



Ash River Fish Passage Feasibility – Background Data Review

Final Report



Prepared for:

Bridge Coastal Restoration Program

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Prepared by:

Adam Lewis, M.Sc., R.P.Bio. and Kevin Ganshorn, M.Sc.

Ecofish Research Ltd.

on behalf of the Hupacasath First Nation



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EXECUTIVE SUMMARY

Background and Purpose

The Bridge Coastal Restoration Program (BCRP) addresses footprint fish and wildlife impacts in 15 watersheds affected by BC Hydro operations in the Bridge Coastal Generation area, including impacts to fish passage. In 2001 BC Hydro completed a project to assess the viability of providing anadromous fish passage at facilities in the Bridge Coastal Generation area (Benneyfield *et al.* 2001). The current report documents the background information pertinent to an assessment of fish passage, and the progress achieved during the period April 1 2005 and March 31 2006. This project was not completed because additional information is required to ensure that appropriate decision are made on which, if any, fish passage opportunities should be pursued. However, this report documents progress to date.

Construction of the Elsie Lake dams for the Ash River hydroelectric project began in the summer of 1957, was completed in July 1958, and the project came into service in 1959. As a result of the impoundment of Elsie Lake and the creation of the reservoir, potential access to what was formerly known as Elsie Lake was blocked to all fish in 1958. The Ash River watershed is a major component of the Somass-Stamp system, which is prolific producer of all 5 species of salmon, steelhead, and the Pacific lamprey.

Anonymous (1953, 1954 in Griffith 1993) states that anadromous fish were historically absent from Elsie Lake, with Dickson Falls blocking access to the Middle and Upper Ash River. It is also stated in Benneyfield *et al.* (2001) that anadromous fish did not access Elsie Lake when it was dammed. Thus, Dickson Falls has been considered by some to be a total barrier to passage of all species of anadromous fish prior to blasting at the falls in 1975-76. In contrast, traditional ecological knowledge (TEK) from the Hupacasath First Nation records recent as well as the ancient presence of anadromous fish in Elsie Lake and upstream tributaries.

Griffith (1993) surmised that Dickson Falls became navigable by summer run steelhead as a result of lower post-dam flows and selective blasting by provincial fisheries in 1977-78, but presented no conclusive evidence of prior absence. However, Hryhorczuk and Silvestri (2002) presented two separate 1974 stream survey records that documented steelhead in the 4.0-km section immediately downstream of the dam. They also cited personal communications with two MWLAP fisheries staff who stated that steelhead were observed above Dickson Falls during snorkel surveys in the early to mid 1970s, prior to blasting. In addition, Pacific lamprey were present in Elsie Lake at the time of construction (Beamish and Northcote 1989). Hupacasath Traditional Ecological Knowledge also states that coho salmon had historical access to Elsie Lake, however, there is no time frame associated with this knowledge. A log jam was removed from Dickson Falls in 1979-80 in the hopes that it would facilitate coho passage above the falls.

During 30 years of stock assessment in the Ash River watershed, there has been no record of coho adults or fry upstream of Dickson Falls. However, during 2005, coho juveniles were captured by BCCF staff in the Ash River upstream of Dickson Lake, documenting of successful coho migration. Two coho (2 year olds – 12 cm length) were identified in the Middle Ash during a 2005 BCRP study (Mike McCullough, Ministry of Environment, pers.comm.) This observation agrees with what was identified during the WUP, where First Nations Traditional Knowledge and some long time sport fishers said coho were found above the two falls.

At the present time, Elsie Lake Reservoir Dam acts as a barrier to upstream anadromous fish passage for summer run steelhead and Pacific lamprey. In conducting the feasibility assessment for restoring passage upstream of Elsie Dam for these anadromous species, we will follow the decision making framework outlined in Bocking and Gaboury (2002, also see Figure 1). There are 4 stages to this process, generally summarized in the following:

Stage 1 (Establish Stock and Habitat Profiles):

- a. Develop stock profiles by compiling historical data on fish species above and below Elsie Dam, focusing on anadromous species. Interviews of elders of local First Nations with Traditional Ecological Knowledge (TEK) will be conducted. Target stock(s) will be identified and a risk analysis of potential impacts to resident stocks above the dam will be undertaken.
- b. Fish habitat profiles will be developed for areas above and below Elsie Dam using existing data. Data gaps in habitat capability assessments or enhancement options will be highlighted.

Stage 2 (Establish Operational Profile):

Flow and water levels required for target fish passage will be examined in relation to current operational profiles. All options specific to Elsie Dam for passing fish will be outlined in detail. Water quality, flooding, and public safety concerns will be factored into the analysis to complete the operational profile.

Stage 3 (Establish Structural Profile):

Potential fish passage designs most suited to Elsie Dam will be examined and ranked for cost and effectiveness. A MWLAP engineer (J. Bomford, Victoria) will provide advice and preliminary designs. Additional funds may be requested from BCRP should design and testing of a scale model be required.

Stage 4 (Cost-effectiveness):

The ecological, commercial, cultural, and biodiversity values associated with restoring fish passage at Elsie Dam will be examined in a cost/benefit analysis of preferred options.

The feasibility assessment is currently at Stage 1, i.e., we are in the process of building the stock and habitat profiles in the Ash River watershed both above and below Elsie Dam. We have reviewed all of the literature known to us on the fisheries work that has been performed in the Ash River watershed. In doing so, we have determined the historical presence of anadromous fish in the Ash River above the Elsie Dam prior to dam construction as discussed above. We have also compiled and/or summarized much of the fish and fish habitat data that has been collected in the watershed to date.

Study Area

The Ash River watershed is located on central Vancouver Island approximately 30 km northwest of Port Alberni at its closest point (Figure 2). The headwaters of the Ash River are in Strathcona Provincial Park with the remainder of the river flowing south between the park to the west and the Beaufort mountain range to the east. The Ash River is a tributary to the Stamp River, which in turn flows into the Somass River, and eventually into Alberni Inlet. The mean basin elevation is 700 m. Much of the watershed is covered in old-growth forest (38.0% coverage, >140 years old, >6 m tall) and young forest (35.5% coverage, <140 years old, >6 m tall). About 13.2% of the watershed has been recently logged, and the remainder of the watershed is comprised of alpine (3.75%), fresh water (3.65%), sub-alpine avalanche chutes (3.12%), glaciers and snow (1.27%), wetlands (1.25%), and barren surfaces (0.17%).

The Ash River is comprised of two sub-basins: the upper (Oshinow Lake and above) and lower (downstream of the Oshinow Lake outlet). BC Hydro facilities are located in the lower sub-basin and most of the fisheries work in the watershed has been conducted in this sub-basin. The lower sub-basin can be broken into three distinct sections as per the Ash River Water Use Plan (Ash River Water Use Plan Consultative Committee 2003): the Upper, Middle, and Lower Ash River. The Upper Ash River is a 13.7 km long section from the outlet of Oshinow Lake to the inlet to Elsie Lake Reservoir. The 10.7 km section downstream of Elsie Lake Reservoir to the inlet of Dickson Lake is considered to be the Middle Ash River. The 12.4 km long section from the outlet of Dickson Lake to the confluence of the Ash River with the Stamp River is considered to be the Lower Ash River.

The Ash River hydroelectric facility consists of Elsie Lake Reservoir which was created following the construction of Elsie Dam at the outlet of Elsie Lake (i.e., the Ash River) and four saddle dams, approximately 30 km northwest of Port Alberni (Figure 2). Water is diverted from the southern side of Elsie Lake Reservoir, about 5 km southwest of the dam, and flows through a 4 km long tunnel and a 3.4 km long penstock, dropping 248 m to a 25.2 MW (dependable capacity is 27 MW) powerhouse located on the north shore of Great Central Lake. There is currently no fishway present at Elsie Dam.

Following the completion of Elsie Dam, 401 ha of land were flooded. This resulted in the loss of 5 km of mainstem habitat in the Ash River upstream of Elsie Lake, or 30 ha of channel habitat and 30 ha of riparian habitat (BC Hydro 2000). Other tributaries to Elsie Lake were also flooded resulting in the loss of 5 km of tributary habitat including 14 ha of riparian habitat (BC Hydro 2000). The flooding of Elsie Lake also resulted in the loss of 72 ha of wetland habitat. There are only 4 tributaries to Elsie Lake Reservoir with substantial year-round flow: the Upper Ash River, Ramsay Creek, Katlum Creek, and Creek #2 (Burt and Robert 2003). These streams all support resident fish while summer steelhead are known to access the Upper Ash River and possibly Ramsay Creek (this is uncertain as steelhead have been stocked in the Ramsay system).

Average flows of 10.7 cms are diverted to Great Central Lake throughout the year, except during a 1-2 week maintenance outage which usually occurs in August (BC Hydro 2000) and when the reservoir is below an elevation of 317.91 m to conserve water for future fish flow releases. The normal drawdown range of Elsie Lake Reservoir is 15 m, about 50% of the reservoir's maximum depth of 30 m.

Water may be released into the Ash River by spilling water over the spillway or by releasing water through the spillway dam sluiceway. Water is continuously released into the Ash River downstream of the dam via a 60 m long, 2.44 m wide compensation culvert through Saddle Dam 1 so that there is a minimum flow of 3.5 cms to provide for fish habitat in the Lower and Middle Ash River (BC Hydro 2003). This minimum flow release applies to the period of May 1 to October 31. From November 1 to April 30, the minimum flow release is 5 cms (BC Hydro 2003). However, during this latter period there is a requirement to have a minimum flow release on two separate occasions such that flow at the WSC Moran Creek gauge is at least 10 cms over a 48 hour period (BC Hydro 2003). The purpose of this extra flow release is to facilitate the passage of steelhead above Lanterman and Dickson Falls in the Lower Ash River. As a result of flow releases from Elsie Lake Reservoir, Ash River flows from early August through November are now generally higher than they were prior to the impoundment of Elsie Lake (Ash River Water Use Plan Consultative Committee 2003).

There is one active Environment Canada hydrometric station in the Ash River watershed: Ash River below Moran Creek (Station # 08HB023, Environment Canada 2005), located 1.5 km upstream of the mouth. From May to July, the Ash River experiences a smooth peak inflow due to snowmelt with low inflows from August to September (BC Hydro 2000). In November the Ash River receives slightly lower, but more volatile peak inflows due to rain events (BC Hydro 2000). The maximum discharge of the Ash River at station 08HB023 is 532 m³/s, the minimum discharge is 1.6 m³/s, and the mean discharge is 16.7 m³/s (Environment Canada 2005).

Barriers & Anadromous Fish Distribution Limits

An examination of literature prior to the completion of Elsie Dam does not give any indication that there may have been a barrier to anadromous fish passage at the outlet of Elsie Lake. Two surveys of the Ash River done in 1953 and 1954 identify Dickson Falls (in the Lower Ash River) as the upstream migration limit of all salmonids (Anon. 1953 and Anon. 1954 in Griffith 1993). Similarly, Crippen Wright Engineering Ltd. (1956), Anon. (1959), Photographic Survey Corporation Ltd (1956), and Anderson *et al.* (1959) do not give any indication of a barrier at the outlet of Elsie Lake prior to its impoundment.

Fish passage was examined by Griffith (1993) at three barriers and by Lewis (2001) at four barriers in the Ash River downstream of Elsie Dam. In the examination by Lewis, the focus was on steelhead passage. The barriers include (from the mouth upstream): Ash mouth riffle (only Lewis 2001), Lanterman Falls, Dickson Falls, and Ash Island Falls. The most significant barrier to fish passage on the Ash River is the Elsie Lake Reservoir Dam.

Ash mouth riffle is a broad cobble/gravel riffle located upstream of the Stamp River confluence with a narrow slot along the right bank. The riffle appeared passable to steelhead at the time of survey (flow of 5 cms) and is also known to be passable to chinook (FWD 2005), coho (FWD 2005), chum (Griffith 1993), sockeye (Griffith 1993), and pink salmon (Hansen 2003 – App. 1) as well as Pacific lamprey (Beamish and Northcote 1989).

Lanterman Falls is approximately 4.7 m in height and is located 5.80 km from the mouth of the Ash River in the Lower Ash River. At a flow of 11.3 cms, the height ranges from 4.12-4.67 m (Griffith 1993). It acts as a barrier to the passage of chinook, chum, sockeye, and winter steelhead (Burt and Lewis 2004). Note that Fish Wizard (FWD 2005) shows chinook to be present above Lanterman Falls, however, this was not confirmed in any of the reviewed literature. Coho adults (from snorkel surveys, Mike McCulloch, BCCF, pers. comm.) and fry (Appendix 2 in Lewis 2001, 300 m above the falls) have been observed above the falls. Summer steelhead and Pacific lamprey can also ascend Lanterman Falls. Lewis (2001) made the assessment that the falls was passable via the northern route at a flow of 3.5 cms (from Elsie Lake Reservoir, 4.35 cms at WSC 08HB023) and Griffith (1993) made the same assessment at an observation flow of 11.3 cms. Lewis conjectured that access at Lanterman Falls would improve at flows of 7 cms relative to 3.5 cms.

Dickson Falls is 9.24 m in height and is located 10.88 km from the mouth of the Ash River in the Lower Ash River, or about 1.38 km downstream of Dickson Lake. Other than Elsie Lake Dam, this is the most serious obstacle to fish passage on the Ash River. This falls is an obstacle but not a barrier for coho salmon, summer steelhead and Pacific lamprey.

Selective blasting of Dickson Falls was carried out by the BC Fish and Wildlife Branch in 1977-78. Prior to blasting, summer steelhead could already ascend the falls (Hryhorczuk and Silvestri 2002), though they held below the falls for prolonged periods, indicating this falls

was an obstacle to passage. In 1979-80 BC Fish and Wildlife] removed a log jam on Dickson Falls in the hopes that it would facilitate the passage of coho salmon. Although 30 years of stock assessment in the Ash River watershed shows no record of coho adults or fry upstream of Dickson Falls (Ash River Water Use Plan Consultative Committee 2003), work during 2005 confirmed their presence. Moreover, Traditional Ecological Knowledge from the Hupacasath First Nation states that coho have historically accessed Elsie Lake.

Ash Island Falls is a series of 3 falls located 18.18 km from the mouth of the Ash River in the Middle Ash River, 3.51 km upstream of Dickson Lake. One set of falls is approximately 2.5 m in height and is located about 50 m above Ash Island. Another falls located in the channel passing on the right side of Ash Island is about 1.8 m in height. The third and smallest falls is about 1.5 m in height and is located on the left side of Ash Island. Ash Island Falls is not a barrier to summer steelhead or Pacific lamprey passage, and it is uncertain if coho, chinook, chum, sockeye, or winter steelhead could ascend these falls if access was facilitated. These falls were surveyed by Lewis (2001) at flows of 3.5 cms (4.35 cms at WSC 08HB023). At this flow, Lewis felt that all 3 falls were passable by summer steelhead. Griffith (1993) felt that steelhead would be able to ascend the falls on the east side over a broad range of flows.

The dam at the outlet of Elsie Lake Reservoir is 30.5 m in height and is located 25.32 km upstream from the mouth of the Ash River in the Middle Ash River, or 10.65 km upstream of Dickson Lake. It represents a barrier to the passage of all fish and is currently blocking the passage of summer run steelhead trout and Pacific lamprey.

Present Fish Resources

Lower and Middle Ash River and Tributaries

The main anadromous species supported by the Lower Ash River are steelhead, coho, chinook, and Pacific lamprey (FWD 2005). There have been reports of small numbers of chum and sockeye salmon in the lower 0.5 km of the river and possibly winter steelhead in the lower 1-2 km (Griffith 1993). There have also been reports of small numbers of pink salmon in the lower 4.4 km of the river. There are three major tributaries to this section of the Ash River which support both resident and anadromous fish: Moran Creek, the Wolf Creek drainage, and the Lanterman Creek drainage.

Dickson Lake and the Middle Ash River are only accessible to summer steelhead (Burt and Horchik 1999) and the Pacific lamprey (Beamish and Northcote 1989). Tributaries to the Middle Ash River are not known to support anadromous fish.

Resident species that inhabit the Lower Ash River include rainbow trout, cutthroat trout, stickleback, and pumpkinseed (exotic species). Stickleback and pumpkinseed are restricted to the Lower Ash River (Griffith 1993), whereas there are rainbow trout, cutthroat trout, and

Dolly Varden populations above Dickson Falls, in Dickson Lake, and in the Middle Ash River up to Elsie Lake Dam. Of these species, the two most abundant are rainbow trout followed by cutthroat trout. There are a few tributaries to the Middle Ash River that support resident fish: Turnbull Lake outflow (assumed based on the presence of cutthroat trout in Turnbull Lake, FWD 2005) and two tributaries just downstream of Elsie Lake Reservoir (Griffith 1993).

a. Steelhead Trout

The Lower Ash River may support a small winter run population of steelhead, however, Lanterman Falls acts as a barrier to upstream migration (Burt and Lewis 2004). Griffith (1993) suspects that winter steelhead only use the lower 1-2 km of the Lower Ash River.

Hirst (1991, in Griffith 1993) reports historic estimates (i.e., pre-1958) of steelhead to be around 1,500 in the Ash River. Summer steelhead counts have been performed from 1983 to 2004 over a distance of 4.4 km in Lower Ash River from the bridge upstream of Lanterman Falls to the confluence with the Stamp River. Counts ranged from 18 to 165 individuals with a mean of 75 ($n = 12$, S.D. = 48). Griffith (1993) observed 30 and 31 steelhead adults downstream of Lanterman Falls in snorkel surveys conducted in November 1992 and May 1993, respectively.

Snorkel surveys of the Middle Ash River were carried out by the B.C. Conservation Foundation (BCCF) in 2001 and 2002. In the September 2001 survey, they observed 84 adult steelhead, of which at least 64 were wild fish. In the January 2002 survey, only 1.2 km of the Ash River downstream of the confluence of the Elsie Lake Reservoir spillway and the low level outlet channel was examined. There were 13 adult steelhead observed on this swim, 5 of which were wild. In February 2002, three adults were observed in the same section, and no fish were observed in a spot swim at the Ash River Road bridge.

Burt and Horchik (1998) estimated the rearing population density and the rearing capacity in 1996 (August to October) for steelhead fry (0+) and yearlings (1+) in the Lower Ash River, the Wolf Creek drainage, the Lanterman Creek drainage, and the Middle Ash River. The Lower Ash River, Wolf Creek drainage, and Lanterman Creek drainage were estimated to contain fry populations numbering 32,753 (73% capacity), 27,692 (74% capacity), and 3,500 (20% capacity), respectively. Yearling abundances in the Wolf and Lanterman Creek drainages were estimated to be 662 (42% capacity) and 139 (6% capacity), respectively. In the entire Lower Ash River watershed (i.e., Lower Ash River plus Wolf and Lanterman Creek drainages), there was estimated to be 65,945 steelhead fry (65% of capacity) and 801 steelhead yearlings (21% capacity; only Wolf and Lanterman Creek drainages).

Over the same time period, the Middle Ash River was estimated to contain 23,518 fry (59% capacity). No yearlings were sampled in the Middle Ash River.

Assessment of juvenile steelhead abundance was carried out at four electrofishing sites in the Middle Ash River in 2001 within 1,500 m of the low level outlet (Hansen 2003). Adjusted (depth and velocity) fry abundance estimates were 61, 21, 3, and 115 fry per 100 m² (geometric mean = 26.5 fry per 100 m²).

b. Coho Salmon

Dickson Falls is an obstacle but not a barrier to the migration of coho in the Ash River. Coho are also present in the three major tributaries to the Lower Ash River: Moran Creek, the Wolf Creek drainage, and the Lanterman Creek drainage.

There are no coho escapement records for the Ash River. Hirst (1991, in Griffith 1993) reports historic estimates (i.e., pre-1958) of coho in the Ash River to be around 1,500. In a snorkel survey conducted in September 2001 from the old bridge upstream of Lanterman Falls downstream 4.4 km to the confluence of the Ash River with the Stamp River, 78 coho were observed (~50% hatchery, 65 in pool at Moran Creek confluence) (Hansen 2003 – App. 1).

Stamp River coho escapement estimates indicate that the population crashed in the early 1980's and again in the early 1990's. The most recent estimate of 25,697 (1998) suggests that the population has recovered to numbers typical of that observed from 1953 to 1965. There was a general increase in escapements from the late 1960's through to the mid 1970's which could be due to either 1) opening of the Robertson Creek spawning channel in 1960, 2) the release of large numbers of coho into the systems by the Robertson Creek Hatchery beginning in 1974, and/or 3) fertilization of Great Central Lake since 1970 (intended to increase sockeye production).

Griffith (1993) estimated the density and theoretical capacity of juvenile coho (0+) in flowing hydraulic habitat in the Lower Ash River (downstream of Lanterman Falls), the Wolf Creek drainage, and the Lanterman Creek drainage by applying habitat use relationships from Lake Ontario. He concluded that there is a general lack of coho habitat in the Ash River mainstem due to the nature of the stream (swift, cobble/boulder cover) as there were 150 fish per 100 m² (191% of capacity). However, Burt and Horchik (1998) estimated there to be 7,250 fry (37% capacity) downstream of Lanterman Falls.

In the Wolf Creek drainage below the falls, Griffith (1993) estimated the mean 0+ coho density to be 13 fish per 100 m² (66% of capacity) and above the falls it was 24 fish per 100 m² (71% of capacity). Burt and Horchik (1998) estimated the Wolf Creek drainage fry population to be 1,272 (24% capacity).

In the Lanterman Creek drainage downstream of the barrier falls, the mean sampled 0+ coho density was 12 fish per 100 m² (47% of capacity) (Griffith 1993). Burt and Horchik (1998) estimated the Lanterman Creek drainage fry population to be 40 (0.4% capacity).

Sampling in isolated pool habitats in ephemeral stream channels in Moran Creek, the Wolf Creek drainage, and the Lanterman Creek revealed that these habitats are oversaturated with coho juveniles (63 to 415 juveniles per 100 m², 122 to 13,607% capacity) (Griffith 1993).

c. Chinook Salmon

The upstream migration limit for chinook salmon in the Ash River is Lanterman Falls. There are no records of chinook in either the Wolf or Lanterman Creek drainages which are located downstream of Lanterman Falls (FWD 2005).

Little is known about the salmonid use of the Ash River other than for coho (Griffith 1993). Data from 1991-1992 indicates that the chinook run in the Ash River consisted of about 250-300 individuals (based on counts from snorkel swim surveys in Griffith 1993). Most of these individuals were observed in the lowermost 0.5 km of the Lower Ash River.

There are no escapement records for the Ash River. Prior to 1985, chinook escapements for the Stamp River were consistently less than 20,000. Escapements began to increase in 1985 peaking at 130,000 in 1990, and began to decline again around 1992 to the most recent estimate of 32,049 (1998).

Burt and Horchik (1998) estimated the capacity in 1996 for chinook presmolts (0+) in the portion of the Lower Ash River downstream of Lanterman Falls to be 7,063 individuals. No estimate of the rearing population size was made since fish had left the river before surveys were conducted.

d. Pacific Lamprey

The upper distribution limit for Pacific lamprey is currently Elsie Lake Reservoir Dam. Prior to the impoundment of Elsie Lake, Pacific lamprey could access the lake and may have utilized the Upper Ash River watershed (Beamish and Northcote 1989).

Larvae and one adult (45 cm) have also been captured in the lower section of Wolf Creek (Griffith 1993) in the Lower Ash River watershed. In the Middle Ash River immediately downstream of Elsie Dam there were 364 ammocoetes (larval lamprey) caught on May 1, 1986. In September 1987, 318 ammocoetes and 11 metamorphosed fish were caught at the same location. Adult lamprey may have been abundant in Ash River watershed prior to 1959 as indicated by counts of adult lamprey moving through an artificial fish bypass on the Stamp River which ranged from 20,000 to 50,000 (Beamish unpubl. data in Beamish and Northcote 1989).

e. Chum Salmon

Lanterman falls is likely the upstream migration barrier for chum. Data from snorkel surveys conducted in 1991 and 1992 indicates that the chum run in the Ash River consists of only a few individuals. There are no records of chum in either Wolf or Lanterman Creeks in the Lower Ash River watershed (FWD 2005).

Compared to coho and chinook, escapements of chum to the Stamp River are substantially smaller with maximum estimates of only 7,500 (4 years, all in the 1950's). From the 1960's to 1998, escapements were highly variable and ranged from 0 to 7,000 and were typically less than 3,500. The general trend from the mid 1970's to the mid 1990's was one of decline, however this decline may be artificial due to changes in enumeration methodology beginning in the early 1980's.

f. Sockeye Salmon

Lanterman falls is likely the upstream migration barrier for sockeye. The sockeye run in the Ash River consists of only a few individuals (Griffith 1993). In a snorkel survey conducted in September 2001 from the old bridge upstream of Lanterman Falls downstream 4.4 km to the confluence of the Ash River with the Stamp River, 3 sockeye were observed (Hansen 2003 – App.1). There are no records of sockeye in either Wolf or Lanterman Creeks in the Lower Ash River watershed (FWD 2005).

There are no escapement records for the Ash River. Sockeye escapements to the Stamp River were relatively consistent from the early 1950's to the mid 1960's with estimates typically being 35,000 individuals. From the mid 1960's to the early 1990's there was a general increase in sockeye escapements which peaked in 1991 at 648,500. Following 1991 there was a general decrease in escapements, although they remained relatively high ranging from 167,634 to 434,933.

g. Pink Salmon

Pink salmon are not native to the Stamp-Somass system (which includes the Ash River) (Burt and Horchik 1998). In a snorkel survey conducted in September 2001 from the old bridge upstream of Lanterman Falls downstream 4.4 km to the confluence of the Ash River with the Stamp River, 6 pink salmon were observed (Hansen 2003 – App.1). The last substantial return to the Stamp-Somass system was 500 individuals in 1976.

h. Resident Fish

Resident fish species present in the Lower and Middle Ash River include rainbow trout, cutthroat trout, Dolly Varden, pumpkinseed, and sticklebacks.

In the Lower Ash River, cutthroat trout have been observed at the confluence with the Stamp River, in the Wolf Creek drainage, the Lanterman Creek drainage, and between the outlet of Dickson Lake and Dickson Falls. An apparently allopatric population is found above the barrier falls located on Lanterman Creek. Griffith (1993) states that the populations in Wolf and Lanterman Creeks were low density, but did not report the densities separate from that of rainbow trout. There is evidence of rainbow-cutthroat hybridization in both the Wolf and Lanterman Creek drainages with most fish being rainbow trout.

Cutthroat trout are present in Dickson Lake, Ash Lake, and McLaughlin Lake. Upstream of Dickson Lake in the Middle Ash River cutthroat abundance is low. They are known to be present in Turnbull Lake (FWD 2005) and in the Ash River near Elsie Lake Dam (Griffith 1993, one fry sampled in 1992). There is some evidence of hybridization with rainbow trout in the Middle Ash River (1 fish) and in two small Middle Ash River tributaries just downstream of Elsie Lake Dam (a few fish caught). The Ministry of Water, Land, and Air Protection considers the 800 m reach immediately downstream of Elsie Lake Reservoir to be important steelhead and trout habitat.

Rainbow trout have a similar distribution to cutthroat trout in the Lower Ash River, although their abundance is greater throughout the Lower Ash River (Griffith 1993). They are also present in Moran Lake. In between the Lower and Middle Ash River, rainbow trout are present in Dickson Lake and Ash Lake (FWD 2005). Upstream of Dickson Lake in the Middle Ash River rainbow trout are the dominant resident species and are present both below and above Ash Island Falls.

Dolly Varden have been observed at the mouth of the Ash River and in Dickson and Ash Lakes. Dolly Varden may be present throughout the Middle Ash River as indicated by the capture of 2 fry near Elsie Lake in 1991.

Griffith (1993) captured pumpkinseed (introduced species) in 1992 in the lower section of the Lower Ash River and in Moran Lake and concluded that their distribution is limited to the portion of the Ash River drainage downstream of Lanterman Falls.

Griffith (1993) captured sticklebacks in 1992 in Moran Lake and concluded that their distribution is limited to the Lower Ash River downstream of Lanterman Falls.

Elsie Lake Reservoir

a. Anadromous Fish

There are currently no anadromous fish species naturally present in Elsie Lake Reservoir. However, summer steelhead (juveniles) have been stocked in the reservoir, but that program ended in 1997 (FWD 2005). In January 2005, approximately 60 tagged adult summer

steelhead were stocked in Elsie Lake Reservoir to investigate the extent to which the fish could access the Upper Ash River.

The Pacific lamprey was historically present in Elsie Lake, but failed to establish a landlocked population following impoundment of the lake (Beamish and Northcote 1989). There are no records of lamprey abundance in Elsie Lake (Beamish and Northcote 1989). However, during the period of lamprey attacks on Elsie Lake Reservoir trout following completion of the dam, the scarring rate of captured trout was as high as 76.6%. This suggests that Elsie Lake may have supported a relatively large larval lamprey population prior to impoundment of Elsie Lake (Beamish and Northcote 1989).

b. Resident Fish

Resident fish species present in Elsie Lake Reservoir include rainbow and cutthroat trout, as well as rainbow/cutthroat hybrids (Triton 1995, Burt and Robert 2003). Both species were present in Elsie Lake prior to its impoundment (Beamish and Northcote 1989). Kokanee have been observed in the pool below the reservoir's spillway (Rick Axford, MWLAP, pers. comm.), but are thought to be uncommon in the reservoir as they have not been detected in any other studies.

Prior to the impoundment of Elsie Lake, the trout population was comprised of roughly half-and-half rainbow and cutthroat trout (1953). Since this time, there has been a general trend towards dominance by rainbow trout. The most recent sampling in August 2002 indicates that over 93% of the trout in Elsie Lake are rainbow.

Length frequency data for rainbow (Triton 1995 and Burt and Robert 2003) and cutthroat (Burt and Robert 2003) trout captured in Elsie Lake was plotted as the percentage of the cumulative total catch versus length category (Figure 23). The data suggest that in 2002 the rainbow trout population consisted of a higher percentage of smaller individuals (< 180 mm) than in 1994. The curve for cutthroat trout indicates that the population is composed of larger individuals than the rainbow trout population, most likely due to life history differences as cutthroat spend more time rearing in tributary streams thereby making it less likely that small individuals will be caught in Elsie Lake Reservoir.

In 2002, the rainbow population in Elsie Lake Reservoir was dominated by ages 2, 3, and 4 with the percentage of each age being between 28.8%, 31.9%, and 28.1%, respectively (n = 160). The cutthroat population was dominated by older individuals with 4 year olds comprising 66.7% of the population (n = 12).

Rainbow trout age and length data for Elsie Lake Reservoir from 1994 and 2002 were combined and plotted to determine the relationship between the two parameters. The relationship is shown in Figure 27 and the equation describing the relationship is generated from a logarithmic fit of the data is:

$$\text{Rainbow Trout Age} = 2.88 * \ln(\text{length (mm)}) - 12.39 \quad (r^2 = 0.78)$$

Tributaries to Elsie Lake Reservoir (Including the Upper Ash River)

a. Fish Captures

Compared to the Lower and Middle Ash River, there has been relatively little work done on fish distribution in tributaries to Elsie Lake Reservoir (including the Upper Ash River). Since no anadromous species can currently access Elsie Lake Reservoir, there are no anadromous fish naturally present in the tributaries to the reservoir. The tributaries most likely to be used by any anadromous species which may eventually be provided with access to Elsie Lake Reservoir are the Upper Ash River, Ramsay Creek, Katlum Creek, and Creek #2. These tributaries can contribute as much as 99.87% of the Elsie Lake Reservoir inflow with the majority of the other tributaries being small and dry for at least part of the year.

The only resident fish species present in tributaries to Elsie Lake Reservoir are rainbow and cutthroat trout, and possibly some hybrids of the two species. Burt and Robert (2002) electrofished 6 total removal sites in the 4 major tributaries (Upper Ash River, Ramsay Creek, Katlum Creek, and Creek #2). The length frequency distribution of all juvenile trout captured at these sites indicates that tributary populations are dominated by 0+ individuals (88%), followed by 1+ (9%), and then 2+ (3%).

For sites below resident barriers, trout fry density ranged from 59-237 fish per 100 m² and parr density ranged from 0-37 fish per 100 m². The highest densities of both fry and parr were found in Katlum Creek and Creek #2, likely because these creeks have easy access at their mouths (in spring) as well as pockets of spawning gravel close to the mouth.

For sites above resident barriers (i.e., Katlum Creek and Upper Ash River), there were contrasting results. Katlum Creek had a very high density of fry (239 fish per 100 m²) whereas the Upper Ash River had the lowest fry density among all sample sites (6 fish per 100 m²). Parr were not caught at these sites.

Adjusted biomass estimates expressed as a percentage of the theoretical maximum biomass provides a measure of habitat saturation, and the 2002 results show that several sites had a trout biomass that were close to or exceeded the theoretical capacity (e.g., Creek #2 (both fry and parr age groups), the upper (fry) and lower (parr) Katlum Creek sites. On the other hand, habitat in the sampled areas of Ramsay Creek and the Upper Ash River appear to be underutilised by both trout fry and parr.

b. Habitat Surveys

When Elsie Lake Reservoir is at full pool, there is no stream habitat within the drawdown zone for trout spawning, whereas at lower reservoir levels there is substantial spawning

habitat for trout within the drawdown zone. As the elevation of the reservoir increases, the rearing habitat within the drawdown zone also decreases, however the quality of rearing habitat has not been assessed. Thus, to maximize spawning and rearing habitat in the lower portion of Elsie Lake tributaries, the reservoir level would have to be kept low during spawning, incubations, and rearing periods.

It was deemed that suitable anadromous spawning gravels are only present in the Upper Ash River, Ramsay Creek, Katlum Creek, Creek #2, and Creek #6b (but it is ephemeral) (Burt and Robert 2003). The Upper Ash River has excellent fish habitat (Horncastle 1978), but a 3.6 m falls located about 0.5 km upstream of the Elsie Lake Reservoir may limit fish access. This is not a barrier to steelhead as BCCF released about 60 tagged summer steelhead adults into Elsie Lake Reservoir in January 2005 and C. Robert observed test digging of redds in Gretchen Creek in the spring of 2005, well upstream of this barrier. There is a log jam barrier (which has created a 3 m fall onto a bedrock shelf) on Katlum Creek and it is only likely to be a barrier to anadromous fish passage at certain flows (C. Robert, Ecodynamic Solutions, Courtenay, pers. comm.). In the lower portion of Creek #2 there is a 5 m falls, which is thought to be a barrier to anadromous fish passage (C. Robert, Ecodynamic Solutions, Courtenay, pers. comm.)

Lewis (2001) conducted a study on Elsie Lake Reservoir tributary habitat within the drawdown zone during a period of large drawdown (reservoir elevation ~318.7 m). In streams that could potentially support anadromous fish, there is 36,602 m² of potential spawning habitat within the drawdown zone, 91.7% of which is located within the Upper Ash River (note these numbers are modified from Lewis (2001) as per the data presented in Burt and Robert (2003). Both the highest quality and quantity of spawning habitat lies in the lowermost sections of the drawdown zone on most of the 20 tributaries examined. Rearing habitat was also quantified in Elsie Lake Reservoir tributaries as a function of reservoir elevation and it was determined that the amount of rearing habitat available steadily declines as reservoir elevation increases. There is only 1.2-2.1 km of Elsie Lake Reservoir tributary habitat available for resident juvenile rearing.

Upstream of the Upper Ash River

The upstream boundary of the Upper Ash River is considered to be the outlet of Oshinow Lake. Above this point, the only fish known to be present are steelhead (stocked), rainbow trout, and cutthroat trout (FWD 2005). Fish Wizard (FWD 2005) indicates that steelhead are also present in Toy Lake, which they must access via Oshinow Lake. These fish were originally stocked about halfway between Elsie Lake Reservoir and Oshinow Lake, which implies that steelhead can access the entire Upper Ash River as there are no significant barriers to their passage downstream of the stocking point.

Ash Watershed Stock Exploitation and Enhancement

a. Stock Exploitation

The Fish Information Summary System (FISS 2006) Ash River report provides a small amount of information on recreational fishery use of the Ash River. Prior to 1979, 1,000 angler days was typical and the 1988 average was 129 days.

According to the Provincial Steelhead Harvest Analysis Database, the mean number of days fished per year for steelhead in the Ash River from 1968 to 2004 is 343 ($n = 37$, $SD = 372$) with a minimum of 33 days and a maximum of 1,409 days fished. Over the same period the mean wild steelhead catch was 176 ($n = 37$, $SD = 146$) with a minimum of 0 fish and a maximum of 601 fish caught. There were no hatchery fish caught in the Ash River prior to 1981. From 1981 to 2004 the mean hatchery catch was 24 ($n = 23$, $SD = 26$) with a minimum catch of 0 and a maximum catch of 96. From 1968 to 2004, the mean CPUE (wild and hatchery combined, units of steelhead catch per day) was 0.79 ($n = 37$, $SD = 0.53$) with a minimum of 0.16 and maximum of 2.67.

From the late 1960's to the early 1980's there was a general decline in the steelhead catch while the CPUE remaining relatively stable ranging from 0.16 to 0.57 (typically less than 0.50) (Figure 31). Hatchery fish began to be caught in 1983 and there is no clear trend in the hatchery catch from this time up until 2004, although hatchery catches were generally higher in the 1980's compared to recent years. The last year in which wild fish were kept was also 1983. After steelhead started to be stocked in the Ash River watershed there was a dramatic increase in the CPUE which peaked in 1992 at 2.67. Since 1992 the CPUE has remained relatively high, ranging from 0.57 to 1.48. However, there has not been a corresponding increase in the catch in most years, indicating that the fishing pressure in more recent times is less than what it was in the late 1960's and through to the early 1980's.

From 2001 to 2004 there has been a decline in the wild catch, the hatchery catch, and the CPUE (Figure 31). The most recent estimates from 2004 are 104 wild fish caught, 11 hatchery fish, and a CPUE of 0.57 (Appendix 4).

b. Enhancement History

There has been a good deal of enhancement work done with trout in the Ash River watershed, with much of the focus on summer steelhead. This work has consisted mainly of fish stocking from Robertson Creek (steelhead and coho) and New Vancouver (rainbow and cutthroat) hatcheries, although there has been some modification of Dickson Falls in the Lower Ash River, placement of spawning gravels for steelhead upstream of Dickson Falls, and fertilization of the Middle Ash River to enhance steelhead production.

c. Fish Stocking

Summer steelhead, Atlantic salmon, coho salmon, rainbow trout, and cutthroat trout have all been stocked in the Lower or Middle Ash River watershed at some point in time (Table 9). Atlantic salmon fry and eggs were stocked in the Ash River (location unknown, assumed to be Lower Ash River) from 1917 to 1924. Coho fry were stocked in Lanterman Creek (Lower Ash River watershed) from 1983 to 1985. In between the Lower and Middle Ash River, summer steelhead fry were stocked in Dickson Lake in 1988 and juveniles were stocked in Ash Lake in 1990. Rainbow trout yearlings were stocked in Ash Lake from 2000 to 2003 and cutthroat trout yearlings have been stocked in McLaughlin Lake from 1999 to 2003. Cutthroat yearlings have also been stocked in Turnbull Lake (drains into Middle Ash River) from 2000 to 2004. In the Middle Ash River, summer steelhead fry, fall fry, and parr were stocked in 1979 (these fish may have been stocked in the Upper Ash River), 1988, and from 1989 to 1992. The number of steelhead stocked over this period ranged from 4,999 to 50,000.

Summer steelhead (fry, parr, juveniles, smolts, and adults) have been stocked in Elsie Lake Reservoir on several occasions between 1982 and 1997 in numbers ranging from 1,633 to 215,000. There is evidence to suggest that the stocked fish migrate out of the reservoir in June when water levels are high enough to spill from the reservoir into the Middle Ash River (Griffith 1993).

In January 2005, 60 tagged adult steelhead were released into Elsie Lake Reservoir to investigate the potential use of the Upper Ash River (M. McCulloch, BCCF, pers. comm.). Snorkel surveys completed in spring 2005 did not identify any steelhead in the Upper Ash River (pers. obs. and M. McCulloch, BCCF, pers. comm.), however there appeared to be steelhead test digging of redds in Gretchen Creek (C. Robert, Ecodynamic Solutions, Courtenay, pers. comm.).

Stocking activities in the Upper Ash River have been limited to summer steelhead which have been placed approximately 7.7 km upstream of Elsie Lake Reservoir. Stocking took place every year from 1993 to 2000 with anywhere from 3,000 to 28,622 fry being released. Summer steelhead fry (5,000) and parr (5,000) were also stocked in June Lake (headwater lake of Ramsay Creek drainage) in 1983 and 1986, respectively. Cutthroat trout fry and fingerlings have been stocked in Junior Lake (another headwater lake of the Ramsay Creek drainage) and Toy Lake (drains into Oshinow Lake).

d. Other Activities

Selective blasting by Fish and Wildlife at Dickson Falls in 1977-78 allowed summer steelhead to ascend the falls and access the Middle Ash River. Fish and Wildlife also removed a log

jam in 1979-80 to facilitate passage of coho salmon, however, no coho have been observed above Dickson Falls to date.

In 1990, approximately 200 m² of specially graded gravels were placed above Dickson Falls in an effort to improve summer steelhead spawning habitat below the outlet of Dickson Lake (Griffith 1990a in Griffith 1993). A moderate amount of good quality spawning gravel still remains (Hansen 2003, App. 1).

On July 19, 2001 the Middle Ash River was fertilized with briquettes at two locations with the intent of increasing summer steelhead production (Hansen 2003). The upstream location was approximately 300 m below the confluence of the Elsie Lake Reservoir spillway channel and the low level outflow. The other site was located 5.5 km downstream of the upstream site. A steelhead census was conducted at two control sites and two treatment sites in the Middle Ash River from September 13-25, 2001. However, Hansen (2003) notes that because of the late application of the fertilizer and an extreme flood event in August 2001, the results did not reflect a successful nutrient addition to the Ash River.

Discussion

The Ash River Fish Passage Feasibility study depends on the findings of the other studies conducted this year in the Ash River watershed, 05.As.01 (Elsie Lake Productive Capacity and Feasibility of Nutrient Enrichment for Fish Restoration), 05.As.02 (Ash River Nutrient Enrichment for Fish Habitat Restoration) and 05.As.03 (Estimation of Productive Capacity of Elsie Lake Tributaries). The final results of these studies were not available within the timeframe of the current study and could not be adequately integrated with the proposed project activities. Considering the need to incorporate the findings of current and future studies into decisions on fish passage improvements in the Ash watershed, a decision was made by the project manager in consultation with AVARG members to delay further work on this project. This decision was communicated to the BCRP project manager in the final quarter of the term of the contribution agreement. The current report provides the available background data to support future decisions on fish passage in the Ash River watershed. The next step of discuss fish passage alternatives should be initiated once the findings of the 2006-2007 studies are available, because an adequate understanding of the benefits of fish passage will depend on the findings of those studies.

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1. INTRODUCTION

The Bridge Coastal Restoration Program (BCRP) addresses footprint fish and wildlife impacts in 15 watersheds affected by BC Hydro operations in the Bridge Coastal Generation area. One of the footprint fish impacts to be addressed by this program is the restoration of anadromous fish passage that has been blocked by BC Hydro facilities. Such migration barriers can substantially reduce the spawning and rearing habitat capacity of a watershed for anadromous fish species, potentially affecting the long term viability of populations of fish for which access has been blocked.

BC Hydro commissioned a report to assess the viability of providing anadromous fish passage at facilities in the Bridge Coastal Generation area (Benneyfield et al. 2001). Following completion of this study, the BCRP initiated a follow-up study to develop a framework for addressing fish passage feasibility (Bocking and Gaboury 2002). That framework is used to organize the current study to assess the feasibility of restoring anadromous fish passage at BC Hydro's Elsie Lake facilities. This report documents the progress achieved during the period April 1 2005 and March 31 2006. The project was not completed because additional information is required to ensure that appropriate decision are made on which, if any, fish passage opportunities should be pursued. This document provides a summary of background information relevant to an assessment of the feasibility of fish passage in the watershed.

The Ash River Restoration Working Group (ARRWG) is headed by the Hupacasath First Nation and includes the Alberni Valley Enhancement Association, other local environmental groups, personnel from DFO and the provincial fisheries ministry, and environmental consultants. In November 2004, the ARRWG applied for contributions from BCRP to study the feasibility of improving fish passage in the Ash River watershed. ARRWG members recognized that there is potential for a substantial increase in fish production if anadromous salmonids were able to access habitat upstream of barriers to migration. Irrespective of whether passage was improved for steelhead trout alone, for resident trout in Elsie Lake, or for coho salmon, there is an opportunity to provide a substantial increase in fish production in the watershed. Although working group members agreed that improving upstream fish passage has a high likelihood of success for increasing fish production in the Ash River, there were several important considerations that must be fully evaluated. These include at a minimum, the potential for legal liabilities, selection of target species, and the monetary costs of physical works. These different "values" have been perceived to be in conflict to the extent that investment in changes to fish passage conditions would be vigorously opposed by one party or another. However, recognizing the considerable overlap in interests among ARRWG members, the groups agreed to the objective of developing a comprehensive strategy for improving passage conditions for fish on the Ash River, to meet the policy goals of all of the stakeholders.

Construction of the Elsie Lake dams for the Ash River hydroelectric project began in the summer of 1957, was completed in July 1958, and the project came into service in 1959. As a result of the impoundment of Elsie Lake and the creation of the reservoir, access to what was formerly known as Elsie Lake was blocked for all anadromous fish in 1958. The Ash River watershed is a major component of the Somass-Stamp system, a historic producer of all 5 species of salmon, steelhead (BC Hydro 2000), and the Pacific lamprey (Beamish and Northcote 1989). Anadromous fish species which are known to enter the lower Ash River via the Stamp River include summer steelhead, coho salmon, chinook salmon, Pacific lamprey; chum salmon, sockeye salmon, pink salmon; winter steelhead also use the Ash River but to a lesser extent. The steelhead population in the Stamp-Somass watershed is one of the largest on Vancouver Island (Burt and Horchik 1998).

Anonymous (1953 and 1954 in Griffith 1993) states that anadromous fish species were historically absent from Elsie Lake, with access to the Middle and Upper Ash River being blocked by Dickson Falls. Thus, Dickson Falls was historically considered to be a total barrier to passage of all species of anadromous fish. Despite reports that no anadromous fish could access Elsie Lake prior to its impoundment, anadromous Pacific lamprey were present in Elsie Lake at the time of construction (Beamish and Northcote 1989). In addition, Hupacasath Traditional Ecological Knowledge states that coho salmon had historical access to Elsie Lake (Ash River Water Use Plan Consultative Committee 2003).

Selective blasting of Dickson Falls by BC Fish and Wildlife in 1977-78 is believed to have allowed summer steelhead to ascend the falls and reach Elsie Lake Reservoir Dam (FISS 2006). This passage is also believed to be facilitated by the lower post-construction flows in the lower Ash River. A log jam was removed from Dickson Falls in 1979-80 in the hopes that it would facilitate coho passage, however, during 30 years of stock assessment in the Ash River watershed, there has been no record of coho adults or fry upstream of Dickson Falls. Recently during 2005, coho juveniles were captured by BCCF staff in the Ash River upstream of Dickson Lake, documenting successful coho migration. Two coho (2 year olds – 12 cm length) were identified in the Middle Ash during a 2005 BCRP study (Mike McCullough, Ministry of Environment, pers.comm.) This observation agrees with what was identified during the WUP, where First Nations Traditional Knowledge and some long time sport fishers stated that coho were found above the two falls.

At the present time, Elsie Lake Reservoir Dam acts as a barrier to upstream anadromous fish passage for summer steelhead and Pacific lamprey. Historically there was no barrier at this location, based on a review of photos taken during site surveys prior to dam construction (see appendix 9.6, historic photos).

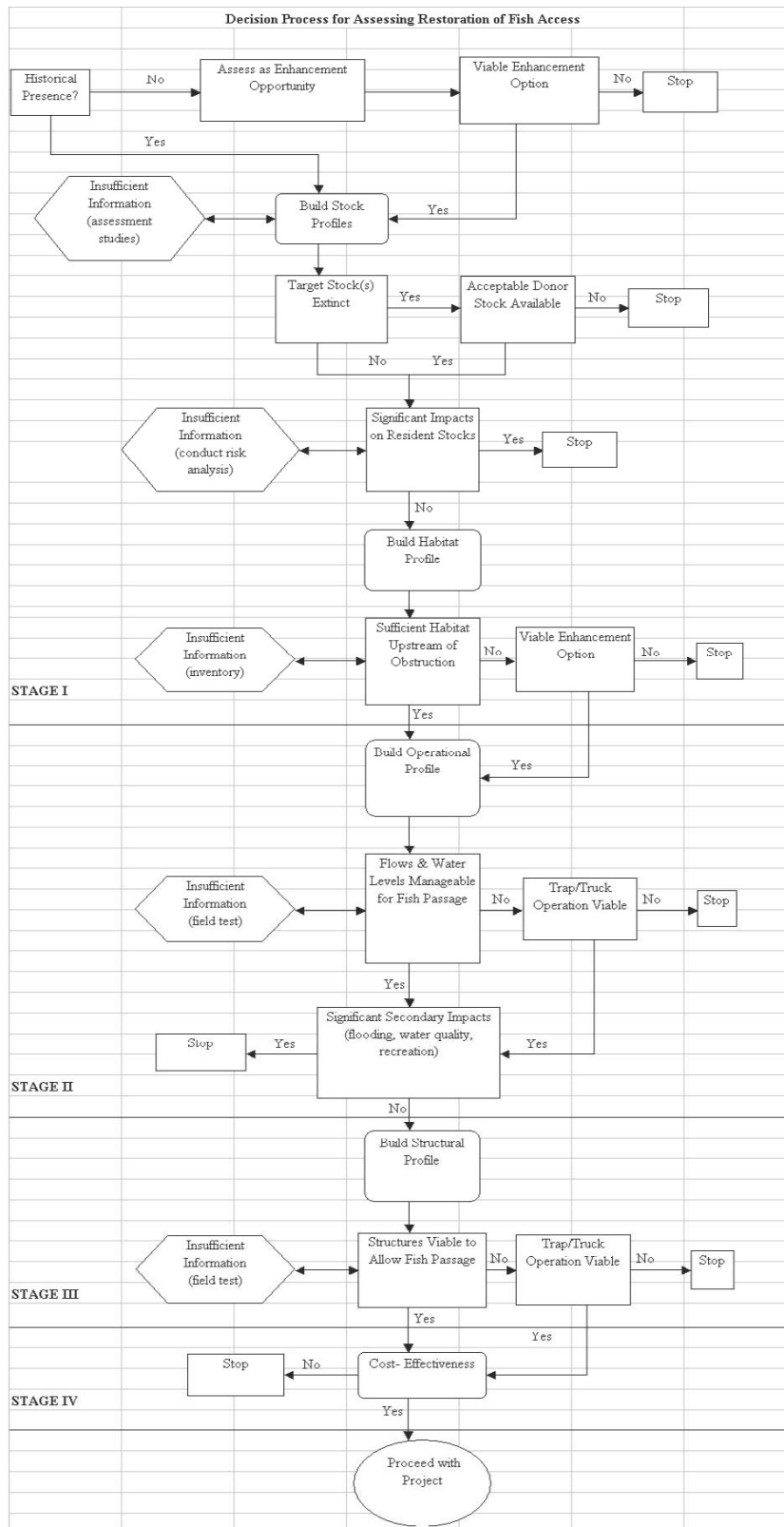
The task of assessing the restoration of anadromous fish access to Elsie Lake, or any waterbody for that matter, is a complicated one. Bocking and Gaboury (2002) provide a detailed framework for carrying out such a task, and it is this framework that will form the basis for future

decisions(see Figure 1). There are four stages in the decision making process outlined in Bocking and Gaboury's framework:

1. consideration of biological and physical (e.g., habitat) issues;
2. consideration of operational issues;
3. consideration of structural issues; and
4. consideration of cost-effectiveness.

This project intends to complete these four stages of the fish passage feasibility assessment framework for Elsie Lake Reservoir. In doing so, existing data will be presented, data gaps will be identified, the work required to reliably determine the feasibility of reintroduction will be identified, and the steps necessary to pursue the restoration of fish access to Elsie Lake will be provided for decision-makers should they decide to further pursue the issue. At this time however, only the background data have been assembled for review.

Figure 1. Decision making process for assessing the restoration of fish access (reproduced from Bocking and Gaboury 2002).



2. GOALS AND OBJECTIVES

The main objectives of the Ash River Fish Passage Feasibility assessment are as follows:

1. Compile and analyse existing biological, physical, and operational data;
2. Establish the biological, physical, and operational feasibility of reintroducing anadromous fish passage to Elsie Lake Reservoir;
3. Identify the key issues to be addressed before further decisions can be made regarding the reintroduction of anadromous fish to Elsie Lake Reservoir;
4. Estimate the approximate costs associated with reintroduction;
5. Establish timelines for reintroduction;
6. Recommend the next steps to BC Hydro and the Bridge-Coastal Restoration Program should they decide to move ahead with restoring anadromous fish passage to Elsie Lake Reservoir

To fulfil the main objectives, a number of specific objectives will be met. They are as follows:

1. Identify the target species for which passage may be restored
2. Evaluate the options for donor stocks;
3. Evaluate artificial propagation needs;
4. Identify existing and potential habitats;
5. Evaluate production potential for the target species;
6. Evaluate potential species interactions and disease concerns;
7. Evaluate potential impacts related to water quality, downstream flows, etc;
8. Evaluate operational requirements to support spawning, incubation, and rearing;
9. Evaluate the operational requirements required to support migrations;
10. Identify the structural requirements to support fish passage at a conceptual level of detail;
11. Identify the steps to reintroduction and associated timelines;
12. Estimate the approximate program costs; and
13. Recommend future studies.

3. STUDY AREA

3.1. ASH RIVER HYDRO GENERATION PROJECT

The Ash River watershed is located on central Vancouver Island approximately 30 km northwest of Port Alberni at its closest point (Figure 2). The headwaters of the Ash River are located in Strathcona Provincial Park, and the remainder of the river flows south between the park to the west and the Beaufort mountain range to the east. The Ash River is a tributary to the Stamp River, which in turn flows into the Somass River, and eventually into Alberni Inlet. The mean basin elevation is 700 m. Based on the composition within the drainage area covered by the WSC hydrometric station below Moran Creek (which covers 99.6% of the entire Ash River drainage), 3.83%, 16.04%, and 80.13% of the watershed is within the Alpine Tundra, Mountain Hemlock, and Coastal Western Hemlock Biogeoclimatic Zones, respectively (Environment Canada 2005). Much of the watershed is covered in old-growth forest (38.0% coverage, >140 years old, >6 m tall) and young forest (35.5% coverage, <140 years old, >6 m tall) (Environment Canada 2005). About 13.2% of the watershed has been recently logged (i.e., harvested in the last 20 years, or older if tree cover is <40% and <6 m tall) and the remainder of the watershed is comprised of alpine (3.75%), fresh water (3.65%), sub-alpine avalanche chutes (3.12%), glaciers and snow (1.27%), wetlands (1.25%), and barren surfaces (0.17%) (Environment Canada 2005).

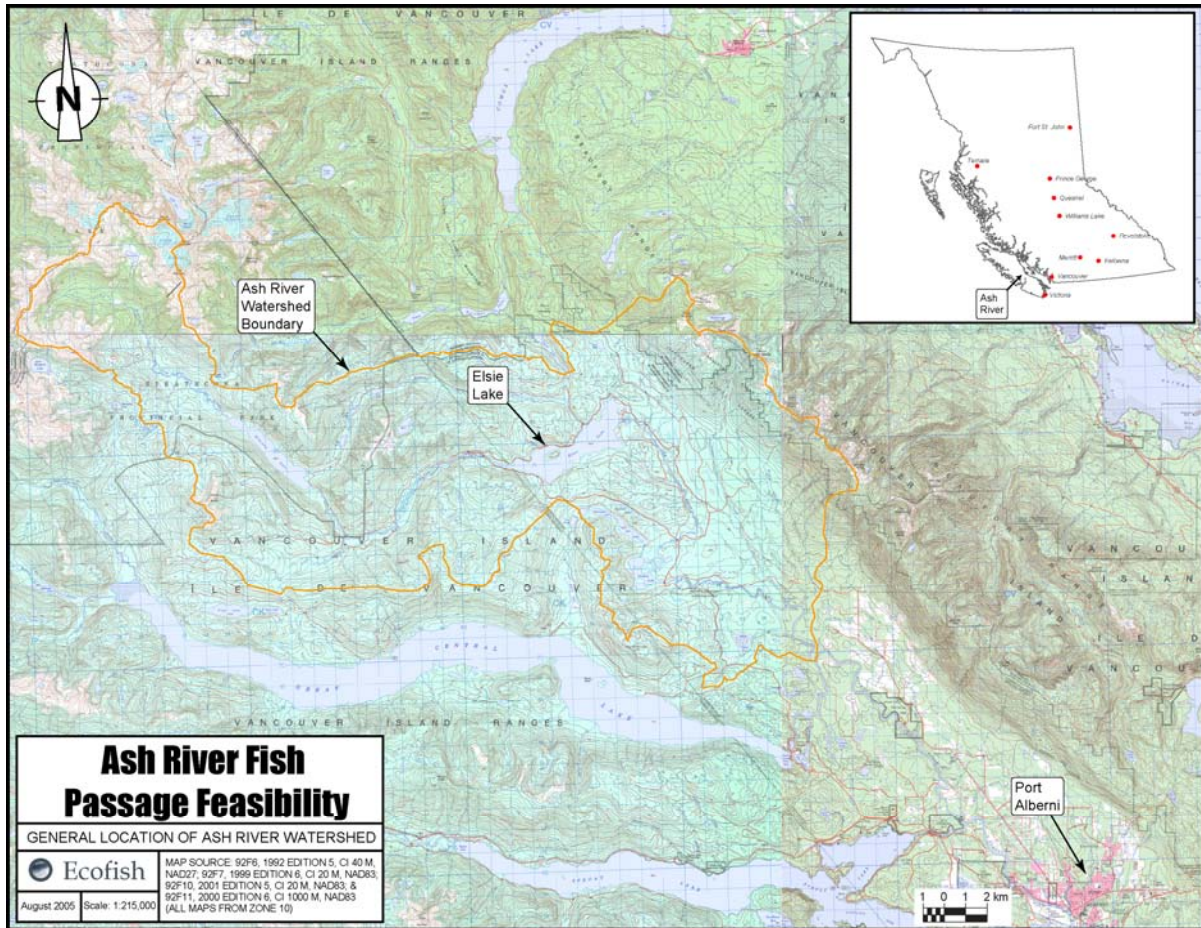
The watershed is located in the transition zone between the wet west coast and drier east coast regions of central Vancouver Island. The west-facing slopes of Vancouver Island are usually cloud covered and wet during the winter due to the warm moist air flowing inland from sea. These slopes can experience prolonged and heavy rains. This rain spills over to the east-facing slopes which generally receive less precipitation. During winter storms, the air temperature may be above freezing at all elevations in the watershed, potentially leading to substantial variation in the accumulated snowpack at lower elevations (BC Hydro 2003). A period of cooler weather which leads to increases in snowpack may be followed by a large Pacific disturbance which raises temperatures and may result in a large portion of the snowpack melting. Indeed, most of the winter precipitation is normally rain rather than snow, resulting in peak discharges from November to February (Griffith 1993). However, the spring time melt of the snowpack also leads to increased discharges from May to June (Griffith 1993).

The Ash River hydroelectric facility consists of Elsie Lake Reservoir which was created following the construction of Elsie Dam at the outlet of Elsie Lake (i.e., the Ash River) and four saddle dams, approximately 30 km northwest of Port Alberni (Figure 2). Construction was completed in July 1958 and the hydroelectric facility began operation in 1959. Water is diverted from the southern side of Elsie Lake Reservoir, about 5 km southwest of the dam, and flows through a 4 km long tunnel and a 3.4 km long penstock, dropping 248 m to a 25.2 MW (dependable capacity is 27 MW) powerhouse located on the north shore of Great Central Lake.

Average flows of 10.7 cms are diverted to Great Central Lake throughout the year, except during a 1-2 week maintenance outage which usually occurs in August (BC Hydro 2000) and when the reservoir is below an elevation of 317.91 m (Ash River Water Use Plan Consultative Committee 2003). The normal drawdown range of Elsie Lake Reservoir is 15 m (BC Hydro 2000), about 50% of the reservoir's maximum depth of 30 m. Creation of the reservoir raised the level of Elsie Lake by approximately 18 m (BC Hydro 1991 in Griffith 1993). Water may be released into the Ash River by spilling water over the spillway or by releasing water through the spillway dam sluiceway; water is continuously released into the Ash River through a hollow cone valve (low level outlet) at the base of Saddle Dam 1. At the confluence of the Ash and Stamp Rivers, the water released from Elsie Lake Reservoir to Great Central Lake for power generation rejoins the water released into the Ash River.

BC Hydro stores water in Elsie Lake Reservoir for power generation during the drier summer and fall months. When the reservoir level drops below an elevation of 317.91 m power generation ceases in order to conserve water for future fish flow releases. Water is continuously released into the Ash River downstream of the dam via a 60 m long 2.44 m wide compensation culvert through Saddle Dam 1 so that there is a minimum flow of 3.5 cms to provide for fish habitat in the Lower and Middle Ash River (BC Hydro 2003). This minimum flow release applies to the period of May 1 to October 31. From November 1 to April 30, the minimum flow release is 5 cms (BC Hydro 2003). However, during this latter period there is a requirement to have a minimum flow release on two separate occasions such that flow at the WSC Moran Creek gauge is at least 10 cms over a 48 hour period (BC Hydro 2003). The purpose of this extra flow release is to facilitate the passage of steelhead above Lanterman and Dickson Falls in the Lower Ash River. These flow pulses are to coincide with naturally increasing inflows from precipitation. As a result of flow releases from Elsie Lake Reservoir, Ash River flows from early August through November are now generally higher than they were prior to the impoundment of Elsie Lake (Ash River Water Use Plan Consultative Committee 2003).

Figure 2. Location of the Ash River watershed showing major tributaries.



3.2. ASH RIVER

The Ash River watershed has two sub-basins: the upper and lower. The upper sub-basin refers to the area upstream of and including Oshinow Lake, while the lower sub-basin refers to everything in the watershed downstream of Oshinow Lake. The entire length of the river is located within the Coastal Western Hemlock Biogeoclimatic Zone. The watershed is located within the Eastern Vancouver Island ecoregion of the Georgia Depression ecoprovince. The dominant tree species are western hemlock (*Tsuga heterophylla*), Douglas fir (*Pseudotsuga menziesii*), and western red cedar (*Thuja plicata*). The understory is dominated by red alder (*Alnus rubra*), salal (*Gaultheria shallon*), devils club (*Oplopanax horridus*), sword fern (*Polystichum munitum*), bracken fern (*Pteridium aquilinum*), and dense mosses. The upper sub-basin contains mountains up to 2,000 m high, and these create a boundary between the Ash, Campbell, and Comox watersheds. In the upper sub-basin there are several receding small glaciated areas and the majority of the area is occupied by old-growth forest. The mountains in this area drain into Oshinow Lake located at an elevation of 410 m, about 16.5 km downstream of the upper headwaters. The lake is 5 km long, 0.6 km wide, and receives inflows from approximately 30% of Ash River drainage (BC Hydro 1991 in BC Hydro 2000).

The lower sub-basin of the Ash River can be broken into three distinct sections as per the Ash River Water Use Plan (Ash River Water Use Plan Consultative Committee 2003): the Upper Ash River, Middle Ash River, and Lower Ash River (Figure 2). Mountains in the lower sub-basin reach a maximum height of about 1,350 m (BC Hydro 2000).

There is one active Environment Canada hydrometric station in the Ash River watershed: Ash River below Moran Creek (Station # 08HB023, Environment Canada 2005). This station is located 1.5 km upstream of the Ash-Stamp confluence in the Lower Ash River and has been recording data since 1959. The station monitors flow for a drainage area of 378 km², or 99.6% of the entire Ash River's 379.5 km² drainage. From May to July the Ash River experiences a smooth peak inflow due to snowmelt with low inflows from August to September (BC Hydro 2000). In November the Ash River receives slightly lower, but more volatile peak inflows due to rain events (BC Hydro 2000). The maximum discharge of the Ash River at station 08HB023 is 532 m³/s, the minimum discharge is 1.6 m³/s, and the mean discharge is 16.7 m³/s (Environment Canada 2005).

There are several tributaries to the Ash River downstream of the Elsie Lake Dam, but only two are major fish-producing streams: Lanterman Creek and Wolf Creek. Both of these streams are located downstream of Dickson Lake in the Lower Ash River and both contain barrier falls (Figure 2). Closer to the dam in the upper portion of the Middle Ash River, there are a couple of unnamed tributaries known to support resident fish (Griffith 1993 and FWD 2005).

The Ash River Water Use Plan (WUP) (Ash River Water Use Plan Consultative Committee 2003) focussed on managing flows in the Middle and Lower Ash River for steelhead and coho

spawning and rearing habitat during the critical stream flow period from August to September. The WUP had 9 objectives for managing fish habitat in the Lower and Middle Ash River, the first of which was managing flows to allow migrating steelhead to pass obstructions in these sections of the river. The remaining objectives focus on maximizing spawning and rearing habitat for steelhead and coho; the performance measure for these objectives is Weighted Usable Width (WUW), focussing on riffle habitats for steelhead as this habitat type is an important producer of food for rearing fish (see Lewis 2001 for Ash River WUP Fish Performance Measures).

3.2.1. Lower Ash River

The Lower Ash River is considered to be the section from the outlet of Dickson Lake to the confluence of the Ash River with the Stamp River, located approximately 12.4 km downstream of the Dickson Lake outlet. The area surrounding the Middle Ash River is dominated by young forest (Environment Canada 2005). Over the Lower Ash River there is an elevation drop of approximately 122 m, with the elevation at the confluence of the Ash and Stamp Rivers being approximately 80 m. This section of the river contains two substantial falls – Lanterman and Dickson Falls (FWD 2005). Other than Elsie Lake Reservoir Dam, Dickson Falls represents the most serious barrier to fish passage on the Ash River. This barrier is discussed in more detail in Section 4. Fish bearing tributaries to the Lower Ash River include Moran Creek, the Wolf Creek drainage, and the Lanterman Creek drainage.

3.2.2. Middle Ash River

The 10.7 km section of the Ash River downstream of Elsie Lake Reservoir to the inlet of Dickson Lake is considered to be the Middle Ash River (Figure 2). The area surrounding the section of the river is dominated by young forest (Environment Canada 2005). The Ash River experiences a 135 m drop in elevation over this section, descending to an average elevation of 202 m at Dickson Lake. Dickson Lake is approximately 1.5 km long and 0.5 km wide. This section of the river contains a set of 3 falls (Ash Island falls) located approximately 3.51 km upstream of Dickson Lake. This set of falls is not considered to be a barrier to summer steelhead passage and is discussed in detail in Section 4. Elsie Lake Reservoir Dam constitutes a barrier to the upstream passage of fish whereas no barrier existed at this location prior to the construction of the dam (Anon. 1953 and Anon. 1954 in Griffith 1993). This barrier is also discussed in more detail in Section 4. There are no major fish bearing tributaries to the Middle Ash River, although there are a few that support resident fish. The Turnbull Lake outflow near the upstream inlet to Dickson Lake supports cutthroat (assumed based on their presence in the lake, FWD 2005) and

there are two tributaries just downstream of Elsie Lake Reservoir that support resident trout (Griffith 1993).

3.2.3. Upper Ash River

The Upper Ash River encompasses a 13.7 km long section of the river from the outlet of Oshinow Lake to the inlet to Elsie Lake Reservoir which is at an elevation of 330.71 m (free spillway crest elevation stated in Ash River Water Use Plan Consultative Committee (2003)). This corresponds to an elevation drop of about 73 m over the length of the Upper Ash River. Elsie Lake Reservoir is about 6.75 km long and roughly 1 km wide. The area surrounding the Upper Ash River is dominated by old-growth forest (Environment Canada 2005). There are no barriers on the Upper Ash River (i.e., above Elsie Lake Reservoir) (Lewis 2001).

3.3. ELSIE LAKE RESERVOIR AND TRIBUTARIES

The watershed of Elsie Lake Reservoir is 218 km² and is comprised of steep, mountainous terrain. The reservoir has a surface area of 672 ha at full pool, a normal drawdown range of 15 m (BC Hydro 2000), and the free spillway is located at an elevation of 330.71 m (Ash River Water Use Plan Consultative Committee 2003). Prior to construction, Elsie Lake had a surface area of 271 ha. The maximum depth of the reservoir is 30 m and the mean depth is 8 m (BC Hydro 2000). There is currently no fishway present at the dam. A photo and bathymetric map of Elsie Lake Reservoir are provided in Figure 3 and Figure 4, respectively.

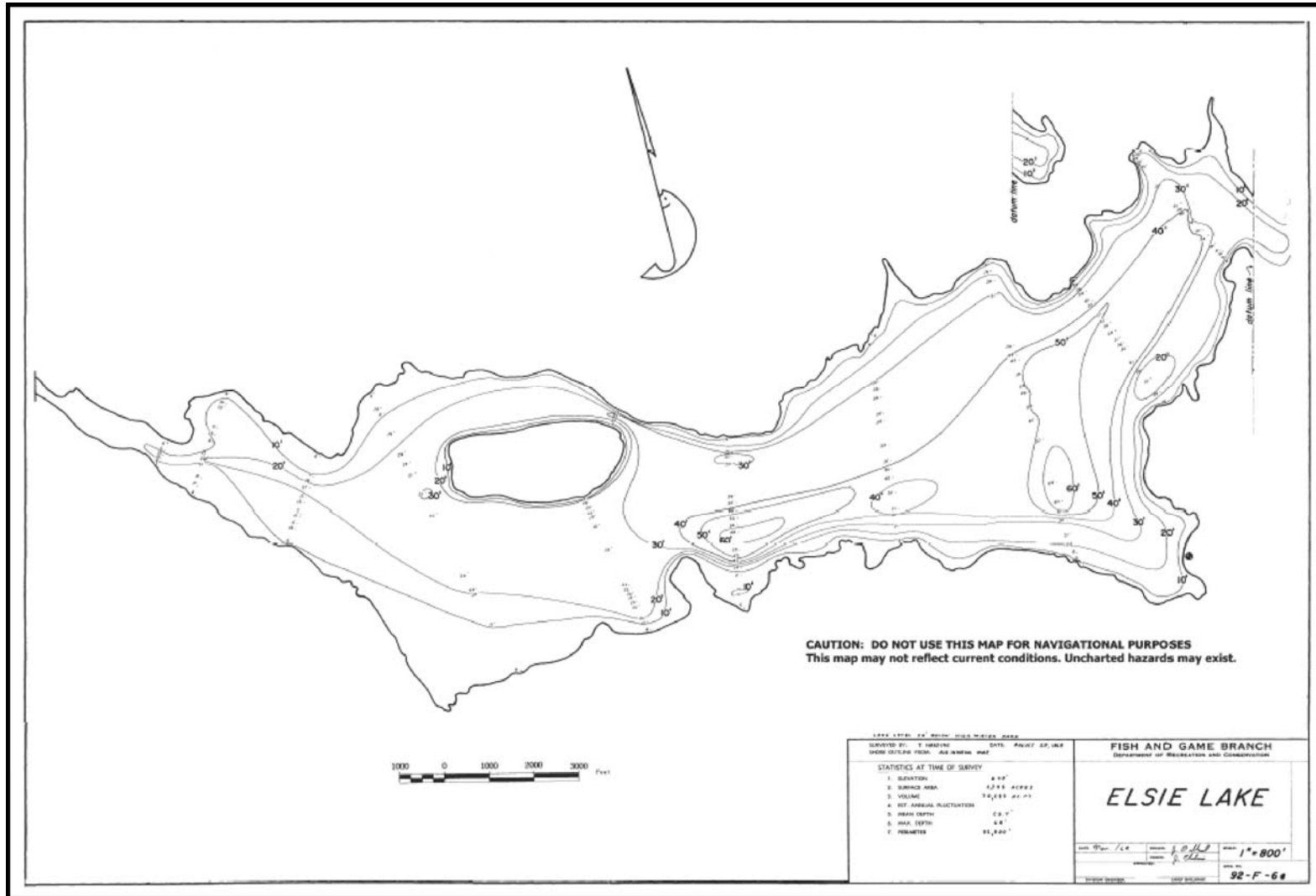
Following the completion of construction of Elsie Dam, 401 ha of land were flooded (see Figures 43 to 48 in the appendices). This resulted in the loss of 5 km of mainstem habitat in the Ash River upstream of Elsie Lake, or 30 ha of channel habitat and 30 ha of riparian habitat (calculated 30 m from each bank) (BC Hydro 2000). Other tributaries to Elsie Lake were also flooded resulting in the loss of 5 km of tributary habitat including 14 ha of riparian habitat (calculated as 15 m from each bank) (BC Hydro 2000). The flooding of Elsie Lake also resulted in the loss of 72 ha of wetland habitat (BC Hydro 2000).

There are only 4 tributaries to Elsie Lake Reservoir with substantial year-round flow: the Upper Ash River, Ramsay Creek, Katlum Creek, and Creek #2 (Burt and Robert 2003). These streams all support resident fish while summer steelhead are known to access the Upper Ash River and possibly Ramsay Creek (this is uncertain as steelhead have been stocked in the Ramsay system).

Figure 3. Photo of Elsie Lake Reservoir taken from lower Ramsay Creek.



Figure 4. Bathymetric map of Elsie Lake Reservoir (reproduced from FWD 2005).



4. MIGRATION BARRIERS

4.1. Lower & Middle Ash River Watershed

4.2. Ash River

An examination of literature prior to the completion of Elsie Dam does not give any indication that there may have been a barrier to anadromous fish passage at the outlet of Elsie Lake. Two surveys of the Ash River done in 1953 and 1954 identify Dickson Falls (in the Lower Ash River) as the upstream migration limit of all salmonids (Anon. 1953 and Anon. 1954 in Griffith 1993). Similarly, Crippen Wright Engineering Ltd. (1956), Anon. (1959), Photographic Survey Corporation Ltd (1956), and Anderson *et al.* (1959) do not give any indication of a barrier at the outlet of Elsie Lake prior to its impoundment (see appendix section 9.6, Figure 40).

Fish passage was examined by Griffith (1993) at three barriers and by Lewis (2001) at four barriers in the Ash River downstream of Elsie Dam. In the examination by Lewis (2001), the focus was on steelhead passage as they migrate further in the Ash River than any other anadromous salmonid. The barriers include (from the mouth upstream): Ash mouth riffle (only Lewis 2001), Lanterman Falls, Dickson Falls, and Ash Island Falls. The most significant barrier to fish passage on the Ash River is the Elsie Lake Reservoir Dam, located at the upstream end of the Middle Ash River.

Lewis (2001) assessed the passability for summer steelhead of four obstructions on the Ash River downstream of Elsie Lake Reservoir: Ash mouth riffle, Lanterman Falls, and Dickson Falls in the Lower Ash River and Ash Island Falls in the Upper Ash River. Summer steelhead were selected as the target species, and although the provision of flows for this species will not necessarily assist the migration of other species with a lesser swimming ability, the greater migration distance of steelhead demands that their flow requirements be met first.

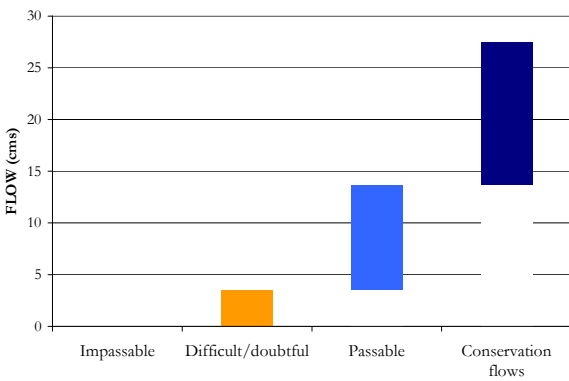
It was determined that the general relationship between steelhead passage and flow is similar at all four barriers: steelhead passage suitability of each barrier increases as flow increases from 0 to 10 cms. The one exception to this is at Dickson Falls where steelhead passage suitability decreases as flows increase from 3.5 to 7 cms. The conservation flow guidelines identify considerably higher flows for steelhead passage ranging from 13.7 to 27.5 cms. Based on the above analysis, Lewis (2001) recommended that a range of flows lasting for a sufficient number of days be provided during summer migration periods to facilitate upstream passage of all anadromous species.

Table 1. Information on fish passage at four barriers on the Ash River with summer steelhead as the target species (modified from Lewis 2001).

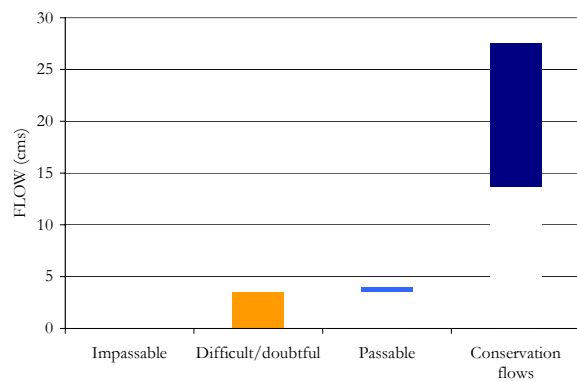
Barrier	Year	Source	Observation
<u>All Barriers</u>	2001	Ron Ptolemy (Provincial criteria)	fish conservation flow of 50-100% MAD (13.7 to 27.5 cms)
<u>Ash Mouth Riffle</u>	2001	D. Burt & Associates	passage possible at 3.5 cms
<u>Lanternman Falls</u>	1992	R.P. Griffith	passage possible at 11.3 cms
	2001	D. Burt & Associates	passage improves as flows increase from 3.5 to 7 cms
<u>Dickson Falls</u>	1992	R.P. Griffith	passage doubtful at 12.9 cms; impossible at 50 cms
	2001	D. Burt & Associates	passage attempts frequent at 7 cms; none successful. Steelhead observed upstream following implementation of lower flows of 3.5 cms
<u>Ash Island Falls</u>	1992	R.P. Griffith	passage possible at 11.3 cms
	2001	D. Burt & Associates	passage possible at 3.5 cms but difficult; improved at higher flows

Figure 5. Flows at different passage difficulty categories for barriers in the Ash River with summer steelhead as the target species (reproduced from Lewis 2001).

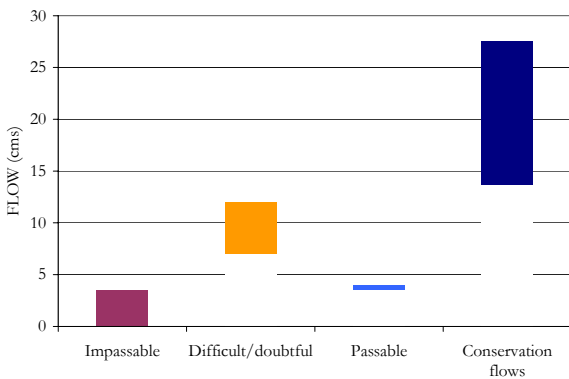
Ash Island Falls



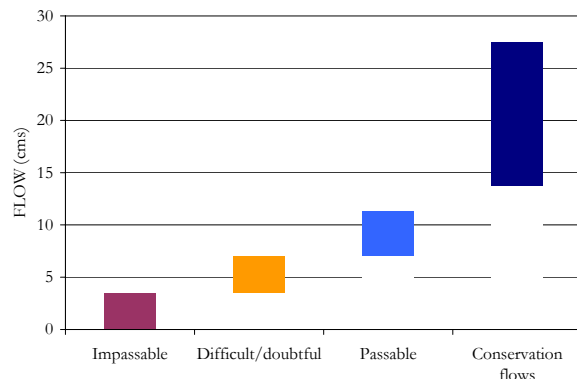
Ash mouth riffle



Dickson Falls



Lanternman Falls



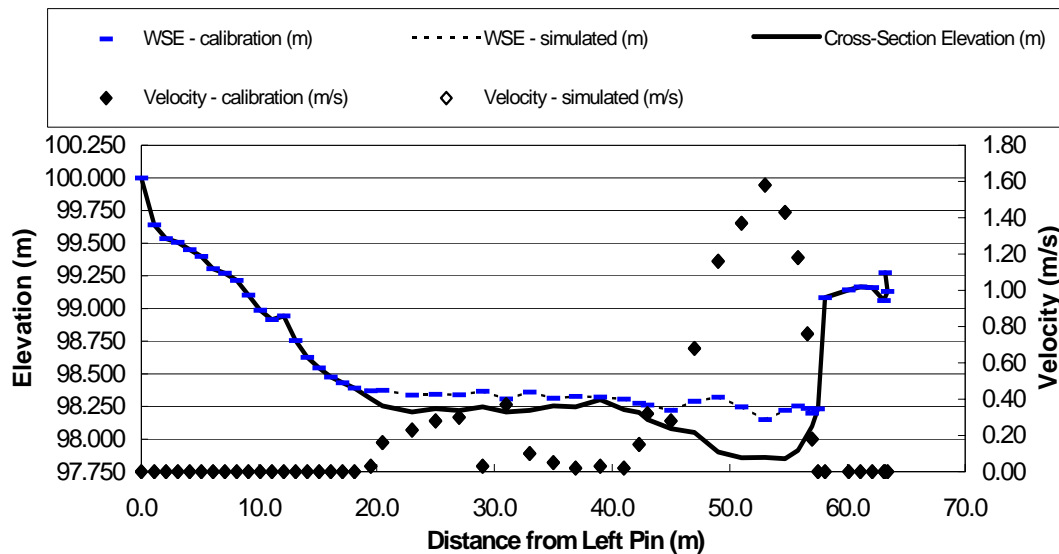
4.3. Ash Mouth Riffle (Lower Ash River)

Ash mouth riffle is a broad cobble/gravel riffle located upstream of the Stamp River confluence with a narrow slot along the right bank (see photo in Figure 6). The cross-sectional profile of the site is provided in Figure 7, with the observed water level shown as a blue dashed line. At the time of the survey there was a flow release of 3.5 cms from the hollow cone valve, and a local inflow of approximately 1.5 cms, for a total flow of 5 cms. The site had a wetted width of 39.4 m, mean depth of 0.16 m, and a maximum depth of 0.42 m. The riffle appeared passable to steelhead at the time of survey and is also known to be passable to chinook (FWD 2005), coho (FWD 2005), chum (Griffith 1993), sockeye (Griffith 1993) and, pink salmon (Hansen 2003 – App. 1) as well as Pacific lamprey (Beamish and Northcote 1989).

Figure 6. Ash mouth riffle looking upstream towards right bank. The discharge at the time of survey was approximately 5 cms.



Figure 7. Cross-sectional profile of transect 17 on the Ash mouth riffle looking downstream. The water surface is shown by the dashed blue line, the water velocity is shown by the black diamonds. The left axis shows elevation in m (relative to a nominal benchmark elevation of 100 m) and the right axis shows water velocity in m/s (reproduced from Lewis 2001).



4.4. Lanterman Falls (Lower Ash River)

Lanterman Falls is approximately 4.7 m in height and is located 5.80 km from the mouth of the Ash River in the Lower Ash River. At a flow of 11.3 cms, the height ranged from 4.12-4.67 m (Griffith 1993). The falls consists of a bedrock shelf with a vertical rise of about 4.2 m (Griffith 1993). It is an obstacle to the passage of chinook, chum, sockeye, and winter steelhead (Burt and Lewis 2004), however, the chinook distribution in Fish Wizard (FWD 2005) shows that chinook are present above Lanterman Falls. The presence of chinook above Lanterman Falls was not confirmed in any of the literature reviewed during the preparation of this report. Griffith (1993) considered Lanterman Falls to be a barrier to all salmonids except steelhead, however, coho adults (from snorkel surveys, Mike McCulloch, BCCF, pers. comm.) and fry (Appendix 2 in Lewis 2001, 300 m above the falls) have been observed above the falls. Summer steelhead (Burt and Horchik 1999) and Pacific lamprey (Beamish and Northcote 1989) can also ascend Lanterman Falls.

The best route for fish passage is the left (north) side of the falls and it involves two jumps (the first is 3 m, the second is about 1 m) (Griffith 1993, see cross sectional and overview profiles in Figure 8 and Figure 9, both reproduced from Griffith 1993). At the observation flow of 11.3 cms, swift shallow flows over smooth bedrock in the left (south) passage likely preclude passage; additionally steps 3 and 4 are highly turbulent any may not offer any tail hold (Griffith 1993). Lewis (2001) made the assessment that the falls was passable via the northern route at the observation flow of 3.5 cms (from Elsie Lake Reservoir, 4.35 cms at WSC 08HB023 Ash River Below Moran Creek), and Griffith (1993) made the same assessment at an observation flow of 11.3 cms. Passage via the north route is facilitated by a slot in the bedrock shelf above the falls which provides passage through the shallow areas of the bedrock shelf. Lewis (2001) also conjectured that access at Lanterman Falls would improve at slightly higher flows (e.g., 7 cms).

Figure 8. Cross-sectional profile of Lanterman Falls from topographic survey (looking upstream; reproduced from Griffith 1993).

Height of Lanterman Falls, looking upstream :

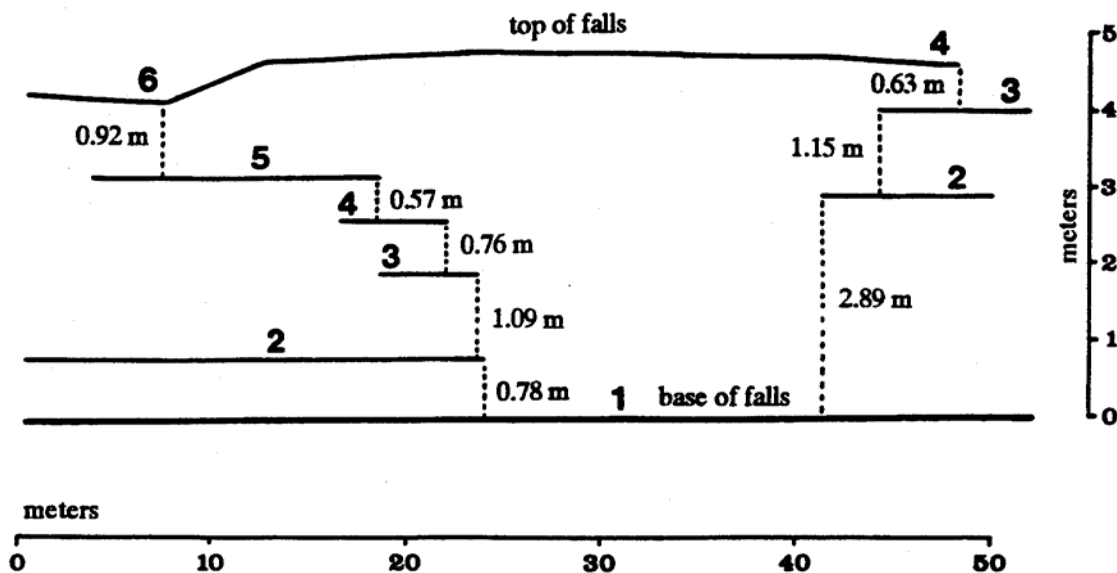
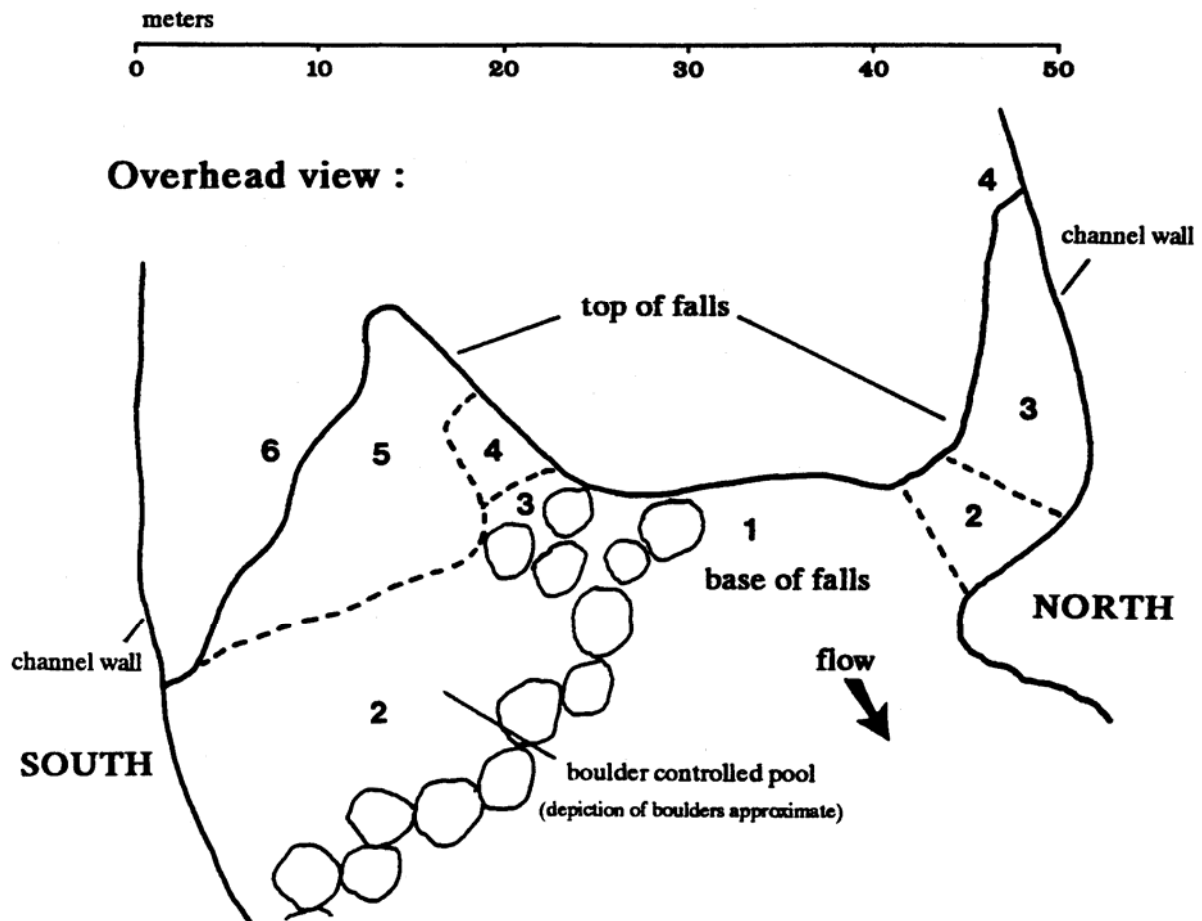


Figure 9. Overhead view of Lanterman Falls from topographic survey (reproduced from Griffith 1993).



4.5. Dickson Falls (Lower Ash River)

Dickson Falls is 9.24 m in height and is located 10.88 km from the mouth of the Ash River in the Lower Ash River, or about 1.38 km downstream of Dickson Lake. Other than Elsie Lake Dam, this falls represents the most serious obstacle to fish passage on the Ash River. Griffith (1993) estimated a vertical gain of 9.24 m over a horizontal distance of 45 m, with 7 steps including the plunge pool and top of the falls (see Figure 10 for a cross-sectional view and Figure 11 for an overhead view, both reproduced from Griffith 1993). It is an obstacle to the passage of coho salmon (FWD 2005, Lewis and Burt 2004), summer steelhead (FWD 2005) and Pacific lamprey (Beamish and Northcote 1989).

In Griffith's assessment, he felt that the most difficult part of the falls to pass was the last step from step 6 to 7, a vertical jump up a 3.2 m tall turbulent chute (Figure 11). This is based on observations at flows ranging from 3.7-12.9 cms. At an observation flow of 50.3 cms, the entire falls was a solid torrent of white water which was clearly impassable (Griffith 1993). Lewis (2001) observed Dickson Falls at a flow of 3.5 cms (from Elsie Lake Reservoir Hollow Cone, 4.35 cms at WSC 08HB023 Ash River Below Moran Creek), and noted an additional step not indicated by Griffith (1993) between step 6 and 7; this step has been included in a modified reproduction from Griffith of an overhead view of the falls (Figure 11). This intermediary step (labelled 6b) requires a 1 m jump from step 6 and another 1 m jump to step 7. There are resting locations in 6b and Lewis (2001) believed that it would be relatively easy for summer steelhead to reach step 7 from 6 via 6b. Step 5 consists of a poorly developed turbulent plunge pool and fish must ascend a rise of 2.5 m over a run of about 1.5 m (hypotenuse = 3 m) to reach step 6. Lewis (2001) also felt that ascent of Dickson Falls is easiest at (or slightly less) than the observation flow of 3.5 cms just below Elsie Lake Reservoir (July 21, 2001, 4.35 cms at WSC 08HB023 Ash River Below Moran Creek), and that increased turbulence at higher flows would make ascent more difficult. This was confirmed after a rainfall event on August 3, 2001 when ascent from step 5 to 6 looked more difficult due to increased turbulence and velocity of water at the lip of step 6 (flows on this date were 6.85 cms at WSC 08HB023 Ash River Below Moran Creek).

On July 21, 2001 at 3.5 cms (from Elsie Lake Reservoir, 4.35 cms at WSC 08HB023 Ash River Below Moran Creek), Lewis (2001) observed steelhead attempting jumps from step 5 to 6. A total of 10 jumping events were observed from 18:00 to 18:30, and none were successful (the best jumps were about 40 cm short of reaching step 6). The largest fish observed jumping was a relatively large and dark individual weighing about 14-15 lb. On August 3, 2001 during a snorkel survey, two adult steelhead (one about 14-15 lb) were observed in a run about 200 m above Dickson Falls. Another 3-4 steelhead were observed in the secondary channel indicated in Figure 11, suggesting that at least some steelhead may be able to ascend Dickson Falls at the flow on

July 21, 2001. This channel is a cut in the rock about 1 m deep, and was a dead end for fish at the flows observed on August 3.

Selective blasting of Dickson Falls was carried out by the BC Fish and Wildlife Branch in 1977-78. Prior to blasting, summer steelhead could already ascend the falls (Hryhorczuk and Silvestri 2002). In 1979-80 BC Fish and Wildlife removed a log jam on Dickson Falls in the hopes that it would facilitate the passage of coho salmon. Although 30 years of stock assessment in the Ash River watershed shows no record of coho adults or fry upstream of Dickson Falls (Ash River Water Use Plan Consultative Committee 2003), coho juveniles were captured upstream of Dickson Falls in 2005 during BCRP study (Mike McCullough, Ministry of Environment, pers.comm.). Moreover, Traditional Ecological Knowledge from the Hupacasath First Nation states that coho have historically accessed Elsie Lake.

Figure 10. Cross-sectional profile of Dickson Falls from topographic survey (viewed from side; reproduced from Griffith 1993).

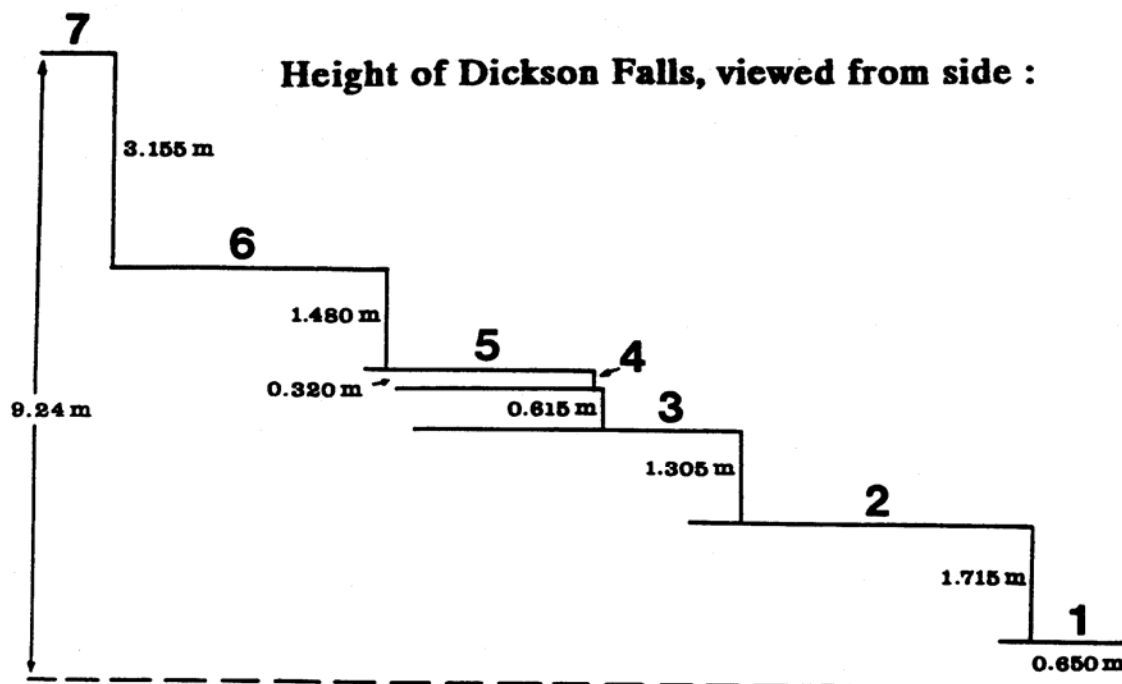
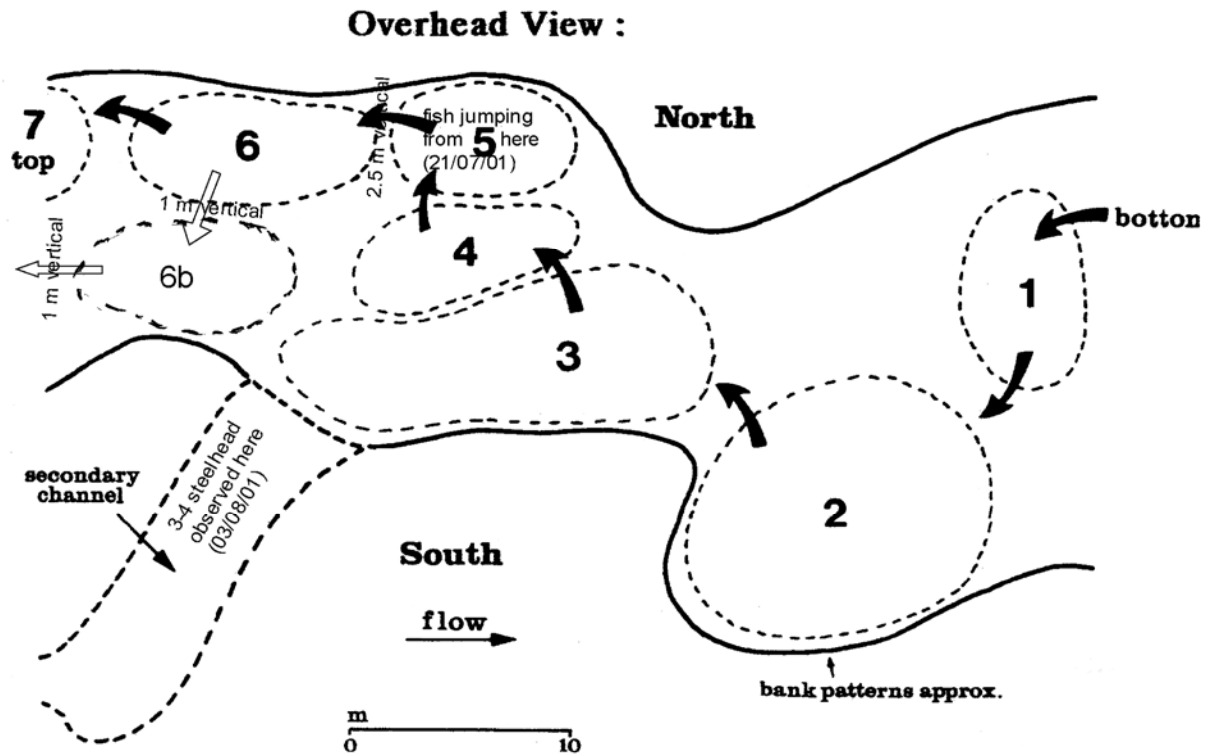


Figure 11. Overhead view of Dickson Falls from topographic survey (reproduced from Lewis 2001 who modified presentation of this figure in Griffith 1993).



4.6. Ash Island Falls (Middle Ash River)

Ash Island Falls is a series of 3 falls located 18.18 km from the mouth of the Ash River in the Middle Ash River, 3.51 km upstream of Dickson Lake and about 2.1 km upstream of the Ash River Bridge. One set of falls is approximately 2.5 m in height and is located about 50 m above Ash Island. Another falls located in the channel passing on the right side of Ash Island is about 1.8 m in height. The third and smallest falls is about 1.5 m in height and is located on the left side of Ash Island. Ash Island Falls is not a barrier to summer steelhead or Pacific lamprey passage, and it is uncertain if coho, chinook, chum, sockeye, or winter steelhead could ascend these falls if access was facilitated.

Griffith (1993) completed a detailed survey of Ash Island Falls and the cross-sectional profile and overhead view presented in his report are reproduced here in Figure 12 and

Figure 13, respectively. These falls were also surveyed by Lewis (2001) at flows of 3.5 cms (4.35 cms at WSC 08HB023 Ash River Below Moran Creek). At this flow, Lewis felt that all 3 falls were passable by summer steelhead. Griffith (1993) felt that steelhead would be able to ascend the falls on the east side over a broad range of flows. The uppermost falls has a transverse fissure that provides fish with access to the left side of the channel where flows across the bedrock shelf above the falls are deepest. The falls on the right side of Ash Island has a deep plunge pool which provides good jumping opportunities for summer steelhead. The falls on the left channel is lower and stepped, and should be passable by steelhead. At 3.5 cms most of the water passes through the right channel making this the most likely route for passage. Lewis (2001) felt that the only difficulty steelhead might have at these falls would be with the shallowness of water at the lip of the falls (~20 cm), particularly at the uppermost and right channel falls. This constraint is less likely to be an issue at higher flows.

Figure 12. Cross-sectional profile of Ash Island Falls from topographic survey (looking upstream; reproduced from Griffith 1993).

Height of Ash Island Falls, looking upstream :

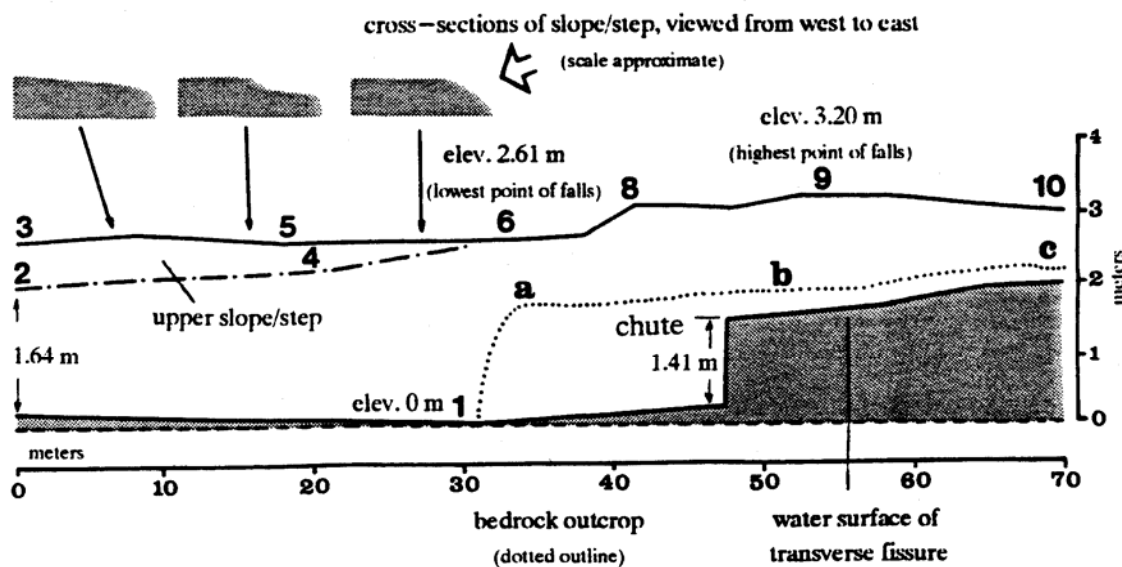
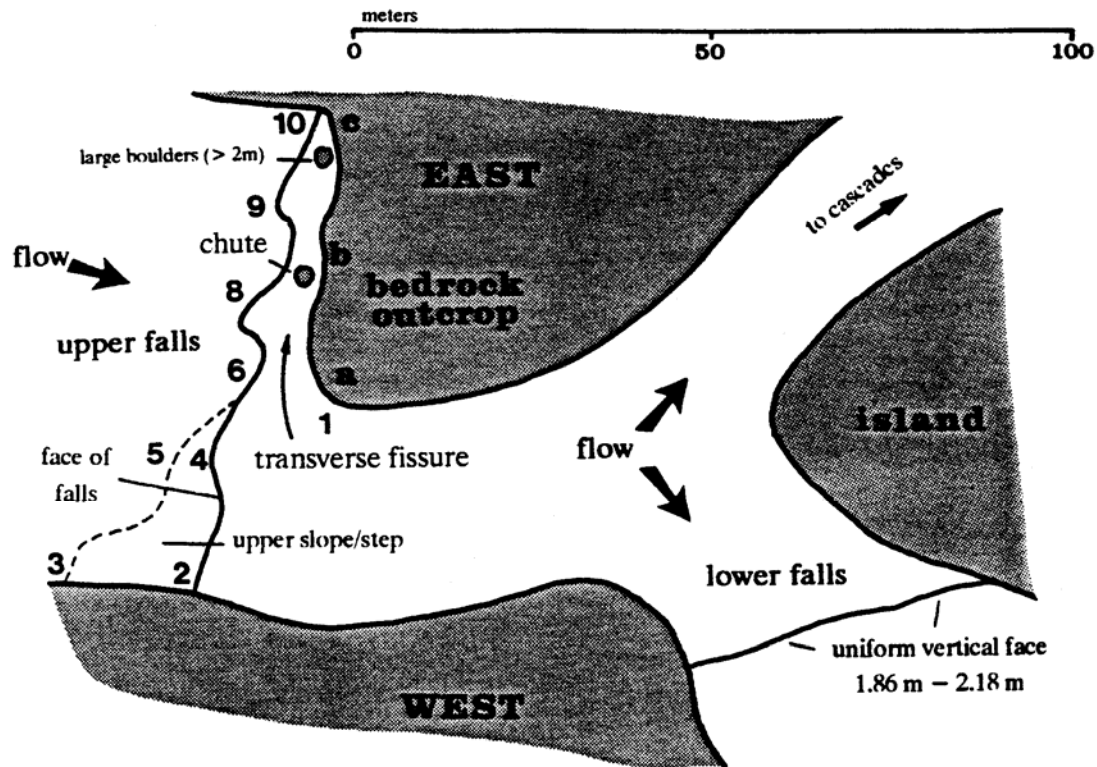


Figure 13. Overhead view of Ash Island Falls from topographic survey (reproduced from Griffith 1993).

Overhead view :



4.7. Elsie Lake Reservoir Dam (Middle Ash River)

4.7.1.

The dam at the outlet of Elsie Lake Reservoir is 30.5 m in height and is located 25.32 km upstream from the mouth of the Ash River in the Middle Ash River, or 10.65 km upstream of Dickson Lake. It represents a barrier to the passage of all anadromous fish and is currently blocking the passage of the following species of anadromous fish: summer run steelhead trout and Pacific lamprey.

4.8. Lower Ash River Tributaries

4.8.1. Wolf Creek

Wolf Creek splits into two forks approximately 2.37 km upstream from the mouth. There are vertical barrier falls in excess of 10 m in height in both forks (Griffith 1993, FWD 2005). In the mainstem portion of the Wolf Creek drainage (west fork), the falls is located approximately 4.08 km upstream from the mouth of Wolf Creek. In the east fork of the drainage, the falls is located approximately 1.38 km upstream from the confluence with the mainstem Wolf Creek.

4.8.2. Lanterman Creek

There is a 10 m barrier falls in the mainstem of Lanterman Creek, approximately 3.1 km upstream from the mouth (Griffith 1993, FWD 2005). There is a tributary to Lanterman Creek approximately 1.6 km upstream from the mouth of Lanterman Creek which contains a 5 m tall barrier falls located about 30 m downstream of the road crossing (Griffith 1993). This road crossing (culverts) was also deemed to be a barrier to fish passage (Griffith 1993).

5. EXISTING FISH RESOURCES

Fish resource information came from various sources, including Griffith (1993), Triton (1995), Burt and Horchik (1998), Lewis (2001), Burt and Robert (2003), Ash River Water Use Plan Consultative Committee (2003), Burt and Lewis (2004), Hryhorczuk and Silvestri (2002), Fish Wizard (FWD 2005), and Mapster (2005), and Hansen (2003). The species of fish present in the Ash River watershed are given in Table 2 along with the scientific name and the Provincial and COSEWIC status for each species. Fish presence in the different sections of the Ash River watershed, including the Lower Ash River and tributaries, Dickson Lake and tributaries, Middle Ash River and tributaries, Elsie Lake Reservoir and tributaries, and the Upper Ash River and tributaries is summarized in Table 3.

The following sections summarize what is known about the present fish resources in each of these sections of the watershed. Note that there are no salmon escapement records for the Ash River watershed in the FISS database (FWD 2005), as such salmon escapements from the Stamp River are presented. The raw escapement estimates are given in Appendix 1.

Table 2. Species of fish present in the Ash River watershed and along with their Provincial and COSEWIC rankings.

Common Name	Scientific Name	Status		
		Provincial ¹	COSEWIC	BC ²
<u>Anadromous Species</u>				
Steelhead ³	<i>Oncorhynchus mykiss</i>	S5	-	Yellow
Chum Salmon	<i>Oncorhynchus keta</i>	S5	-	Yellow
Sockeye Salmon	<i>Oncorhynchus nerka</i>	S4	E (May 2003)	Yellow
Coho Salmon	<i>Oncorhynchus kisutch</i>	S4	-	Yellow
Chinook Salmon	<i>Oncorhynchus tshawytscha</i>	S4	-	Yellow
Pink Salmon	<i>Oncorhynchus gorbuscha</i>	S5	-	Yellow
Pacific Lamprey	<i>Lampetra tridentata</i>	S4	-	Yellow
Atlantic Salmon	<i>Salmo salar</i>	SE	-	Introduced
<u>Resident Species</u>				
Cutthroat Trout	<i>Oncorhynchus clarki clarki</i>	S3S4	-	Blue
Dolly Varden	<i>Salvelinus malma</i>	S3S4	-	Blue
Rainbow Trout	<i>Oncorhynchus mykiss</i>	S5	-	Yellow
Kokanee ⁴	<i>Oncorhynchus nerka</i>	S4	E (May 2003)	Yellow
Stickleback	<i>Gasterosteus aculeatus</i>	S5	SC (May 1983)	Yellow
Pumpkinseed	<i>Lepomis gibbosus</i>	SE	-	Introduced

¹ S refers to the subnational (i.e., Provincial) status;

- a ranking of 3 means that the species is vulnerable to extirpation or extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation
- a ranking of 4 means that the species is apparently secure; it is uncommon but not rare; some cause for long-term concern due to declines or other factors
- a ranking of 5 means that the species is demonstrably widespread, abundant, and secure
- the rank modifier "E" indicates an exotic species in British Columbia

² - Blue listed species are those that are not immediately threatened, but are of concern because they possess characteristics that make them particularly sensitive to human activities or natural events

- Yellow listed species are apparently secure and not at risk of extinction and may be common, uncommon, declining, or increasing
- Introduced species are species that humans have transported to an area previously outside of that species' geographic range

³ Status rankings are those for Rainbow Trout (*Oncorhynchus mykiss*)

⁴ Status rankings are those for Sockeye salmon (*Oncorhynchus nerka*)

Table 3. Fish presence in various sections of the Ash River watershed according to FWD (2005) unless otherwise noted.

Species	Present				
	Lower Ash River & Tribs	Dickson Lake & Tribs	Middle Ash River & Tribs	Elsie Lake Reservoir & Tribs	Upper Ash River & Tribs
Anadromous Species					
Steelhead				stocked	stocked
Chum Salmon ¹					
Sockeye Salmon ¹					
Coho Salmon		?????????????2	?????????????2	historical ³	
Chinook Salmon					
Pink Salmon ⁴	introduced ⁵				
Pacific Lamprey				historical ⁶	
Atlantic Salmon	??exotic??7				
Resident Species					
Cutthroat Trout					
Dolly Varden					
Rainbow Trout					
Kokanee				uncommon ¹	
Stickleback ¹					
Pumpkinseed	exotic				

¹ Griffith (1993)

² FWD (2005) only gives the distribution to Dickson Falls, but notes that coho can now ascend Dickson Falls due to a fishway enhancement project

³ according to Hupacasath First Nations (Port Alberni) Traditional Ecological Knowledge (Ash River Water Use Plan Consultative Committee 2003)

⁴ Hansen (2003 - App. 1)

⁵ Burt and Horchik (1998)

⁶ Beamish and Northcote (1989)

⁷ presence in the Ash River indicated in FWD (2005) Ash River stream report, but distribution not given on map, and as such, is uncertain

5.1.

LOWER AND MIDDLE ASH RIVER AND TRIBUTARIES

The Lower Ash River includes the mouth (confluence with the Stamp River) up to the outlet of Dickson Lake. There are three major tributaries to this section of the Ash River which support both resident and anadromous fish: Moran Creek, the Wolf Creek drainage, and the Lanterman Creek drainage. Dickson Lake lies in between the Lower and Middle Ash River and receives the outflow from both Ash Lake and McLaughlin Lake. The Middle Ash River encompasses the section between Dickson Lake and Elsie Lake Reservoir Dam. Tributaries to this section of the river are not known to support anadromous fish, but there are a few that support resident fish: Turnbull Lake outflow (assumed based on the presence of cutthroat trout in Turnbull Lake, FWD 2005) and two tributaries just downstream of Elsie Lake Reservoir (Griffith 1993).

The main anadromous species supported by the Lower Ash River are steelhead, coho, chinook, and Pacific lamprey (FWD 2005). There have also been reports of small numbers of chum and sockeye salmon in the lower 0.5 km of the river and possibly winter steelhead in the lower 1-2 km (Griffith 1993). Pink salmon were introduced to the Stamp-Somass system, and during a snorkel survey conducted in September 2001 from the old bridge upstream of Lanterman Falls downstream 4.4 km to the confluence of the Ash River with the Stamp River, 6 pink salmon were observed (Hansen 2003 – App.1). The stream report for the Ash River in FWD (2005) indicates that an exotic anadromous species, Atlantic salmon, is present in the Ash River, but their presence/distribution is not given. They were stocked from 1917 to 1924, and given the lack of recorded observations in the literature, it is unlikely that they are still present in the Ash River system, though it is possible that the occasional stray from a salmon farm enters the Ash River. Dickson Lake and the Middle Ash River are only accessible to summer steelhead (Burt and Horchik 1999), Pacific lamprey (Beamish and Northcote 1989), and coho salmon (Mike McCullough, Ministry of Environment, pers.comm.).

Resident species that inhabit the Lower Ash River include rainbow trout, cutthroat trout, stickleback, and pumpkinseed (exotic species). Stickleback and pumpkinseed are restricted to the Lower Ash River (Griffith 1993), whereas there are rainbow trout, cutthroat trout, and Dolly Varden populations above Dickson Falls, in Dickson Lake, and in the Middle Ash River up to Elsie Lake Dam. Of these species, the two most abundant are rainbow trout followed by cutthroat trout.

5.1.1. Fish Stocks

Steelhead

The steelhead trout that use the Ash River are primarily summer run fish which can ascend both Lanterman and Dickson Falls and access the entire Lower Ash River and Middle Ash River up

to Elsie Dam (Burt and Horchik 1999). Most steelhead that enter the Stamp-Somass River system spawn above Stamp Falls, and the Lower Ash River and Middle Ash River constitute two of the major spawning areas for steelhead in this system (Burt and Horchik 1998). The Ministry of Water, Land, and Air Protection considers the 800 m reach immediately downstream of Elsie Lake Reservoir to be important steelhead and trout habitat (Ash River Water Use Plan Consultative Committee 2003).

Two surveys of the Ash River done in 1953 and 1954 identify Dickson Falls (in the Lower Ash River) as the upstream migration limit of all salmonids (Anon. 1953 and Anon. 1954 in Griffith 1993). The 1953 survey included overnight gill netting in 4 lakes upstream of Dickson Falls – Dickson Lake, Ash Lake, Elsie Lake, and Oshinow Lake, and is expected to have revealed the presence of summer steelhead if indeed they were above Dickson Falls (Griffith 1993). Thus, it would appear that steelhead did not historically access Elsie Lake prior to its impoundment. However, relatively recent enhancement activities at Dickson Falls in conjunction with lower post-dam flows downstream of Elsie Lake Reservoir have allowed summer steelhead to ascend Dickson Falls. Steelhead may also be present in the Wolf Creek drainage in the Lower Ash River watershed, but there is some uncertainty as to whether the fry caught in this drainage were rainbow or steelhead (FWD 2005).

Winter steelhead that enter the Stamp-Somass watershed primarily spawn below Stamp Falls, meaning that a relatively small portion of the population migrates to the confluence of the Ash and Stamp Rivers (Burt and Horchick 1998). The Lower Ash River may support a small winter run population of steelhead, however, Lanterman Falls in the Lower Ash River acts as a barrier to upstream migration (Burt and Lewis 2004). Griffith (1993) suspects that winter steelhead only use the lower 1-2 km of the Lower Ash River.

Steelhead escapement data is not available for the Ash River, however there are some estimates of adult abundance. Hirst (1991, in Griffith 1993) reports historic estimates (i.e., pre-1958) of steelhead to be around 1,500 in the Ash River. Griffith (1993) suspects that this is unlikely given that in the early 1990's the Ash River only supported an estimated run of 100-150 summer steelhead. Summer steelhead counts have been performed from 1983 to 2004 in the Lower Ash River from the bridge upstream of Lanterman Falls to the confluence with the Stamp River (Figure 14, Greater Georgia Basin Steelhead Recovery Plan 2005). These surveys covered a distance of 4.4 km and counts ranged from 18 to 165 individuals with a mean of 75 ($n = 12$, S.D. = 48). The raw data used to generate Figure 14 is presented in Appendix 1. Griffith (1993) observed 30 and 31 steelhead adults downstream of Lanterman Falls in snorkel surveys conducted in November 1992 and May 1993, respectively.

Snorkel surveys of the Lower and Middle Ash River have been carried out by the Steelhead Crew (Nanaimo) of the B.C. Conservation Foundation (BCCF) in 2001 and 2002 (data is presented in Hansen 2001 - App. 1). The first survey was completed from September 12-13, 2001 and the Ash River was divided into four sections for the swim. From the confluence of the

Elsie Lake Reservoir spillway and the low level outlet channel downstream to the first left bank tributary (~1.2 km) there were 15 adult steelhead (12 wild, 3 unconfirmed). In the section from Ash Island Falls to 2.7 km downstream (i.e., to 1 km downstream of bridge crossing) 16 adult steelhead were observed (12 wild, 2 hatchery, 2 unconfirmed). From the Dickson Lake outlet to Dickson Falls pool (~1.2 km) 53 adult steelhead were observed (40 wild, 1 hatchery, 12 unconfirmed). Of these fish, 28 were evenly distributed above Dickson Falls, 10 were observed resting in a bedrock pool located halfway up the falls, and 15 fish were holding in the pool tailout. The final section surveyed was from the old bridge upstream of Lanterman Falls to the confluence of the Ash River with the Stamp River in which 165 adult steelhead were observed (7 hatchery). In total, 249 steelhead were observed over 10.3 km with estimated weights ranging from 2-7 kg and the sex ratio appeared to be 1:1.

The second BCCF survey was completed on January 24, 2002 and only covered the section from the confluence of the Elsie Lake Reservoir spillway and the low level outlet channel downstream to the first left bank tributary (~1.2 km). There were 13 steelhead observed on this swim (5 wild) with two fish in the first pool downstream of the spillway and the other 11 in the canyon pool tailout 1.0 km downstream from the survey starting point (Hansen 2003 – App. 1).

A third BCCF snorkel survey was completed on February 14, 2002 and covered three sections of the river. From the confluence of the Elsie Lake Reservoir spillway and the low level outlet channel downstream to the first left bank tributary (~1.2 km) there were three adult steelhead observed. There were also 6 redds and about 10 small test redds observed (Hansen 2003 – App. 1). A spot swim was performed at the upper Ash River Road bridge crossing covering a distance of 100 m – no fish were observed. Another spot swim was performed from the Dickson Lake outlet to the lower Ash River Road bridge crossing covering a distance of 150 m. In this final swim, three steelhead (2 wild) were observed. There were also 6 large redds identified immediately upstream of the riffle break at the lake outlet and two more downstream of this.

Assessment of juvenile steelhead abundance was carried out at four electrofishing sites in the Middle Ash River in 2001 (Hansen 2003 - App. 1). These sites were all located within 1,500 m of the low level outlet. The abundance of fry was adjusted for depth and velocity and the resulting estimates of density at the four sites were 61, 21, 3, and 115 fry per 100 m² (geometric mean = 26.5 fry per 100 m²). Burt and Horchik (1998) estimated the steelhead fry (0+) population in the Middle Ash River in 1996 to be 23,518 (59% capacity, Table 4).

Burt and Horchik (1998) estimated the rearing population density and the rearing capacity in 1996 for steelhead fry (0+) and yearlings (1+) in the Lower Ash River, the Wolf Creek drainage, the Lanterman Creek drainage (Table 4). Note that habitat suitability sampling was conducted from August to October, 1996 to generate these estimates. The general finding is that the available habitat in the Lower Ash River watershed is below carrying capacity, but to varying degrees. The Lower Ash River, Wolf Creek drainage, and Lanterman Creek drainage were estimated to contain 32,753 fry (73% capacity), 27,692 (74% capacity), and 3,500 (20% capacity),

respectively. Juvenile abundances in Wolf Creek and Lanterman Creek drainages were estimated to be 662 (42% capacity) and 139 (6% capacity), respectively. Considering the Lower Ash River watershed as a whole (i.e., Lower Ash River plus Wolf Creek drainage plus Lanterman Creek drainage), there was estimated to be 65,945 steelhead fry in 1996 (65% of capacity) and 801 steelhead yearlings (21% capacity; only Wolf and Lanterman Creek drainages).

Figure 14. Ash River summer steelhead counts from the bridge upstream of Lanterman Falls to Stamp River (4.4 km), 1983-2004 (data source: Georgia Basin Steelhead Recovery Plan (2005) website). Note: not all fish are wild.

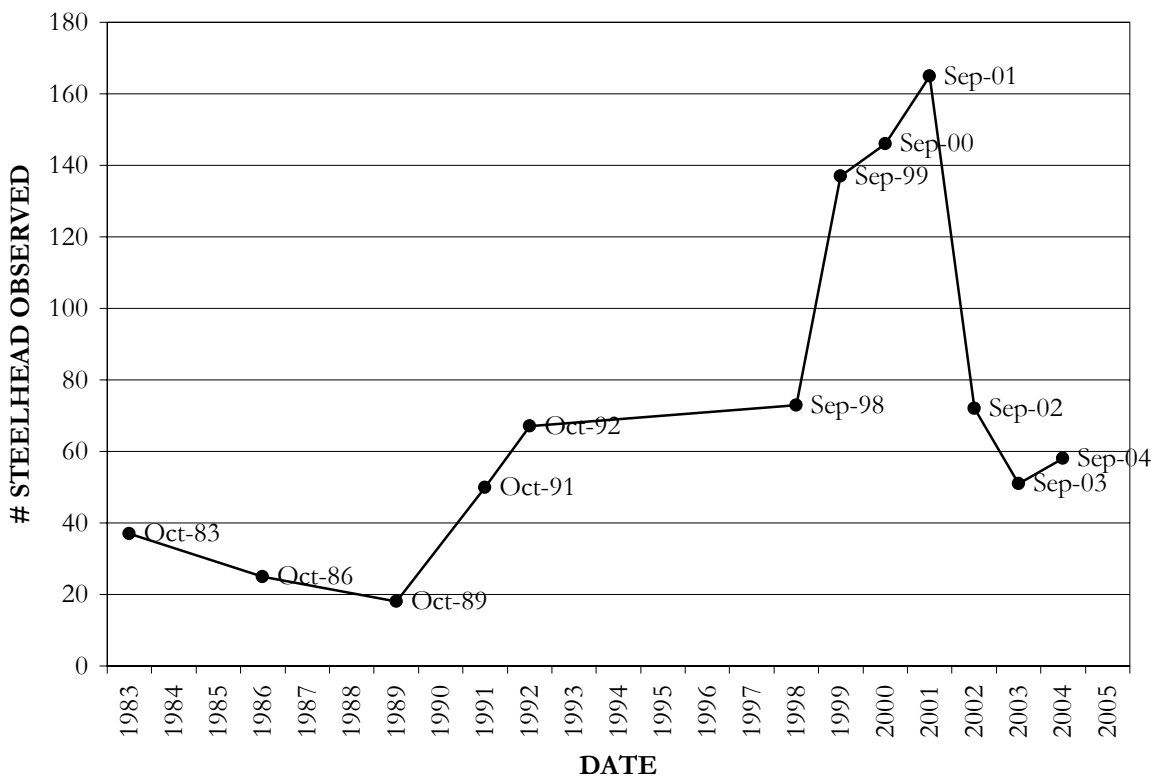


Table 4. Juvenile steelhead abundance and capacity estimates in 1996 for the Lower Ash River, Wolf Creek drainage, Lanterman Creek drainage, and the Middle Ash River (data from Burt and Horchik 1998).

Stream	Fry (0+)			Yearlings (1+)		
	Rearing Population	Rearing Capacity	% of Capacity	Rearing Population	Rearing Capacity	% of Capacity
Lower Ash River	34,753	47,486	73%	n/a	n/a	n/a
Wolf Creek drainage	27,692	37,202	74%	662	1,582	42%
Lanterman Creek drainage	3,500	17,517	20%	139	2,288	6%
Middle Ash River	23,518	40,068	59%	n/a	n/a	n/a
Total (Lower Ash River and Tributaries)	65,945	102,205	65%	801	3,870	21%
Total (Middle Ash River):	23,518	40,068	59%	n/a	n/a	n/a

Coho Salmon

Coho are also present downstream of Lanterman Falls, and in the three major tributaries to the Lower Ash River: Moran Creek, the Wolf Creek drainage, and the Lanterman Creek drainage. Past work has suggested that Lanterman Falls in the Lower Ash River is the upstream distribution limit for coho in the Ash River (Griffith 1993). However, sampling upstream of Lanterman Falls and downstream of Dickson Falls has shown that both adult (from snorkel surveys, Mike McCulloch, BCCF, pers. comm., Appendix 2 in Lewis 2001) are present in this reach of the river. In 1979-80 BC Fish and Wildlife] removed a log jam on Dickson Falls in the hopes that it would facilitate the passage of coho salmon. Although 30 years of stock assessment in the Ash River watershed shows no record of coho adults or fry upstream of Dickson Falls (Ash River Water Use Plan Consultative Committee 2003), work during 2005 confirmed their presence. Coho juveniles were captured upstream of Dickson Falls in 2005 during a BCRP study, documenting their presence (Mike, McCullough, Ministry of Environment, pers. comm.) Moreover, Traditional Ecological Knowledge from the Hupacasath First Nation states that coho have historically accessed Elsie Lake. The notation in Fish Wizard (FWD 2005) of Dickson Falls as the upstream distribution limit for coho in the Ash River is incorrect.

There are no coho escapement records for the Ash River, but there are for the Stamp River (Somass System, plotted in Figure 15, raw data in Appendix 1). From 1953 to 1965 coho escapements to the Stamp River were typically about 35,000. From 1966 to 1974 escapements were generally higher and more variable, ranging from 30,000 to 130,000. From 1975 to 1979

escapements varied from 31,200 to 40,000 and then there appeared to be a population crash in the early 1980's with no fish observed in 1980 and only 8,035 in 1982. From 1985 to 1992 escapements were similar to those observed in the late 1950's and early 1960's. However, the population crashed again in the early 1990's. The most recent estimate of 36,611 in 1998 suggests that the population may be recovering. The mean escapement estimate for 1989 to 1998 is 25,697 individuals.

Burt and Horchik (1998) put forward some possible explanations for the observed coho escapement patterns. The general increase observed from the late 1960's through to the mid 1970's could be due to either 1) opening of the Robertson Creek spawning channel in 1960, 2) the release of large numbers of coho into the systems by the Robertson Creek Hatchery beginning in 1974, and 3) fertilization of Great Central Lake since 1970 (intended to increase sockeye production). Following fertilization, primary production of Great Central Lake was 5 fold greater than it was prior to fertilization, potentially leading to an increased freshwater survival rate for coho via an increased food supply.

The general decline of coho and the increased variability in escapements since the mid 1970's may be due to a several factors (Burt and Horchik 1998). In 1976, heating fuel was released into Kitsucksus Creek (from repairs to a Super-Valu store) via a storm drain causing a major fish kill. In 1978 there were extensive coho stranding mortalities in Weiner Creek due to a lack of rainfall and 115 litres of diesel fuel were spilled into the Taylor River (logging truck accident). The low returns observed from 1993 onwards may also be due to the effects of El Nino events on oceanic survival.

Based on the escapement data available for the Stamp River, there is the potential for a substantial number of coho to enter the Ash River from the Stamp River. Hirst (1991, in Griffith 1993) reports historic estimates (i.e., pre-1958) of coho in the Ash River to be around 1,500. From 1953 to 1958, coho escapements to the Stamp River ranged from 15,000 to 35,000. Taken together these data imply that in the 1950's, approximately 4.3% to 10.0 % of coho that enter the Stamp River migrate up the Lower Ash River. However, only 17 coho adults were observed downstream of Lanterman Falls in a snorkel survey completed in November 1992 (Griffith 1993). Comparatively, the 1992 coho escapement estimate for the Stamp River was 50,400 (Figure 15). Taken together, these data suggest that in more recent times, only approximately 0.03% of coho that enter the Stamp River migrate into the Lower Ash River. In a snorkel survey conducted in September 2001 from the old bridge upstream of Lanterman Falls downstream 4.4 km to the confluence of the Ash River with the Stamp River, 78 coho were observed (~50% hatchery, 65 in pool at Moran Creek confluence) (Hansen 2003 – App. 1).

Griffith (1993) estimated the density and theoretical capacity of coho juveniles in flowing hydraulic habitat in the Lower Ash River (downstream of Lanterman Falls), the Wolf Creek drainage, and the Lanterman Creek drainage. Caution should be exercised in the interpretation of these results given that habitat use relationships from Lake Ontario were used (Griffith 1993).

The mean sampled density in the Lower Ash River (downstream of Lanterman Falls) was 150 fish per 100 m² (191% of capacity). Griffith (1993) concluded that there is a general lack of coho habitat in the Ash River mainstem due to the nature of the stream (swift, cobbly/bouldery). Sampling in flowing habitats in the Wolf Creek drainage was broken down into two sections: one below the falls and one above the falls. Below the falls, the mean estimated juvenile coho density was 13 fish per 100 m² (66% of capacity) and above the falls the mean estimated density was 24 fish per 100 m² (71% of capacity). The Lanterman Creek drainage was sampled downstream of the barrier falls and the mean sampled juvenile coho density was 12 fish per 100 m² (47% of capacity).

Griffith (1993) also estimated the density and theoretical capacity of coho juveniles in isolated pools located in ephemeral stream channels in Moran Creek, the Wolf Creek drainage, and the Lanterman Creek drainage by electrofishing (this habitat was not present in the Lower Ash River). Again, caution should be exercised in the interpretation of these results given that habitat use relationships from Lake Ontario were used (Griffith 1993). In Moran Creek, the sampled density of juvenile coho was 280 juveniles per 100 m² (122% of capacity). In the Wolf Creek drainage the sampled juvenile coho density was 125 per 100 m² (2,581% of capacity) in the first tributary upstream from the mouth and 415 juveniles per 100 m² (13,607% of capacity) in the second tributary upstream from the mouth. In the first tributary to Lanterman Creek upstream of its mouth, juvenile coho were sampled at a density of 63 juveniles per 100 m² (2,219% of capacity).

Burt and Horchik (1998) estimated the rearing population and the rearing capacity in 1996 for coho fry (0+) in the portion of the Lower Ash River downstream of Lanterman Falls, the Wolf Creek drainage, and the Lanterman Creek drainage (Table 5). To generate these estimates, habitat suitability sampling was conducted from August to October, 1996. The Lower Ash River, Wolf Creek drainage, and Lanterman Creek drainage were estimated to contain 7,250 fry (37% capacity), 1,272 (24% capacity), and 40 (0.4% capacity), respectively. Considering the Lower Ash River watershed as a whole (i.e., Lower Ash River plus Wolf Creek drainage plus Lanterman Creek drainage), there was estimated to be 8,562 coho fry in 1996 (25% of capacity).

The data presented in Griffith (1993) and Burt and Horchik (1998) suggest that the Lower Ash River watershed can support more juvenile coho than it currently does with capacities ranging from 0.4% in the Lanterman Creek drainage.

Figure 15. Annual coho escapement estimates for the Stamp River (Somass River system) from 1953-1998 (data from FWD 2005).

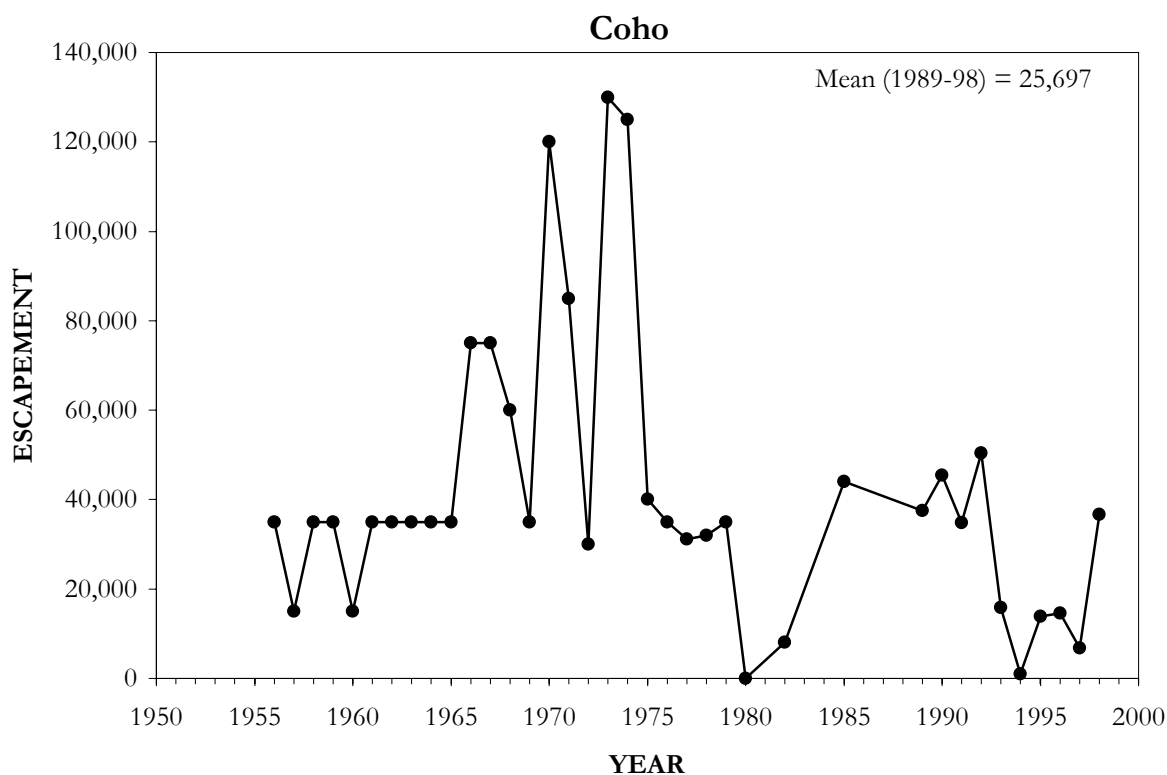


Table 5. Coho fry (0+) abundance and capacity estimates in 1996 for the Lower Ash River (downstream of Lanterman Falls), the Wolf Creek drainage, and the Lanterman Creek drainage (data from Burt and Horchik 1998).

Stream	Fry (0+)		
	Rearing Population	Rearing Capacity	% of Capacity
Lower Ash River (d/s Lanterman Falls)	7,250	19,735	37%
Wolf Creek drainage	1,272	5,391	24%
Lanterman Creek drainage	40	9,290	0.4%
Middle Ash River	n/a	n/a	n/a
Total (Ash River Watershed Downstream of Lanterman Falls):	8,562	34,416	25%

Chinook Salmon

Fish Wizard (FWD 2005) indicates that chinook salmon migrations are restricted to the Lower Ash River below Dickson Falls. However, Griffith (1993) and Burt and Lewis (2004) state that chinook salmon cannot ascend Lanterman Falls located downstream of Dickson Falls. There are no records of chinook in either Wolf or Lanterman Creek in the Lower Ash River watershed (FWD 2005).

Little is known about the salmonid use of the Ash River other than for coho (Griffith 1993). There are no chinook escapement records for the Ash River, but there are for the Stamp River (Somass System, plotted in Figure 16, raw data in Appendix 1). Prior to 1985, escapements were consistently less than 20,000 fish and an increase began in 1985. Around 1992, escapements began to decline and the most recent estimate from 1998 is 32,049 individuals. The mean escapement estimate for 1989 to 1998 is 68,294 individuals.

Burt and Horchik (1998) put forward three possible explanations for the increase in chinook escapements beginning in 1985. The first is the Pacific Salmon Treaty of 1985 which established catch limits on the commercial troll fishery off of the west coast of Vancouver Island. The second possible explanation is a high survival rate of the early marine life stage (from Wilf Leudke, DFO Nanaimo, pers. comm. in Burt and Horchik 1998). Finally, the increase may be due to Robertson Creek Hatchery which has been releasing large numbers of chinook since 1983. The latter explanation seems to be the least likely (on its own at least) since the increase was not observed until 1985.

The more recent decline in escapements may be due to reduced oceanic chinook survival caused by an increased frequency of El Niño events. During such events, predation from mackerel is high and has the potential to affect the migratory patterns of returning adults (Burt and Horchik 1998).

Data from 1991-1992 indicates that the chinook run in the Ash River consisted of about 250-300 individuals (based on counts from snorkel swim surveys in Griffith 1993). Most of these individuals were observed in the lowermost 0.5 km of the Lower Ash River. In 1991 and 1992 chinook escapements for the Stamp River were 100,000 and 124,200, respectively. Taken together, these data suggest that somewhere between 0.20% and 0.30% of the chinook that enter the Stamp River eventually enter the Lower Ash River.

Burt and Horchik (1998) estimated the rearing capacity in 1996 for chinook psmolts (0+) in the portion of the Lower Ash River downstream of Lanterman Falls to be 7,063 individuals. To generate this estimate, habitat suitability sampling was conducted from August to October, 1996. No estimate of the rearing population size was made since fish had left the river before surveys were conducted.

Figure 16. Annual chinook escapement estimates for the Stamp River (Somass River system) from 1953-1998 (data from FWD 2005).

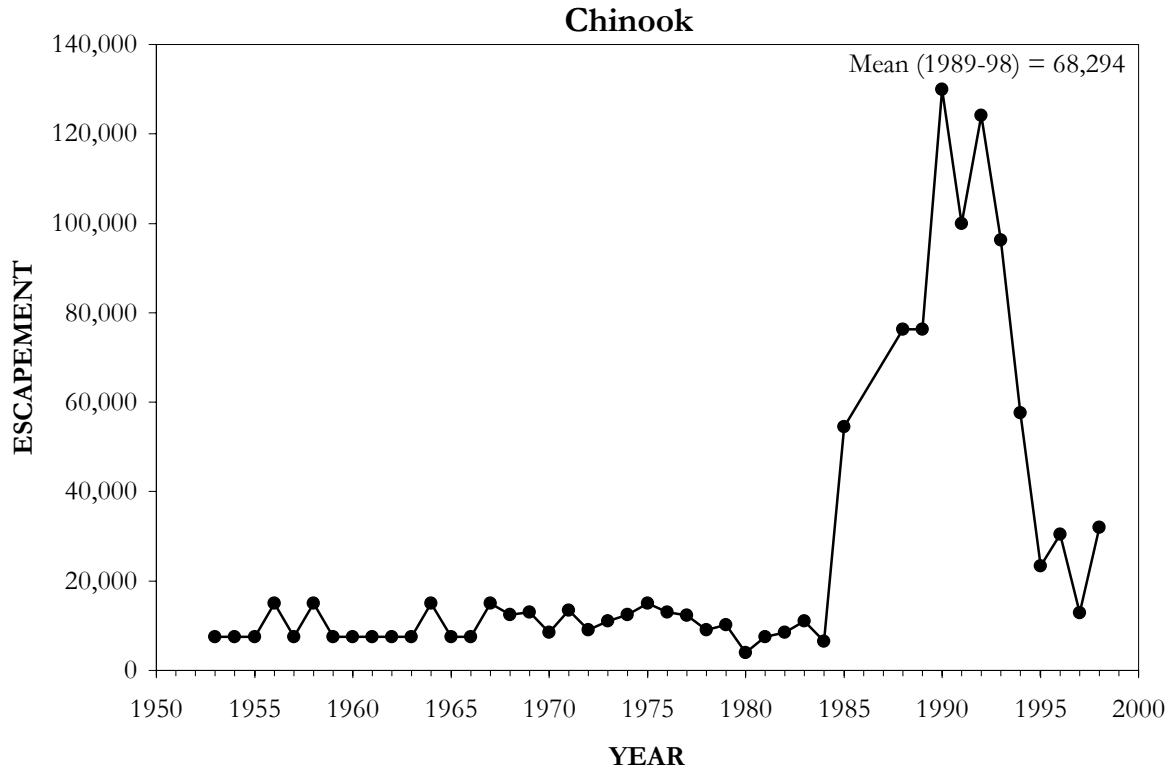


Table 6. Chinook presmolt (0+) abundance and capacity estimates in 1996 for the Lower Ash River (downstream of Lanterman Falls), the Wolf Creek drainage, and the Lanterman Creek drainage (data from Burt and Horchik 1998).

Stream	Fry (0+)		
	Rearing Population	Rearing Capacity	% of Capacity
Lower Ash River (d/s Lanterman Falls)	7,250	19,735	37%
Wolf Creek drainage	1,272	5,391	24%
Lanterman Creek drainage	40	9,290	0.4%
Middle Ash River	n/a	n/a	n/a
Total (Ash River Watershed Downstream of Lanterman Falls):	8,562	34,416	25%

Pacific Lamprey

The Pacific lamprey is present in both the Lower and Middle Ash River (FWD 2005, Beamish and Northcote 1989). Prior to the impoundment of Elsie Lake, Pacific lamprey could access the lake and may have utilized the Upper Ash River watershed (Beamish and Northcote 1989). The upper distribution limit for Pacific lamprey is currently Elsie Lake Reservoir Dam.

Larvae and one adult (45 cm) have also been captured in the lower section of Wolf Creek (Griffith 1993) in the Lower Ash River watershed. Beamish and Northcote (1989) searched for evidence of lamprey by electroshocking in the Middle Ash River immediately downstream of Elsie Lake Dam in May 1986 and September 1987. On May 1, 1986 there were 364 ammocoetes (larval lamprey) caught and on September 14, 1987 318 ammocoetes and 11 metamorphosed fish were caught. Adult lamprey may have been abundant in Ash River watershed prior to 1959 as indicated by counts of adult lamprey moving through an artificial fish bypass on the Stamp River which ranged from 20,000 to 50,000 (Beamish unpubl. data in Beamish and Northcote 1989).

Chum Salmon

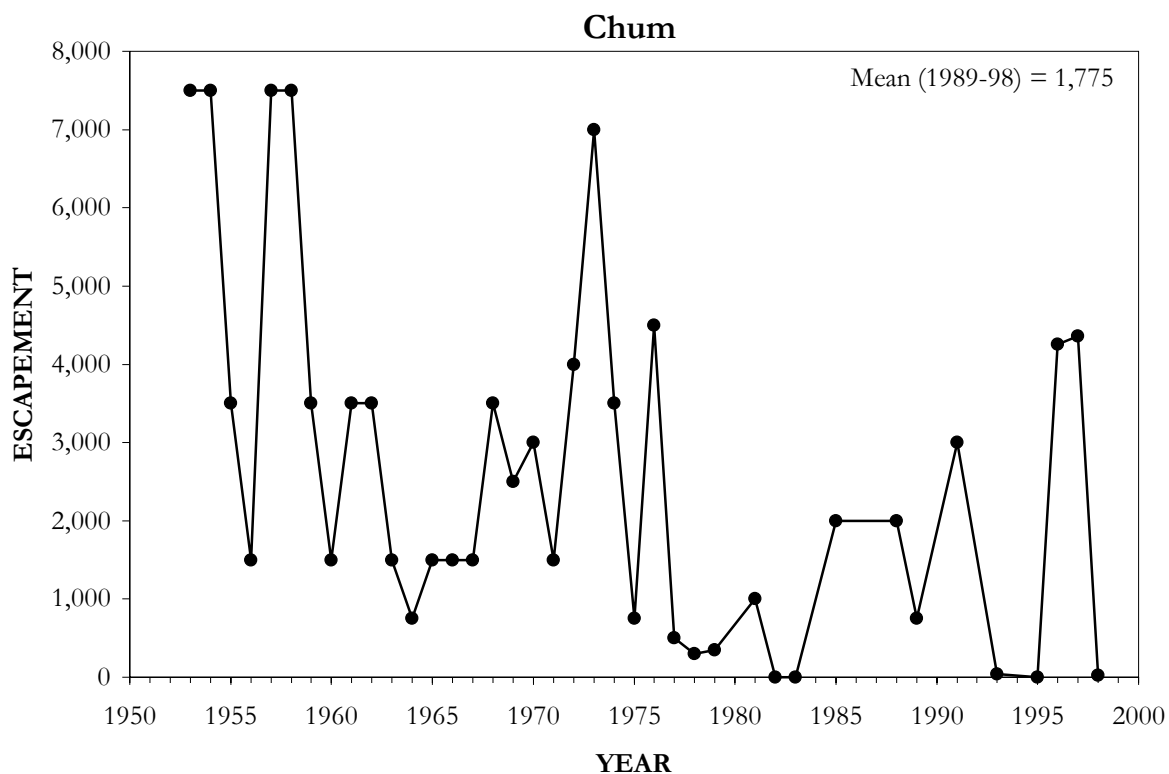
Data from snorkel surveys conducted in 1991 and 1992 indicates that the chum inhabit the Ash River consists of only a few individuals and they appear to be restricted to the lower 0.5 km of the Ash River (Griffith 1993). However, Burt and Lewis (2004) suggest that Lanterman Falls is the upstream limit for chum as it is the first substantial barrier upstream of the mouth of the river. There are no records of chum in either Wolf or Lanterman Creek in the Lower Ash River watershed (FWD 2005).

Little is known about the salmonid use of the Ash River other than for coho (Griffith 1993). There are no chum escapement records for the Ash River, but there is for the Stamp River (Somass System, plotted in Figure 17, raw data in Appendix 1). Compared to coho and chinook, escapements of chum are substantially smaller with maximum estimates of only 7,500 (4 years, all in the 1950's). From the 1960's to 1998, escapements were highly variable and ranged from 0 to 7,000 and were typically less than 3,500. The general trend from the mid 1970's to the mid 1990's was one of decline. The mean escapement estimate for 1989 to 1998 (excluding 1990, 1992, and 1994 where the number is unknown) is 1,775 individuals.

Burt and Horchik (1998) put forward some possible explanations for the chum decline from the mid 1970's to the mid 1990's. In 1967 it was determined that pulp mill effluent and sewage from Port Alberni was heavily polluting the Somass River estuary (Brown *et al.* 1979) in Burt and Horchik (1998). This pollution could have led to increased mortality among chum fry which migrate to the estuary soon after emergence compared to other salmonid juveniles that may enter the estuary when they are older and larger. This assumes that small fry newly emerged fry

are relatively highly susceptible to pollution compared to larger and older juveniles of other salmonids that may be exposed to the same conditions. It is also possible that chum escapement data may not be accurate from the mid 1980's onwards due to a change in enumeration methods (Wilf Leudke, DFO Nanaimo, pers. comm. in Burt and Horchik 1998). Prior to this time, enumerations were done using boat and snorkel surveys, stream walks, and overflight counts. After this time, counts were done at the Sproat and Stamp Falls fishways and at the outlet of Great Central Lake. However, chum mainly spawn below these locations suggesting that estimates after the mid 1980's are overly conservative.

Figure 17. Annual chum escapement estimates for the Stamp River (Somass River system) from 1953-1998 (data from FWD 2005).



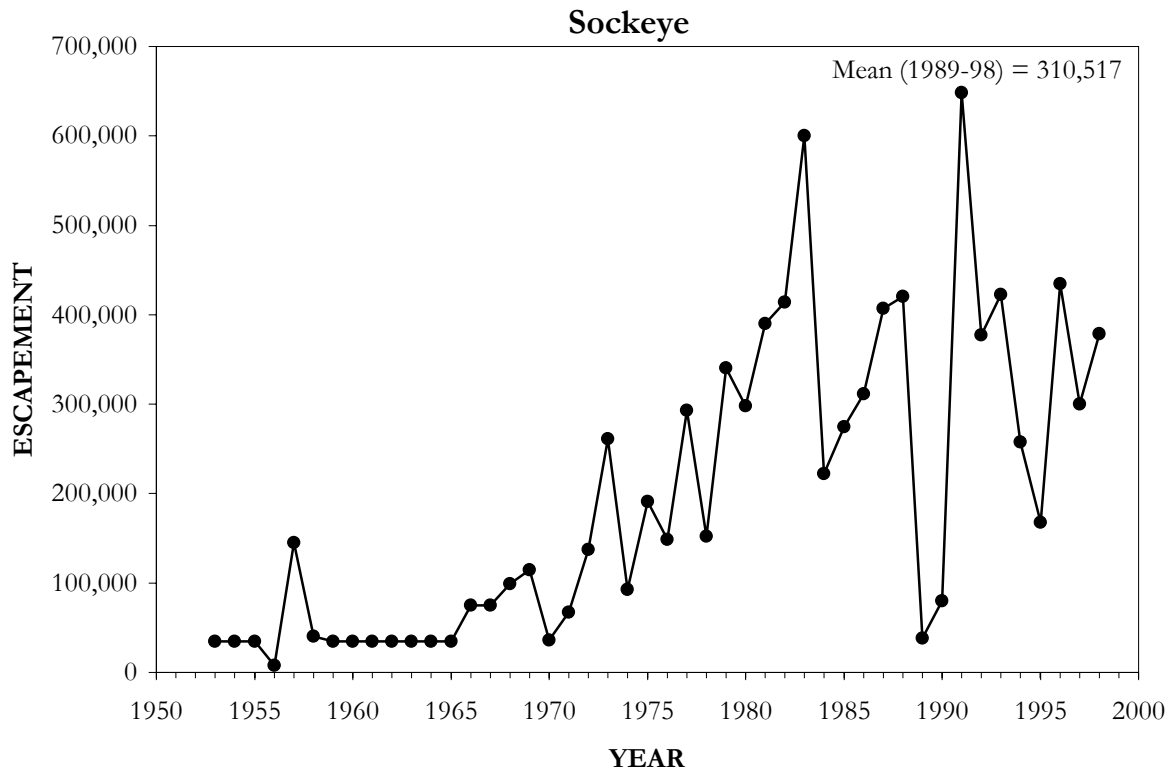
Sockeye Salmon

Data from snorkel surveys conducted in 1991 and 1992 indicate that the sockeye run in the Ash River consists of only a few individuals and they appear to be restricted to the lower 0.5 km of the Ash River (Griffith 1993). However, Burt and Lewis (2004) suggest that Lanterman Falls is the upstream limit for chum as it is the first substantial barrier upstream of the mouth of the river. There are no records of sockeye in either Wolf or Lanterman Creek in the Lower Ash River watershed (FWD 2005).

Little is known about the salmonid use of the Ash River other than for coho (Griffith 1993). There are no sockeye escapement records for the Ash River, but there are for the Stamp River (Somass System, plotted in Figure 18, raw data in Appendix 1). Sockeye escapements to the Stamp River were relatively consistent from the early 1950's to the mid 1960's with estimates typically being 35,000 individuals. From the mid 1960's to the early 1990's there was a general increase in sockeye escapements which peaked in 1991 at 648,500. Following 1991 there was a general decrease in escapements, although they remained relatively high ranging from 167,634 to 434,933. The 10 year average escapement from 1989 to 1998 is 310,517. In a snorkel survey conducted in September 2001 from the old bridge upstream of Lanterman Falls downstream 4.4 km to the confluence of the Ash River with the Stamp River, 3 sockeye were observed (Hansen 2003 – App.1).

The increase in sockeye numbers from the mid 1960's to early 1990's has been attributed to a combination of fertilization of Great Central Lake with escapement optimization activities (including stock protection and enhancement activities for the Barkley Sound sockeye) (Hyatt and Steer 1987 in Burt and Horchik 1998). The decline in escapements after 1991 may be related to the increased frequency of El Nino events with the associated effects of increased predation from mackerel and altered migration patterns for sockeye (Burt and Horchik 1998). Overfishing has also been implicated as a possible cause of the decline (Burt and Horchik 1998).

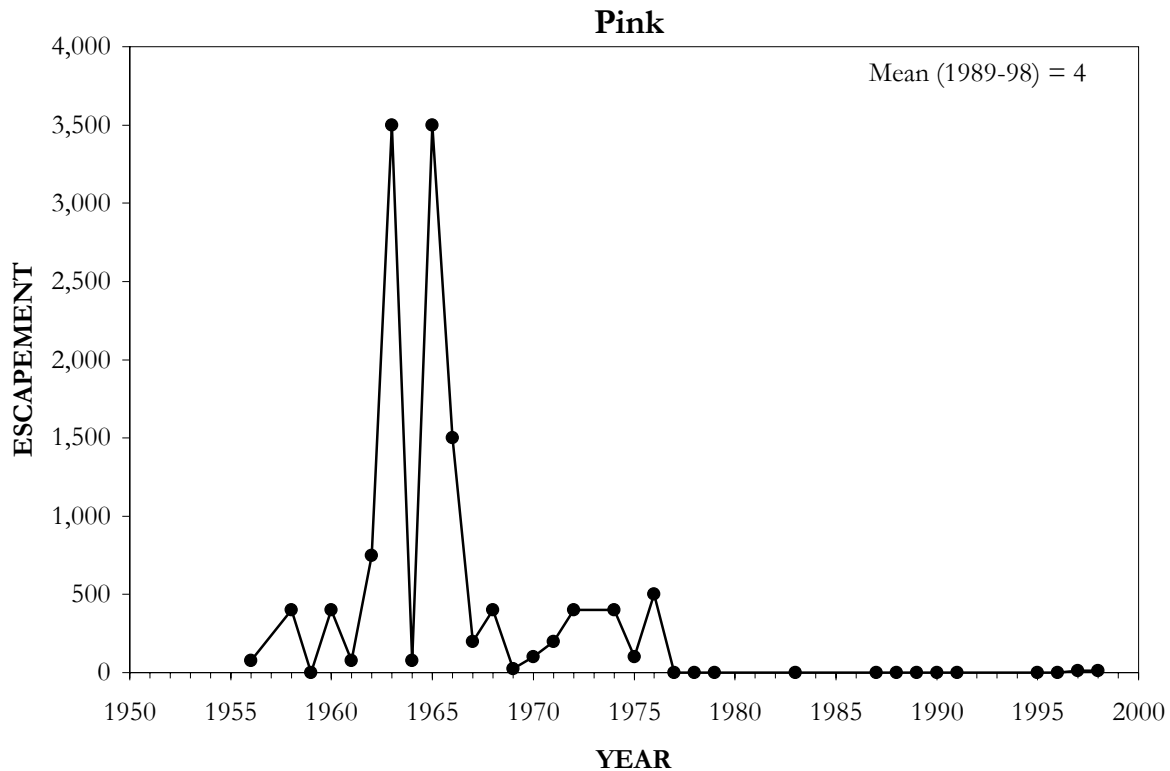
Figure 18. Annual sockeye escapement estimates for the Stamp River (Somass River system) from 1953-1998 (data from FWD 2005).



Pink Salmon

Pink salmon are not native to the Stamp-Somass system (which includes the Ash River) (Burt and Horchik 1998). DFO planted eyed eggs from the Tsolum, Courtenay, Atnarko, Cheakamus, and Indian Rivers and from Bear Creek (a.k.a. Amour de Cosmos) in the Robertson Creek spawning channel. These introductions stopped in the early 1970's due to heavy prespawn mortalities caused by high water temperatures. Pink salmon escapement data for the Stamp River is presented in Figure 19 (raw data in Appendix 1). The last substantial return was 500 individuals in 1976. Prior to 1997, the last observation of pink salmon in the Stamp River was 2 individuals in 1983. In 1997 and 1998, 14 and 12 individuals respectively were observed in the Stamp River. Fish Wizard (FWD 2005) does not contain any record of pink salmon presence in the Ash River. However, in a snorkel survey conducted in September 2001 from the old bridge upstream of Lanterman Falls downstream 4.4 km to the confluence of the Ash River with the Stamp River, 6 pink salmon were observed (Hansen 2003 – App.1).

Figure 19. Annual pink escapement estimates for the Stamp River (Somass River system) from 1953-1998 (data from FWD 2005).



Atlantic Salmon

Atlantic salmon are an introduced species in British Columbia. Their presence in the Ash River is indicated in the Ash River stream report in Fish Wizard, but no distribution within the river is given (FWD 2005). There were no references to Atlantic salmon in the Ash River in the literature that was reviewed for this report. However, an Ash River query done using the Fisheries Inventory Data Queries (<http://srmapps.gov.bc.ca/apps/fidq/main.do>) tool shows that Atlantic salmon were stocked in the Ash River (location not given) in 1917, 1919, 1923, and 1924. Thus, the available information suggests that Atlantic salmon are no longer present in the Ash River watershed.

Cutthroat Trout

In the Lower Ash River, cutthroat trout have been observed at the confluence with the Stamp River (FWD 2005), in the Wolf Creek drainage (Griffith 1993, Burt and Horchik 1998, FWD 2005), the Lanterman Creek drainage (Griffith 1993, Burt and Horchik 1998, FWD 2005), and between the outlet of Dickson Lake and Dickson Falls (FWD 2005). An apparently allopatric population is found above the barrier falls located on Lanterman Creek (Griffith 1993). Griffith (1993) states that the populations in Wolf and Lanterman Creeks were low density, but did not report the densities separate from that of rainbow trout. There was evidence of rainbow-cutthroat hybridization in both the Wolf and Lanterman Creek drainages but most fish were deemed to be rainbow (Griffith 1993).

In between the Lower and Middle Ash River, cutthroat trout are present in Dickson Lake, Ash Lake, and McLaughlin Lake (FWD 2005). Upstream of Dickson Lake in the Middle Ash River cutthroat abundance is low. They are known to be present in Turnbull Lake (FWD 2005) and in the Ash River near Elsie Lake Dam (Griffith 1993, one fry sampled in 1992). As in the Wolf and Lanterman Creek drainages, there was some evidence of hybridization with rainbow trout in the Middle Ash River (1 fish) and in two small Middle Ash River tributaries just downstream of Elsie Lake Dam (a few fish caught) (Griffith 1993). However, these fish were all ultimately deemed to be rainbow trout. The Ministry of Water, Land, and Air Protection considers the 800 m reach immediately downstream of Elsie Lake Reservoir to be important steelhead and trout habitat (Ash River Water Use Plan Consultative Committee 2003).

Rainbow Trout

Rainbow trout have a similar distribution to cutthroat trout in the Lower Ash River, although their abundance is greater throughout the Lower Ash River (Griffith 1993). They have been observed at the confluence with the Stamp River (FWD 2005), in the Wolf Creek drainage (Griffith 1993, Burt and Horchik 1998, FWD 2005), the Lanterman Creek drainage (Griffith 1993, Burt and Horchik 1998, FWD 2005), and between the outlet of Dickson Lake and Dickson Falls (FWD 2005). In addition, rainbow trout are present in Moran Lake. There was evidence of rainbow-cutthroat hybridization in both the Wolf and Lanterman Creek drainages but most fish were deemed to be rainbow (Griffith 1993).

In between the Lower and Middle Ash River, rainbow trout are present in Dickson Lake and Ash Lake (FWD 2005). Upstream of Dickson Lake in the Middle Ash River rainbow trout is the dominant resident species (Griffith 1993). They are present both below and above Ash Island Falls (Griffith 1993). The Ministry of Water, Land, and Air Protection considers the 800 m reach immediately downstream of Elsie Lake Reservoir to be important steelhead and trout habitat (Ash River Water Use Plan Consultative Committee 2003).

Dolly Varden

Dolly Varden have been observed at the mouth of the Ash River, but surveys conducted in 1992 did not identify any fish in Lower Ash River (Griffith 1993). Dolly Varden have been documented in between the Lower and Middle Ash River in Dickson and Ash Lakes (FWD 2005). However, Griffith (1993) sampled (electrofishing, minnow trapping) Dickson Lake in 1992 and found no evidence of Dolly Varden. The presence of Dolly Varden in the Middle Ash River is uncertain as two fry were captured near Elsie Lake in 1991, but no individuals were observed in sampling conducted in 1992 (Griffith 1993). However, juvenile Dolly Varden are notoriously hard to sample (even by electrofishing), so a lack of capture does not necessarily indicate a lack of presence (Griffith 1993). Considering this, Dolly Varden may be present throughout the Middle Ash River. They may also be present in isolated headwater lakes (workshop, BCRP 2000).

Pumpkinseed

Pumpkinseed is an introduced species in British Columbia. Fish Wizard indicates their presence in the Ash River (FWD 2005), but does not give the distribution. Griffith (1993) captured pumpkinseed in 1992 in the lower section of the Lower Ash River and in Moran Lake. It was determined that their distribution is limited to the portion of the Ash River drainage downstream of Lanterman Falls.

Stickleback

The presence of sticklebacks in the Ash River is not indicated in Fish Wizard (FWD 2005), but they were captured by Griffith (1993) in 1992 in Moran Lake. Griffith states that their distribution is limited to the Lower Ash River downstream of Lanterman Falls.

5.3. ELSIE LAKE RESERVOIR AND TRIBUTARIES (INCLUDING THE UPPER ASH RIVER)

5.3.1. Elsie Lake Reservoir

Data concerning fish captures in Elsie Lake Reservoir goes back to 1953. Data are presented in Beamish and Northcote (1989), Triton (1995), and Burt and Robert (2003). The following text describes the fish species composition of Elsie Lake Reservoir both prior to and after its impoundment. There are currently no anadromous fish species present in Elsie Lake Reservoir, except for steelhead that are stocked/transported by the Province. Summer steelhead (juveniles) were stocked in the reservoir until 1997 (FWD 2005). In January 2005, approximately 60 tagged adult summer steelhead were stocked in Elsie Lake Reservoir to investigate the extent to which the fish could access the Upper Ash River (M. McCulloch, BCCF, pers. comm.).

Resident fish species present in Elsie Lake Reservoir include rainbow and cutthroat trout, as well as hybrids between the two species (Triton 1995, Burt and Robert 2003). Both species were present in Elsie Lake prior to its impoundment (Beamish and Northcote 1989). Kokanee have been observed in the pool below the reservoir's spillway (Rick Axford, MWLAP, pers. comm.), but are thought to be uncommon in the reservoir (Burt and Robert 2003).

Anadromous Fish

Historically, Pacific lamprey had access to Elsie Lake which is known to have been inhabited by larval lamprey immediately prior to (and after) impoundment (Beamish and Northcote 1989). After the construction of the dams at the outlet of Elsie Lake in 1958, young lamprey could no longer migrate out of the lake and adults could no longer migrate into Elsie Lake. The last year in which they could have spawned in Elsie Lake or its inlet tributaries would have been 1958, although the spawning run would have been interrupted by the completion of Elsie Lake Dam. At first it appeared that a landlocked population of lamprey had established in Elsie Lake Reservoir as indicated by attacks on Elsie Lake Reservoir trout. However, 7 years after the completion of construction, the attacks stopped. This period of time coincides with the average age when larval lamprey metamorphose. Beamish and Northcote (1989) searched for evidence of lamprey in Elsie Lake Reservoir in May 1986 and September 1987 by electroshocking two inlets to the reservoir but they found no lamprey. Based on the above evidence, it was concluded that the anadromous lamprey that inhabits the Ash River watershed failed to establish a landlocked freshwater population following the impoundment of Elsie Lake (Beamish and Northcote 1989). This conclusion is further supported in that there are no documented landlocked Pacific lamprey populations in British Columbia (Beamish and Northcote 1989).

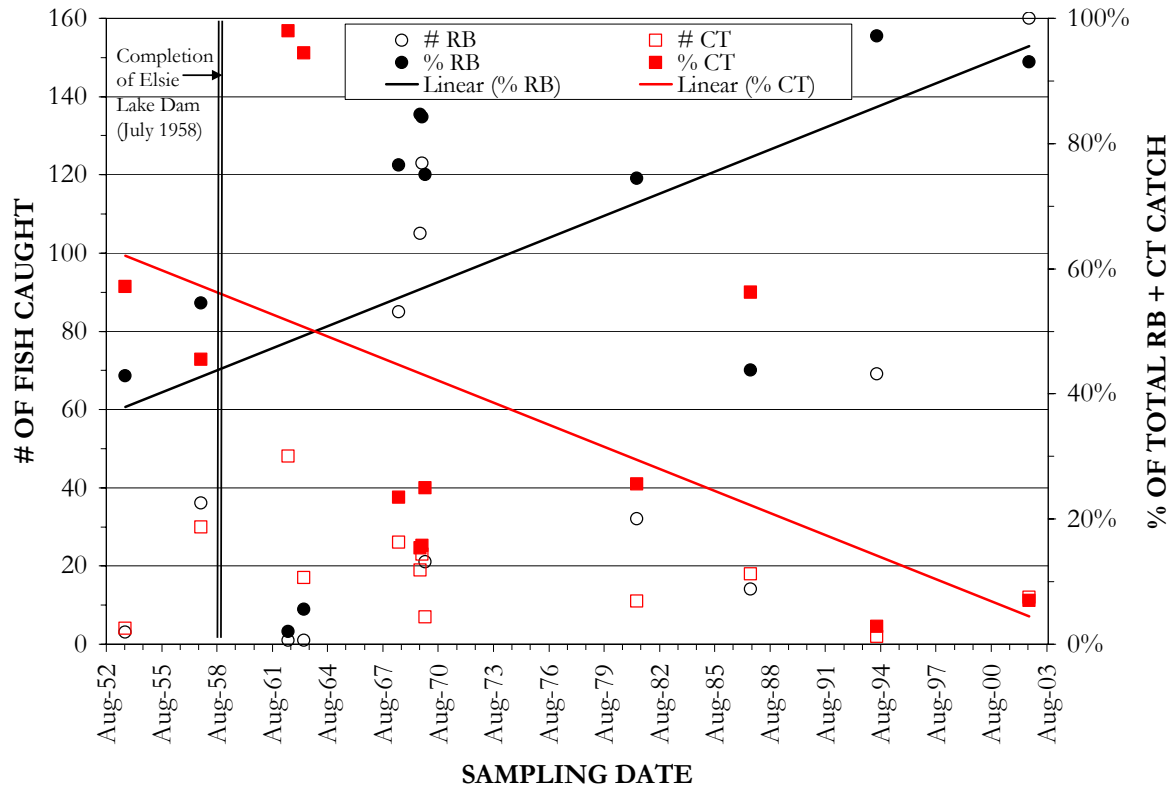
There are no records of lamprey abundance in Elsie Lake (Beamish and Northcote 1989). However, during the period of lamprey attacks on Elsie Lake Reservoir trout following completion of the dam, the scarring rate of captured trout was as high as 76.6%. This suggests that Elsie Lake may have supported a relatively large larval lamprey population prior to impoundment of Elsie Lake (Beamish and Northcote 1989).

Resident Fish

Rainbow and cutthroat trout catch data for Elsie Lake comes from various sources including the Province of British Columbia (in Beamish and Northcote (1989)), BC Fish and Game data recorded in Pletcher (1963, in Beamish and Northcote (1989)), Beamish and Northcote (1989), Triton (1995), and Burt and Robert (2003). Sampling dates back to the summer of 1953 prior to the impoundment of Elsie Lake in 1958. In several instances the type of gill nets used and the lengths of sets are not available. As such, abundances are not comparable among years, only within a year between the number of rainbow and cutthroat trout caught. It follows that an examination of trends in the species composition of Elsie Lake Reservoir trout over time must be done with relative abundance estimates. For each year in which Elsie Lake Reservoir rainbow and cutthroat trout were sampled, the number of each species caught was plotted as was the percentage of each species caught in terms of the total number of rainbow and cutthroat caught (note: hybrids were ignored). This is shown in Figure 21 and the data used to generate the plot is provided in Appendix 2.

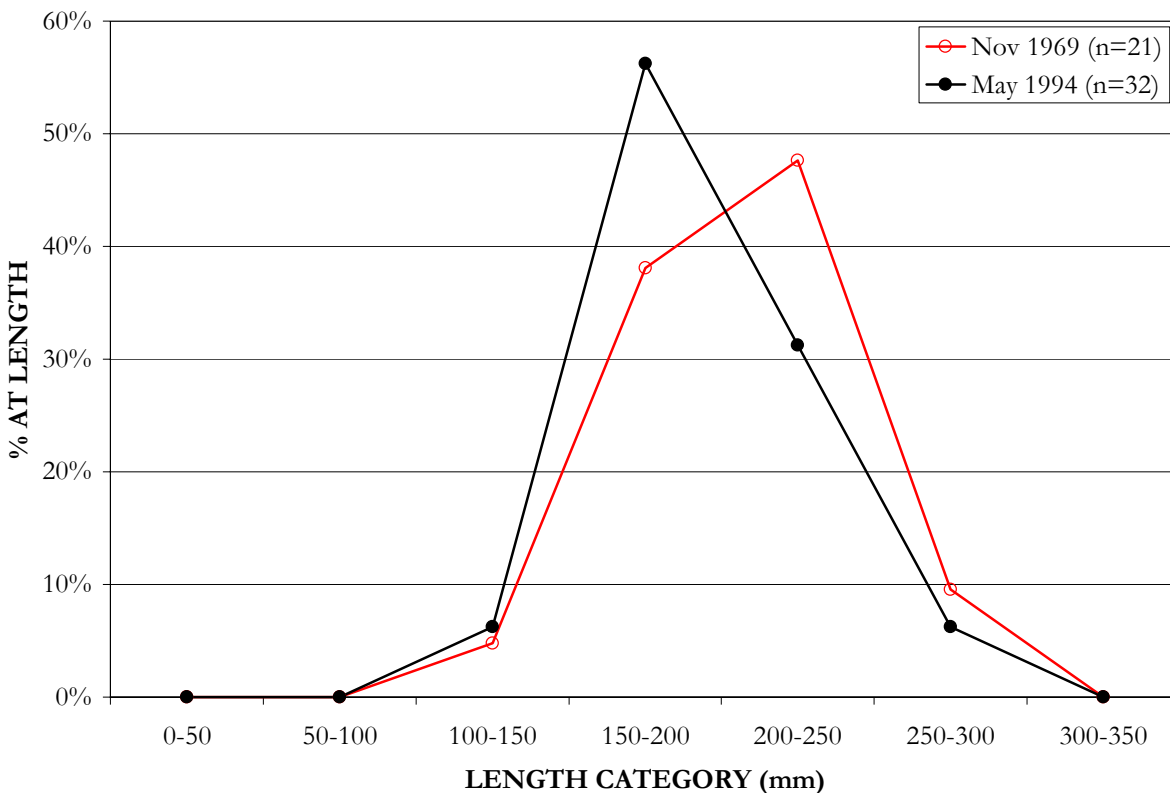
Prior to the impoundment of Elsie Lake, the data suggest that the trout population in the lake was comprised of roughly half-and-half rainbow and cutthroat trout (Figure 21). Since this time, there has been a general trend towards dominance by rainbow trout as indicated by the linear trend lines in Figure 21. In the early 1960's, shortly after the impoundment of Elsie Lake in 1958, the trout composition dramatically shifted such that the majority (>94%) of fish caught were cutthroat trout. By the late 1960's the situation had reversed with the trout population being dominated by rainbow trout; this continued into the early 1980's and over this time period the percentage of rainbow trout in the lake ranged from 74-85%. At one point in the late 1980's the rainbow-cutthroat composition of Elsie Lake Reservoir was nearly half-and-half, i.e., what was observed in pre-impoundment sampling. However, sampling that has taken place after this time has shown that over 93% of the trout in Elsie Lake are rainbow.

Figure 21. Elsie Lake (pre July 1958) and Elsie Lake Reservoir (post July 1958) fish sampling data.



Triton (1995) presents rainbow trout catch data from Elsie Lake Reservoir in November 1969 and May 1994 by length category. This data is provided in Appendix 2 and has been plotted as % at Length vs. Length Category to illustrate how the size composition of rainbow trout in Elsie Lake Reservoir has changed over time (Figure 22). Note that in the 1994 data (Triton 1995), there were 36 fish caught in the 165 – 220 mm size range for which the lengths of individual fish were not provided; as such these fish are not represented in Figure 22; were this data to be included, it would shift the peak of the 1994 curve to the right making the size distribution in 1994 similar to that observed in 1969.

Figure 22. Percentage of rainbow trout captured in Elsie Lake Reservoir by length category in November 1969 and May 1994 (data from Triton 1995).

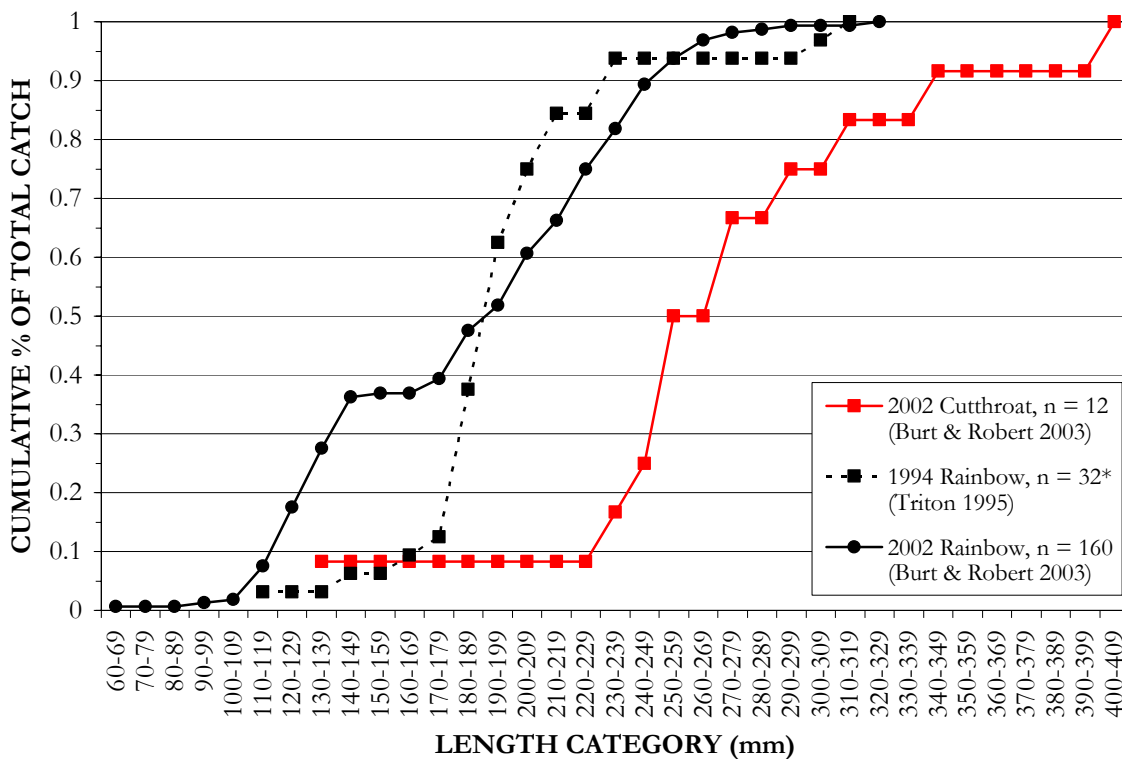


Burt and Robert (2003) sampled Elsie Lake Reservoir fish from August 6-9, 2002 by minnow trapping, angling, and gillnetting. The data from all samples sites is provided in Appendix 2; it is broken down by species and age and includes mean length, length range, mean weight, and mean Fulton's condition factor. The only species captured were rainbow trout, cutthroat trout, and one individual fish that appeared to be a hybrid between the two species as indicated by overlapping characteristics. Despite reports that a small kokanee population may exist in the lake, none were detected in lake sampling (or in Elsie Lake Reservoir tributary sampling, see the following section).

The length frequency data for rainbow (Triton 1995 and Burt and Robert 2003) and cutthroat (Burt and Robert 2003) trout captured in Elsie Lake was plotted as the percentage of the cumulative total catch versus length category (Figure 23). Note that in the 1994 data in Triton (1995), there were 36 fish caught in the 165 – 220 mm size range for which the lengths of individual fish were not provided; as such these fish are not represented in Figure 23; were this data to be included, it would further depress the cumulative percentage of the total catch for fish less than 165 mm and make the curve steeper between 165 and 220 mm. Also note that only 12 cutthroat trout were caught in 2002 compared to 160 rainbow trout (Burt and Robert 2003). The

1969 data presented in Triton (1995) is not included in this plot as length data for individual fish was not available. The data in Figure 23 suggest that in 2002 the rainbow trout population consisted of a higher percentage of smaller individuals (< 180 mm) than in 1994. The curve for cutthroat trout indicates that the population is composed of larger individuals than the rainbow trout population, most likely due to life history differences as cutthroat spend more time rearing in tributary streams thereby making it less likely that small individuals will be caught in Elsie Lake Reservoir.

Figure 23. Cumulative percentage of total catch for rainbow and cutthroat trout in Elsie Lake in 1994 (Triton 1995, rainbow only) and 2002 (Burt and Robert 2003) by length category.



* 36 fish in the 165-220 mm size range are excluded as lengths for individual fish were not provided

Burt and Robert (2003) concluded that rainbow trout were the dominant species in Elsie Lake Reservoir with 160 fish captured compared to only 12 cutthroat trout (Appendix 2). To get an understanding of the differences in the age composition between the two species, the percentage of each species at each age was plotted against age (Figure 24). The cutthroat population in Elsie Lake Reservoir was dominated by older individuals with 4 year olds comprising 66.7% of the

population ($n = 12$). The rainbow population was not dominated by a single age class but by ages 2 to 4 with the percentage of each age being between 28.1% and 31.9% ($n = 160$). The observed difference may be simply due to the small cutthroat sample size, or perhaps younger cutthroat tend spend more time in Elsie Lake Reservoir tributaries compared to rainbow.

Length frequency distributions for both rainbow (Figure 25) and cutthroat trout caught in Elsie Lake Reservoir were produced by Burt and Robert (2003). These figures have been reproduced here in Figure 25 (rainbow, $n = 160$) and Figure 26 (cutthroat, $n = 12$). The arrows at the base of the rainbow trout length frequency distribution indicated the general size range of each age group based on the analysis of 57 scale samples. However, note that these are only generalized boundaries in that overlap was observed between the different age groups (Burt and Robert 2003). As with Figure 24, Figure 25 demonstrates that the rainbow trout population in August 2002 was dominated by age 2, 3, and 4 individuals, with the largest number of fish being caught in the age 2 size class. Little information can be extracted from the length frequency distribution for cutthroat (Figure 26) due to the small sample size and (which also precluded the assignment of age categories to the different lengths).

Figure 24. Percentage of rainbow trout captured in Elsie Lake Reservoir by age from August 7-9, 2002 (data Burt and Robert 2003).

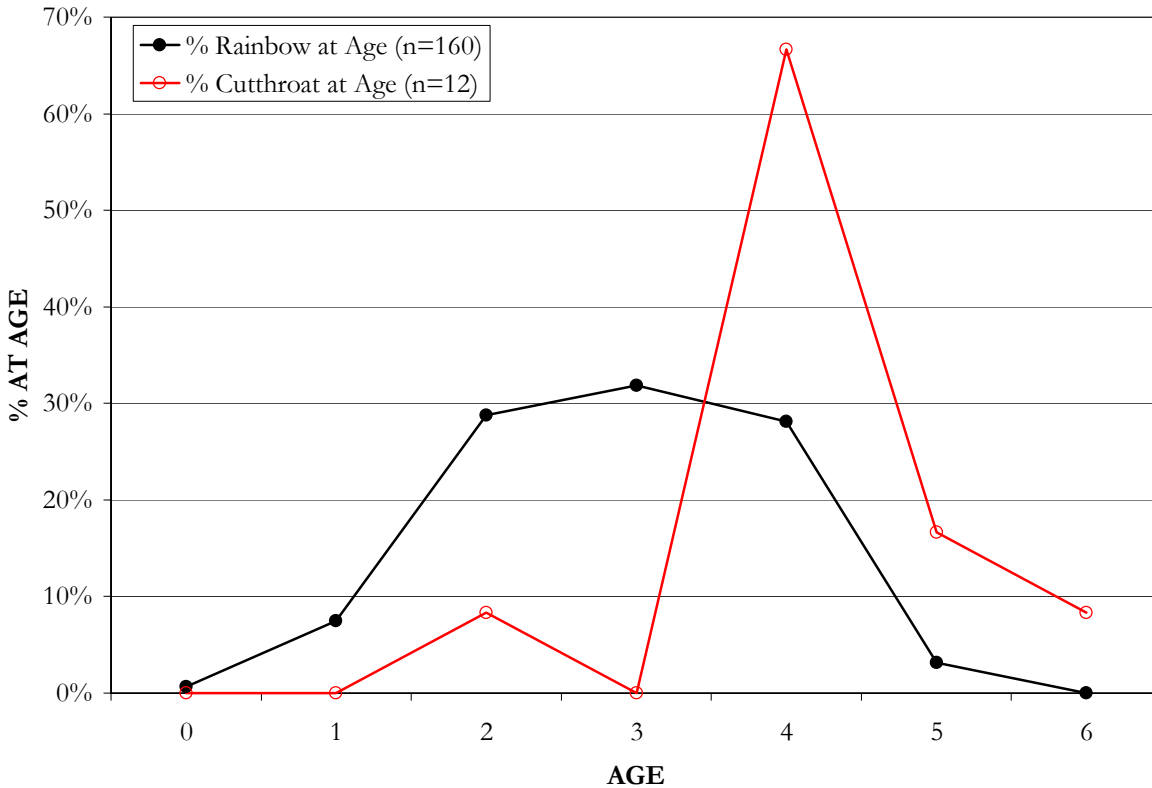


Figure 25. Length frequency distribution of rainbow trout captured in Elsie Lake Reservoir by gillnetting, angling, and minnow trapping (reproduced from Burt and Robert 2003).

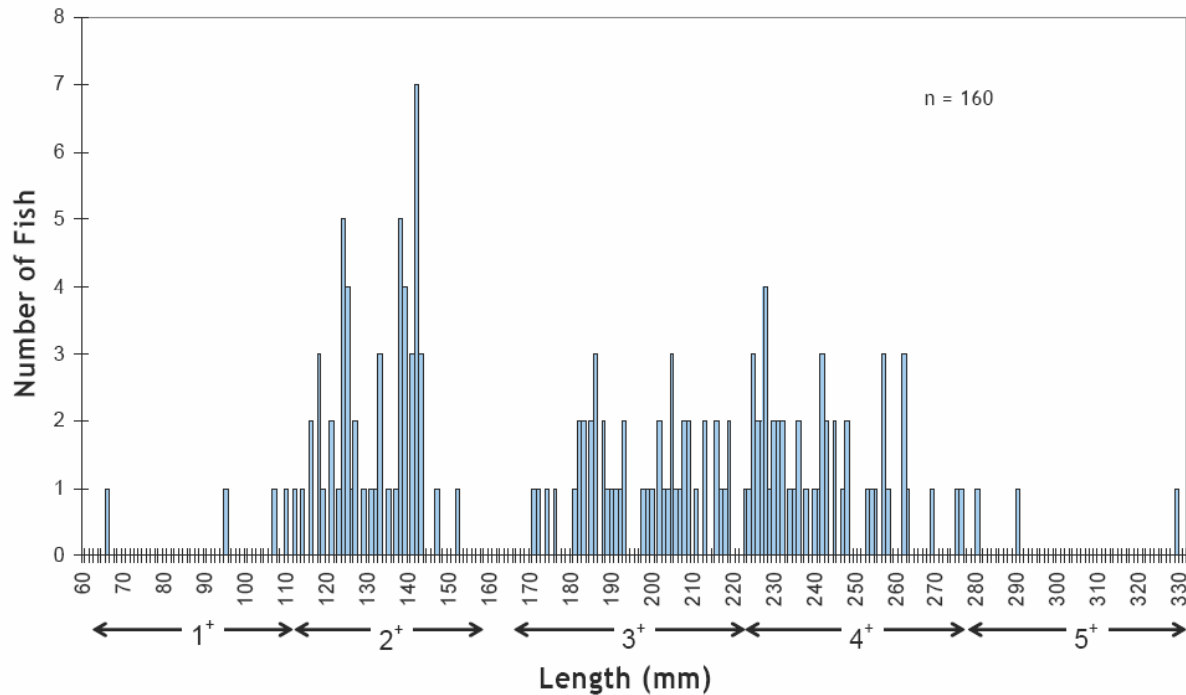
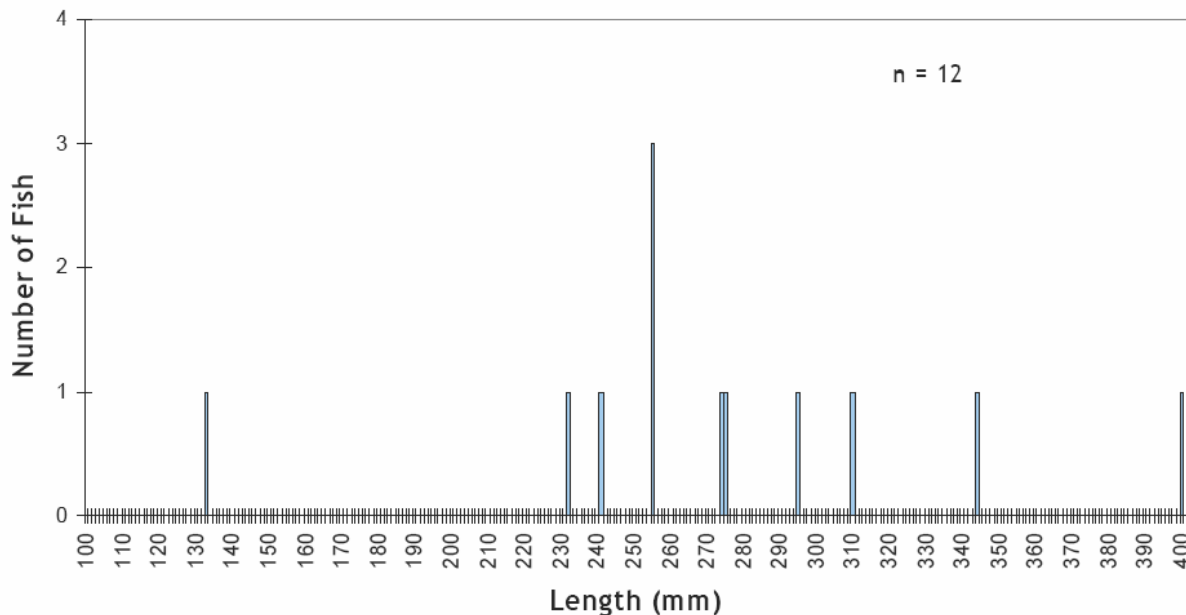


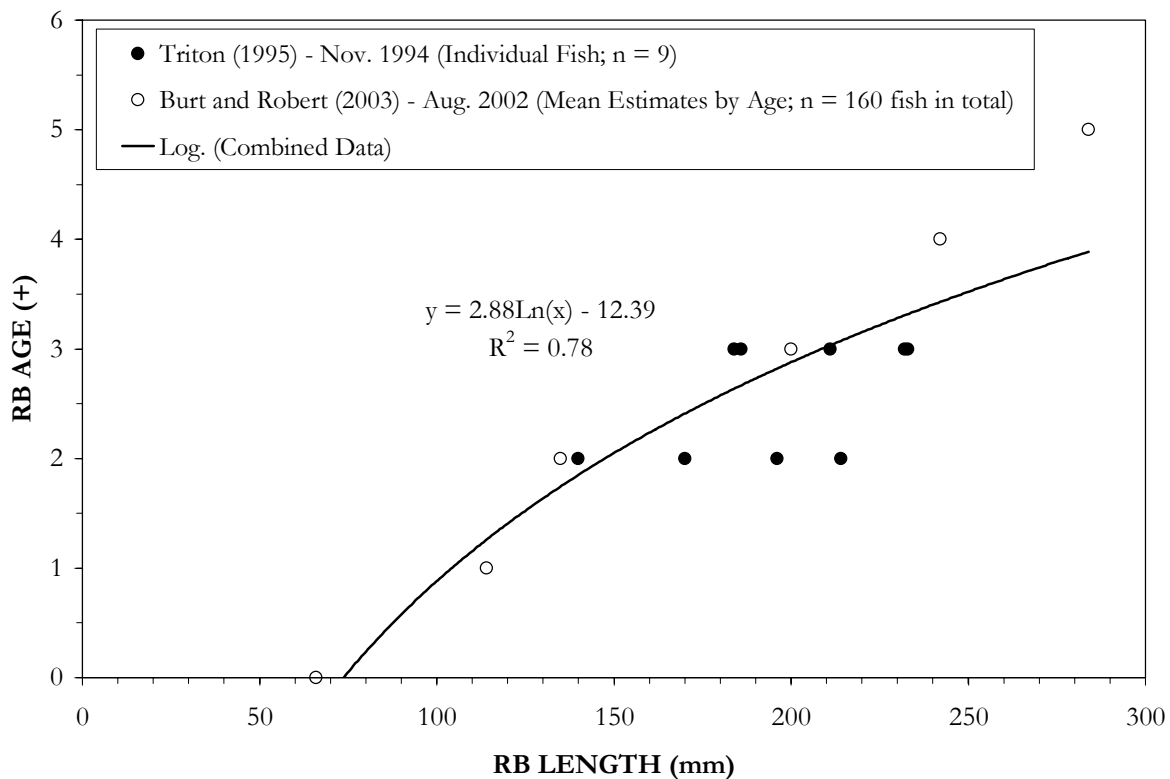
Figure 26. Length frequency distribution of cutthroat trout captured in Elsie Lake Reservoir by gillnetting and angling (no cutthroat were captured in minnow traps) (reproduced from Burt and Robert 2003).



Rainbow trout age and length data for Elsie Lake Reservoir from Triton (1995, collected on May 26, 1994) and from Burt and Robert (2003, collected from August 7-9, 2002) were combined and plotted to determine the relationship between the two parameters. The Triton data is for individual fish whereas the data from Burt and Robert is expressed as a mean for each age class. The relationship is shown in Figure 27 and the equation describing the relationship is generated from a logarithmic fit of the data is:

$$\text{Rainbow Trout Age} = 2.88 * \ln(\text{length (mm)}) - 12.39 \quad (r^2 = 0.78)$$

Figure 27. Relationship between length and age for rainbow trout captured in Elsie Lake Reservoir on May 26, 1994 (data from Triton 1995) and from August 7-9, 2002 (data from Burt and Robert 2003).



5.3.2. Reservoir Tributary Fish Captures/Observations

Compared to the Lower and Middle Ash River, there has been relatively little work done on fish distribution in tributaries to Elsie Lake Reservoir (including the Upper Ash River). Since no anadromous species can currently access Elsie Lake Reservoir, there are no anadromous fish naturally present in the tributaries to the reservoir. The tributaries most likely to be used by any anadromous species which may eventually be provided with access to Elsie Lake Reservoir are the Upper Ash River, Ramsay Creek, Katlum Creek, and Creek #2. These tributaries can contribute as much as 99.87% of the Elsie Lake Reservoir inflow with the majority of the other tributaries being small and dry for at least part of the year (Burt and Robert 2003).

Summer steelhead (juveniles) have been stocked in Elsie Lake Reservoir, in June Lake in the Ramsay Creek drainage, and in the Upper Ash River, and as such, they are the only anadromous species potentially present in tributaries to the reservoir in recent years. They have also been observed in Junior Lake upstream of June Lake. The stocking program ended in 1997 (FWD 2005). In the early 1990's, steelhead were sampled at the mouth of Ramsay Creek (FWD 2005). In September 2002, no steelhead were captured in sampling in the Upper Ash River, Ramsay Creek, Katlum Creek, and Creek #2 (Burt and Robert 2003).

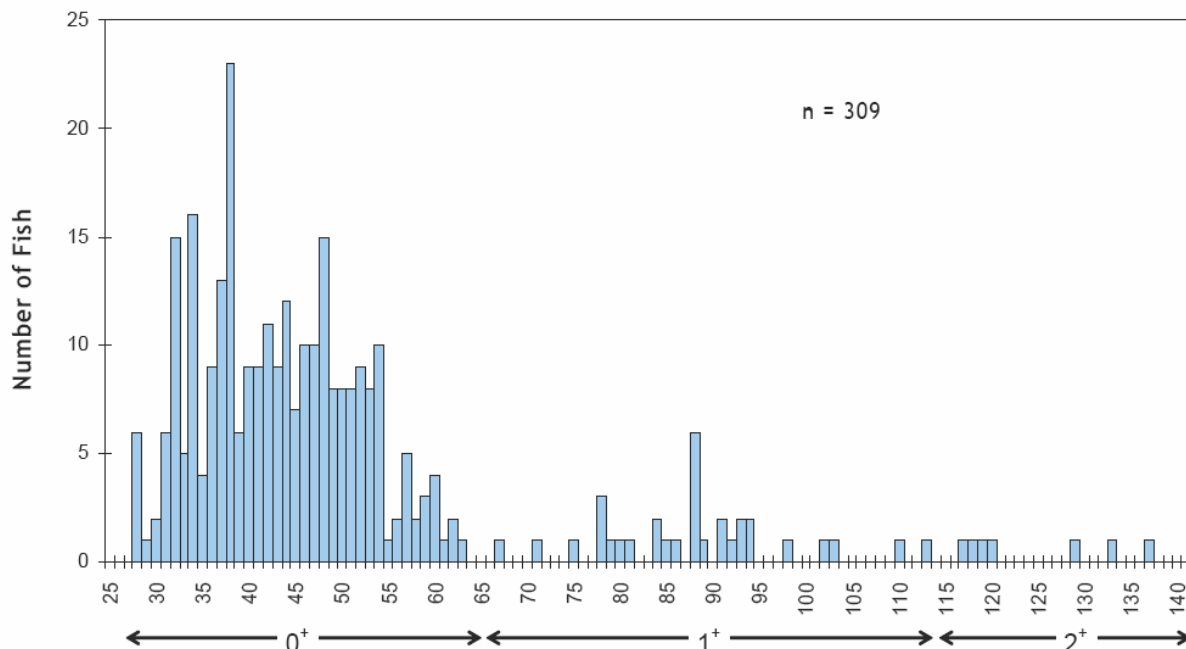
In January 2005 approximately 60 tagged adult steelhead were stocked in Elsie Lake to investigate the extent of upstream migration. However, none of these fish were observed in snorkel surveys of the Upper Ash River in spring 2005 (pers. obs. and M. McCulloch, BCCF, pers. comm.). However, during a snorkel survey of Gretchen Creek (the only significant tributary to the Upper Ash River) in April 2005, there was evidence of redd test digging (C. Robert, Ecodynamic Solutions, Courtenay, pers. comm.). The historical use of the Upper Ash River by the Pacific lamprey prior to the impoundment of Elsie Lake is unknown (Beamish and Northcote 1989). According to Hupacasath First Nation (Port Alberni) Traditional Ecological Knowledge, coho historically accessed Elsie Lake, but it is unknown to what extent they may have utilized the tributaries to Elsie Lake (Ash River Water Use Plan Consultative Committee 2003).

The only resident fish species present in tributaries to Elsie Lake Reservoir are rainbow and cutthroat trout (Burt and Robert 2003 and FWD 2005), and possibly some hybrids of the two species (Burt and Robert 2003). Burt and Robert electrofished 6 total removal sites in the 4 major tributaries (Upper Ash River, Ramsay Creek, Katlum Creek, and Creek #2) to Elsie Lake Reservoir from September 15-19, 2002. There was one site in the Upper Ash River (5.8 km upstream of Elsie Lake Reservoir, just upstream of the braided channel network), one site in Creek #2 (2 m upstream of the mouth), two sites in Katlum Creek (90 and 225 m upstream of the mouth), and two sites in Ramsay Creek (200 m and 1.27 km upstream of the mouth). The upper Katlum Creek site and the Upper Ash River site were located above resident fish barriers,

and as such, fish sampled at these sites were likely from stream-type adults as opposed to lake-type fish captured at the other sites. Trout fry (0+) were caught at each of the sample sites whereas juveniles were only captured at the downstream Katlum Creek site and in the Creek #2 site. Burt and Robert had difficulty assigning positive identifications to rainbow and cutthroat fry (0+) and saw some evidence of hybridization, and as such all tributary catch data was examined by grouping rainbow and cutthroat trout together. Accordingly, it is not known if both trout species are present in all four tributaries. It is however known that both species are present in Ramsay Creek (FWD 2005) and in the Upper Ash River (pers. obs. during an April 2005 snorkel swim) and that cutthroat trout are present in Katlum Creek (FWD 2005). It is also known that both rainbow and cutthroat are present in June and Junior Lakes in the headwaters of Ramsay Creek (FWD 2005).

The length frequency distribution of all juvenile trout captured at the above sites combined is given in Figure 28 (reproduced from Burt and Robert 2003) along with generalized age categories (based on scale analysis and size distribution). The length frequency distribution of trout caught in the Elsie Lake Reservoir tributaries was dominated by 0+ individuals, followed by 1+, and then 2+. A mixture analysis (MIX 3.1 software) indicated that 88% of the trout in the tributaries were 0+, 9% were 1+, and 3% were 2+ (Burt and Robert 2003). Rainbow trout parr were generally smaller than the cutthroat parr caught (see Appendix 3 for a summary of the mean length, weight, and condition factor for trout caught in the tributaries).

Figure 28. Length frequency distribution of juvenile trout (rainbow, cutthroat, possibly hybrids) captured in the Upper Ash River, Creek #2, Ramsay Creek, and Katlum Creek from September 15-19, 2002 (reproduced from Burt and Robert (2003)).



Burt and Robert (2003) also estimated the density and biomass (adjusted to weighted usable area or WUA) of the trout (rainbow and cutthroat combined) caught in the 4 Elsie Lake Reservoir tributaries by electrofishing (Figure 29). A summary of trout density and biomass statistics from electrofishing sites is provided in Appendix 3 (reproduced from Burt and Robert 2003).

For sites below barriers, trout fry density ranged from 59-237 FPU (FPU = fish / 100 m²) and parr density ranged from 0-37 FPU. The highest densities of both fry and parr were found in Katlum Creek and Creek #2, likely because these creeks have easy access at their mouths (in spring) as well as pockets of spawning gravel close to the mouth. The Upper Ash River was not sampled below the resident fish barrier and Ramsay Creek has a 900 m long step cascade section beginning with 77 m long cascade of 5% gradient before significant amounts of spawning gravel are encountered.

For sites above barriers (i.e., Katlum Creek and Upper Ash River), there were contrasting results. Katlum Creek had a very high density of fry whereas the Upper Ash River had the lowest fry density among all sample sites (Burt and Robert 2003, Figure 29). There was a pool immediately above the Katlum Creek site with a sizeable pocket of high quality spawning gravel in the pool tailout. This, in addition to the observation of 4 adult trout in the pool, may explain why this site had a very high fry density.

The biomass of trout captured in the electrofished Elsie Lake Reservoir tributaries is shown in Figure 30 where adjusted biomass (to WUA) is expressed as a percentage of the theoretical maximum biomass. This provides a measure of habitat saturation in the sampled areas, and the results show that several sites had a trout biomass that were close to or exceeded the theoretical capacity. Sites where this occurred include Creek #2 (both fry and parr age groups), the upper Katlum Creek site (fry), and the Katlum Creek site (parr). On the other hand, habitat in the sampled areas of Ramsay Creek and the Upper Ash River appear to be underutilised by trout fry and parr.

Figure 29. Adjusted (by WUA) density of 0+ and 1+ trout from total removal electrofishing sites in 4 Elsie Lake Reservoir tributaries (the Upper Ash River, Creek #2, Ramsay Creek, and Katlum Creek) from September 15-19, 2002 (reproduced from Burt and Robert (2003)). Hatched bars indicate sites above barriers to resident fish.

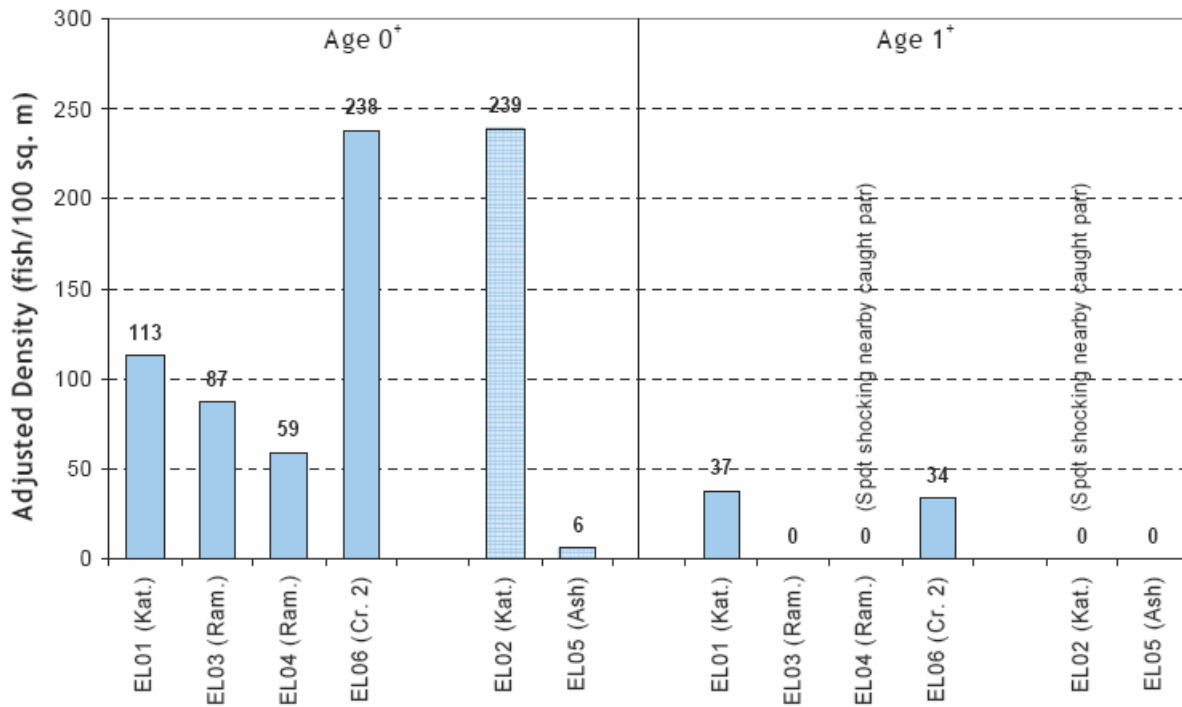
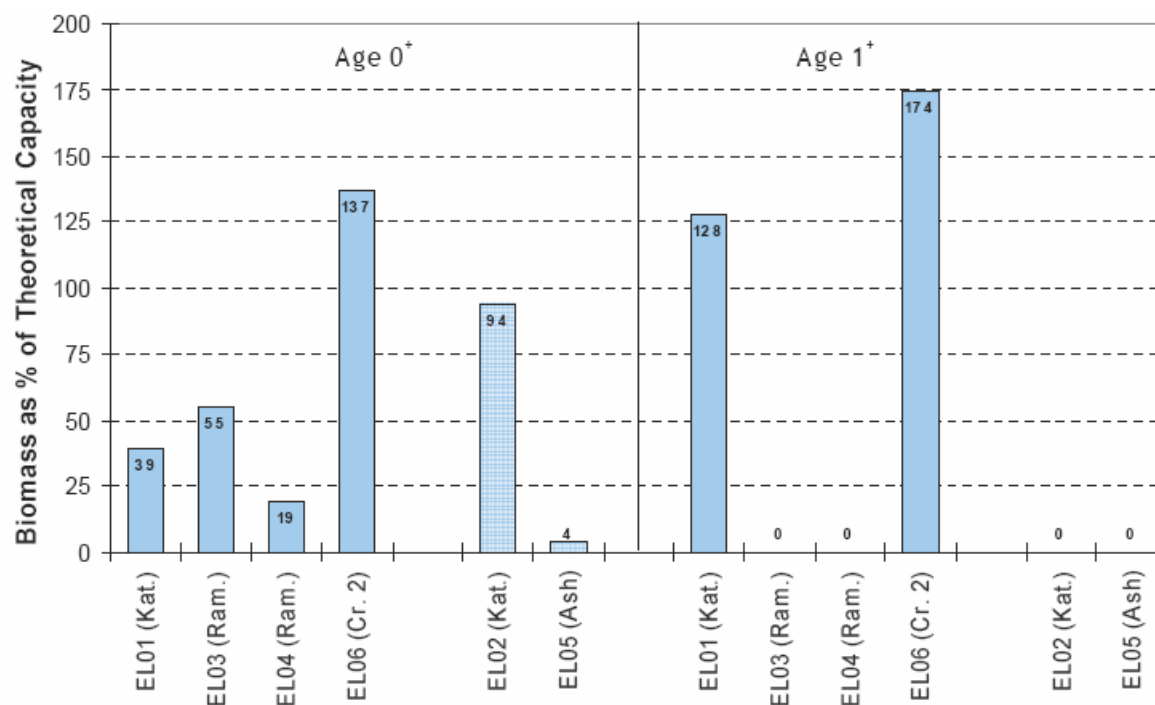


Figure 30. Adjusted (by WUA) biomass of 0+ and 1+ trout as a percentage of the theoretical maximum biomass for fish population sites from total removal electrofishing sites in 4 Elsie Lake Reservoir tributaries (the Upper Ash River, Creek #2, Ramsay Creek, and Katlum Creek) from September 15-19, 2002 (reproduced from Burt and Robert (2003)). Hatched bars indicate sites above barriers to resident fish.



Reservoir Tributary Stream Habitat Surveys

When the reservoir is at full pool, there is no stream habitat within the drawdown zone for trout spawning, whereas at lower reservoir levels there is substantial spawning habitat for trout in streams within the drawdown zone (Ash River Water Use Plan Consultative Committee 2003). However, if fish were to spawn in the drawdown zone at lower reservoir levels, the eggs would be inundated if the reservoir level increased to full pool. This could have the effect of reducing the oxygen-rich stream flow that the eggs would be exposed to at low reservoir levels potentially resulting in high egg mortality. Thus, to maximize spawning habitat in Elsie Lake tributaries, the reservoir level would have to be kept low during spawning seasons and remain near the same level during egg incubation.

Another habitat issue in Elsie Lake Reservoir tributaries is the reduction of rearing habitat in streams within the drawdown zone. As the elevation of the reservoir increases, the rearing

habitat within the drawdown zone decreases, however the quality of rearing habitat has not been assessed due to the lack of information on Elsie Lake Reservoir fish biology (Ash River Water Use Plan Consultative Committee 2003).

Work on Elsie Lake Reservoir tributary habitat has been completed by Horncastle (1978), Triton (1995), Lewis (2001) and Burt and Robert (2003). The following text summarizes the findings of this work.

Horncastle (1978) inventoried various reaches in the Somass watershed and completed a snorkel survey of the Upper Ash River from Oshinow Lake to Elsie Lake Reservoir. General notes were taken on channel characteristics, substrate, vegetation, benthos, fish observations, barriers, and suitability for spawning, rearing, and holding. It was noted that the Upper Ash River had excellent fish habitat, but that a 3.6 m falls (height from Burt and Robert 2003) located about 0.5 km upstream of the Elsie Lake Reservoir may limit fish access. In the spring of 2005, M. McCulloch (BCCF, pers. comm.) examined this barrier and felt that it would not be a barrier to summer steelhead passage over a range of flows as it is basically equivalent to a single step on Dickson Falls which steelhead are known to ascend.

In 1993 and 1994 Triton (1995) assessed the potential impacts of using flashboards on the Elsie Lake Reservoir spillway to increase storage capacity by an elevation of 0.9 m. They conducted a bathymetric survey, limnological sampling, and fish population sampling in Elsie Lake Reservoir. In May of 1994, they assessed the potential spawning habitat for resident Elsie Lake Reservoir fish (i.e., cutthroat and rainbow trout) in 20 tributaries to the reservoir by completing a habitat survey of the lower 100 to 200 m of these inlet tributaries. At the time of the survey, the reservoir was at an elevation of 330.28 m, 0.43 m below full pool. Spawning area was calculated by taking the stream width and length within the section that would be inundated under the use of flashboards (even if spawning gravels only occurred in pockets).

At the time of the near full pool survey in May 1994, 5 of the 20 streams examined were not accessible to fish, 6 had no flow, and the remaining streams had flow, appeared to be accessible, and had suitable substrate for resident trout spawning (Triton 1995). The larger tributaries typically had cobble-boulder substrates at their confluence with Elsie Lake Reservoir, and even the smaller ephemeral tributaries had sizable substrate at the full pool mouth (Triton 1995). In the small, more permanent streams, the best spawning gravels were typically 10 to 15 m upstream of the full pool reservoir elevation (Triton 1995). It was concluded that Katlum Creek and Creek #2 provided the best opportunity for spawning trout and that Katlum Creek and the Upper Ash River had barriers to resident trout access. M. McCulloch (BCCF, pers. comm.) confirms that while resident trout may have difficulty ascending the Upper Ash River barrier, it should not block anadromous steelhead passage. Furthermore, C. Robert (Ecodynamic Solutions, Courtenay, pers. comm.) states that the log jam barrier (which has created a 3 m fall

onto a bedrock shelf) on Katlum Creek is only likely to be a barrier to anadromous fish passage at certain flows. Thus, based on Triton's work, the best streams for providing anadromous spawning habitat would be the Upper Ash River, Ramsay Creek, Creek #2, and Katlum Creek. However, note that Triton (1995) concluded that in the lower 100 to 200 m of Elsie Lake Reservoir tributaries, trout spawning habitat is in short supply and may limit recruitment to Elsie Lake. This may or may not apply to anadromous fish as they can access more of these tributaries than what was surveyed by Triton (1995).

As part of the Ash Water Use Plan, Lewis (2001) conducted a study on Elsie Lake Reservoir tributary habitat within the drawdown zone during a period of large drawdown (reservoir elevation ~318.7 m). Data were collected from the reservoir elevation to the full pool elevation of 330.71 m and included documenting various channel features, gradient, obstructions, and quantity of spawning gravel (data for streams that could potentially support anadromous fish is presented in Table 7; data for all streams surveyed given in Appendix 3). It was concluded that within the drawdown zone, there is 36,602 m² of potential spawning habitat in Elsie Lake Reservoir tributaries, 91.7% of which is located within the Upper Ash River (note these numbers are modified from Lewis (2001) as per the data presented in Burt and Robert (2003).

Lewis (2001) also found that as the reservoir rises, spawning habitat decreases most rapidly between 318 and 322 m elevation. There is little change in the available spawning habitat as the reservoir elevation changes between 328 and 330 m. Lewis (2001) determined that both the highest quality and quantity of spawning habitat lies in the lowermost sections of the drawdown zone on most of the 20 tributaries examined. At the survey elevation, it was determined that 14 of the 20 tributaries to the reservoir had barriers ranging from 0.5 m to over 7 m in height.

Rearing habitat for resident fish was also quantified in Elsie Lake Reservoir tributaries as a function of reservoir elevation and it was determined that the amount of rearing habitat available steadily declines as reservoir elevation increases (Lewis 2001).

In 2002, the Hupacasath First Nations received funding through BC Hydro's BCRP to carry out restoration initiatives on Elsie Lake Reservoir and its tributaries (Burt and Robert 2003). This study consisted of an inventory of fish and fish habitat in Elsie Lake Reservoir (riparian and drawdown habitat) and its tributaries including the Upper Ash River (with emphasis on migration barriers and quantification of adfluvial spawning gravels). It was deemed that suitable anadromous spawning gravels are only present in the Upper Ash River, Ramsay Creek, Katlum Creek, Creek #2, and Creek #6b (but it is ephemeral). Burt and Robert (2003) also concluded that the spawning habitat available in Elsie Lake Reservoir tributaries for reservoir trout is in short supply and may limit recruitment to the reservoir. However, there may be more spawning habitat available to anadromous fish as they should be able to ascend barriers in the Upper Ash

River, Ramsay Creek (only large resident fish can pass the barrier), and Katlum Creek that resident trout cannot. Rearing habitat was quantified in the stream surveys and it was found that there is only 1.2-2.1 km of Elsie Lake Reservoir tributary habitat available for resident juvenile rearing, depending on the level of spring runoff (greater runoff allows greater access to small tributaries). This could be considered a conservative estimate for anadromous fish rearing habitat as anadromous fish can ascend barriers in the tributaries that resident fish cannot. The findings of Burt and Robert (2003) are discussed in further detail below.

Burt and Robert (2003) examined adfluvial spawning habitat in a total of 20 tributaries to Elsie Lake Reservoir upstream from full pool elevation from June 3 to 21, 2002. The habitat characteristics of each stream surveyed are reproduced from Burt and Robert (2003) and provided in Appendix 3. Spawning area was quantified in each tributary by estimating the area of each pocket of suitable gravel that was encountered and summing for the entire accessible stream length. Smaller streams were walked to the point where the stream emerged from a groundwater source, or where the gradient was greater than 20%, or where a major barrier was encountered. On larger streams (e.g., Upper Ash River, Ramsay Creek), the lowermost reach was walked in its entirety and other reaches were walked in sections close to access points. Burt and Robert (2003) determined that there were only 4 tributaries with significant flow at the time of the survey (June 3-21, 2002), contributing 99.87% of Elsie Lake Reservoir inflow over the survey period. The Upper Ash River had a flow of 11.3 m³/s, Ramsay Creek had a flow of 1.8 m³/s, Katlum Creek had a flow of 0.4 m³/s, and Creek 2 had a flow of 0.3 m³/s. The other tributaries were small and often ephemeral, and were deemed to be unlikely to support fish. Most of the tributaries to the reservoir do not have suitable substrate for anadromous fish spawning habitat, with the exceptions being the Upper Ash River, Ramsay Creek, Katlum Creek, Creek #2, and possibly Creek #6b (but it is ephemeral) (C. Robert, Ecodynamic Solutions, Courtenay, pers. comm.).

In the lower 2.4 km of the Upper Ash River, Burt and Robert (2003) estimated there to be at least 1,746 m² of resident spawning habitat above full pool (Table 7). Steelhead are thought to be able to ascend the barrier in a canyon near the Ash River bridge (M. McCulloch, BCCF, pers. comm.) and should be able to reach Oshinow Lake (13.7 km upstream from Elsie Lake). This has been indirectly confirmed as BCCF released about 60 tagged summer steelhead adults into Elsie Lake Reservoir in January 2005 and C. Robert observed test digging of redds in Gretchen Creek in the spring of 2005, well upstream of this barrier. Thus, the available evidence suggests that spawning habitat for anadromous fish in the Upper Ash River may be substantially greater than that estimated for resident fish.

In the lower 2.8 km of Ramsay Creek, Burt and Robert (2003) estimated there to be at least 1,511 m² of resident spawning habitat (Table 7). Anadromous fish should be able to access more of Ramsay Creek by ascending small barriers in the lower reaches (C. Robert, Ecodynamic

Solutions, Courtenay, pers. comm.) suggesting that spawning habitat for anadromous fish in Ramsay Creek may be substantially greater than for resident fish.

Burt and Robert (2003) estimated there to be 134 m² of resident spawning habitat in the lower 1.0 km of Katlum Creek (Table 7). Assuming that anadromous fish can access more than the lower 1.0 km of Katlum Creek, spawning habitat for anadromous fish in Katlum Creek may be substantially more than that for resident fish.

Creek #2 is smaller than the above three tributaries to Elsie Lake Reservoir, and may have the potential to support spawning coho (C. Robert, Ecodynamic Solutions, Courtenay, pers. comm.) In the lower 813 m of Creek #2, at which point there is a 5 m falls, Burt and Robert (2003) estimated there to be only 23 m² of resident spawning habitat (Burt and Robert 2003, Table 7). This set of falls is felt to be a barrier to anadromous fish passage (C. Robert, Ecodynamic Solutions, Courtenay, pers. comm.) Thus, the availability of anadromous spawning habitat in Creek #2 is low based on the amount of resident spawning habitat.

In the lower 245 m of Creek #6b there is an estimated 18 m² of spawning habitat available to resident reservoir fish (Burt and Robert 2003, Table 7). However, at the time of the survey (June 2002), the flow in the stream was only 0.0025 cms making it unlikely that anadromous fish would be able to use Creek #6b for spawning.

Table 7. Adfluvial spawning habitat estimates in Elsie Lake Reservoir tributaries that could potentially support anadromous fish as per Burt and Robert (2003) (data from Burt and Robert 2003 and Lewis 2001).

Stream	Survey Length Upstream from Full Pool Elevation (km)	Distance Full Pool To Adfluvial Barrier (m)	Quantity Of Adfluvial Spawning Gravel			
			Below Full Pool ¹ (m ²)	Full Pool To Adfluvial Barrier (m ²)	Above Adfluvial Barrier (m ²)	From Full Pool Elevation Upstream as far as Surveyed Length (m ²) ²
Upper Ash River	2.4	35	33,549	0	1,746+	1,746+
Ramsay Creek	2.8	12,550	49	11	1,500+	1,511+
Katlum Creek	1.0	157	579	13	121	134
Creek #2	1.1	813	192	23		23+
Creek 6b	0.25	350	—	18		18

¹ Amounts of spawning gravel below full pool are from WUP surveys conducted by Burt and Robert in 2001 and encompassed habitat surveys of Elsie Lake tributaries from the 318.7 m pool elevation to near full pool (330.5-330.8 m) and have been modified. The data were originally presented in Lewis (2001), and have been re-worked and are slightly different than in Lewis (2001).

² for Creek #2 and Creek #6b the estimate is from full pool elevation upstream to the adfluvial barrier.

5.3.3. UPSTREAM OF THE UPPER ASH RIVER

The upstream boundary of the Upper Ash River is considered to be the outlet of Oshinow Lake. Above this point, the only fish known to be present are steelhead, rainbow trout, and cutthroat trout (FWD 2005). Rainbow and cutthroat trout are known to be present in Oshinow Lake (FWD 2005) and Toy Lake (the outflow of which drains into Oshinow Lake). Fish Wizard (FWD 2005) indicates that steelhead are also present in Toy Lake, which they must access via Oshinow Lake. These fish were originally stocked about halfway between Elsie Lake Reservoir and Oshinow Lake, which corroborates the observation that significant passage barriers are absent between this point and Oshinow Lake.

6. ASH WATERSHED STOCK EXPLOITATION AND ENHANCEMENT

6.1. Stock Exploitation

The FISS Ash River report provides a small amount of information on recreational fishery use of the Ash River. Prior to 1979, 1,000 angler days was typical and the 1988 average was 129 days. The only known exploitation data for Ash River watershed fish is that for steelhead from the Provincial Steelhead Harvest Analysis Database. This database contains steelhead catch and effort in the several rivers in the province from 1968 to 2004, including the Ash River. The data also distinguishes between the amount of wild and hatchery fish in the catch. The raw data is given in Appendix 4 and the associated plot (Figure 31) has been provided courtesy of www.steelheadrecoveryplan.ca (M. McCulloch). Summary statistics (mean, SD, n, min, max) are provided in Table 8. Note that the units for effort are days fished per year and that catch data represents the sum of the number of fish that were kept and released.

The mean number of days fished per year for steelhead in the Ash River from 1968 to 2004 is 343 (n = 37, SD = 372) with a minimum of 33 days and a maximum of 1,409 days fished. Over the same period the mean wild steelhead catch was 176 (n = 37, SD = 146) with a minimum of 0 fish and a maximum of 601 fish caught. There were no hatchery fish caught in the Ash River prior to 1981, so summary statistics for hatchery fish caught were calculated to reflect the period from 1981 to 2004. During this time, the mean hatchery catch was 24 (n = 23, SD = 26) with a minimum catch of 0 and a maximum catch of 96. The catch per unit effort (CPUE) data is in units of fish caught per day and the estimates apply to the wild and hatchery catch combined. From 1968 to 2004, the mean CPUE was 0.79 (n = 37, SD = 0.53) with a minimum of 0.16 and maximum of 2.67.

From the late 1960's to the early 1980's there was a general decline in the steelhead catch in the Ash River while the CPUE remaining relatively stable ranging from 0.16 to 0.57 (typically less than 0.50) (Figure 31). Hatchery fish began to be caught in 1983 and there is no clear trend in the hatchery catch from this time up until 2004, although hatchery catches were generally higher in the 1980's compared to recent years. The last year in which wild fish were kept was also 1983. After steelhead started to be stocked in the Ash River watershed there was a dramatic increase in the CPUE which peaked in 1992 at 2.67. Since 1992 the CPUE has remained relatively high, ranging from 0.57 to 1.48. However, there has not been a corresponding increase in the catch in most years, indicating that the fishing pressure in more recent times is less than what it was in the late 1960's and through to the early 1980's. Mapster (2005) summarizes the angling pressure on steelhead in the Ash River by describing it as moderate.

From 2001 to 2004 there has been a decline in the wild catch, the hatchery catch, and the CPUE (Figure 31). The most recent estimates from 2004 are 104 wild fish caught, 11 hatchery fish, and a CPUE of 0.57 (Appendix 4).

Figure 31. Steelhead catch and effort in the Ash River from 1968 to 2004 illustrating the relative amount of wild and hatchery fish in the catch (figure courtesy of the Greater Georgia Basin Steelhead Recovery Plan (Mike McCulloch), www.steelheadrecoveryplan.ca).

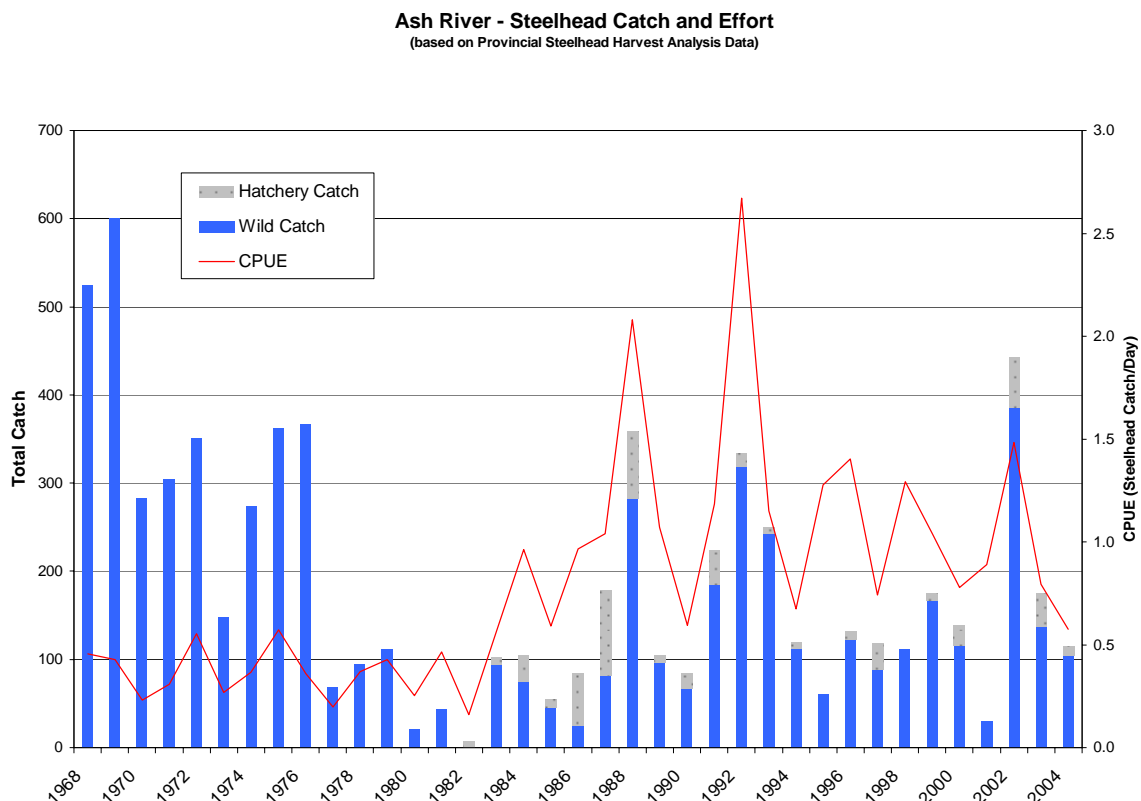


Table 8. Summary statistics for steelhead catch and effort data in the Ash River from 1968 to 2004 (data from Steelhead Harvest Analysis Database).

Statistic	# Days Fished per Year	Wild Catch	Hatchery Catch ¹	CPUE
Mean	343	176	24	0.79
SD	372	146	26	0.53
n	37	37	23	37
Min	33	0	0	0.16
Max	1,409	601	96	2.67

¹ No hatchery fish were caught prior to 1982; summary stats reflect the period from 1982 to 2004.

6.2. Enhancement History

There has been a good deal of enhancement work done with trout in the Ash River watershed, with much of the focus on summer steelhead. This work has consisted mainly of fish stocking from Robertson Creek (steelhead and coho) and New Vancouver (rainbow and cutthroat) hatcheries, although there has been some modification of Dickson Falls in the Lower Ash River, placement of spawning gravels for steelhead upstream of Dickson Falls, and fertilization of the Middle Ash River to enhance steelhead production.

6.3. Fish Stocking

A summary of stocking activities in the Lower Ash River, the Dickson Lake area, and the Middle Ash River is provided in Table 9; see Table 10 for stocking activities in Elsie Lake Reservoir and the Upper Ash River. These tables include the general stocking location, stocking date, the number of fish stocked, the stock of fish used, the life stage stocked, the hatchery of origin, and the data source. Data sources include B.C. Environment Victoria (in Griffith 1993), Fish Wizard (FWD 2005), Mike McCulloch (BCCF, pers. comm.), and the online Fisheries Inventory Data Query tool. (<http://srmapps.gov.bc.ca/apps/fidq/main.do>).

Summer steelhead, Atlantic salmon, coho salmon, rainbow trout, and cutthroat trout have all been stocked in the Lower or Middle Ash River watershed (Table 9). Atlantic salmon fry and eggs were stocked in the Ash River (location unknown, assumed to be Lower Ash River) from

1917 to 1924. Coho fry were stocked in Lanterman Creek (Lower Ash River watershed) from 1983 to 1985. In between the Lower and Middle Ash River, summer steelhead fry were stocked in Dickson Lake in 1988 and juveniles were stocked in Ash Lake in 1990. Rainbow trout yearlings were stocked in Ash Lake from 2000 to 2003 and cutthroat trout yearlings have been stocked in McLaughlin Lake from 1999 to 2003. Cutthroat yearlings have also been stocked in Turnbull Lake (drains into Middle Ash River) from 2000 to 2004. In the Middle Ash River, summer steelhead fry, fall fry, and parr have been stocked in 1979 (these fish may have been stocked in the Upper Ash River), 1988, and from 1989 to 1992. The number of steelhead stocked over this period ranged from 4,999 to 50,000.

Summer steelhead have been stocked in Elsie Lake Reservoir on several occasions, with a variety of life stages being stocked over the years (Table 10). Stocking began in 1982 and this program ended in 1997. During this time, fry, parr, juveniles, smolts, and adults have been stocked in numbers ranging from 1,633 to 215,000 individuals. These fish were not marked so it is not possible to determine the number of fish that become lake residents versus those that moved out of the lake (Triton 1995). However, there is evidence to suggest that the stocked fish migrate out of the reservoir in June when water levels are high enough to spill from the reservoir into the Middle Ash River (Griffith 1993).

In January 2005, 60 tagged adult steelhead were released into Elsie Lake Reservoir to investigate the potential use of the Upper Ash River (M. McCulloch, BCCF, pers. comm.). Snorkel surveys completed in spring 2005 did not identify any steelhead in the Upper Ash River (pers. obs. and M. McCulloch, BCCF, pers. comm.), however there appeared to be steelhead test digging of redds in Gretchen Creek (C. Robert, Ecodynamic Solutions, Courtenay, pers. comm.).

Stocking activities in the Upper Ash River have been limited to summer steelhead which have been placed approximately 7.7 km upstream of Elsie Lake Reservoir. Stocking took place every year from 1993 to 2000 with anywhere from 3,000 to 28,622 fry being released. Summer steelhead fry (5,000) and parr (5,000) were also stocked in June Lake (headwater lake of Ramsay Creek drainage) in 1983 and 1986, respectively. Cutthroat trout have also been stocked in a headwater lake of the Ramsay Creek drainage – Junior Lake. Cutthroat fry and fingerlings have been released into this lake from 1999 to 2003. From 1999 to 2003, cutthroat fry and fingerlings were also stocked in Toy Lake (drains into Oshinow Lake).

Table 9. Fish stocking history in the Lower and Middle Ash River.

Stocking Location	Species ¹	Date	# of Fish	Stock	Life Stage	Hatchery of Origin	Data Source ²
Lower Ash River & Tributaries							
Ash River	Atlantic Salmon ³	1917	20,000	?	Fry	?	1
		1919	18,000	?	Fry	?	1
		1923	70,000	Miramichi-R	Eyed Egg	?	1
		1924	36,000	Miramichi-R	Eyed Egg	?	1
Lanterman Creek	Coho Salmon	1983-1985	?	?	fry	Robertson Creek	2
Dickson Lake Area & Middle Ash River							
Dickson Lake	Summer Steelhead	6-Jul-88	4,666	Robertson SR	Fall Fry	Robertson Creek	3
Ash Lake	Summer Steelhead	Jul-90	10,000	?	Juveniles	?	4
		28-Apr-03	500	Tzenzaicut	Yearling	New Vancouver	3
		29-May-01	500	Tzenzaicut DR	Yearling	New Vancouver	3
		15-May-00	500	Tzenzaicut	Yearling	New Vancouver	3
McLaughlin Lake	Cutthroat Trout	3-Apr-03	1,000	Taylor	Yearling	New Vancouver	3
		21-Mar-01	1,000	Taylor	Yearling	New Vancouver	3
		17-May-99	1,000	Taylor	Yearling	New Vancouver	3
Turnbull Lake	Cutthroat Trout	29-Mar-04	500	Taylor	Yearling	New Vancouver	3
		12-Apr-02	500	Taylor	Yearling	New Vancouver	3
		18-Apr-00	500	Taylor	Yearling	New Vancouver	3
Middle Ash River (between Dickson and Elsie Lakes) ⁴	Summer Steelhead	Jul-92	14,000	Robertson SR	Fry	Robertson Creek	1,4
		Jul-91	4,999	Stamp SR	Fry	?	1,4
		Jul-91	17,047	Robertson SR	Fry	Robertson Creek	1,4
		18-Jul-90	20,000	Robertson SR	Fry	Robertson Creek	1,4
		10-Aug-89	9,980	Robertson SR	Fall Fry	Robertson Creek	1,4
		1988	50,000	Robertson SR	Fall Fry	Robertson Creek	1,4
1979	18,551	Robertson SR	Parr	Robertson Creek	1 ⁴		

¹ - Coho from the Robertson Creek hatchery were transplanted into the Ash River in 1979 (Mapster 2005), however, the location was not specified

² 1: FISS Ash River Stocking Report

2: FISS Lanterman Creek Report

3: Fish Wizard (FWD 2005); Note: data is limited to a 5 year period previous to the most recent record

4: B.C. Environment (Victoria) data presented in Griffith (1993)

³ Stocking location unknown, assumed to be Lower Ash River. FISS Ash River Report says that stocking of Atlantic salmon ended in 2000, but the last record in FISS Stocking Report for the Ash R. is 1924.

⁴ Stocking location unknown, assumed to be Middle Ash River

Table 10. Fish stocking history in Elsie Lake Reservoir and the Upper Ash River.

Stocking Location	Species	Date	# of Fish	Stock	Life Stage	Hatchery of Origin	Data Source ¹
<u>Elsie Lake Reservoir</u>							
Elsie Lake Reservoir	Summer	Jan-05	60	Robertson SR	Tagged	Robertson Creek	1
	Steelhead	14-May-97	10,274	Robertson SR	Smolt	Robertson Creek	2
		21-Jul-94	64,781	Robertson SR	Fry	Robertson Creek	2
		17-Aug-93	68,078	Robertson SR	Fry	Robertson Creek	2
		26-Aug-92	1,633	Robertson SR	Parr	Robertson Creek	2
		6-Jul-92	58,284	Robertson SR	Fry	Robertson Creek	2
		Jul-90	39,000	?	Juveniles	?	3
		Jul-90	56,000	?	Juveniles	?	3
		Jul-88	127,000	?	Juveniles	?	3
		1988	?	?	Adults	?	3
		Jul-86	66,000	?	Juveniles	?	3
		Jul-83	215,000	?	Juveniles	?	3
		1983	?	?	Adults	?	4
		Jul-82	170,000	?	Juveniles	?	4
<u>Upper Ash River</u>							
Upper Ash River (above Elsie Lake) ²	Summer	3-Oct-00	25,000	Robertson SR	Fry	Robertson Creek	2
	Steelhead	2-Oct-98	3,000	Robertson SR	Fry	Robertson Creek	2
		2-Jun-97	18,668	Robertson SR	Fry	Robertson Creek	2
		9-Jul-96	20,000	Robertson SR	Fry	Robertson Creek	2
		21-Jul-95	20,000	Robertson SR	Fry	Robertson Creek	4 ³
		5-Jul-94	28,622	Robertson SR	Fry	Robertson Creek	4 ³
		6-Jul-93	25,000	Robertson SR	Fry	Robertson Creek	4 ³
June Lake	Summer	17-Dec-86	5,000	Robertson SR	Parr	Robertson Creek	2
	Steelhead	15-Jun-83	5,000	Robertson SR	Fry	Robertson Creek	2
Junior Lake	Cutthroat Trout	20-Jun-03	1,000	Taylor	Fry	New Vancouver	2
		12-Jun-01	1,000	Taylor	Fry	New Vancouver	2
		21-Sep-99	1,000	Taylor	Fingerling	New Vancouver	2
Toy Lake	Cutthroat Trout	20-Jun-03	1,000	Taylor	Fry	New Vancouver	2
		12-Jun-01	1,000	Taylor	Fry	New Vancouver	2
		21-Sep-99	1,000	Taylor	Fingerling	New Vancouver	2

¹ 1: M. McCulloch, BCCF, personal communication

2: Fish Wizard (FWD 2005); Note: data is limited to a 5 year period previous to the most recent record

3: B.C. Environment (Victoria) data presented in Griffith (1993)

4: FISS Ash River Stocking Report

² ~7.74 km upstream of Elsie Lake at UTM 336510.9 E, 5476347.8 N³ Location not given, assumed to be Upper Ash R.

6.4. Other Activities

Selective blasting by Fish and Wildlife at Dickson Falls in 1977-78 allowed summer steelhead to ascend the falls and access the Middle Ash River. Fish and Wildlife also removed a log jam in 1979-80 to facilitate passage of coho salmon, with questionable success (Ash River Water Use Plan Consultative Committee 2003).

In 1990, enhancement activities were undertaken in the Middle Ash River upstream of Dickson Falls. Approximately 200 m² of specially graded gravels were placed above Dickson Falls in an effort to improve summer steelhead spawning habitat below the outlet of Dickson Lake (Griffith 1990a in Griffith 1993). A moderate amount of good quality spawning gravel still remains (Hansen 2003, App. 1).

On July 19, 2001 the Middle Ash River was fertilized with briquettes at two locations with the intent of increasing summer steelhead production (Hansen 2003). The upstream location was approximately 300 m below the confluence of the Elsie Lake Reservoir spillway channel and the low level outflow. The other site was located 5.5 km downstream of the upstream site. A steelhead census was conducted at two control sites and two treatment sites in the Middle Ash River from September 13-25, 2001. However, Hansen (2003) notes that because of the late application of the fertilizer and an extreme flood event in August 2001, the results did not reflect a successful nutrient addition to the Ash River.

7. DISCUSSION

The Ash River Fish Passage Feasibility study depends on the findings of the other studies conducted this year in the Ash River watershed, 05.As.01 (Elsie Lake Productive Capacity and Feasibility of Nutrient Enrichment for Fish Restoration), 05.As.02 (Ash River Nutrient Enrichment for Fish Habitat Restoration) and 05.As.03 (Estimation of Productive Capacity of Elsie Lake Tributaries). The final results of these studies were not available within the timeframe of the current study and could not be adequately integrated with the proposed project activities. In addition, there was a key new finding from 05.As.02, specifically that coho salmon can currently ascend Dickson Falls, which refutes the contention made during the Ash WUP that this was a total barrier to coho salmon passage. Moreover, this finding raises questions over their present and scientific historical distribution in the watershed and the value of habitats for them. This question and others will be answered with the conditionally approved studies the Ash River in 2006 (06.ASH.02 Lower Ash River - Identification of Fish Habitat Restoration Opportunities; and 06.ASH.04 Assessment of Historic Distribution of Anadromous Fish), providing important data relevant to making decisions on fish passage in the Ash River.

Considering the need to incorporate the findings of current and future studies into decisions on fish passage improvements in the Ash watershed, a decision was made by the project manager in consultation with AVARG members to delay further work on this project. This decision was communicated to the BCRP project manager in the final quarter of the term of the contribution agreement. The current report provides the available background data to support future decisions on fish passage in the Ash River watershed. The next step of discuss fish passage alternatives should be initiated once the findings of the 2006-2007 studies are available, because an adequate understanding of the benefits of fish passage will depend on the findings of those studies.

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9. APPENDICES

9.1.

Anadromous Fish Abundance Data**Table 11. Salmon escapement data for the Stamp River (Somass System); data source FWD (2005).**

YEAR	SOCKEYE	COHO	PINK ¹	CHUM ¹	CHINOOK
1953	35,000	35,000	UNK	7,500	7,500
1954	35,000	35,000	UNK	7,500	7,500
1955	35,000	35,000	UNK	3,500	7,500
1956	7,500	35,000	75	1,500	15,000
1957	145,000	15,000	UNK	7,500	7,500
1958	40,000	35,000	400	7,500	15,000
1959	35,000	35,000	NO	3,500	7,500
1960	35,000	15,000	400	1,500	7,500
1961	35,000	35,000	75	3,500	7,500
1962	35,000	35,000	750	3,500	7,500
1963	35,000	35,000	3,500	1,500	7,500
1964	35,000	35,000	75	750	15,000
1965	35,000	35,000	3,500	1,500	7,500
1966	75,000	75,000	1,500	1,500	7,500
1967	75,000	75,000	200	1,500	15,000
1968	99,000	60,000	400	3,500	12,500
1969	115,000	35,000	25	2,500	13,000
1970	36,000	120,000	100	3,000	8,500
1971	67,000	85,000	200	1,500	13,500
1972	137,000	30,000	400	4,000	9,000
1973	261,000	130,000	UNK	7,000	11,000
1974	93,000	125,000	400	3,500	12,500
1975	191,000	40,000	100	750	15,000
1976	148,322	35,000	500	4,500	13,000
1977	293,000	31,200	NO	500	12,300
1978	151,900	32,000	NO	300	9,000
1979	340,441	35,000	NO	350	10,200
1980	297,976	NO	UNK	UNK	4,000
1981	389,837	UNK	UNK	1,000	7,500
1982	414,196	8,035	UNK	NO	8,474
1983	600,000	UNK	2	1	11,000
1984	222,402	UNK	UNK	UNK	6,500
1985	274,719	44,000	UNK	2,000	54,500
1986	311,361	UNK	UNK	UNK	UNK
1987	406,969	UNK	0	UNK	UNK
1988	420,694	UNK	0	2,000	76,310
1989	38,270	37,448	NO	750	76,251
1990	80,000	45,500	NO	UNK	130,000
1991	648,500	34,800	0	3,000	100,000
1992	377,100	50,400	UNK	UNK	124,200
1993	422,809	15,879	UNK	40	96,254
1994	257,283	977	UNK	UNK	57,678
1995	167,634	13,941	NO	NO	23,313
1996	434,933	14,623	NO	4,252	30,383
1997	300,036	6,788	14	4,359	12,811
1998	378,606	36,611	12	25	32,049
Avg (1989-1998)	30,744	25,697	4	1,775	68,294

Data Source: nuSEDS V1.0 Fisheries and Oceans, Canada (FWD 2005); Extraction Date: October 1, 2001

NO = Stream Inspected but None Observed; UNK = # Unknown or Unknown

¹ for for 1989-1998 average, the estimate excluded years in which the escapement was "UNK" and includes years in which the escapement was "NO" (counted as 0)

Table 12. Ash River summer steelhead counts from the bridge upstream of Lanterman Falls to Stamp River (4.4 km), 1983-2004 (data source: Georgia Basin steelhead recovery plan (2005) website).

Date	# Summer Steelhead Observed
Oct-83	37
Oct-86	25
Oct-89	18
Oct-91	50
Oct-92	67
Sep-98	73
Sep-99	137
Sep-00	146
Sep-01	165
Sep-02	72
Sep-03	51
Sep-04	58
Mean	75
n	12
S.D.	48

9.2.

Elsie lake reservoir fish sampling data Triton (1995)**Table 13. Length, weight, and age of rainbow and cutthroat trout sampled from Elsie Lake Reservoir on May 26, 1994 (from Triton 1995).**

Species	Date	Length (mm)	Weight	Age	Comments
CT	26-May-94	307	8	4	male spent, int parasites
CT	26-May-94	225	118	3	spent, int parasites
RB	26-May-94	170	59	2+	
RB	26-May-94	184	71	3+	
RB	26-May-94	211	95	3+	
RB	26-May-94	184	63		male, imm
RB	26-May-94	190	75		male, imm
RB	26-May-94	187	63		female, imm
RB	26-May-94	189	76		female, imm
RB	26-May-94	191	80		
RB	26-May-94	201	77		
RB	26-May-94	186	58	3	male ripe
RB	26-May-94	196	81	2+	male ripe
RB	26-May-94	193	81		
RB	26-May-94	197	83		
RB	26-May-94	214	103	2+	
RB	26-May-94	180	66		
RB	26-May-94	199	87		
RB	26-May-94	204	80		
RB	26-May-94	190	75		
RB	26-May-94	188	76		
RB	26-May-94	194	75		
RB	26-May-94	205	101		
RB	26-May-94	189			
RB	26-May-94	166	56		imm
RB	26-May-94	207	99		
RB	26-May-94	217	111		
RB	26-May-94	232	142	3+	imm
RB	26-May-94	310	10	regenerate	female, ripe
RB	26-May-94	236	142		imm
RB	26-May-94	233	200	3+	female, imm
RB	26-May-94	140	28	2+	imm
RB	26-May-94	119	19		female imm, parasites
RB	26-May-94	305			released alive
RB	26-May-94	165-220	36 fish in this size range		

Table 14. Number of rainbow trout caught by length category from Elsie Lake Reservoir in November 1969 and May 1994 (data from Triton 1995).

Length Category (mm)	# of Rainbow Trout Caught in May 1994	# of Rainbow Trout Caught in November 1969
0	0	0
50	0	0
100	2	1
150	18	8
200	10	10
250	2	2
300	0	0

Table 15. Length, weight, and age summary statistics for rainbow and cutthroat trout caught in Elsie Lake Reservoir on May 26, 1994 (data from Triton 1995).

Statistic	Rainbow Trout	Cutthroat Trout
<u>Length</u>		
N	32	2
Mean Length (mm)	200	266
S.D. for Length (mm)	37	58
Range of Lengths (mm)	119-310	225-307
<u>Weight</u>		
N	30	2
Mean Weight (g)	81	63
S.D. for Weight (g)	36	78
Range of Weights (g)	10-200	8-118
<u>Age</u>		
N	8	2
Average Age (yrs)	2.5	3.5
Range of Ages (yrs)	2+-3+	3-4

Table 16. Mean length, weight, and condition factor by age for trout captured in Elsie Lake Reservoir (August 7-9, 2002) (reproduced from Burt and Robert (2003)).

Species	Age	# Fish Caught	Mean Length (mm)	Length Range (mm)	Mean Weight (g)	Mean Fulton's Condition Factor ¹
Rainbow	0	1	66	66	2.9	1
Cutthroat		0	—	—	—	—
Rainbow	1	12	114	95-121	18.6	1.24
Cutthroat		0	—	—	—	—
Rainbow	2	46	135	118-152	29	1.18
Cutthroat		1	133	133	24.6	1.05
Rainbow	3	51	200	171-231	87.2	1.09
Cutthroat		0	—	—	—	—
Rainbow	4	45	242	217-275	142.4	1
Cutthroat		8	260	232-295	182.3	1.01
Rainbow	5	5	284	243-329	215.6	0.93
Cutthroat		2	327	310-344	327.8	0.93
Rainbow	6	0	—	—	—	—
Cutthroat		1	400	400	640	1
Rainbow	AllAges	160	188	66-329	84.3	1.09
Cutthroat		12	272	133-400	231.6	1

Notes:

All fish captured by gillnet with exception of the one 0+ fish captured in a minnow trap.

¹ Fulton's condition factor = $\text{Weight (g)} \div \text{Length}^3 \times 100,000$.

9.3. Elsie Lake Reservoir tributary fish and habitat sampling data (Burt and Robert 2003).**Table 17. Summary of habitat data collected on Elsie Lake Reservoir Inlet Tributaries (June 3-21, 2002) - reproduced from Burt and Robert (2003).**

Stream	Discharge At Time Of Survey	Survey Distance	Distance To Adfluvial Barrier	Available Length At Survey Flow	Mean Field Gradient	Mean Channel Width	Mean Wetted Width	Mean Substrate Characteristics						Mean Cover Characteristics						
								Fi	Gr	Co	Bo	Br	D95	Bo	LWD	SWD	IV	OV	CB	DP
								(%)	(%)	(%)	(%)	(%)	(cm)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Upper Ash, R1	11.3	1,338	35	35	1.6	19.5	19.5	1	5	31	41	17	140	24	0	0	0	2	0	13
Upper Ash, R2	11.3	1,050	—	—	0.4	28.5	27.0	15	68	18	0	0	9	0	0	0	0	7	3	0
Ramsay Creek, R1	1.8	930	—	—	3.5	17.1	13.2	3	8	38	43	9	313	35	0	0	0	1	0	3
Ramsay Creek, R2	1.8	1,877	12,550	(12,550)	0.6	19.8	18.8	19	19	47	15	0	80	12	0	0	0	9	3	0
Katum Creek, R1	0.4	982	157	157	2.6	9.7	7.2	14	24	39	20	3	89	11	1	0	0	6	2	1
Katum Creek, R2	0.4	50	—	—	2.0	7.7	5.0	20	30	50	0	0	20	ns						
Creek 1	0.0005	80	20	3	5.4	3.0	1.0	23	48	15	6	9	15	0	6	8	0	5	4	0
Creek 2	0.3	1,148	813	813	5.2	15.3	10.1	4	9	25	27	31	122	14	0	0	0	5	0	2
Creek 3	0.00001	74	0	0	40.8	2.5	0.3	8	30	40	23	0	33	6	6	3	0	3	3	0
Creek 3a	Dry	20	0	0	36		Dry	ns						ns						
Creek 3b	Dry	20	0	0	36	2.5	Dry	10	15	45	30	0	40	ns						
Creek 4b	0.0002	101	0	0	17.1	2.2	0.7	38	23	23	18	0	25	5	0	28	0	5	0	0
Creek 5	0.0001	20	0	0	38	1.8	0.2	20	15	20	45	0	30	70	0	0	0	15	0	0
Creek 6	0.0025	98	49	0	19.4	2.7	0.8	40	35	20	5	0	17	1	5	30	0	5	10	0
Creek 6b	0.0025	245	350	0	4	2.2	1.3	33	41	20	6	0	16	4	3	8	13	20	8	0
Creek 7	0.0008	219	40	3	5.6	2.5	1.9	49	40	10	1	0	9	0	13	27	0	26	0	0
Creek 7b	0.001	50	0	0	20	ns	ns	ns						ns						
Creek 8	Dry	30	30	0	1	ns	Dry	ns						ns						
Creek 9	0.0003	186	112	14	5	2.8	1.4	8	18	58	15	3	31	12	2	1	0	2	1	0
Creek 10	0.01	275	275	129	8	4.1	2.3	10	23	39	27	0	57	23	0	0	0	0	0	0
Creek 13	0.0003	156	77	0	8	3.7	1.2	8	35	35	18	0	35	8	0	0	0	4	0	0
Creek 14	0.0001	58	47	0	16	2.7	0.7	13	39	16	30	3	43	15	1	3	0	2	2	0
Creek 15	0.0001	112	81	27	4.5	4.2	1.7	8	28	10	24	32	27	0	9	0	0	0	1	0
Totals (w/o Ramsay)		6,312	2,086	1,181																
Totals (with Ramsay)	27.3	9,119	14,636	13,731																

Table 18. Quantities of spawning gravel available in Elsie Lake tributaries (modified from Burt and Robert 2003) during a June 3-21, 2002 survey. Spawning gravels below full pool are also shown from an August 2001 survey (Lewis 2001) to illustrate spawning gravel available to Elsie Lake Reservoir trout prior to impoundment.

Stream	Distance Full Pool To Adfluvial Barrier (m)	Quantity Of Adfluvial Spawning Gravel		
		Below Full Pool ¹ (m ²)	Full Pool To Adfluvial Barrier (m ²)	Above Adfluvial Barrier (m ²)
Upper Ash, R1	35	33,549	0	46
Upper Ash, R2	—	—	—	1,700+
Ramsay Creek, R1	—	49	11	
Ramsay Creek, R2	12,550	—	(1,500+) ²	
Katlum Creek, R1	157	579	13	121
Katlum Creek, R2	—	—	—	
Creek 1	20	12	2	
Creek 2	813	192	23	
Creek 3	0	116	0	
Creek 3a	0	—	0	
Creek 3b	0	—	0	
Creek 4b	0	11	0	
Creek 5	0	0	0	
Creek 6	49	2	0.2	
Creek 6b	350	—	18	
Creek 7	40	5	5	
Creek 7b	0	—	0	
Creek 8	30	—	0	
Creek 9	112	544	5	
Creek 10	275	1,483	6	
Creek 13	77	36	1	
Creek 14	47	10	1	
Creek 15	81	14	8	
Totals (excluding Ramsay)	2086		82.2	1,867+
Totals (including Ramsay)	14636	36,602	1,593+	
Total all creeks as % of pre-impoundment gravel		96%	4%	

¹ Amounts of spawning gravel below full pool are from WUP surveys conducted by Burt and Robert in 2001 and encompassed habitat surveys of Elsie Lake tributaries from the 318.7 m elevation to near full pool (330.5-330.8 m) and have been modified. The data were originally presented in Lewis (2001), and have been re-worked and are slightly different than in Lewis (2001).

² Spawning gravel in Ramsay Creek is shown in brackets because it is not known whether resident fish can access the main spawning beds in Reach 2.

Table 19. Mean Length, weight, and condition factor for trout captured in Elsie Lake Reservoir tributaries (Upper Ash River, Katlum Creek, Ramsay Creek, and Creek #2) from September 15-19, 2002 (modified from Burt and Robert (2003)).

Species	Age	# Fish Caught	Mean Length (mm)	Length Range (mm)	Mean Weight (g)	Mean Fulton's Condition Factor ¹
Trout	0 ⁺	270	43	28-63	0.9	1.01
Rainbow	1 ⁺	12	83	67-102	6.5	1.11
Cutthroat		21	94	78-120	9.5	1.08
Rainbow	2 ⁺	4	112	85-129	16.8	1.15
Cutthroat		2	135	133-137	25.1	1.02
Trout	All Ages	309		28-137		1.02

Table 20. Summary of trout density and biomass statistics from electrofishing sites on Elsie Lake Reservoir tributaries from September 15-19, 2002 (modified from Burt and Robert 2003).

Site	Stream	Above or Below Barrier	Site PUA %	Adjusted Density (fish/100 m ²)	Adjusted Biomass (g/100 m ²)	Alkalinity (mg/L)	Theoretical Maximum Biomass (g/100 m ²)	Biomass as Percent of Maximum (%)
<u>0+ Age Group</u>								
EL01	Katlum Cr.	Below	68	113.3	90.8	41	232	39
EL03	Ramsay Cr.	Below	53	86.7	98.6	24	178	55
EL04	Ramsay Cr.	Below	74	59.4	33.6	24	178	19
EL06	Creek #2	Below	50	237.6	258.6	27	189	137
EL02	Katlum Cr.	Above	60	239	217.5	41	232	94
EL05	Upper Ash R.	Above	77	6.4	6.1	20	162	4
<u>1+ Age Group</u>								
EL01	Katlum Cr.	Below	50	37.4	295.9	41	232	128
EL03	Ramsay Cr.	Below	48	0	0	24	178	0
EL04	Ramsay Cr.	Below	21	0	0	24	178	0
EL06	Creek #2	Below	70	33.7	329.2	27	189	174
EL02	Katlum Cr.	Above	10	0	0	41	232	0
EL05	Upper Ash R.	Above	11	0	0	20	162	0

Notes:

Site PUA = Percent Usable Area = weighted usable area as a percent of total site area. Weighting was based on rainbow habitat suitability index curves (see Methods in Burt and Robert (2003)).

Adjusted density = Observed density ÷ PUA × 100

Adjusted Biomass = Observed biomass ÷ PUA × 100

Theoretical Maximum Biomass = (Alkalinity).5 × 36.2 (see Ptolemy 1993)

Percent of Maximum biomass = Adjusted Biomass ÷ Theoretical Maximum Biomass × 100

9.4.

Elsie Lake Reservoir tributary fish and habitat sampling data (Lewis 2001).

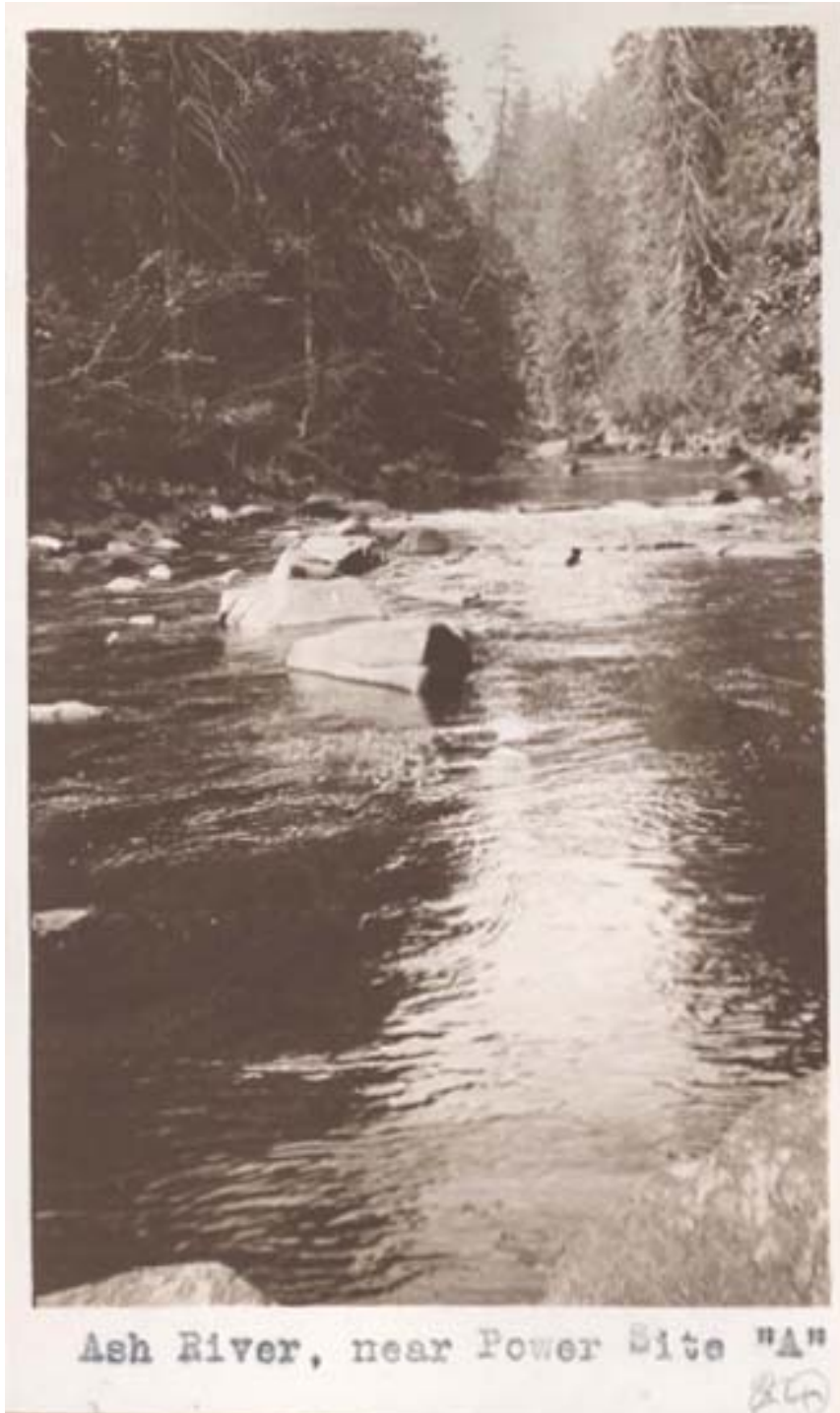
Table 21. Spawning area available in the drawdown zone of tributaries to Elsie Lake Reservoir.

Parameter	Value
Total Spawning Area (m ²) (Including Upper Ash R.):	38,350
Total Spawning Area (m ²) (Excluding Upper Ash R.):	4,801
Mean Spawning Area (m ²) per Meter (m) in Elevation (Including Upper Ash R.):	2,639
Mean Spawning Area (m ²) per Meter (m) in Elevation (Excluding Upper Ash R.):	331
Total Length of Stream Surveyed (m):	7,285
Total Number of Streams Surveyed:	20

9.5.

Ash River watershed stock exploitation data**Table 22. Steelhead (from the Provincial steelhead harvest analysis database, 1968-2004).**

Year	# Wild Fish Kept	# Wild Fish Released	Total Wild Catch	# Hatchery Fish Kept	# Hatchery Fish Released	Total Hatchery Catch	Total Catch (Wild + Hatchery)	Total # Days Fished	CPUE
1968	525	0	525	0	0	0	525	1153	0.46
1969	601	0	601	0	0	0	601	1409	0.43
1970	283	0	283	0	0	0	283	1222	0.23
1971	184	121	305	0	0	0	305	990	0.31
1972	258	93	351	0	0	0	351	632	0.56
1973	78	70	148	0	0	0	148	555	0.27
1974	222	52	274	0	0	0	274	751	0.36
1975	225	137	362	0	0	0	362	633	0.57
1976	201	166	367	0	0	0	367	1023	0.36
1977	48	20	68	0	0	0	68	346	0.20
1978	33	62	95	0	0	0	95	258	0.37
1979	24	87	111	0	0	0	111	259	0.43
1980	0	21	21	0	0	0	21	83	0.25
1981	0	44	44	0	0	0	44	95	0.46
1982	0	0	0	7	0	7	7	44	0.16
1983	4	91	95	4	4	8	103	182	0.57
1984	0	75	75	4	26	30	105	109	0.96
1985	0	45	45	0	10	10	55	93	0.59
1986	0	25	25	7	53	60	85	88	0.97
1987	0	82	82	52	44	96	178	171	1.04
1988	0	283	283	0	75	75	358	172	2.08
1989	0	96	96	0	8	8	104	97	1.07
1990	0	67	67	5	13	18	85	143	0.59
1991	0	185	185	4	35	39	224	189	1.19
1992	0	319	319	0	15	15	334	125	2.67
1993	0	243	243	0	7	7	250	217	1.15
1994	0	112	112	0	8	8	120	178	0.67
1995	0	60	60	0	0	0	60	47	1.28
1996	0	123	123	0	9	9	132	94	1.40
1997	0	89	89	6	22	29	118	159	0.74
1998	0	112	112	0	0	0	112	86	1.29
1999	0	167	167	0	8	8	175	168	1.04
2000	0	115	115	9	14	23	138	177	0.78
2001	0	30	30	0	0	0	30	33	0.89
2002	0	386	386	3	54	57	443	299	1.48
2003	0	137	137	4	34	38	175	221	0.79
2004	0	104	104	0	11	11	115	200	0.57

9.6. Historic Photographs of the Ash River Watershed from Knewstubb (1923)*Miscellaneous***Figure 32.** Ash River near a potential power site (1922).

Lower Ash River

Figure 33. Dickson Falls (1922).

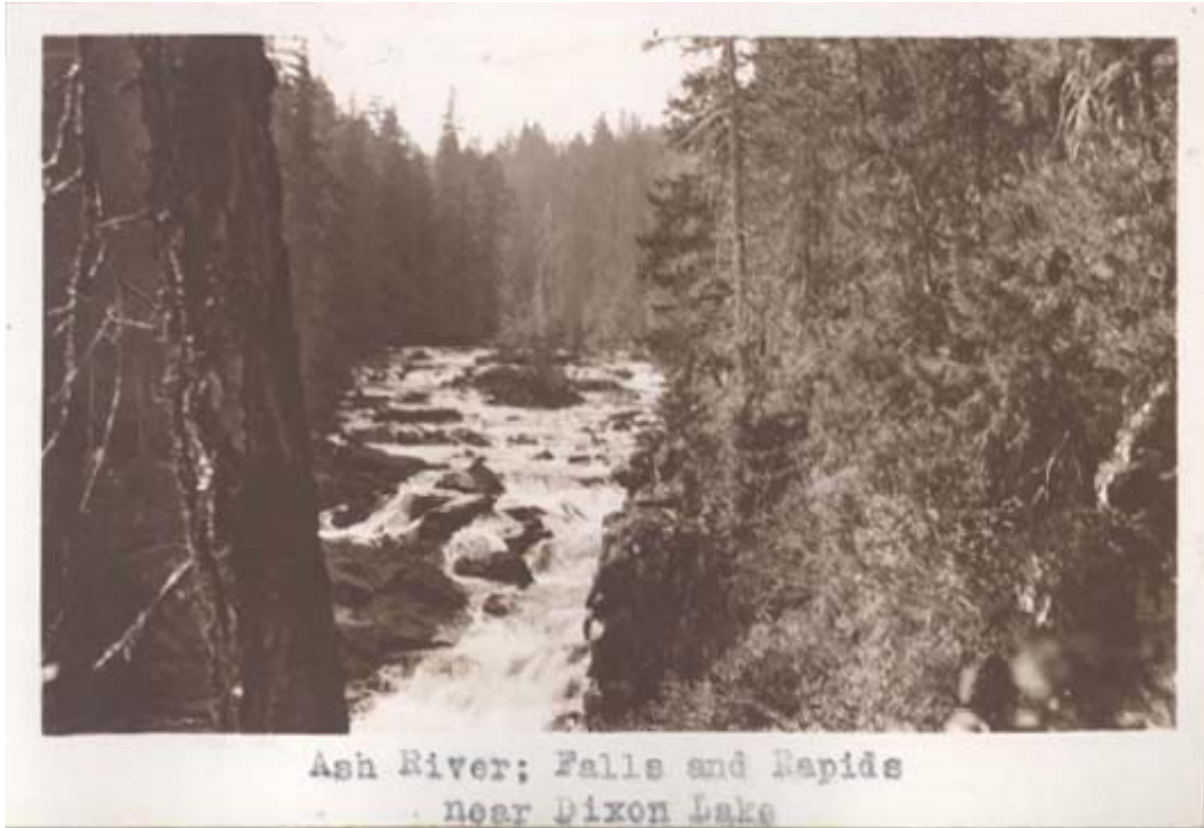


Figure 34. Dickson Falls (alternate view, 1922).



Figure 35. Potential site for a diversion dam below Dickson Lake (1922).



Middle Ash River

Figure 36. Ash River below Elsie Lake (1922).

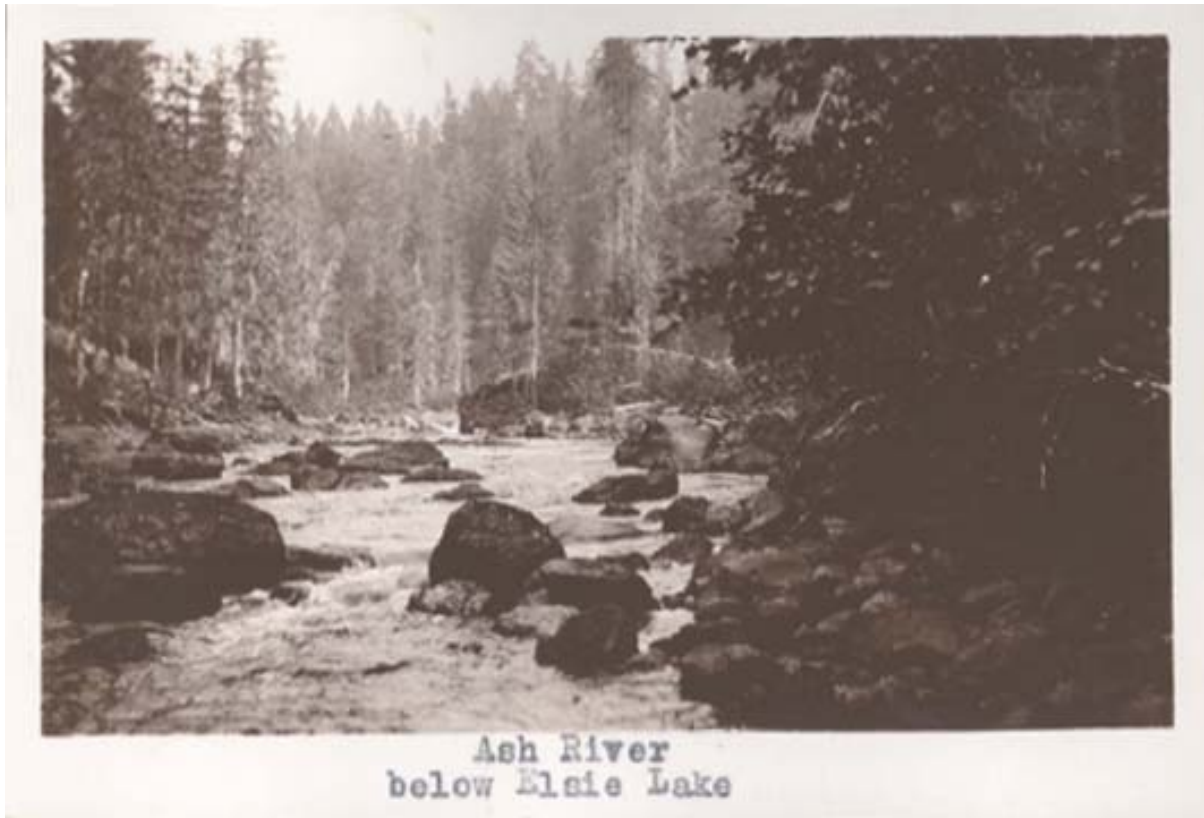


Figure 37. Potential site for a diversion dam below Elsie Lake showing east side (1922).



Figure 38. Potential site for a diversion dam below Elsie Lake showing west side (1922).



Figure 39. Rapids below Elsie Lake (1922).

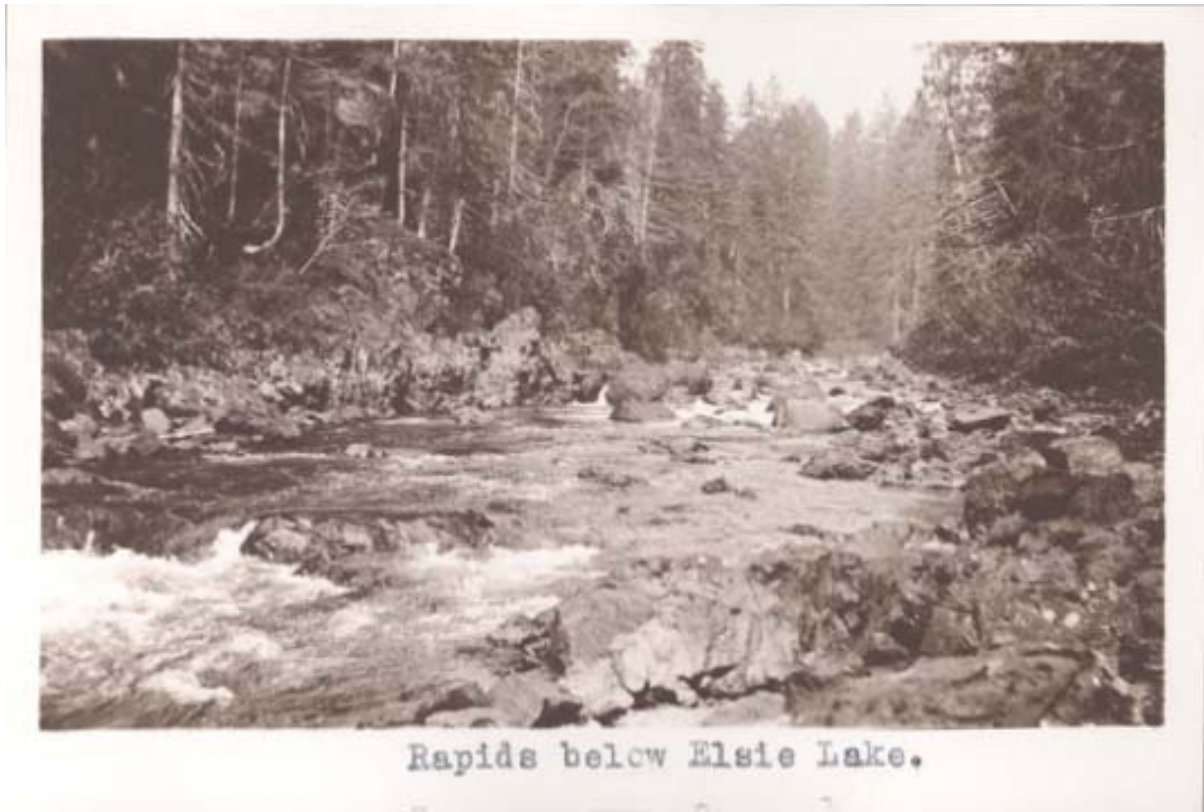


Figure 40. Potential site for a storage dam below Elsie Lake (1922).



Elsie Lake

Figure 41. Elsie Lake (1922).



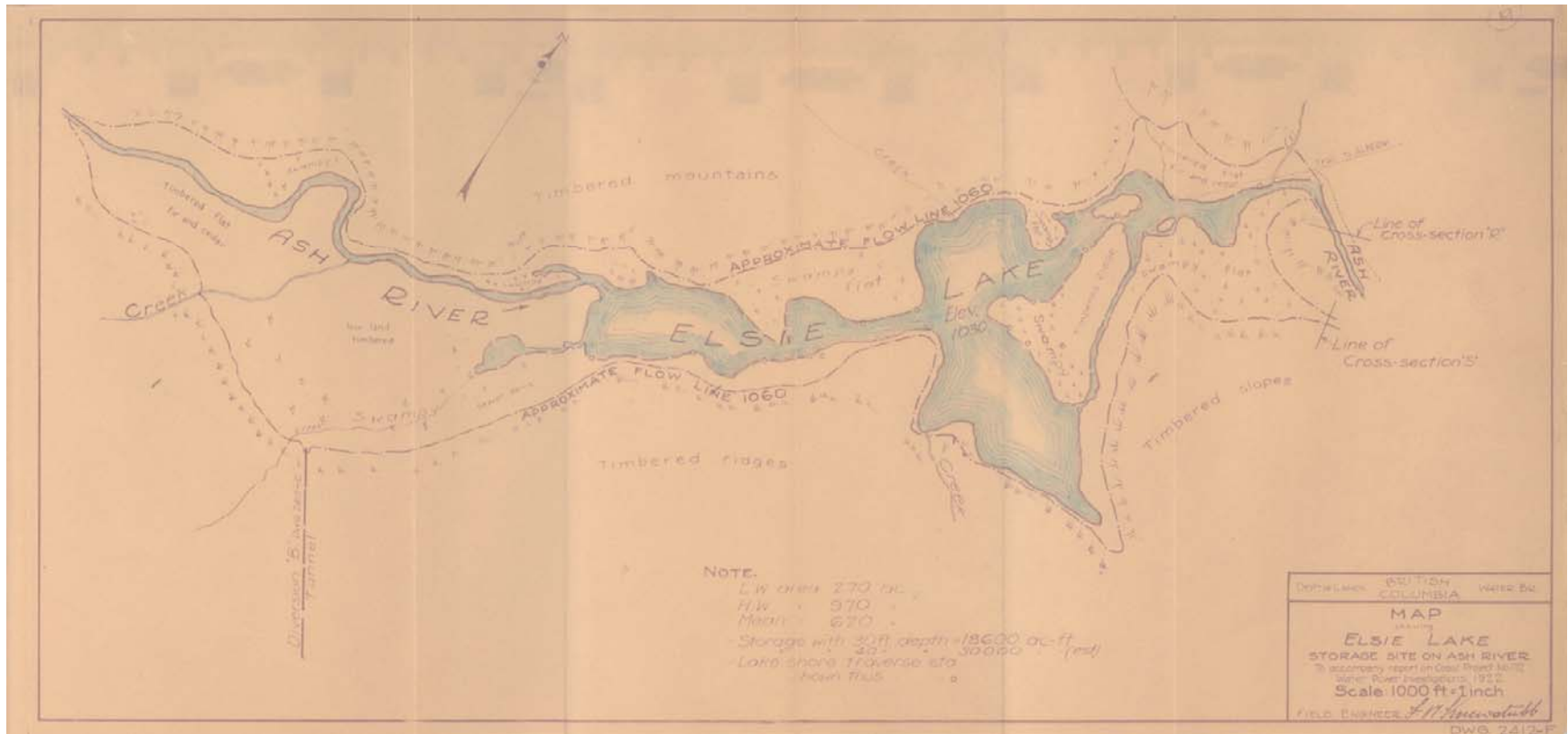
Figure 42. Elsie Lake (shown from centre of lake, 1922).



Figure 43. Outlet of Elsie Lake looking east (1922).



Figure 44. Sketch of Elsie Lake (1922).



9.7. Historic Air Photos of the Elsie Lake Area (courtesy of Steve Toth)

Figure 45. Air photo of Elsie Lake taken in 1946.

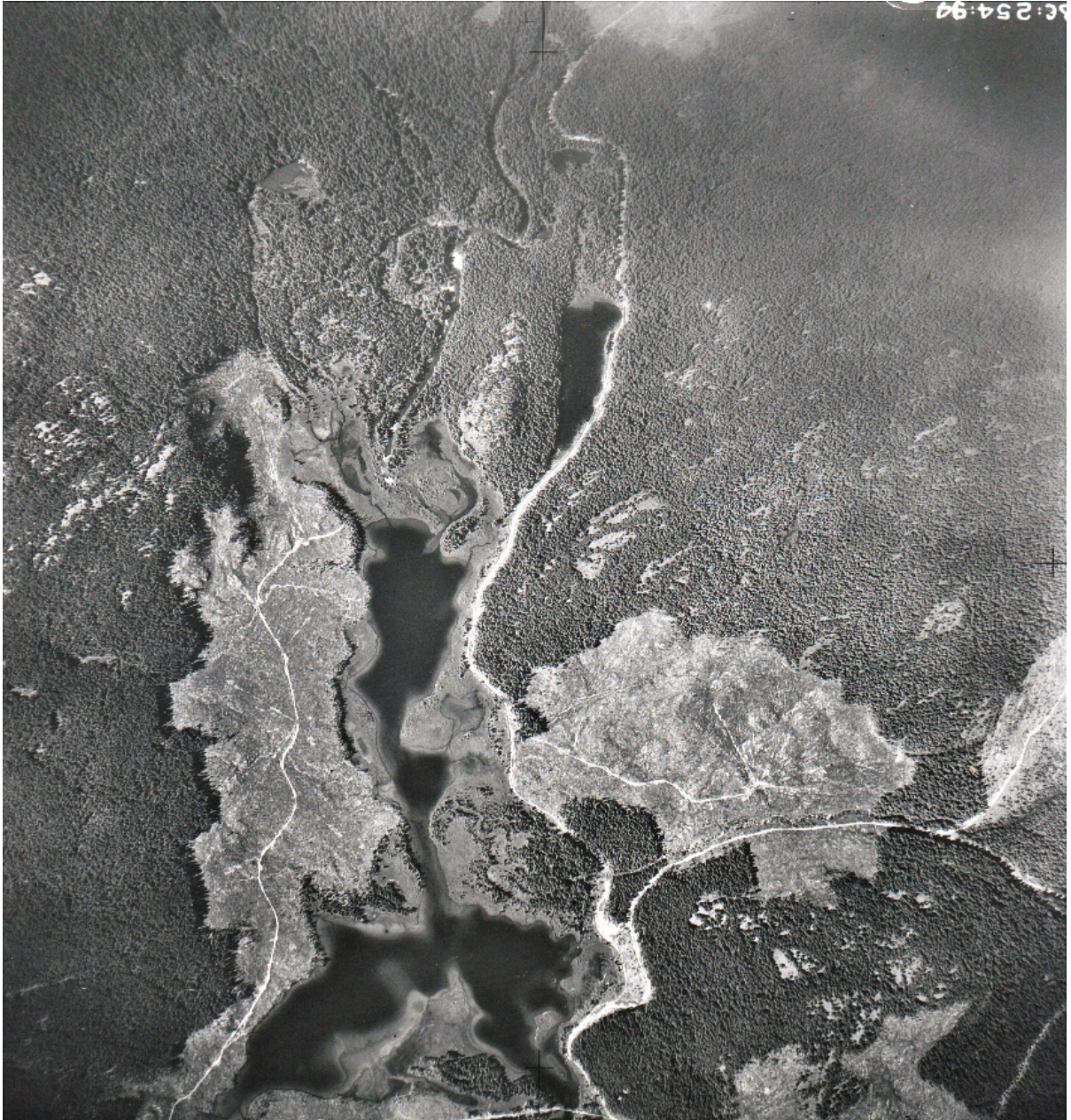


Figure 46. Air photo of Elsie Lake taken in 1951.



9.8. Financial Statement (Statement of income and expenditures-form attached)Project # 05.As.04

Financial Statement Form

	BUDGET		ACTUAL	
	BCRP	Other	BCRP	Other
INCOME				
Total Income by Source	49,505.00	2,000.00	49,505.00	2,000.00
Grand Total Income		51,505.00		51,505.00
EXPENSES				
Project Personnel				
Wages				
Consultant Fees	42,980.00	2,000.00	12,050.00	400.00
Materials & Equipment				
Equipment Rental				
Materials Purchased	250.00		320.00	
Travel Expenses	1,775.00		94.50	
Permits				
Communications				
Administration				
Office Supplies	900.00			
Photocopies & printing	200.00			
Postage				
Administration	3,400.00		890.00	
Total Expenses	49,505.00	2,000.00	13,354.50	400.00
Grand Total Expenses		51,505.00		13,754.50
BALANCE (Grand Total Income - Grand Total Expenses)		0.00		37,750.50

9.9. Performance Measures-Actual Outcomes

There were no performance measures identified for this project. This project provides data and analysis that will support decisions on fish passage works or activities that are being considered for the Ash River. Should fish passage improvements be made, performance measures will be developed to measure efficacy.

- 9.10. Confirmation of BCRP Recognition (newspaper clippings, press releases, newsletters, brochures, photographs of signs/plaques, etc.)

MEDIA ARTICLE

Cash for Ash River

Alberni Valley Times

Wed 01 Mar 2006

Page: 1 / Front

Section: News

Byline: Shayne Morrow

Source: Alberni Valley Times

A group headed by Hupacasath First Nation has attracted increased funding from BC Hydro for habitat enhancement in the Elsie Lake watershed.

Since the late 1990s, the Bridge Coastal Restoration Program (BCRP) has provided funding for restoration work in watersheds affected by hydro development. Hupacasath manager Trevor Jones said it's been a natural fit for the band, but until recently, getting the money was a hit-or-miss proposition.

"Hupacasath were quick out the door to take advantage of the program in the watershed," Jones said Tuesday. But BCRP money was hard to come by until local interest groups banded together, he said.

"We've now created partnerships in a multi-stakeholder group, known as the Alberni Valley Aquatic Resource Group," Jones said.

AVARG includes parties diverse as the Alberni Valley Enhancement Association, personnel from local Fisheries and Oceans Canada operations and the provincial fisheries ministry. The effect has been an expanded centre of gravity for habitat restoration efforts.

"AVARG has become a model for groups in other Hydro jurisdictions," Jones said. And the results are showing, he added. Prior to AVARG, the band was lucky to get funding for one or two projects per year.

"For 2005-06, we've had four projects funded, and another five for 06-07," Jones said.

FEEDING A RIVER

Three of those projects involve assessment and study. But according to AVARG consulting biologist Adam Lewis, one of the programs is simple, hands-on stuff.

Called the Ash River Nutrient Enrichment program, it's just that -- putting more food into the eco-system.

"There are many ways of fertilizing a stream," Lewis explained. "Last year, we started putting in slow-dissolving, pollock-based blocks of nutrient."

Besides adding food for fish and other aquatic life forms, the supplements also raise critical phosphorous and nitrogen levels in the water. When available, coho and chinook carcasses from Robertson Creek hatchery are also introduced back into the watershed, to replicate the effect of historic spawning patterns

"This program takes place in the Middle Ash River, between Elsie and Dickson Lakes," Lewis said. The river is home to both resident and sea-run trout, as well as coho salmon. Total cost of the program is about \$27,000 per year, of which BCRP provides about \$18,000. The balance comes from the AVARG stakeholders, Lewis said.

ELSIE ON STEROIDS?

The Elsie Lake Productive Capacity Assessment project was fully funded by BCRP, at a budget of \$81,000, with Hupacasath providing the boat and sampling crew.

"We're assessing whether putting fertilizer in Elsie Lake would improve salmon capacity," Lewis said. While lake fertilization to increase nutrients is common (nearby Great Central Lake is one beneficiary), it isn't always a good idea.

"Depending on the food-webs within the eco-system, fertilizing a lake can encourage the growth of species that are actually detrimental to the desired species," he explained. You can wind up boosting the population sticklebacks, which prey on juvenile salmonids, or zooplankton, which benefits no one.

"The lake may be producing more biomass of food, but it may be food that the fish can't eat," Lewis said. The good news is, Elsie Lake appears to be an excellent candidate for fertilization, he added.

The fertilizer comes in the form of a phosphorous-nitrogen drip, which is fed into the lake from barge-based tanks over a period of four or five weeks.

HABITAT AVAILABLE

A third study, budgeted at \$63,000, is assessing the productive capacity of the tributaries flowing into Elsie Lake.

"What we know is that the Upper Ash River contains a large quantity of habitat," Lewis said. "Fertilizing Elsie Lake would encourage migration of native rainbow and cutthroat trout up into the tributaries."

According to Hupacasath elders, both coho and sockeye salmon spawned in the upper reaches of the Ash prior to construction of the Elsie Lake Dam in the 1950s.

Now the study has turned up a pair of wild cards, with the discovery of both juvenile coho and land-locked sockeye salmon (known as kokanee) in the system.

"We now know kokanee are present in the lake, but nobody is catching them," Lewis said. That raises some interesting scenarios, he explained.

"It's quite possible that the native cutthroat are preying on juvenile kokanee. On the other hand, fertilization would increase the size of the kokanee," he said.

Whether the kokanee are a historic population similar to those found in other B.C. lakes, or a new race created when the dam blocked passage to the lake is another question the scientists will have to wrestle with.

OPENING THE BARRIERS

The \$50,000 Ash River Fish Passage Study will deal with both technical and ethical questions, according to Lewis.

"A great way to increase fish production is to link habitat together," he said. Along the Middle Ash are a number of barriers, including Dickson and Lanterman Falls. Increasing fish passage brings into question the wisdom of tampering with the existing eco-balance -- especially when it involves a glamour species.

"Upstream of Dickson Falls, the only fish that can pass (according to current wisdom) are summer steelhead, and the province is reluctant to allow salmon passage," Lewis said. And then there's the dam itself.

"There was no barrier there historically, and it's another place where we could look at fish passage," he said. Technically, it's possible, but there are difficulties, such as screening the Ash River turbine intakes to protect migrating salmon smolts.

But restoring coho salmon above the dam, to take advantage of nearly 20 kilometres of Class A spawning habitat, raises another political issue.

The Upper Ash watershed is private timberland owned by Island Timberlands. Should the property be re-designated as salmon spawning habitat, that puts the owner under a whole new set of federal regulations governing harvesting operations, Jones said.

"Hupacasath would like to see salmon in the headwaters for that reason," Jones said.

"Island Timberlands has supported this work from the beginning," he added.

Lewis noted that AVARG has applied to extend the passage assessment for another year, partly as a result of the discoveries.

"Halfway through the project, we found coho, so that changed everything," he said.

"We've realized there are a lot of holes in our knowledge -- especially in the small tributaries on the Upper Ash."

RETURN OF THE KING

For Al Ross (Kaa-nowsh), hereditary chief of Hupacasath First Nation, the AVARG work has been an opportunity to return to his roots, in more ways than one.

"I worked as a fisheries guardian for Tseshah First Nation for 15 years.

"This has given me a chance to come back," Ross said.

He now serves as acting fisheries manager for Hupacasath, and has been the go-to guy when it comes to field work.

Ross noted that Hupacasath First Nation is actually a coalition of three inland tribes which lived in the Alberni Valley.

"My own people ruled in the Ash River/Elsie Lake area, right where we're working," he said.

IMMEDIATE BENEFITS

AVEA chair Dave Chitty said AVARG has been a boost for his group.

"Any time we can work together with other groups, it's a win-win," Chitty said. "For example, we had anecdotal knowledge of coho above the barriers, and now we have proof."

One of the biggest benefits has been a change in policy by BC Hydro, Chitty said.

"As a result of the Ash River Water Use Plan, Hydro is now required to increase its fish flows during the early fall," he said.

In past years, during the dry season, the utility allowed flows to drop to minimal levels, Chitty explained.

"Now they've moved the flows back closer to historic levels, which improves the migration of species such as steelhead and coho," he said.

Hupacasath First Nation will be hosting an open house at the House of Gathering, from 4-6 p.m. on March 30. Jones said the public will have a chance to check out the BCRP projects and talk to the biologists.

Edition: Final

Story Type: News

10. OPEN HOUSE

11.



12. HUPACASATH FIRST NATION

5500 Ahahswinis Dr.

Port Alberni, BC

V9Y 7M7

OPEN HOUSE INVITATION

The Hupacasath First Nation invites you to attend an open house and learn all about the exciting fish habitat restoration projects now underway in the Alberni Valley. The Hupacasath are part of AVARG –the Alberni Valley Aquatic Resource Group, which includes the Alberni Valley Enhancement Association, personnel from local Fisheries and Oceans Canada operations and the provincial fisheries ministry. This group has completed four fish habitat restoration projects on the Ash River this year, with the help of the Bridge Coastal Restoration Program (BCRP), who have provided funding for restoration work in watersheds affected by hydro development.

The open house provides an opportunity to learn about fish habitat restoration and the Ash River, and meet the people doing this interesting work. The Open House will be held from 4 pm to 7 pm on March 30, 2006 at the Hupacasath House of Gathering, 5500 Ahahswinis Drive, Port Alberni. Refreshments will be served.

For more information please call 724-4041 and speak to Ness

OPEN HOUSE MINUTES

The Open House was held from 4 pm to 7 pm on March 30, 2006 at the Hupacasath House of Gathering, 5500 Ahahswinis Drive, Port Alberni. Poster boards were prepared for each project. Four members of the general public attended. General questions about the objectives of the work were asked. No follow up actions were identified.

Hosts:

Al Ross
Harlan Wright
Jim Lane
Adam Lewis
Cedric Robert

Attendees:

Carol Schmidt
Female age 45
Female, age 40
Female, age 60

OPEN HOUSE POSTERS

Ash River Fish Passage Feasibility

Background

- Elsie Lake Dam was built in 1958
 - The dam blocked passage of all fish into and out of Elsie Lake via the middle Ash River (Figure 1)
 - Ocean going fish that likely had access to Elsie Lake and the Upper Ash watershed before dam construction include:
 - ▷ Coho and sockeye salmon (Traditional Ecological Knowledge)
 - ▷ Summer steelhead (Hryhorczuk and Silvestri 2002)
 - ▷ Pacific lamprey (Beamish & Northcote 1989)
- Currently only coho, summer steelhead, and Pacific lamprey are known to reach Elsie Dam

Methods

- Follow the "Framework for the Evaluation of Restoring Historic Fish Passage for Anadromous Fish at BC Hydro Bridge Coastal Generation Area Dams" (Bocking & Gaboury 2002) (also see Figure 2)
- Examine historical anadromous (ocean-going) fish stock data above and below Elsie Dam
 - Review and summarize literature for the Ash watershed describing the physical setting, including:
 - ▷ The Ash River Hydro Generation Project
 - ▷ The physical features of the Ash watershed
 - ▷ Natural barriers to fish passage (e.g., Figure 3 & 4)
 - ▷ Physical features of Elsie Lake Reservoir and its tributary streams
 - Review and summarize all known fish literature for the Ash watershed, including:
 - ▷ Present fish resources (e.g., distribution, migratory timing, available habitat, population size and density, habitat saturation)
 - ▷ Stock exploitation and enhancement

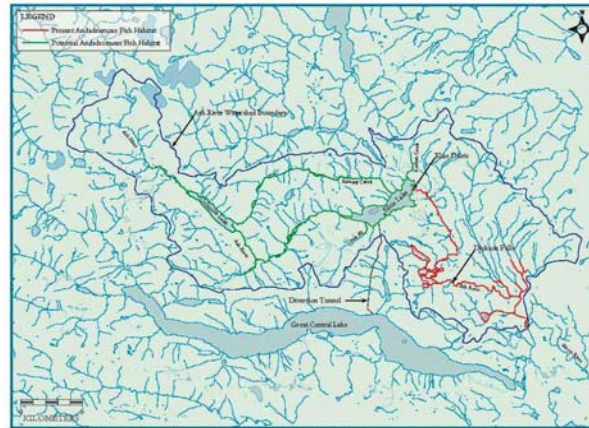


Figure 1. Present and potential anadromous (ocean-run) fish habitat in the Ash River watershed. Potential habitat assumes passage is restored at Elsie Dam.



Figure 3. Dickson Falls - the largest natural barrier in the Ash watershed.



Figure 4. Summer steelhead jumping at Dickson Falls.

Acknowledgements

This project is in progress and is being carried out by Ecofish Research Ltd. and the Hupacasath First Nation under contract to the BCRP.

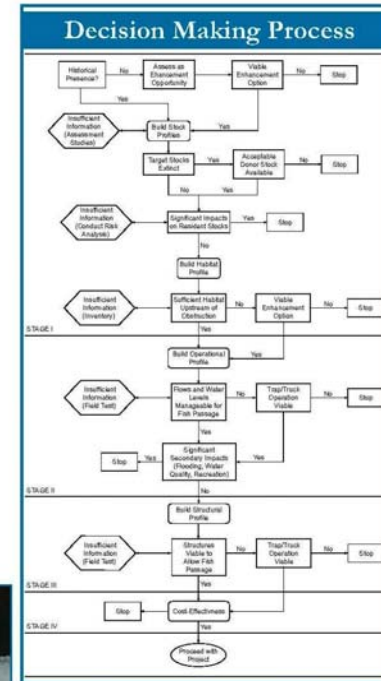


Figure 2. Decision making process for assessing the feasibility of restoring fish passage at BC Hydro dams in the Bridge Coastal Generation area (reproduced from Bocking & Gaboury 2002).

Project Status

- The ARRWG (Ash River Restoration Working Group) has applied to extend the fish passage assessment for another year, partly as a result of the discovery half way through this project that coho salmon can pass Dickson Falls (Figure 1 and 2) and likely reach Elsie Dam
- We will continue to follow the decision making process outlined in Figure 2

