodological problems. Others, such as water quality (temperature, sediment, etc.,) and reservoir productivity were not particularly useful in distinguishing differences between alternatives and were eventually dropped. The Coquitlam experience suggests that setting performance measures is a dynamic, trial and error process. [8]

Some scoping and tiering of performance measures also occurred. For example, the Ash River Consultative Committee initially identified 28 performance measures plus 6 auxiliary performance measures. These were reduced to 18 Key Performance Measures and 4 second priority performance measures. The approach was to use the key measures to identify better performing alternatives, and where alternatives were not significantly different in their performance, to apply the second-priority and auxiliary performance measures. There were 6 Key measures and 4 Second-priority measures related to fish conservation that were used to analyze trade-offs between alternatives at Ash River:

BOX 1 – COQUITLAM PERFORMANCE MEASURES (original version)

Limiting Factors in the Coquitlam River:
The productivity and success of fish in the Coquitlam River, as in many other coastal streams, is dependent on the rearing stages for those salmonids that rear in the river after emergence. In the case of steelhead, parr habitats are considered limiting in the context of all other life history habitats.

Measure 1: Fish habitat suitability PM, expressed as weighted usable area available for each of three salmonid life histories. Life History Period (Fish Periodicity): The following four salmonid life histories are evaluated in the river:

- salmon spawning (late Sept. to early January, covering chinook, pink and coho spawning periods);
- steelhead spawning (beginning of March to early June);
- steelhead parr (late March to mid October);
- steelhead parr – bottleneck period (August only).

Measure 2: Invertebrate habitat suitability PM, expressed as weighted usable area in square metres. Invertebrate preference curves, defined for an indicator subgroup of species in the Coquitlam River, are integrated with transect flow modeling to develop habitat versus flow data for the river. The PM is then integrated against daily flows in the river to define median habitat area values for invertebrate life history (beginning of March to end of October). The results are meant to act as a check on the fish WUA PM outputs primarily because they mirror the results of the steelhead parr results, and secondly to reduce the amount of information the CC must consider.

Measure 3: Frequency of Events (FOE) PMs represent the frequency with which alternatives satisfy flow requirements for various life histories. FOE PMs are compared to natural events, as this links the operating alternatives to the expected natural hydrograph results for the evaluation period. Flow requirements are described below:

(a) **Short Term Survival Flows** (STSF): STSF, defined as 10% of mean annual discharge (MAD, 2.7m^3/s at the Port Coquitlam gauge) , has been documented on natural BC rivers as the minimum flow for sustaining a natural river ecosystem. The minimum flow must be increased after a short period of time (less than two weeks), in order to maintain year class success. This PM is presented as the percentage of time flows are below 2.7m^3/s during the life history period. The lower the percentage, the better the habitat conditions.

(b) **Rearing Flows:** Defined as 20% of MAD (5.4m^3/s at the Port Coquitlam gauge) for steelhead parr requirements, rearing flow criteria are based on natural river studies in BC. Such flows have been judged in this evaluation as optimal for rearing salmonids, and aquatic insects. WUA PMs developed specifically for the Coquitlam River, using riffle/cascade transects, have indicated that parr habitat is maximized at a much higher flow (10.1m^3/s at the Port Coquitlam gauge). This PM is presented as the percentage of time flows are below 5.4m^3/s during the life history period. The lower the percentage, the better the habitat conditions.

(c) **Spawning Flows:** Defined as 46% MAD (12m^3/s at the Port Coquitlam gauge) for steelhead and chinook based on studies of natural rivers. WUA PMs for the Coquitlam River indicate that habitat is maximized for chinook spawners at 7.5m^3/s, and steelhead spawners at 14.15m^3/s. This PM is presented as the percentage of time flows are above 12m^3/s during the salmon life history period. The higher the percentage, the better the habitat conditions.

Source: Appendix E Fish Information Sheets, Report of the Consultative Committee – Coquitlam-Buntzen Water Use Plan EcoPlan International, Inc. / Maria Harris, p. 132

8 - "Throughout the process, the Consultative Committee removed several objectives and associated performance measures from further consideration because they did not aid in decision making between the alternatives or it was recognized that changes in operations had an insignificant affect on the performance measures." Maria Harris & William Trousdale, Coquitlam-Buntzen Water Use Plan: Report of the Consultative Committee, June 2002, p. vii.

KEY PERFORMANCE MEASURES:

- Ash River naturalized flow (1=Yes, 0=No)
- Reservoir trout spawning habitat (m^2)
- Reservoir trout rearing habitat (m^2)
- Elsie River steelhead parr rearing (WUW) (m)
- Great Central Lake shoreline incubation M m^3 discharge from Ash River powerhouse
- Great Central Lake Stamp River migration (M m^3) discharge from Ash R. powerhouse

SECOND-PRIORITY MEASURES:

- Ash River at Moran Creek steelhead parr rearing (WUW) (m)
- Ash River at Moran Creek steelhead spawning (WUW) (m)
- Ash River at Moran Creek coho fry rearing (WUW) (m)
- Ash River at Moran Creek coho spawning (WUW) (m)

In order to compare the 13 operating alternatives across the 10 fish performance measures at Ash River, colour coded rating of the performance was undertaken based on: Yellow: Not significantly different from the reference alternative (selected comparisons); Red: Significantly worse that the reference alternative; and Blue: Significantly better that the reference alternative. The two-tiered measures and the paired comparison method provided an efficient screening process.

The selection of performance measures was, in some cases, a critical factor in determining consensus. At Cheakamus, the selection of performance measures was a key issue that divided the Consultative Committee. Once the measures were adopted, some members wanted to maintain the limited range of evaluation criteria while others felt the measures were insufficient, primarily because they did not include the engineered side channels as fish habitat. The evaluation proceeded as an iterative process but "as the range of flows within alternatives narrowed, distinctions based on performance measures were less clear for some Consultative Committee members and values became more important in the discussion". [9]

In some cases, the performance measures were also developed for particular issues, separate from the evaluation of operating alternatives. For example, in the Shuswap WUP, objectives and performance measures for 'tripping events' (frequency, scale and duration of dewatering events during outage and bypass valve failure, and estimated impact of flow disruption on eggs in gravel, alevins, and on juvenile and adult fish) were identified in order to address the criteria for mitigating effects on fish from facility outages.

The extent to which performance measures effectively represented fish conservation requirements depended in large part on the particular status of knowledge about impacts on fish and the degree to which the measures served as surrogate indicators of the fish conservation requirements, and the various elements of scientific uncertainty associated with them.

5.2 Reliability

The WUP process was charged with the task of weighing the fisheries and ecological benefits and costs associated with a range of possible flow operations, taking into account changes in habitat suitability and probable response of fish to these changes. The discussions often focussed on the reliability of the performance measurement data to sufficiently reflect limiting factors for certain species. For example, the area of effective littoral zone in a reservoir was a common measure of aquatic productivity that was thought to have a direct linear relationship with certain species production but the nature of this relationship was generally poorly defined. Similarly, there were questions about stream habitat indicators (habitat quantity and quality for each life stage of each species for each reach). This included how to ensure transect analysis that is representative and how to take account of variability between wet and dry years. It was thought that habitat transect analysis did not sufficiently capture 'habitat bottlenecks' that affect fish populations and therefore the time duration of flows and their relation to habitat need at different stages became an important aspect of measurement. [10] Narrow snapshots of habitat suitability were therefore recognized as having limitations that needed to be supplemented by other measures.

Several of the WUPs endeavoured to develop a Natural Flow Regime performance measure that could mimic the shape of the natural hydrograph and attempt to "naturalize" the instream flow regime. An optimum flow under the natural flow regime concept would require at least 50% of MAD. [11] In the Shuwap WUP, the natural hydrograph performance measure was designed to supplement the fish modelling results that did not take account of a wider variety of environmental indicators. A qualitative, binary rating (0 or 1) was used to classify the shape of the hydrograph and assess whether the flow alternatives posed risks to fish productivity that would not be picked up by the spawning, incubation, and rearing performance measures. These risks included departures from flows that had a single peak in

9 - David R. Marmorek & Ian Parnell, Cheakamus River Water Use Plan Report of the Consultative Committee, ESSA Technologies, Ltd May 24, 2002, p.vi.
10 - Ron Ptolemy, Habitat Bottlenecks and the Interpretation of WUP Performance Measures, April 10, 2001.
11 - Author unknown, Natural Flow Regime Performance Measure, submission to Fisheries Technical Committee, Bridge River WUP, Jan. 24, 2001.

freshet with flows trending lower in either direction, and/or running out of stored water in the late winter.

The natural hydrograph concept was explored at Coquitlam, Ash, Shuswap and Bridge River WUPs (amongst others). Some useful insights were suggested for the application of this concept:

- a naturalized flow regime for regulated rivers offers geomorphological and biological benefits that can restore some elements of the normal ecosystem functions of a river;
- a certain base flow (e.g., 50% of MAD) is required to have a meaningful effect on ecosystem functions;
- it is difficult to quantify the benefits of a naturalized flow over a constant minimum flow; the specific relationship between the degree to which the natural hydrograph is mimicked and the resulting fish benefits is often not clearly understood;
- there are opportunities to introduce the concept at BC Hydro facilities but this requires an ability to distinguish and to model the components of a natural hydrograph (e.g., flushing flows, rearing flows) and their relationships to species life cycle requirements; and
- restoring the shape of the natural hydrograph may require trade-offs with other reservoir and downstream fisheries enhancement objectives (e.g., Ash River WUP).

Another important tool for assisting the interpretation of performance measures was the use of "Minimum Significant Incremental Change" (MSIC). There was a considerable amount of measurement and modelling error and subjective expert judgement associated with the calculation of performance measures. MSIC assisted in defining and exposing judgements about the minimum change needed before concluding that one alternative was better than another. MSIC also affected the results of the performance measure. For example, a small MSIC (e.g. 2%) applied to power production had a relatively greater response than the comparable standard applied to fish production. Thus, the power performance measures were more sensitive than most other measures.

The performance measures also needed to reflect the relative importance of the different types of sub-component measures. Weighting criteria were applied based on subjective professional judgement. For example, in the Stave WUP, performance measures were distinguished by the use of a normalized index of several sub-components of the measures. The weightings, assigned by the Fisheries Technical Committee, reflect the relative importance of the sub-components to the committee members. Table 11 presents the 2-4 sub-components of the five performance measures and their assigned weightings (0 – 50 %) that were used to generate an overall index value. While this method provides a useful composite index of effects, it also highlights the potential to overlook trade-offs between sub-components.

At Stave River WUP, normalized indices were used at the early stages of the evaluation process where a large number of alternatives were being screened. They were considered particularly useful in screening out alternatives that risked compromising the gains already achieved in downstream fish populations. [12]

Table 11: Stave WUP Weighting Criteria for Performance Measures Index Values

SUB-COMPONENTS OF THE PERFORMANCE MEASURES

Spawning Habitat	Quantity 40%	Day to day variability 30%	Within day variability 30%	
Rearing Habitat	Quantity – main channel 0%	Day to day variability -main channel 10%	Within day variability - main channel 40%	Availability - side channels 50%
Redd Stranding Risk	Median stranding risk 50%	High stranding risk 50%		
Total Gas Pressure	TGP between 103-110% 20%	TGP between 110-115% 30%	TGP >115% 50%	
Effective Littoral Zone	Quantity >80% 50%	Quantity – between 50-80% 10%	Quantity – between 20-50% 0%	Cutthroat hab. # days>77m 40%

12 - Lee Failing, Stave River Water Use Plan: Report of the Consultative Committee, July 1999, p.10.

At Bridge River WUP, reservoir levels and discharge rates affected the potential for fish stranding and for fish entrainment and these effects were combined into a single 'entrainment value' for convenience, even though they are very different issues. The objective was not to gain insight into these issues but rather to combine impacts that may have had some similar correlations to flow. Similarly, a 'spills index' was used to represent the effects related to the frequency, magnitude and timing of spills but this was apparently not easily understood by participants and was later abandoned. The search for convenient impact proxies seemed to drive much of the discussion in the WUP process.

The reliability of performance measures as indicators of impacts of hydroelectric operations on fish depended on the availability of several measures or sub-components that could be readily quantified, and the confidence that the technical advisors had on the extent to which fish populations relied on these measures. Whether they were accurate and realistic may be related to the fish-flow complexity of the particular system, the availability of field data on previous fish impacts, and the risk tolerance of participants to make professional judgements under certain information, time and process constraints.

5.3 Responsiveness

The ability of the performance measures to assist comparison of flow alternatives affected the final form and application of the measures. For example, for fish in the Coquitlam River, rearing habitat is one of the key limiting factors. The differences in expected rearing habitat were assessed using the weighted useable area (calculated by weighting habitat quality considerations for different sections of the river) for steelhead parr, which was considered the most sensitive species and therefore a good indicator of all rearing habitat. However, this habitat measure was not considered sufficiently sensitive, particularly considering the importance of flows during the summer months. Therefore, a flow threshold performance measure was used which indicated the frequency with which river flows did not meet minimum rearing requirements (based on 20% of the mean annual discharge) for steelhead during August. Under the two final alternatives, these minimum flows are not met 87% of the time and 58% of the time (a difference of 29% between the alternatives).

The Bridge River WUP involved one of the more structured and iteratively evolving uses of performance measures. For example, measures for juvenile, habitat and spawning habitat were initially proposed as good proxies of fish abundance and diversity in Seton River. However, after the first round of alternatives analysis, the Fisheries Technical Committee reported a lack of confidence that these measures were reporting the correct direction of fish response and acknowledged that their use overstates the degree of knowledge about the kind of flow regimes good for fish. The committee concluded that, provided flows stayed between 5 and 60 m^3/s, the most important factor affecting fish productivity was the shape of the hydrograph, with hydrographs more closely mimicking the natural hydrograph being preferred. The habitat performance measures were therefore replaced by a 'fish impact rating' scheme based on a) hydrograph shape similarity to natural pre-regulation flows, b) hydrograph magnitude (# weeks outside the preferred bounds) and c) spills magnitude and frequency (weighted number of spill weeks). These professional judgement ratings included:

- **0** - Combination of recurring direct mortality risks and consistently degraded habitat year over year is expected to produce negative population-level responses in abundance for at least some species.
- **1** – Improvements in habitat and/or mortality risks are expected (relative to "0"); but it is uncertain whether these are sufficient to produce positive population-level responses in abundance. Long term productivity and abundance of at least some species likely to remain depressed.
- **2** – Significant negative impacts from operations are limited to roughly 10% of years. Net effect on habitat and fisheries productivity expected to produce positive population-level responses in abundance for at least some species.

The analysis undertaken for the Cheakamus River WUP also showed that the fish performance measures can be relatively insensitive to the flow alternatives because of the particular circumstances of the facility. The differences in the effects of these flows on performance measures were either masked or reduced by the high proportion of inputs from tributaries and by the role of floodplain dykes in confining the habitat effects (and hence the FTC presentation that "more water isn't always better for fish").

It is apparent that some performance measures were useful for the initial analysis of fish conservation requirements but not necessarily for distinguishing detailed differences between alternatives. Changes in performance measures were therefore sometimes required to improve their usefulness over the course of the planning process. These adjustments also occurred where scientific gaps or comfort levels about the accuracy of the selected indices created problems for the participants in applying the measures.

6. ANALYSIS OF TRADE-OFFS AFFECTING FISH CONSERVATION

THIS SECTION DESCRIBES THE DIFFERENT TRADE-OFFS made in the fisheries sector in each of the WUPs. It addresses the following lead question:

What trade-offs between water uses were made in order to reach agreement about fisheries conservation and what factors influenced these trade-offs?

Table 12 summarizes the major features of the trade-off process. A key task in the trade-off process was to narrow the range of operating alternatives to focus on those where measurable differences in performance measures could be observed. Consultative Committees separated the technical analysis from the "value-based" or qualitative rating of operating alternatives.

Table 12: Features of the Water Use Trade-offs Process

RANGE OF TRADE-OFFS IN THE FINAL ALTERNATIVES	PARTICIPANT RATING OR RANKING METHOD IN VALUE TRADE-OFFS	CRITICAL FACTORS IN TRADE-OFF ANALYSIS
Cheakamus **Trade-offs related to 6 alternatives:** ■ Hydroelectric Power revenue per year: $ 26.9–35.6 million ■ Kayaking # days/yr: 124–242 ■ Sportfishing #days/yr: 58–193 ■ Fish – Rainbow Parr habitat (m^2 x 103): 35.8 – 42.5 ■ Fish – Chum Spawning area (m^2 x 103): 6 – 9.8 ■ Ecosystem: Riffle Benthic Biomass (g x 106): 2.2 – 3.4	■ Screening of 25 alternatives using several techniques, primarily ranking and pairwise comparisons ■ Use of 5-level preference ratings by committee members: Endorse, Acceptable, Not Sure, Less Acceptable, Block	■ 6 final operating alternatives considered ■ As the range of alternatives narrowed, distinctions based on performance measures were less clear and values became more important ■ Issue of which performance measures to utilize in the trade-off analysis and whether engineered channels should be used as a measure of habitat ■ Extent of iteration and value-based negotiation permitted was a factor in WUP process
Coquitlam **Trade-offs related to 2 preferred alternatives:** ■ Domestic Water Supply capital cost savings: $ 1.84 – 3.74 M ■ Hydroelectric Power revenue losses: $ 1.4 – 2.2 M ■ Fish – Steelhead parr rearing habitat available (weighted useable area): 10.4 – 19.5 % increase over current operations ■ Fish – Steelhead parr rearing minimum flows (frequency of flows <5.4 m^3/s in August): 58 – 87% occurrence of not meeting the threshold	■ Use of a 0-5 rating system: Block (0), Accept (1-2), Endorse (3-4) to measure level of CC member support for operating alternatives ■ Use of pair-wise comparison to help understand differences between preferred alternatives ■ Separate analysis of flushing flow (substrate cleaning) alternatives to reduce effects of sedimentation on habitat quality	■ 8 final operating alternatives considered. Narrowing the range of alternatives to focus early on those with significant differences in objectives ■ Inclusion of substrate quality in weighting estimates of useable spawning and rearing habitat in the river ■ Use of steelhead parr survival requirements as an indicator of the requirements of all salmon species ■ Selection of the particular 'life history thresholds' for steelhead and Chinook survival, rearing and spawning (see box page 31)

Table 12: Features of the Water Use Trade-offs Process (continued)

RANGE OF TRADE-OFFS IN THE FINAL ALTERNATIVES	PARTICIPANT RATING OR RANKING METHOD IN VALUE TRADE-OFFS	CRITICAL FACTORS IN TRADE-OFF ANALYSIS
Alouette		
Trade-offs related to 3 groups of alternatives: ■ Flushing Flows: - Poor to improved substrate habitat - None to more natural hydrograph - $ 0 to $ 2000-75,000 /yr ■ Expanding Outlet Flow Capacity: - 79-99% to 100% of optimum habitat - $270-440,000/yr to $0.7-1.055 M/yr and $3-6 M capital cost (expanded outlet) ■ Water Releases without Expanded Outlet Capacity: - 30-78% to 79-99% of summer optimum habitat - 43-70% to 97-99% of winter optimum habitat - $ 0 to $270,000-450,000 in annual power costs	■ Multiple accounts qualitative and quantitative assessment by the Alouette Stakeholder Committee	■ Uncertainty and lack of experience in the effects of higher than 20cfs flows on fish habitat and fish populations ■ Uncertainty in the estimates of costs of providing additional habitat associated with winter flows greater than 70 cfs
Stave		
Trade-offs related to 2 preferred alternatives: ■ Fish: effective littoral zone increase 840-1440 ha; carbon production increased 21-33% ■ Recreation: possible increases in fishery ■ Heritage: possible adverse effects on artefact recovery & First Nations ■ Hydroelectric Power – loss of $180,000 to a gain of $510,000/yr	■ The fish interests preference is for Combo 4 due to benefits for reservoir productivity ■ Heritage, recreation and power interests prefer Combo 5	■ 8 final operating alternatives considered. ■ Uncertainty about effects of increase in littoral zone productivity on fish production ■ Issues related to heritage and recreation gains relative to costs of power losses
Ash		
Trade-offs related to 4 alternatives: ■ Fish-Elsie Lake Reservoir: Increased trout rearing habitat in tributaries to the reservoir ■ Fish- Ash River: Increased rearing and spawning habitat including a nearly 14-fold increase in steelhead parr rearing habitat just below Elsie Dam relative to existing licensed flows ■ Increased opportunities for fish to migrate past Lanterman Falls and Dickson Falls ■ Increased minimum base flows in the Ash River ■ Recreation – potential loss due to lower elevations ■ Hydroelectric Power – increased revenue of >$600,000/yr, or 6% over current water licence	■ With a colour-coded comparative rating method (better, equal, worse), the committee used a process of eliminating and setting aside alternatives that performed less well and identified 4 top choices ■ Each committee member was asked to rate final preferences for the 4 alternatives: Support, Accept, Block	■ 4 final operating alternatives considered ■ Use of Key Performance Measures and Second-priority Performance Measures and colour coded ratings to compare alternatives with a selected reference alternative ■ Spreadsheet analysis also used the value of Minimum Significant Incremental Change (MISC) to compare differences between performance scores ■ Use of 'box plots' – variation in values over a simulated 38 years of operation (rather than only the median values) through a range of dry to wet inflow years

Table 12: Features of the Water Use Trade-offs Process (continued)

RANGE OF TRADE-OFFS IN THE FINAL ALTERNATIVES	PARTICIPANT RATING OR RANKING METHOD IN VALUE TRADE-OFFS	CRITICAL FACTORS IN TRADE-OFF ANALYSIS
Bridge **Trade-offs related to 5 alternatives:** ■ Fish: Lower Bridge: OK – NO Seton R.: 0 –2 rating scale Downton Res.: 66-67 scale Carpenter Res: 39-53 scale ■ Wildlife: Carpenter Res.: 1106-1200 weighted hectares habitat index Water Quality: suspended sediment load: 125-173 tonnes/yr ■ Power: $145-147 M/yr	■ Given scientific uncertainties many of the performance measures evolved into combined indices that depended on professional judgements about the relative performance of alternatives ■ The preferred alternative substantially satisfied all objectives, assisted by little variation in power revenues between alternatives	■ 5 final operating alternatives considered ■ The range of error in modelling studies and the MISC estimates were important factors ■ Some trade-off between reservoir wildlife and downstream fish values was offset by riparian enhancement for wildlife added to the preferred alternative
Shuswap **Trade-offs related to 8 alternatives:** ■ Sugar Lake Dam: - Recreation (reservoir): 22 – 91 days - Recreation (paddling): 80-101 days - Wildlife: 3-4 rating (0-5) - Power: $ 1.58 – 1.6 M - Flood & erosion control: 340 -365 (#days at x elev.) - Fish (reservoir): 4.0 -4.3 ha ELZ • Fish (river): - Chinook survival: 86-99 % - Chinook Effective Spawning: 22-26 ha - Coho survival: 60-86% - Coho Effective Spawning: 11-19 ha - Kokanee survival: 20-46% - Kokanee Effective Spawning: 0.6 – 2.1 ha - Rainbow Trout Rearing: 7.4 - 9.6 m^2 • Shape of Hydrograph (1 is good, 0 is bad): 0-1 rating ■ Wilsey Dam: • Trade-offs based on value assessments of the status quo and 3 alternatives	■ Used the following ratings: - S - fully support this alternative - A – accept this alternative with reservations, but I can live with it - B – block – I cannot live with it	■ 14 alternatives evaluated in Round 2 of the Shuswap WUP. 8 alternatives for Sugar Lake and 3 for Wilsey Dam considered (3rd Round) ■ An emphasis on pairwise comparisons ■ Members of the CC who were impacted by flooding on the river wanted to see an emphasis on flood control

The trade-off process was reviewed in terms of:

Fish Conservation Benefits: to what extent were fish conservation conditions improved over the status quo flow operations?

Trade-off Efficiencies: to what extent were trade-off compromises required between objectives in order to reach consensus on fish conservation requirements?

Fisheries Non-consensus/Partial Agreements: to what extent did Consultative Committees disagree on fish conservation requirements in flow operations?

6.1 Fish Conservation Benefits

From the perspective of fish conservation interests, major shifts from the pre-WUP flow regimes were required for fish conservation interests to be satisfied with the outcomes. Many of the results of WUP have been positive for fish in terms of more available water and habitat, or increased knowledge that will assist narrowing the range of uncertainties and in better managing impacts on fish. As noted in Section 4 above, the Consultative Committees proposed some significant changes from the status quo. Many of these changes arose from technical studies that provided greater insight into the opportunities to mitigate impacts on fish and fish habitat. One way of assessing the results is to compare the final recommended alternative(s) to the 'fish friendly' flow alternatives or similar 'conservation ideals' that were often identified in the WUP trade-off process.

In Coquitlam River WUP, for example, eight alternatives were assessed relative to the three performance measures (Table 13). The range of effects across these alternatives was significant; for example from -9% to +75% change in spawning habitats. The preferred alternatives indicated some significant improvements – approximately 50-70% increase in steelhead spawning habitats and a 10-20% increase in steelhead parr habitats. These estimates of effects were refined in the final analysis and focussed on two key measures (Table 14) – steelhead parr rearing habitat area and a fish flow ideal for steelhead parr rearing in the lower Coquitlam River. Relative to the flow ideal of 5.4 m^3/s at PoCo gauge in August, the two preferred alternatives performed better than the other options, but they still failed to meet this steelhead rearing standard 58% and 87% of the time.

In Stave River WUP, impact indices were generated to consolidate and normalize the fish performance measures. Relative to the base case (ESOR), the two preferred alternatives demonstrated a 23-26% increase in the rearing habitat index, an 11-12% decrease in the spawning habitat index, and a 7-30% improvement in egg stranding. If we compare this to the ideal fish-focussed alternatives that were eliminated in the trade-off process, the respective num-

Table 13: Coquitlam Preliminary Analysis: Estimated Effects on (Original) Performance Measures over Current Operations

OPERATING ALTERNATIVES	PM 1: HABITAT SUITABILITY (weighted usable area m^2 for life history stages)	PM 2: INVERTEBRATE SUITABILITY (weighted usable area m^2/indicator)	PM 3: FREQUENCY OF EVENTS (% of time flows were below the life history thresholds)(survival 10% MAD=<2.7, rearing 20% MAD =<5.4, spawning 46% MAD=>12)		
ESOR		-8.9 %	<2.7 m^3/s	<5.4 m^3/s	>12 m^3/s
ST Spawning	-8.8 %		19 %	55 %	-81 %
ST Parr	-9.1 %		35 %	57 %	-60 %
CH Spawning			36 %	57 %	-60 %
2FV-CA		0.0 %			
ST Spawning	0.0 %		16 %	50 %	-80 %
ST Parr	0.0 %		26 %	52 %	-59 %
CH Spawning	0.0 %		27 %	52 %	-58 %
DWF (2FV-PA)		0.4 %			
ST Spawning	6.6 %		13 %	48 %	-79 %
ST Parr	-0.2 %		27 %	50 %	-59 %
CH Spawning	-1.2 %		25 %	51 %	-58 %
4FV Optimized (final alt.)		12.2 %			
ST Spawning	48.4 %		0 %	14 %	-72 %
ST Parr	9.9 %		9 %	32 %	-55 %
CH Spawning	-1.0 %		25 %	-52 %	-58 %
STP4		22.1 %			
ST Spawning	66.4 %		0 %	6 %	-53 %
ST Parr	16.7 %		-6 %	19 %	-49 %
CH Spawning	24.4 %		0 %	34 %	-54 %
STP5 (final alt.)		24.2 %			
ST Spawning	68.8 %		0 %	5 %	-53 %
ST Parr	18.6 %		-6 %	9 %	19 %
CH Spawning	24.4 %		0 %	34 %	-54 %
Cons Q-GVRD		20.4 %			
ST Spawning	69.8 %		0 %	2 %	-53 %
ST Parr	14.7 %		6 %	33 %	19 %
CH Spawning	32.7 %		3 %	7 %	-49 %
FFQ		32.9 %			
ST Spawning	75.8 %		0 %	0 %	-20 %
ST Parr	22.0 %		-6 %	-12 %	-30 %
CH Spawning	20.7 %		5 %	38 %	-55 %

bers are +24%, -3% and +20%.[13] The difference between the final alternatives and the ideal fish conservation alternatives is therefore an 11-12% loss of spawning habitat values with the recommended alternative instead of a 3% loss with the rejected 'fish friendly' alternative.

At Bridge River WUP, impact indices were also used. The numerical rating for Carpenter reservoir fish/ecosystem impact was 70 for the best fish alternative versus 51 for the recommended alternative and 35 for the status quo, implying that the final alternative was 27% worse than the best fish alternative but 45% better that the status quo.[14] The values for Downton fish were only slightly better in the best fish alternative versus the preferred and status quo alternatives. The downstream Bridge River and Seton River fish trade-offs were analyzed by general pass/fail rating and the best fish options rated the same as the final alternative. This screening method reflected the fact that many questions remain to be addressed in the monitoring program.

At Shuswap River, the main objective was to retain some of the freshet and release it gradually over the remainder of the year until spring, and thereby both increase power production and enhance spawning and incubation flows downstream of the facilities. While power generation was relatively constant over a wide variety of alternatives, the challenge for the committee was to find an alternative that maximized what was best for these fish downstream of the power plant, and in the end, a version of the Status Quo was recommended.

Conclusions regarding fish conservation benefits depend upon whether benefits are assessed against some standards (e.g., steelhead parr rearing standards) or in terms of the comparative ranking of flow alternatives. The recommended flow alternatives were sometimes but not always the best choice for fisheries conservation, but they were usually better than the status quo. Even when the selected alternative was best for fish, it may not have met the particular performance standard set for fish at that facility (e.g., Coquitlam).

6.2 Trade-off Efficiencies

The opportunity costs of fish conservation under WUP turned out to be less than originally anticipated. Table 15 summarizes the effects of the recommended alternative(s) on power and fish compared to the status quo. It shows that the WUP outcomes, as reported in the Consultative Committee reports, resulted in estimated changes in power revenues from –21% at Coquitlam River to +6 % at Ash River, and changes in fish indicators in the range of + 10-30% at the study facilities.

The nature of the trade-offs associated with fish conservation varied widely between WUPs. In some cases, increased fish flows meant reduced power revenues, but not always. At Coquitlam, for example, power revenues associated with the preferred alternatives were estimated to decrease by 14-22% per year. But at Stave River, the preferred option may increase revenues by $ 0.4-0.5 Million per year, and at Ash River revenues are estimated to increase by 6% ($ 0.6 M/yr) under the preferred option. At Bridge River, power revenues are expected to increase by $1.8 million per year.[15] At Shuswap, no changes in the flow regime were proposed at Sugar Lake Dam and Wilsey Dam operations remain to be determined.

Table 14: Coquitlam Final Analysis: Estimated Effects on Key Performance Measures

OPERATING ALTERNATIVES	STEELHEAD PARR REARING HABITAT weighted useable area in sq metres % over current operations	STEELHEAD PARR FISH FLOWS that are <5.4 m^3/s at PoCo gauge in August (frequency not met)
2 Fish Valves Proposed	0.2 %	97 %
4 Fish Valves New (final alt.)	10.4 %	87 %
Share The Pain #4	17.3 %	77 %
Share The Pain #5 (final alt.)	19.5 %	58 %
Fish Friendly Flows	22.5 %	0 %

Data Sources: Report of the Consultative Committee - Coquitlam-Buntzen Water Use Plan. June 2002

13 - Based on Appendix 4, Alternative Screening – Summary of Performance Measures, Stave River WUP Consultative Committee Report, Oct. 1999.
14 - Based on Table 6-1 Round 4 Consequence Table and Table 6-3 Round 5 Consequence Table, Bridge River Water Use Plan Consultative Committee Report, 2002.
15 - All of these estimates exclude the cost of the proposed WUP monitoring and adaptive management programs.

Trade-offs with other objectives besides power production were also apparent. At Bridge River, reservoir stability and related wildlife habitat benefits were at direct odds with downstream fish habitat benefits and measures were subsequently added to mitigate the reservoir impacts. At Ash River, the gains in downstream fish conservation objectives conflicted with reservoir fisheries and recreation (increased flows and lower reservoir elevations tended to reduce the recreation experience), and preference was given to the downstream fish objectives. At Stave River, the trade-off was between reduced spawning habitat and improvement in rearing habitat and incubation conditions.

The general conclusion regarding trade-off efficiencies is that fish conservation improvements involved either relatively modest or in some cases, increased benefits for the power and other sectors. Additional costs are involved in the ongoing monitoring programs, but these will assist in further resolving many uncertainties about optimum flows. Where reduced reservoir fisheries or wildlife habitat benefits occurred under a preferred alternative, there were opportunities to mitigate or offset these losses that contributed to more efficient solutions. There were however, exceptions to the generally positive fisheries consensus, as summarized in Section 6.3.

6.3 Fisheries Non-consensus/ Partial Agreements

There were several WUPs where no consensus on a single alternative was reached:

Cheakamus: There was a lack of agreement because of particular concerns about the planning process and the exclusion of engineered off-channel habitat from the performance measures, and the general discomfort with the extent of uncertainties in the Fisheries Technical Committee's models and studies. Some conservation and First Nations groups felt that the process was too inflexible. After first agreeing to reject the status quo Interim Flow Agreement (IFA), and then hearing about the scientific uncertainties of the alternatives and observing good returns of fish populations, many participants wanted to re-introduce the IFA option at least for a certain period until better information was available. This resulted in one group favouring lower flow alternatives supported by the performance measures and a second group that preferred higher flows (IFA) that were perceived as more precautionary.

Table 15: Summary Effects of Preferred Alternative(s) on Power and Fish

	% CHANGE IN POWER REVENUES OVER STATUS QUO	% CHANGE IN FISH PERFORMANCE MEASURES OVER STATUS QUO
Cheakamus	0 %	0% (no recommendation)
Coquitlam	- 13.7 –21.2 % (-$ 1.4 – 2.2 M/yr)	+ 10.4 – 19.5 % steelhead parr rearing habitat
Alouette	-? % (-$0.27-0.515 M/yr)	+50-70% increase in optimum habitat (from historical 30% with 20 cfs release to 79-99% with 105 cfs release)
Stave	+ ? (+ $ 0.44-0.51 M/yr)	- 11-12% spawning habitat index% + 23-26% rearing habitat index + 7-30% egg stranding index + 21-33% tonnes carbon/yr
Ash	+ 6 % (+$ 0.6 M/yr)	+ 1400% steelhead parr rearing habitat over licenced flows
Bridge	+ 1.5 % est. (+1.8 M/yr)	+ 31% Carpenter fish index 0 % Downton fish index Not quantified - river fish
Shuswap	0 %	0% (The status quo was the recommended alternative)

Coquitlam: The final alternatives resulted in a split between one group (GVRD and BC Hydro) that believed the costs and uncertain benefits of providing water releases beyond option 4FVN were not justified, and many others who felt that, although the case for fish benefits is burdened by scientific uncertainty, conservation should be given priority with detailed study and field-testing of flows, particularly option STP5. A flow range between these very different alternatives was endorsed along with a 15-year monitoring and adaptive management program. "Although consensus was reached regarding future BC Hydro operations, there are clear value-based differences with the CC regarding trade-offs between objectives within the range of alternatives being considered." [16]

Wilsey Dam, Shuswap:
The issue for Wilsey Dam focussed on the effects of sudden power outages which interrupt the flows below the powerhouse for anywhere from a few minutes to several hours. The effects include displacement and stranding mortality for downstream aquatic life. However, the extent of impact and the species affected are highly dependent on the seasonal timing, the magnitude, and the duration of the flow disruption. Previous attempts to mitigate this through the installation of a bypass valve have only been partially successful and flow outages remained a specific concern of the Department of Fisheries and Oceans. The WUP committees considered ways to change the routing of water at Wilsey Dam. However, there was no agreement as to whether a gated spillway should be installed as a means of protecting fish downstream from the unexpected outages and therefore no consensus on operations at Wilsey Dam.

7. FIRST NATIONS FISHERIES CONCERNS

7.1 WUP Outcomes for First Nations

THIS CHAPTER SUMMARIZES THE GENERAL fisheries issues expressed by First Nations during the WUP processes and the general results of the WUPs in relation to First Nation's inputs. Table 16 compares the inputs and responses at each of the study WUPs based on documentation in the Consultative Committee reports and interviews with First Nation representatives. Most of the First Nations participation focussed on effects on archaeological resources and traditional uses. Of the seven study WUPs, two (Cheakamus and Ash) did not receive First Nations endorsement.

Key issues that were noted by First Nations representatives included the following:

- There was no mechanism within WUP to address the historical footprint impacts of hydroelectric development which in many cases, overwhelm the operational impacts; nor is there an alternate process for systematically identifying these issues directly with First Nations.
- The WUP process did not sufficiently acknowledge the status, rights and entitlements of First Nations, but rather accommodated First Nations input as simply one of many stakeholders in water use decisions.
- In some cases, such as Bridge River, the WUP outcome constrains or even precludes the potential to undertake fisheries restoration and rehabilitation.
- There was no commitment to providing First Nations with the resources to adequately and consistently participate in the technical aspects of the fisheries assessments and therefore they depended upon government technical staff to represent fish conservation concerns and interests.
- There was a commitment by WUP to address the issues related to protection and access to archaeological and cultural sites, which was a priority for most of the First Nations. Not all of the facilities have received the same level of attention to archaeological and cultural sites protection.
- Where traditional use studies were completed, they had some effect in highlighting issues that would have been otherwise overlooked, and in at least one case (Campbell River) likely altered the final recommendations.

16 - Maria Harris & William Trousdale, Report of the Consultative Committee: Coquitlam-Buntzen Water Use Plan, June 2002, P. 63.

- Even where consensus was reached, however, First Nations had a largely passive role in accepting the recommended alternative because they were often not directly and intensively involved in the decisions and the proposed alternative usually appeared to be better than the status quo and therefore was supported.
- First Nations are seeking post-WUP consultation with the Provincial government, DFO and BC Hydro to address the outstanding concerns related to both the pending updates to water licenses and the historical footprint impacts.

7.2 Fisheries Monitoring Programs

First Nations have participated in all of the BC Hydro water use planning processes. First Nations have the following objectives for the WUP monitoring program:

- To provide more information to First Nations governments and community members about the effects of hydro operations on fish and aquatic ecosystems, terrestrial ecosystems, archaeological sites, traditional use areas and more generally on aboriginal rights and interests.
- To contribute towards monitoring programs which will determine with a high degree of certainty the effectiveness of WUP-mandated operational changes and produce information to substantially reduce uncertainty in future WUP (and other operational) decisions.
- To improve the technical, professional and related skills of First Nations fisheries technicians in fish and wildlife population and habitat assessments and limnological techniques.
- To increase the administrative and professional capacity of First Nations governments and businesses to contract to undertake fisheries and other scientific investigations. First Nations entities will increase their capacity to a level where they can either partner with consultants to undertake this monitoring work or bid directly for contracts for WUP monitoring projects. In other cases, First Nation members will be eligible for employment with consultants undertaking WUP monitoring projects.

Table 16: First Nations Inputs and Responses in Water Use Planning

FIRST NATIONS	FIRST NATIONS COMMENTS AND OBJECTIVES IN WUP	RESPONSES TO FIRST NATIONS INPUTS
Cheakamus Squamish First Nation	■ WUP process alienates Squamish Nation aboriginal rights ■ No preferences for the operating alternatives ■ Consider potential for using water from powerhouse to maintain Pilchuk channels along the Squamish River ■ Kayaking and rafting activities can have a negative impact on Squamish Nation bathing rituals	■ No agreement by First Nations
Coquitlam Kwikwetlem FN Katzie FN Musqueam FN Sto:lo Nation Tsleil-Waututh FN	■ Maximize access for First Nations traditional uses ■ Maximize access for recovery of artifacts/inventory of sites ■ Maximize protection of sites from erosion, pot hunting, flooding ■ First Nations expressed an interest in capacity building and employment in fish research as well as other areas (monitoring, operations management, archaeological research) ■ Request for compensation for destruction of the Coquitlam River salmonid population	■ No comments on the alternatives ■ Concerned about continued funding after the decision and the problems faced by those involved in the Alouette and Stave ■ Key issue of fish passage and feasibility of re-introduction of sockeye is being addressed under the Bridge-Coastal Restoration Program
Alouette Katzie First Nation	■ Separate discussions occurred between BC Hydro and Katzie First Nation ■ Specific inputs of participants were not documented	■ Specific responses not documented; general consensus on recommendations reached by the full committee

Table 16: First Nations Inputs and Responses in Water Use Planning (continued)

FIRST NATIONS	FIRST NATIONS COMMENTS AND OBJECTIVES IN WUP	RESPONSES TO FIRST NATIONS INPUTS
Stave Kwantlen FN In-SHUCK-ch FN	■ Protection of heritage sites from erosion and illegal collecting, accessing sites for artefact recovery and cultural/spiritual visits ■ Concerns about options that increase recreational access to Stave reservoir	■ The recommended Combo 6 allowed for improved First Nations access and protection of heritage sites and artifacts ■ First Nations endorsed the recommended Combo 6 ■ Monitoring plan is to address First Nations heritage concerns ■ A Heritage Management Plan was developed by Kwantlen First Nation
Ash Tseshaht FN Hupacasath FN	■ Maximize protection of First Nations archaeological resources from unauthorized collection and from wave erosion ■ Maximize opportunities for study and traditional use in the drawdown zone ■ Maximize traditional First Nations use in the Ash River ■ Hupacasath First Nations equally valued gains in both reservoir and Ash River fish production; they were not willing to trade-off one for the other ■ Requested that BC Hydro provide notice when the reservoir is expected to drop below 318.5m. Hupacasath FN are interested in opportunities for traditional use and archaeological study in the drawdown zone	■ Opportunities to address archaeological and heritage issues through the monitoring program ■ An Archaeology Overview Study was completed and BC hydro committed to an Archaeological Management Plan ■ First Nations accepted (but did not fully support) the recommended Alternative C; they felt it did not address impacts on their rights and title nor sufficiently protect archaeological resources
Bridge Stl'atl'imx Nation	■ No support given to any preferred alternative ■ Expressed concern about the need for capacity building and involvement in the monitoring and adaptive management program	■ A TEK study was supported by BC Hydro ■ Consideration of possible plant upgrade if the opportunity exists to reduce Seton Lake water levels ■ Follow-up participation in monitoring
Shuswap Spallumcheen Band Shuswap Nation Tribal Council (SNTC)	■ Maximize the protection of archaeological resources around the reservoir ■ Maximize opportunities for First Nations' access to archaeological sites around the reservoir	■ The recommended Status Quo option was accepted, although preferential support was given to the other alternative because it was the better of the two alternatives in protecting archaeological sites around the reservoir from erosion A limited archaeological investigation of the drawdown zone was completed in June 2001. The location of the sites in the drawdown zone helped establish the threshold elevations for the three archaeology performance measures above and guided development of the operating alternatives

8. CONCLUSIONS

THE CENTRAL QUESTIONS ADDRESSED BY this report were whether water use plans will lead to substantially increased conservation and production of fish, and whether the WUP process has satisfied the conditions laid out in the May 2000 CEC/NAFTA "Factual Record" on water use planning and fish conservation. It is apparent that WUP has improved the knowledge base and better defined the flow requirements for fish conservation at BC Hydro facilities. The outcomes to date for fish conservation have, overall, been generally positive, although not without some level of compromise on fish objectives and a lack of full consensus at some of the facilities. The recommended flow alternatives were sometimes, although not always, the best choice for fish conservation, but they were usually better than the status quo. Even when the selected alternative was best for fish, it may not have met the particular performance standard set for fish at that facility. Based on the final consultative committee reports, fish conservation stakeholders endorsed the recommended operating alternative(s) at six of the seven study WUPs.

Seven key issues were identified in the NAFTA complaint and the results of WUP in addressing these issues at the study facilities can be generally summarized as follows:

- **Reduced flows:** a comparison between pre-WUP fish flow agreements and the WUP recommendations showed that a much more complex and risk-conscious set of recommended flow regimes has evolved, recognizing the importance of target flows, timing and ramping rate specifications as well as flow volumes.
- **Rapid flow fluctuation:** many uncertainties exist about optimum ramping rates and some rates were recommended, but the various monitoring and related adaptive management programs at each facility should assist in resolving this issue.
- **Adequate flushing flows:** this was an issue at only a few facilities and despite special studies no definitive solutions were presented, but adaptive management experiments are proposed to determine the feasibility of flushing flows at certain facilities.
- **Altered water quality:** temperature effects are to be considered within the monitoring programs but other aspects of water quality (e.g., total gas pressure) were either not considered an issue or deemed to be outside the scope of WUP.
- **Entrainment of fish:** in most cases, this was not a focus of WUP discussion or concern, although minimum and maximum elevations were recommended at Bridge River WUP to mitigate entrainment risks in Downton reservoir.
- **Flow diversion:** Five of the study facilities have out-of-basin diversions and the effects were considered in some detail, resulting in recommended flow prescriptions to reduce the effects of lower flows during summer and dry years, and some experimental test flows to address unresolved issues.
- **Reservoir drawdown:** the effects of operations on reservoir productivity and tributary access by fish were considered at most of the facilities, with considerable uncertainty about littoral productivity (carbon production) – fish abundance/diversity relationships. Various measures were proposed for balancing reservoir productivity/tributary access and downstream fish flow requirements; these remain to be tested.

The technical analysis and stakeholder discussions provide a foundation for addressing most of the issues identified in the CEC/NAFTA report, with the possible exception of entrainment. In many cases, this meant deferring specific issues to the subsequent monitoring phase. One of the more important contributions of WUP therefore has been to identify critical uncertainties and data gaps and to establish the framework and parameters for ongoing monitoring and adaptive management of the key fish flow issues.

BC Hydro's water use planning process has also resulted in some significant advances in understanding the interactions between hydroelectric operations and fish conservation, and improving the methods for balancing competing objectives. In many cases, these advances led to important efficiencies and net gains in both power and fish production potential – results that were generally not anticipated. For example, in the case of Bridge River, by withdrawing the constraints that existed on the separate reservoir operations, operating efficiencies and power revenues were improved while providing greater flexibility to accommodate multiple objectives, including many of the fish conservation objectives.

A comparison of the recommended flow alternatives with the 'fish friendly' alternatives or similar 'conservation ideals' (that were not selected) revealed some definite trade-offs to fish values at some facilities, although these were comparatively small. For example, at Stave River WUP, while the preferred alternative resulted in 23-26% increased rearing habitat, it also involved an 11-12% loss of spawning habitat values compared with a 3% loss under the rejected 'fish friendly' alternative. At Bridge River WUP, the numerical rating for Carpenter reservoir fish/ecosystem benefits was 70 for the best fish alternative versus 51 for the recommended

alternative and 35 for the status quo, implying that the final alternative was 27% worse than the best fish alternative but 45% better that the status quo.

Some constraints in the scope of the WUP process terms of reference clearly limited the range of possible outcomes. For example, the Cheakamus WUP was unable to resolve the fish conservation issues in large part because of the narrow focus of the WUP analysis on flow regulation rather than on the fish habitat limiting factors that were indirectly related to flow operations. Similarly, the option of de-commissioning was also outside of the scope of WUP, although the primary candidate, Shuswap, could have benefited from a more full analysis of this option. More flexibility in addressing all fish flow issues could have contributed to more room for innovative solutions and agreements.

Valuable experience was also gained in the use of performance measures, which was a key focus of the WUP model. The type and detail of performance measures varied between WUPs and over the course of the WUP processes. While a long list of performance measures were often developed, the comparative analysis of flow alternatives usually focussed on only a few selected measures that represented the key variables and indicators (e.g. steelhead parr habitat as a "keystone indicator") that captured requirements of several species. It is apparent that some performance measures were useful for the initial analysis of fish conservation requirements but not necessarily for distinguishing detailed differences between alternatives. In some cases, major changes occurred in the use of performance measures that served as particular indicators at various stages of the review. In other cases, the reluctance to change performance measures appears to have constrained the ability to reach consensus. This may reflect differences in whether these measures were viewed as dynamic tools to assist analysis, or normative criteria to guide decisions.

The reliability of performance measures as indicators of impacts of hydroelectric operations on fish depended on the availability of several measures or sub-components that could be readily quantified, and the confidence that the technical advisors had on the extent to which fish populations relied on these measures. Whether they were accurate and realistic may be related to the fish-flow complexity of the particular system, the availability of field data on previous fish impacts, and the risk tolerance of participants to make professional judgements under certain information, time and process constraints. It is also important to recognize that there was considerable potential for measurement and modelling error and subjective expert judgement associated with the calculation of performance measures.

A critical aspect of applying performance measures at some of the WUPs was the concept of "minimum significant incremental change" (MSIC) – the amount by which an alternative must outperform another alternative (in terms of performance measure scores) in order to be considered a better choice. MSIC assisted in defining and exposing judgements and modelling error about the preferred alternatives and thereby strengthened confidence in the technical aspects of the final recommendations. But this form of sensitivity analysis also depended on the responsiveness of the performance measure, which was sometimes weak in the case of fish.

In most of the WUPs, much of the analysis focussed on flow regime effects on habitat suitability and quality. It proved more difficult to estimate the biological impacts. These were largely derived from professional judgement. For example, the Shuswap Fisheries Technical Committee spent a considerable amount of effort discussing a "damage function" that would relate the amount of time that the water was low to the aggregate amount of damage done to species life stages in the river. The group could not find common ground in deciding how long it would take before the majority of damage had occurred to each life stage. This type of technical uncertainty was typical of the WUPs and many of the assumptions and predictions will need to be tested in the subsequent monitoring phase.

Balancing of reservoir and downstream river fish objectives and management strategies also presented some difficulties at several facilities. Maximizing the "effective littoral zone" and minimizing the range of water level fluctuations was a common objective, with some uncertainty about how this was correlated with reservoir fish production. This objective was sometimes at odds with the optimum flows for downstream species, and trade-offs were occasionally required. In general, preference was given to the requirements of the river fish.

Restoring flows to a pattern that reflects some elements of pre-regulation conditions (i.e., mimicking the shape of the natural hydrograph) was often but not always the best overall solution for fish. For example, the 'naturalized flow alternatives' at Ash River increased reservoir fluctuations and reduced the availability of water for fish enhancement facilities in the receiving watersheds (e.g., Ash River diversion to Great Central Lake) and increased flooding damages to downstream habitats. At other facilities, such as Bridge-Seton River, replicating aspects of the natural flow regime was the preferred alternative, albeit with uncertainties about biological effects. Components of a naturalized flow regime need to be assessed in terms of species life cycle requirements.

There was wide divergence in the willingness of consultative committee members to forego provincial power revenues or investment to reduce the impacts on fish. As the Shuswap River report noted, for example, "many were risk averse in the direction of wanting to protect fish stocks from unquantified, but negative impacts of unplanned flow disruptions. Some were risk averse in the direction of not wanting to commit provincial funds towards a project with unquantified benefits". The lack of a cost-effectiveness and risk management framework created some significant challenges for consultative committee members to determine the context for appropriate trade-offs.

The BC Hydro's water use planning process is a highly structured and managed process that involves a large number of stakeholders and a complex set of issues and alternatives. There has been substantial progress in reaching consensus on the appropriate operating alternatives for fish conservation in context with other objectives at many of the facilities, and/or defining the specific uncertainties that need to be addressed to better determine the appropriate flow regimes. But the technical solutions generated by the fisheries technical committees and BC Hydro's project teams tended to drive the process and set the frame of reference within which value-based inputs from stakeholders were solicited. Where the process failed to reach full consensus was generally where a lack of flexibility was available to adjust the process to accommodate the particular expectations, perceptions, performance standards and risk sensitivities of the participants. There are some important lessons from the WUP experience to date, including:

- technical analysis and consultation can generate significant water use efficiencies and benefits;
- stakeholder agreement on the process and flexibility to address a range of interests is essential;
- performance measures need to maintain adaptability to the issues that emerge in the process;
- there is a close relationship between historical 'footprint' impacts and contemporary operational impacts which are often inseparable; and
- there are limitations of a multi-stakeholder process in meeting the consultative needs of First Nations.

First Nations accepted the recommended operating alternatives at five of the seven study WUPs, primarily because they were better than the status quo. Their inputs focussed on the effects on archaeological resources and traditional uses. However, some significant concerns remain about the process, including (i) the lack of a mechanism to address the historical footprint impacts of hydroelectric development, which in many cases overwhelm the operational impacts, (ii) the inadequate acknowledgement of First Nation's status, rights and entitlements in water management rather than simply the ascribed role within WUP as one of many stakeholders in water use decisions, and (iii) a lack of resources to support First Nation's participation in the technical aspects of the fisheries assessment and monitoring. These concerns are most evident at Cheakamus River and Ash River watersheds.

WUP is, to date, largely a BC Hydro process for engaging key stakeholders in the review and updating of its operating licences, rather than a more public process by the regulator of determining the long-term allocation and management of water within watersheds. BC Hydro has sponsored and organised a thorough review of the alternatives for managing the hydroelectric operations to meet multiple objectives within the limited scope of the water use planning process. While significant fish conservation benefits and consensus have been achieved, there remain many specific issues to be resolved in the monitoring phase. There is a concern by many of the participants that the support and role of monitoring will be diminished once the revised licences are issued. For this reason, the ongoing monitoring program needs to actively incorporate the broad array of public interests in WUP implementation.

ARE THE PROPOSED WUPs AN ADEQUATE RESPONSE TO THE CEC CITIZEN SUBMISSION ON CANADA'S ALLEGED FAILURE TO ENFORCE THE FISHERIES ACT?

Prepared by: **Linda Nowlan, Environmental Lawyer**

THIS REPORT IS THE SECOND PART of the Watershed Watch Salmon Society's project to examine the effectiveness of the water use plans (WUP) developed by multi-stakeholder committees under BC Hydro's guidance.

The principal purpose of the review is to examine whether the WUP process satisfies the concerns expressed by a 1997 North American Agreement on Environmental Cooperation Article 14 submission about Canada's alleged failure to effectively enforce its environmental law with respect to the harmful effects of BC Hydro operations on fish habitat, and the 2000 Commission on Environmental Cooperation (CEC) "Factual Record" developed in response to that submission.

This review relies on the preceding Quadra report, the CEC Final Factual Record, and other related legal literature to examine whether the implementation of WUP is addressing the concerns that formed the subject of the Citizens Submission process.

This report is organized as follows.

- It briefly summarizes:
  - The CEC submission process
  - The substance of the BC Hydro Submission
  - The process used to develop the Factual Record
  - The findings of the Expert Group
  - The substance of Final Factual record released 30 May 2000.
- It analyzes whether the WUP process as outlined in the Watershed Watch review is adequately addressing the concerns of the Submitters, Experts Group, and Final Factual Record in the BC Hydro case in terms of:
  - Procedural adequacy
  - Substantive improved protection for fish habitat
  - More time needed to gauge full effects of WUP.
- It summarizes conclusions.

This report is limited to examining the effectiveness of the WUP process as one response to the allegation that Canada has failed to enforce the federal *Fisheries Act* against BC Hydro's operations in BC which affect fish habitat. As the CEC Factual Record makes clear, the WUP process is one of six strategies that the Canadian government uses to enforce the federal *Fisheries Act.* The others are:

- Prosecutions
- New Projects
- Emergency Operations
- Regional Technical Committees
- Water Quality Guidelines.

However, WUP is "a centerpiece of Canada's efforts to resolve the harm to fish habitat caused by BC Hydro operations" (Para. 221, CEC Secretariat Factual Record) and so merits close attention.

1.1. The CEC Citizens Submission Process – Articles 14 and 15 North American Agreement on Environmental Cooperation (NAAEC)

The *North American Agreement on Environmental Cooperation* (NAAEC) sets up a public complaint procedure for persistent non-enforcement of domestic environmental laws.

Any person or non-governmental organization from one of the three Parties to NAAEC (Canada, the US and Mexico) may make a claim to the Commission for Environmental Cooperation that a government is failing to enforce its environmental law, catalyzing a process that can lead to the development of a factual record.

First, the CEC Secretariat determines that the initial criteria for a claim of non-enforcement are met. The Secretariat must find that the submission "appears to be aimed at promoting enforcement rather than at harassing industry". The test for "failing to effectively enforce its environmental law" is narrowed by two key exceptions: the "reasonable exercise of discretion" and a "decision to allocate enforcement resources". The complainant must first pursue any available "private remedies" and the complaint cannot proceed if there is judicial or administrative proceeding underway. The penalty provision restricts the remedy to situations involving

a "persistent pattern" of non-enforcement, which is defined to exclude anything before the agreement came into force.

The Secretariat then determines whether the submission merits requesting a response from the Party. If a response is requested and received, the Secretariat may then recommend to the Council that a factual record be prepared. The Council (the environment ministers of Canada, Mexico and the United States) may then instruct the Secretariat to prepare a factual record on the submission. The final factual record is made publicly available upon a two-thirds vote of the Council. [17] As of March 2004, the CEC had prepared nine factual records.

The Factual Record for Submission SEM-97-001, the subject of this report, concerns non-enforcement of the Canadian *Fisheries Act* and *National Energy Board Act* against BC Hydro's hydroelectric dam operations in BC, and is the subject of this report. (The submission regarding the *National Energy Board Act* was not pursued and not addressed in the Final Factual Record, and is not examined in this report.)

1.2 Substance of SEM-97-001

In 1997, the B.C. Aboriginal Fisheries Commission, British Columbia Wildlife Federation, Trail Wildlife Association, Steelhead Society, Trout Unlimited (section Spokane), Sierra Club (EU), Pacific Coast Federation of Fishermen's Association, and Institute for Fisheries Resources launched a submission under Article 14 of the North American Agreement on Environmental Cooperation alleging that Canada was failing to ensure the protection of fish and fish habitat in British Columbia's rivers from ongoing and repeated environmental damage caused by hydro-electric dams.

The Submission asserted that BC Hydro "consistently and routinely violated" section 35 (1) of the federal *Fisheries Act,* which states that: "No person shall carry on any work or undertaking that results in the harmful alteration, disruption, or destruction of fish habitat."

There is an exception to this provision. Section 35 (2) permits the alteration, disruption or destruction of fish habitat by any means authorized by the Minister of Fisheries or Oceans or under regulations made under the *Act*.

The Submitters alleged that the regular operation of BC Hydro's dams "causes consistent and substantial damage to fish and fish habitat'' and that as no authorizations were issued under section 35 (2) and no regulations issued that would exempt BC Hydro from complying with s. 35 (1), the Canadian government was in breach of its duty to effectively enforce the federal *Fisheries Act* with respect to BC Hydro.

The Submission asserted that BC Hydro dams harm fish habitat in at least 7 ways:

- Reduced Flows
- Rapid Flow Fluctuation
- Inadequate Flushing Flows
- Altered Water Quality
- Entrainment
- Flow Diversion
- Reservoir Drawdown.

According to the Submitters, "the Department of Fisheries and Oceans (DFO) have only laid two isolated charges pursuant to sections 35(1) and 40(1) against Hydro since 1990, despite clear and well documented evidence that Hydro's operations have damaged fish habitat on numerous occasions."

The Submitters also challenged the adequacy of WUP, presenting arguments that the WUP process, among other defects, lacked procedural safeguards available in other federal laws.

The government of Canada responded that it was enforcing its environmental laws, and was in full compliance with its obligations under the NAAEC. Canada did not support the development of a Factual Record for this submission. However, as both the United States and Mexico did vote in favour of instructing the CEC Secretariat to prepare a Factual Record, the Secretariat proceeded using the process described in section 1.3 below. The final factual record was publicly released on 11/06/2000.

1.3 Process Used to Develop the Factual Record in the BC Hydro case

The CEC Secretariat retained an expert, Stephen Owen, former Ombudsman of BC and Commissioner of Resources and the Environment to assist it with the development of the process to obtain information for the purposes of the Factual Record.

The Secretariat established an Expert Group of three people with expertise in hydro operations, law and fish habitat. The Expert Group prepared a report which is attached as an Appendix to the Factual Record.

The Secretariat also identified four key stakeholders: Canada, the Submitters (the B.C. Aboriginal Fisheries Commission, British Columbia Wildlife Federation, Trail Wildlife Association, Steelhead Society, Trout Unlimited (sec-

17 See the Commission's web at www.cec.org, for a description of the procedure, a Citizen's Guide to the complaint procedure, and the full text of all cases.

tion Spokane), Sierra Club (EU), Pacific Coast Federation of Fishermen's Association, and Institute for Fisheries Resources), the Province of BC and BC Hydro, and invited them to provide information on the Submission.

The process that the Secretariat then followed is described in the Final Factual Record in Section IIIA. Of note in this description of this process is paragraph 52 which explains that as much of the Factual Record is based on the nature and effectiveness of Canadian enforcement efforts, several attempts were made to meet with knowledgeable government officials but that such meetings never occurred.

The Secretariat also placed relevant documents on the CEC website, notified the public of opportunities to participate, established a document repository, and asked the Joint Public Advisory Committee of the CEC to comment.

1.4 Findings of the Expert Group

The Expert Group submitted its report to the CEC Secretariat in February 2000. It contains six sections:

- Background on BC Hydro Operations and the Types of Harm that Such Operations May Cause to Fish Habitat
- Experts Group Charge to Assist Secretariat
- Concept of 'No Net Loss' and its Role in Canada's general Approach to Enforcement
- Canada's Policy Context – A Review of Canada's Enforcement Responses Concerning the Statutory Prohibition Against Harming Fish Habitat
- Review of Information for Six Facilities
- Overall Expert Group's Comments Concerning Canada's Approach to Enforcement.

Section 6.5 of the Report, WUP As A Means to Address Habitat Issues, is particularly relevant for the current analysis.

This section noted that no formal WUPs had yet been completed as of the date of the Experts Group report. It also noted that as WUP was a future process "it is not clear whether this consultative process has or will effectively reduce adverse impacts on fish and fish habitat resulting from hydroelectric operations." Despite this caveat, the Group continued: "Nevertheless the Expert Group regards the WUP process as positive with potentially beneficial consequences for fish habitat management."

It also noted important shortcomings with WUP that should be addressed. These shortcomings were also reproduced in the Secretariat's Final Factual Record, and are discussed in more detail in s. 2.1 below.

1.5 Substance of the Final Factual Record

As with the other Factual Records published by the CEC Secretariat to date, the final Factual Record in the BC Hydro case does not conclude whether the allegations of persistent non-enforcement of environmental law were proved or not. The CEC is not an adjudicative body, so it is appropriate that it reaches no conclusions.

The Final Record did repeat the conclusions of the Expert Group on possible shortcomings of the WUP process as a response to non-enforcement but expressed no additional opinion about whether Secretariat staff shared the Experts' view.

Despite the fact that there is no direct statement in the Factual Record on the central issue of whether Canada had or had not enforced the Federal *Fisheries Act* against BC Hydro, it is possible to draw an inference that non-enforcement did occur in this case, from the information presented by the Submitters and the Expert Group that was not rebutted by the government of Canada.

However, the Record also sets out Canada's response in detail. Canada did not agree with the allegations and urged the Secretariat to take a broad view of environmental enforcement. In answer to the charge that only two charges of violating the *Fisheries Act* had been laid against BC Hydro since 1990, Canada responded that: "Enforcement through prosecutions is a last resort after cooperation and persuasion have failed." Canada's response described six enforcement strategies. The WUP process is one of these strategies. The main body of the Factual Record is lengthy, and divided in five sections.

First, it provides background on BC Hydro operations and the types of harm such operations cause to fish habitat. On this point, the record is clear. There is no doubt that fish habitat has been negatively impacted by hydro operations in BC. "Hydroelectric operations inherently affect fish and fish habitat, such that through generation of hydroelectric power there is conflict with the *Fisheries Act* as interpreted by fisheries agencies (WUP Management Committee March 1999 Submission, p. 104 Factual Record)."

Second, the Record details how it defined the scope of information developed concerning the allegations of failing to effectively enforce the *Fisheries Act.*

Third, it outlines the information it collected on significant Canadian enforcement responses concerning the statutory prohibition against harming fish habitat. This section contains facts on the WUP process. The federal government explained the genesis of the WUP process, noting the key events leading to its development:

- The Electric System Operations Review undertaken by BC Hydro and the provincial response to the review showed that fish issues had not been adequately addressed.
- The findings of the Ward review indicated that some Hydro operations might not be in compliance with the terms of their licences.
- Public concern over high profile habitat impacts, e.g., the loss of spawning gravel habitat in Campbell River; forced spills; the Downton lake deep drawdown; and the draft Alouette and Campbell River Water Use Plans showed that the public interest in habitat protection had increased over the years.

The fourth section of this report reviewed information on six BC Hydro facilities chosen to illustrate the range of habitat concerns and effects.

And the fifth and final section summarizes the voluminous information collected for the Record, concluding with a discussion on "The WUP Process as a Means to Address Fish Habitat Issues". This section lists the concerns of the Submitters and the Expert Group about the WUP process, which are considered in more detail in section 2.1 of this report, below.

The Factual Record report concludes with a 'final statement' on the differing opinions on the WUP process, listing three outstanding questions from the Submitters and responses to each question from the government:

1. Will a s. 35(2) authorization be needed for each BC Hydro operation that continues to cause harm to fish habitat? Answer: "It is likely that authorizations will be issued at many facilities as WUPs are implemented throughout BC".
2. Will s.35 (2)/CEAA be followed when an authorization is issued? Answer: Canada points to its Decision Framework for Authorizations, which does contemplate that a CEAA review is needed for a s. 35(2) authorization.
3. Third, what actions Canada will take in the event that one or more WUPs do not lead to issuance of s 35(2) authorizations, or if the terms of a WUP intended to prevent harm to fish habitat are not met or do not accomplish their purpose? Answer: Canada will investigate and proceed with charges where evidence is available. An example of a post-WUP enforcement action taken against BC Hydro under the *Fisheries Act* is attached as Appendix 1 to this report.

2. Is the WUP process as outlined in the Watershed Watch audit adequately addressing the concerns of the Submitters, Experts Group, and Final Factual Record in the CEC BC Hydro Case?

THE EFFECTIVENESS OF WUP AS THE KEY governmental response to the concerns raised in the BC Hydro citizen submission can be analyzed from procedural and substantive viewpoints. Four years after the Factual Record was released, there has been time to determine how well WUP has worked to date, though more time is still needed to gauge the full effects of WUP. The final part of this section explains why more time is needed.

2.1 Procedural Adequacy of WUP

Neither the Submitters nor the Experts Group believed that the WUP process, by itself, would be sufficient to address the alleged non-enforcement of the federal *Fisheries Act* against BC Hydro.

As the design of WUP did not change as a result of the CEC Record, the original concerns of the Submitters and the Experts remain legitimate. And as no amended water licence embodying a WUP has yet been issued, and consequently no s.35 (2) *Fisheries Act* authorization has yet been issued for such a licence/WUP, either with or without a CEAA process, testing the contemplated full regulatory procedure from start to finish is not yet possible.

The procedural concerns of the Submitters and the Experts are set out below, followed by a short analysis of whether current practice in the WUP implementation is addressing those concerns. The issue of substantive improvement in fish habitat protection as a result of WUP is next discussed with reference to the Quadra report, and to other commentators on the CEC BC Hydro case.

The concerns of the Submitters and the Experts have been combined below, as they largely overlap. The Expert Group's concerns with WUP are listed in para. 235 of its Report, an Appendix in the Factual Record. The concerns of the Submitters about WUP are found in paras. 227-229 of the Factual Record.

WUP Unable to Address All First Nations Concerns— The BC government's Water Use Planning Guidelines devotes a section to constitutionally protected treaty rights and aboriginal title in the context of WUP, stating that: "one of the Province's intentions in developing WUPs is to deal with First Nations issues." However, for historical grievances,

First Nations are directed to resolve claims through negotiation outside the WUP process. Impacts from current operations of BC Hydro facilities are to be considered through water use planning. In the WUP process, First Nations have the opportunity to review the draft plan as affected parties as part of Step 10, when the Comptroller is making a decision. First Nations representatives have limited appeal rights under the BC *Water Act*, described below.

Section 7 of the Quadra report discusses First Nations concerns with the WUP process, including the fact that there is no alternate process to WUP, which address historical grievances; First Nations unique status was not recognized in WUP processes; and First Nations did not have the resources to fully participate in the technical aspects of fisheries assessments.

Limited Applicability of WUP Process— The s.35 (2) *Fisheries Act* /CEAA process applies to any activity or undertaking that harmfully alters etc. fish habitat, which is a broader range of activities than the WUP process, as WUP is limited to new facilities, amendments to water licences, discretion of Water Comptroller, and by licensee request.

Analysis: The WUP process may be triggered when one of the four conditions outlined in the Water Use Planning Guidelines occurs, yet impacts to fish habitat could occur at a BC Hydro facility as a result of BC Hydro activities in a broader range of circumstances. And as WUP is a voluntary process, there is no guarantee that a WUP will be triggered when one of the four specified conditions does occur.

Limited Scope of WUP Process— The Submitters note that WUP fails to consider cumulative impacts, and the Expert Group expresses concern about using the potentially degraded state of habitat as the baseline from which WUP proceeds: "If arresting the ongoing decline in fish habitat quality at most facilities is a 'sufficient' outcome from WUP, as suggested by Canada, then this will compromise the long-term productivity of many important fish stocks".

Analysis: WUP will not remedy the historical impact of BC Hydro's operations, as WUPs are not intended to "address historic grievances from facility construction (Water Use Planning Guidelines, p.12)." [18] Though WUP is not meant to address historic grievances, in the absence of "a region wide vision and priorities for habitat conservation and management against which the individual projects can be judged" (quoting from the Expert Group report, para 235) the issue of cumulative impacts of BC Hydro operations on fish and fish habitat remains a critical issue, one that WUP will not tackle.

Limited Public Participation in WUP— The Submitters say the public is guaranteed greater access to information and greater levels of input under the combined s 35(2)/CEAA process, which also fulfills Canada's requirement under Article 7 (1) (b) of NAAEC to ensure that administrative proceedings are open to the public. The Experts also note that CEAA process, based in statute, contains a number of procedural requirements not present in the WUP process.

Analysis: The Submitters provide details about the greater degree of public participation available under the combined s. 35 *Fisheries Act*/CEAA process, which is uncontested by any other key stakeholders. In any event, it will likely still be necessary to follow the combined *Fisheries Act*/CEAA procedure after a WUP is approved and an amended water licence issued, raising questions about duplicative procedures.

Uncertain Legal Status of WUPs— The Submitters note that it is unclear whether the Comptroller can reject a completed WUP. Also, Hydro, the proponent, rather than the government, the regulator, largely directs WUP. The Experts say that WUP is not embodied in legislation or regulations, is purely voluntary and not mandated by any particular statute

Analysis: Other than the expressed intent of the Comptroller of Water to include approved WUPs as conditions of amended water licences for BC Hydro facilities, there is no basis in law to ensure that a draft WUP recommended by a Consultative Committee becomes binding on BC Hydro. The discretion about whether to implement a WUP is left firstly to the Comptroller to embody in licence terms and then to the licensee, BCH, to implement. There is no role for the public to shape or influence WUPs if they are not involved in a particular WUP process, and there remains great uncertainty about what action can be taken if the licence or permit conditions do not produce the intended benefits to fish or fish habitat.

The issue of whether a WUP can be rejected has not been tested. All the written documents provided by the provincial government and BC Hydro state that it is the intent of the Comptroller to issue amended water licences based on agreed upon WUPs. Water use plans "will form part of the BCH water licences and as such, be binding statutory instruments (Canada's response, Factual Record, p.57)". If there are continuing fish impacts, and if Canada

18 BC Hydro has established a separate coastal restoration program (BC Hydro Fish & Wildlife Bridge Coastal Restoration Program (http://www.bchydro.com/bcrp) to address "Footprint" impacts.

supports issuance of the WUP, Canada will issue "a single authorization to cover all impacts arising from the WUP operating parameters, with all mitigation and compensation embedded in the WUP (P 57 Factual Record citing WUP Management Committee's March 1999 Submission)."

Limited Reviewability of WUPs— Appeal rights are limited compared to the other potentially applicable federal procedures.

Analysis: The procedural safeguards and opportunities for public review are more limited in a WUP process than in a CEAA review. The differences between the two procedures are well documented by both the Submitters and the Expert Group in the Factual Record.

For example, if a WUP results in a licence decision by the Comptroller, an interested party has limited rights of appeal.

First, that party must have the legal right under the BC *Water Act* to appeal the licence decision. Only a licencee, riparian owner or applicant for a licence who considers that his or her rights would be prejudiced by the granting of a licence may object to the granting of a licence and the comptroller or regional water manager may decide whether or not to hold a hearing when receiving such an objection, pursuant to s. 11.

Second, only a person subject to an order, an owner whose land is or is likely to be physically affected by the order, or a licencee, riparian owner, or applicant for a licence who considers that their rights are or will be affected by the order can appeal an order of the comptroller, regional water manager or an engineer to the Environmental Appeal Board pursuant to s. 40 of that *Act*.

Then even if successful at the Environmental Appeal Board, a further review is possible from the Lieutenant Governor in Council. There are no procedural safeguards associated with this final review and no appeal from any LGIC decision is available. Contrast this set of options with the much broader set of appeal rights, including judicial review, available under CEAA.

"The limited range of people who can bring an appeal to the Environmental Appeal Board under this *Act* [the BC *Water Act*] makes it difficult to use the appeal mechanism to raise general watershed protection issues. However, if someone who holds a licence or land and is affected by the order is willing to appeal it, it is possible that the Board could be asked to consider such issues." (B.C. Guide to Watershed Law and Planning, 2003, online at http://www.bcwatersheds.org/issues/water/bcgwlp/).

Reliance on No Net Loss as the guiding objective for fish habitat

Analysis: The Expert Group details its concerns with the NNL policy of Fisheries and Oceans Canada in an extensive section of its Report (paras 32-54). The WUP process makes no change to nor does it suggest that any change is required for this federal government policy.

Failure to Address Integrated Nature of BC Hydro Operations— The Experts Group states that: "It is well known that impacts at individual sites will vary according to the way in which the entire system is operated and vice versa. Dealing with this issue from a fish habitat perspective would be facilitated if Canada were to have its own system wide objectives and priorities for fish habitat and conservation."

Analysis: An advantage of the WUP process is that it is tailored for the individual conditions present at each facility. As the Expert Group notes, a drawback is the fact that this reliance on facility-by-facility operations does not provide the 'big picture' outlook needed to manage the full range of BC Hydro's operations to eliminate harmful alteration, damage to or destruction of fish habitat.

Long-term Nature of the Process— Both the Submitters and the Expert Group were concerned about the length of time the WUP process was taking, since as the Expert Group noted: 'the longer the process takes to complete the greater will be the ongoing impacts on fish habitat.'

Analysis: The initial delays in WUP were extensive. Initiated in 1996, with the expressed intention of reviewing all BC Hydro projects within 5 years, by 2000, when the Factual Record was published, no WUPs had been completed though several Interim Orders had been issued for a select group of facilities to help mitigate impacts where sufficient current fisheries data were available. The process has speeded up considerably since then. As of April 2004, according to the BC Hydro web site, 18 WUPs have been completed, and 5 are in progress. Yet no amended water licence for a BC Hydro with an approved WUP had been issued as of April 2004.

Unclear Trade-Off Procedure— Each WUP requires trade-offs between power production and habitat protection, among other competing interests. Yet little guidance was provided by the government regulators on how the trade-offs between fish habitat protection and other water uses were to be made.

Analysis: As the Quadra report demonstrates, the process of trade-offs is a complex undertaking within each WUP,

and the method for resolving differences of opinion could have been assisted by higher-level guidance from the regulators. (see e.g., s.8, para 13 of the Quadra report). The guidance provided by the province in its document titled "Water Use Planning Guidelines" is minimal.

WUPs Must Be Accompanied by Other Enforcement Efforts— The Expert Group noted that WUP on its own will not address all habitat enforcement problems related to BC Hydro operations., The Submitters warned that the WUP process runs the risk of repeating the mistakes made in the US Pacific Northwest by spending enormous resources on a negotiated, stakeholder process that may ultimately provide little benefit because "ultimately, once the WUP Process is completed, BC Hydro will still be out of compliance with section 35 of the *Fisheries Act* unless an assessment under CEAA is conducted and an authorization under subsection (2) is issued."

Analysis: The federal government must fulfill its statutory duties under the *Fisheries Act*, and must prevent damage to fish habitat. WUPs were not intended to fetter the discretion of either the Comptroller or the Minister of Fisheries and Oceans to exercise the regulatory options conferred upon them by statute. The federal government will still need to enforce the *Fisheries Act* against BC Hydro even if a WUP is underway or completed. And a WUP will include measures to assess compliance, a monitoring plan, and the possibility of adaptive management. DFO may trigger review of a WUP if new issues or conflicts affecting fish or fish habitat emerge during a plan's implementation.

An example of a recent enforcement action taken against BC Hydro in the case of the Keenleyside Dam, a facility now undergoing a WUP process, is attached as Exhibit 1. The violation occurred when BC Hydro reduced flows from the Keenleyside Dam without authorization from Fisheries and Oceans resulting in stranding of juvenile fish, in July 2001. A settlement was reached in February 2004. In this case, no prosecution occurred, apparently because court action "could take many years and legal costs to resolve" (BC Hydro press release). BC Hydro instead agreed to pay $375,000 and undertake actions to prevent recurrence.

More Time Needed— The Expert Group said it was early to judge WUP and that more time would be needed to monitor its effectiveness.

Analysis: Monitoring both how each completed WUP is implemented as well as how the ongoing WUP processes for other facilities are proceeding is essential. The public members entrusted with participating on Consultative Committees for WUPs have a heavy burden in upholding the public interest. Unlike their fellow Committee members from government or industry, the public members are not paid and have invested significant volunteer time into the lengthy technical and complex procedures. The media has not paid much attention to this story. Public awareness of conflicts between dams and fish, to put it simply, is relatively low, and there is even less public awareness of WUPs as a means to resolve these conflicts.

2.2 Substantive Adequacy of WUP

Though it is still too early to judge the procedural merits of WUP (since no WUP has been translated into an amended water licence and it is unclear if that process will be accompanied by a s.35(2)/CEAA process), some substantive benefits from WUP are evident.

Improvements to fish habitat resulting from WUPs have occurred since the issuance of interim flow orders. A 2001 report from the Pacific Fisheries Resource Conservation Council, notes that "The utility [BC Hydro] operates more than 30 hydroelectric facilities, some of which are on British Columbia's richest salmon and steelhead streams and have caused substantial losses to the fish populations. However, water use planning has already been remarkably successful in redressing some of these past losses in salmon and steelhead habitat. Significant gains have already been realized through interim flow orders, part of the WUP process, at the Puntledge, Campbell, Alouette, Stave/Ruskin, Salmon, Heber, Coquitlam and Cheakamus rivers."

The Quadra report details the improvements in habitat protection that have resulted from the WUP process, concluding that in each case where a WUP has been developed, the changes to BC Hydro's operations have been an improvement to the status quo, even if not the optimal solution for fish habitat.

Of the seven negative impacts on fish identified by the Submitters, six have been addressed in WUPs, with the one exception being fish entrainment. As the Quadra report notes, the WUP process has had a number of benefits to date:

- Improved the knowledge base and better defined the flow requirements for fish conservation at BC Hydro facilities,
- Outcomes for fish conservation have generally been positive, although not without some compromise on lack of full consensus at some facilities, and
- Recommended flow alternatives better than the status quo in all cases.

The Quadra report emphasizes the need to continually examine WUP results, especially as the key monitoring phase approaches.

Other commentators generally rate the WUP process as beneficial for fish. Bill Green, executive director of the Columbia Inter-Tribal Fisheries Commission, stated in the CEC's newsletter, *Trio,* that while the WUP would probably have gone ahead anyway in the absence of the CEC complaint, he believes that without the factual record the WUP would have been a "much weaker" program. "It would have been a very different balance than what we're moving toward now."

Randy Christensen, SLDF counsel for the Submitters in the BC Hydro case, states that despite difficulties caused by the government's insistence on confidentiality and its inability to produce some key information related to the citizen submission, the BC Hydro citizen submission process was valuable in bringing attention the issues. Some commentators have also pointed to the indirect effect that the CEC citizen complaint procedure has had on enforcement of the federal *Fisheries Act* against BC Hydro. Academic studies have pointed to improvements in environmental law enforcement that while hard to measure are apparent. For example, Mark Goldschmidt, writing in the Boston College Law School Environmental Affairs Review, states that:

"...Although the Commission does not have the ability to directly dictate domestic behavior through the citizen submission process, the citizen submission process does affect domestic environmental behavior due to its transparent effect on domestic public and private decision-making and conduct. As a mechanism of transparency in publicizing environmental mismanagement and governmental failure to enforce environmental laws effectively, the citizen submission process and specifically the factual record is successful. Further, this mechanism has affected domestic behavior. Governments have been more responsive to citizen concerns, as in the case of BC Hydro ..."

A 2002 study undertaken by students at the McGill Law School for the Commission on Environmental Cooperation on the effectiveness of the CEC citizen submission process reached a similar conclusion. The BC Hydro case was one of the cases studies examined for this report. "Our study of the CSP, within the Canadian legal framework, shows that the process is an important review mechanism for governments to reflect on their method of enforcement. The process of producing the factual record not only draws the attention of the public, but also draws attention to issues within government agencies. Overall, our findings indicate that the role of the CSP in enforcement of environmental law is an indirect one. Although we were not able to prove that the CSP promotes government enforcement actions, we can conclude that it does bring light to a given situation."

2.3 More Time Needed to Assess How WUP Works in Practice

One of the Expert Group's main conclusions was that it was too early to judge whether WUP would be successful. Overall, the Expert Group said that WUP was an improvement over previous strategies to resolve harm to fish caused by BC Hydro operations and that the proof will lie in results over the next few years.

Similarly, one of the main factual statements in the Record was that not enough time had elapsed since the inception of WUP to be able to judge its effects: "The lesson for this Factual Record flowing from this central feature of the WUP process is that important information relevant to the effectiveness of WUP does not yet exist." ..."In sum, the WUP process holds promise as an enforcement strategy. Because the process is at an early stage, little information exists concerning the extent to which the WUP process will prove to be an effective enforcement strategy. Assessments of its effectiveness must await implementation of the process over the next several years...."

The Factual Record report concludes with a 'final statement' on the differing opinions on the WUP process, listing three outstanding questions from the Submitters and responses to each question from the government. It is still impossible to assess whether Canada's responses are adequate as one of the key events, issuing an authorization pursuant to s. 35(2) of the federal *Fisheries Act*, to a BC Hydro facility with an approved WUP and an amended water licence in place, has still not occurred.

So although four years have passed since this Factual Record was released it is still too early to decide whether the WUP process is adequate.

3. Conclusions

WHILE WUP HAS GENERALLY IMPROVED THE LEVEL of fish habitat protection in BC Hydro's operations, the procedural problems identified by the Submitters in the original CEC complaint remain. The adequacy of WUP as a response to the CEC complaint can be addressed on two levels: procedural and substantive.

First, the original problems with WUP identified by both the Submitters and the Expert Group were not addressed when WUP was implemented. The WUP process lacks a statutory base, lacks public participation opportunities compared to other applicable laws, could not resolve uncertainty about how trade-offs would be made in light of the federal *Fisheries Act*'s absolute prohibition on habitat destruction; and was unable to remedy the historical 'footprint' negative impacts of hydro operations.

The fact that it is the proponent of the work rather than the regulator who is running this planning process also creates concerns, even though Fisheries and Oceans signs off on a WUP as one of the stages in the process.

As WUPs have not yet been translated into amended water licences, it is impossible to reach conclusions about how the final stages of the process work in practice.

For example, if one of the Submitters wanted to challenge the amended water licence decision, would they have the legal standing to do so? What if they had participated in the Consultative Committee but had not signed off on the final recommended WUP? If an appeal of the WUP-approved licence is unsuccessful, other legal remedies, i.e. judicial review, are more restricted than with the combined CEAA/*Fisheries Act* procedure. The government has said that Fisheries and Oceans will issue a section 35(2) authorization for WUPs that will negatively affect fish habitat. If no authorization is issued, the original criticism of non-enforcement of the *Fisheries Act* remains. If an authorization is issued, CEAA is triggered with all its attendant public process. Will the federal government assert that WUP is legally equivalent to the CEAA process? Will a WUP be evidence in a federal environmental assessment procedure that the environmental implications of the decision have already been taken into account?

Many of the original legal questions will remain unanswered until the WUP process reaches a final, implemented stage in the regulatory sequence.

However, looking at the seven harmful impacts of hydro operation on fish habitat identified by the Submitters, the Quadra review concludes that six of those impacts are being seriously considered and addressed. Their report also concludes that WUP is a definite improvement over the old way of regulating and managing the often competing goals of power production and protection of fish habitat, though First Nations concerns have not been adequately addressed.

In summary, from a procedural point of view, WUP may not be the ideal public process that the government should be undertaking to balance the needs of fish with power production, but from a substantive viewpoint, fish habitat in and around hydroelectric facilities is now receiving a higher level of protection from both BC Hydro and the provincial and federal governments than in pre-WUP days. Monitoring will continue to be essential. And though four years have elapsed since the CEC Factual Record was released, more time is still needed to assess whether the WUP process has answered the concerns raised in the CEC Citizen Submission. Only when the final regulatory approvals have reached an end, and the monitoring data for fish in a WUP area have reached a critical mass, will the public be able to judge if this process is a success.

Appendix 1

Reprinted from BC Hydro web site at http://www.bchydro.com/news/2004/feb/release9863.html

February 18, 2004

BC HYDRO AND FISHERIES AND OCEANS CANADA REACH AGREEMENT IN FISH STRANDING INCIDENT NEAR HUGH KEENLEYSIDE DAM

CASTLEGAR — BC Hydro and Fisheries and Oceans Canada (DFO) have reached an agreement related to a July 2001 incident on the Columbia River that resulted in the stranding and loss of juvenile fish.

Under the agreement, BC Hydro commits to several measures designed to prevent a similar incident in the future and will pay the federal government a total of $375,000 to support conservation and protection of fish and fish habitat in the Columbia River basin. The agreement is an alternative to possible prosecution and court proceedings, which could take many years and legal costs to resolve.

In July 2001, BC Hydro reduced water flows at the Hugh Keenleyside (HLK) Dam, near Castlegar. The flow reduction did not have prior authorization from DFO. Despite efforts by BC Hydro to salvage fish, stranding and mortality of juvenile fish on the Columbia River resulted from dewatering and predation.

"Protection and conservation of fish and fish habitat is very important to BC Hydro. In partnership with DFO and Ministry of Water, Land & Air Protection, we are working hard through the Water Use Planning process and the Columbia Basin Fish and Wildlife Compensation Program to ensure enhanced habitat restoration and conservation efforts continue," said BC Hydro's Generation Sustainability manager, Kevin Conlin.

"This agreement is in the best interests of the public and fish," said Paul Macgillivray, DFO's Acting Regional Director. "A key for the Department is that BC Hydro has reaffirmed its commitment to define, through the Water Use Planning process, operational changes that recognize the need to protect fish and fish habitat in the Columbia River watershed."

BC Hydro has agreed to initiate studies and to develop established procedures, in conjunction with DFO, to reduce the potential for future fish stranding incidents. The studies include examining water flow changes at the Keenleyside and Duncan dams, and collecting information on fish populations such as whitefish and rainbow trout on the Lower Columbia River. BC Hydro will also develop a strategy to reduce the number of fish killed in turbines at its Columbia River dams.

The total payment of $375,000 includes:

- Payment of $60,000 by the end of January 2004 for the sole use by community groups in DFO-approved fish habitat conservation activities.
- Payment of $105,000 to DFO annually for three years, starting on April 1, 2004, for conservation of fish habitat in the Columbia River basin.

"Through this agreement, BC Hydro accepts responsibility for the environmental consequences of the incident," said BC Hydro's Associate General Counsel, David Avren. "Resolving the Hugh Keenleyside Dam fish stranding incident out of court helps uphold a positive working relationship between BC Hydro and Fisheries and Oceans Canada, and avoids lengthy and expensive court proceedings."

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