

ELSIE LAKE RESERVOIR

Feasibility Assessment for Wildlife Restoration Activities in the Ash River Watershed



Final Report

Prepared for

The Hupacasath First Nation



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Bridge Coastal Restoration Program
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EXECUTIVE SUMMARY

One of the challenges in mitigating for impacts on terrestrial wildlife is to ensure that the mitigation strategy used does not adversely affect other species. Wildlife species have widely varying and often opposing habitat requirements. For every management option exercised, there will be winners and losers among wildlife populations and these tradeoffs must be understood and incorporated into integrated prescriptions for habitat restoration. This is particularly true when considering restoration as it relates to conservation. Although restoration can enhance conservation efforts, restoration is always a poor second to the preservation of original (unaltered) habitats.

To avoid a “band-aid” approach to habitat restoration Hawkes (2007) developed an integrated wildlife habitat restoration plan (IWHRP) for the Jordan River watershed on southern Vancouver Island. The concept of the IWHRP was born out of the need to develop an ecologically-based restoration plan that considered the habitat needs of the species that do, or that are expected to occur in watersheds affected by hydroelectric development. Because the strategic plans developed for the 15 watersheds within the Bridge Coastal Generation Area do not provide direction for habitat restoration, it was anticipated that the development of the IWHRP would have value for all watersheds in the Bridge Coastal Generation Area and for all watersheds in BC where BC Hydro operates.

Using the IWHRP developed for the Jordan River watershed as a guide, a wildlife habitat restoration feasibility assessment was completed for the Ash River Watershed, which is located in central Vancouver Island. An emphasis was put on selecting an area where wetland habitat could be constructed within the draw down zone of Elsie Lake Reservoir. This document describes the feasibility assessment process used in the Ash River watershed, identifies an area where wetland habitat could be created, and prioritises restoration activities for the drawdown zone of Elsie Lake Reservoir and adjacent upland habitats.

There is at least one area in the drawdown zone of Elsie Lake where a constructed wetland could be built. Because of its location (entirely within the drawdown zone), it is likely that BC Hydro’s existing water licence would fulfill the water licence requirements for the proposed construction. The site identified has several appealing features including nearby road access, existing water courses entering from two different locations, relatively easy topography to work with, and it occurs entirely within the drawdown zone of Elsie Lake Reservoir (i.e., it is below the maximum normal operating elevation for Elsie Lake).

Applying other Restoration strategies will increase the productivity of the Elsie Lake / Ash River watershed for wildlife and should be pursued. This includes the mapping of unique / significant habitat features, the protection of important areas like existing wetlands and ponds, planting of portions of the drawdown zone with native plants (e.g., sedges, willows, dogwood) to increase vegetative cover, improve wildlife habitat within the drawdown zone, and provide bank/drawdown zone stabilization, and managing woody debris rafts that have built around the high water mark of Elsie Lake Reservoir that prevent vegetation from becoming established within the drawdown zone.

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1 INTRODUCTION

Flooding resulting from dam construction and water storage creates a complex disturbance that can modify entire ecosystems, with effects extending upstream and downstream of the dam (Nilsson et al. 1991; Hill et al. 1998; Luken and Bezold 2000). The upstream effects of dam construction and water storage include inundation of streams and floodplains, the trapping of river transported sediment, and the creation of new lakeshore vegetation types (Petts 1979; Nilsson and Keddy 1988; Roelle and Gladwin 1999; Nilsson and Berggren 2004). The specific effects of inundation depend on the depth, duration, and timing (Luken and Bezold 2000), and the degree of exposure and the slope of a flooded site can also determine if plants and substrate remain on site or are removed (Keddy 1985).

The upstream impacts of flooding on fish, vertebrates and some invertebrates have been relatively well documented (Petts 1979; Nilsson and Keddy 1988; Roelle and Gladwin 1999; Nilsson and Berggren 2004), and previous studies have identified that reservoir creation also leads to changes in shoreline vegetation (Nilsson 1978; Keddy 1985; Obot 1986; Nilsson and Keddy 1988; Wilcox and Meeker 1991; Nilsson et al. 1991; Nilsson and Jansson 1995). However, the ability to adequately mitigate for these impacts remains limited.

Established in 1999, the goal of the Bridge Coastal Restoration Program (BCRP) is to restore fish and wildlife resources that have been adversely affected by the original footprint development of hydroelectric facilities in the Bridge Coastal Generation Area (Figure 1). These footprint impacts include historical effects on fish and wildlife that have occurred as a result of reservoir creation, watercourse diversions, and the construction of dam structures. The strategic plans developed for the 15 watersheds within the Bridge Coastal Generation Area (BC Hydro 2001) provide general direction for habitat restoration, but are too general to direct specific restoration activities in a particular watershed and do not provide designs for habitat replacement or enhancement projects. For all 15 watersheds in the Bridge Coastal Generation Area, the loss of terrestrial wildlife habitat has been quantified, approximated, or acknowledged, yet surprisingly few restoration projects have occurred to mitigate for the impacts of hydroelectric activities on wildlife.

The goal of many ecological restoration projects is to return ecosystem structures, functions, and processes to “natural” or reference conditions (Block et al. 2003). This is typically accomplished by manipulating vegetation and/or the physical environment to move the system towards pre-defined reference conditions that presumably existed at some point in the past. To date, many of the restoration initiatives that have occurred under the purview of the BCRP have been relevant only to fish and fish habitat. Furthermore, many restoration activities have been ad hoc, site, and situation specific (cf. Hobbs and Norton 1996; Manning et al. 2006), and have not been considered in a broader ecological context. In most cases, these restoration activities have also occurred in the absence of an understanding of the potential effects of those restoration activities on terrestrial wildlife. Moreover, simply providing habitat for wildlife does not infer success; the spatial and temporal component of a given suite of restoration activities must also be considered. For example, creating snags does not ensure that a site will be suitable for use by snag-dependent species. The size, age, and spacing of snags and their juxtaposition to other habitat elements must also be considered (George and Zack 2001; Smallwood 2001).

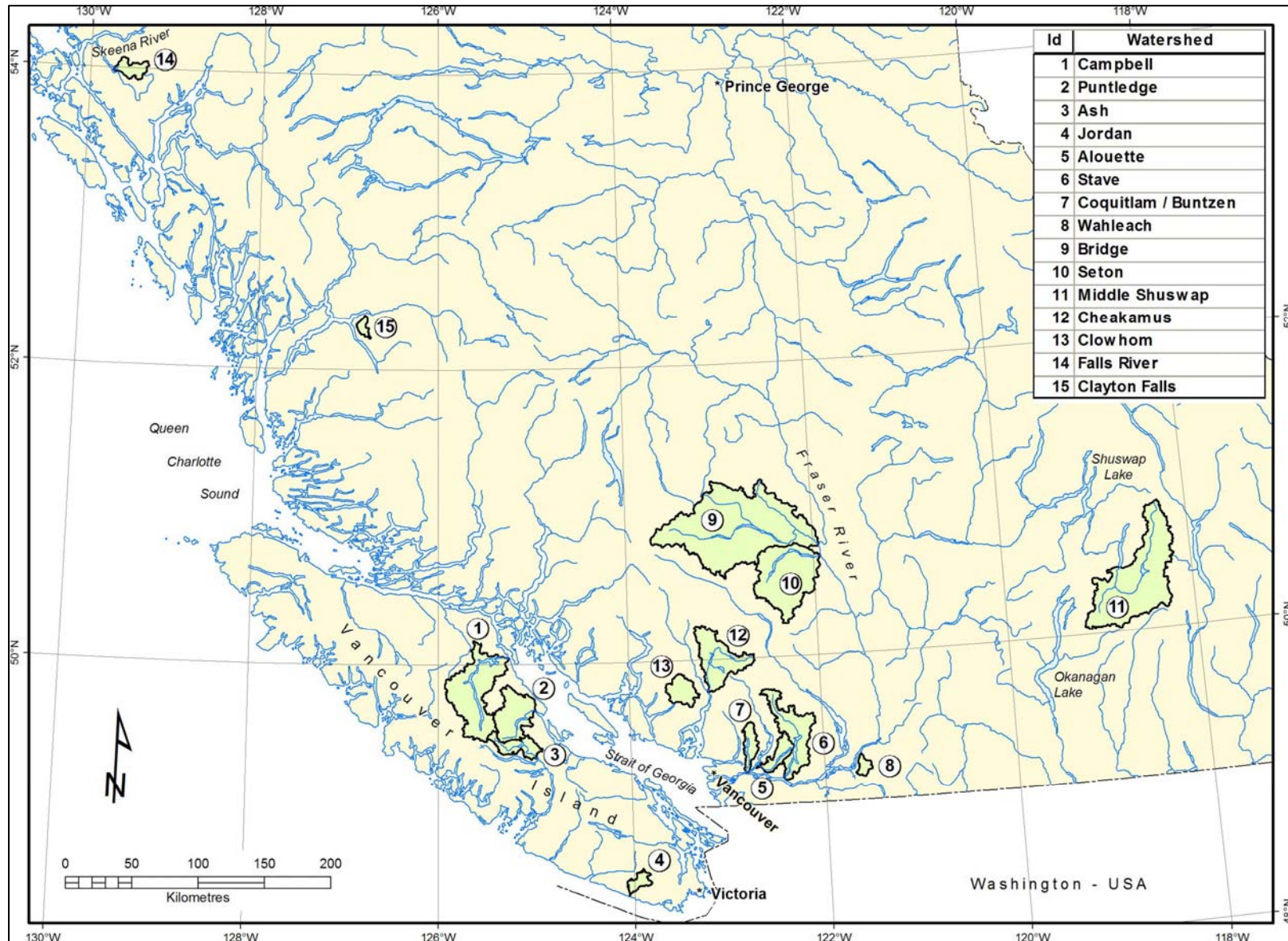


Figure 1. Distribution of hydroelectric facilities in the Bridge Coastal Generation Area.

One of the challenges in mitigating for impacts on terrestrial wildlife is to ensure that the mitigation strategy used does not adversely affect other species. Wildlife species have widely varying and often opposing habitat requirements. For every management option exercised, there will be winners and losers among wildlife populations (Chan-McLeod 2007) and these tradeoffs must be understood and incorporated into integrated prescriptions for habitat restoration. This is particularly true when considering restoration as it relates to conservation. Although restoration can enhance conservation efforts, restoration is always a poor second to the preservation of original (unaltered) habitats (Young 2000).

To avoid a “band-aid” approach to habitat restoration (and possibly conservation; Young 2000), Hawkes (2007) developed an integrated wildlife habitat restoration plan (IWHRP) for the Jordan River watershed on southern Vancouver Island. The concept of the IWHRP was born out of the need to develop an ecologically-based restoration plan that considered the habitat needs of the species that do, or that are expected to occur in watersheds affected by hydroelectric development. Because the strategic plans developed for the 15 watersheds within the Bridge Coastal Generation Area do not provide direction for habit restoration, it was anticipated that the development of the IWHRP would have value for all watersheds in the Bridge Coastal Generation Area and for all watersheds in BC where BC Hydro operates.

Using the IWHRP developed for the Jordan River watershed as a guide, a wildlife habitat restoration feasibility assessment was completed for the Ash River Watershed, which is located in central Vancouver Island (number 3, Figure 1). This document describes the feasibility assessment process used in the Ash River watershed and prioritises restoration activities for the drawdown zone of Elsie Lake Reservoir and adjacent upland habitats.

This project will address several BCRP principles: to restore habitats within a watershed context using an ecosystem approach that coordinates with the Water Use Plan and with fish and wildlife management agencies. The restoration strategy developed by BCRP (BC Hydro 2001) also indicates that habitat-forming processes and habitat development should be considered for watersheds within the area covered by the BCRP – constructed wetlands would begin to address those considerations in the Ash River watershed.

2 Background

Elsie Lake is a natural lake that was impounded in 1958. The impoundment structures include a main dam (Elsie Dam) at the outlet of Elsie Lake and four saddle dams in low relief areas to the south of the main dam (Burt and Roberts 2003). These structures have allowed the elevation of the lake to increase from 312.5 m to 330.7 m Above Sea Level (ASL) (Triton 1995).

In 2003, Burt and Roberts completed a study to quantify and describe fish habitat in the tributaries and reservoir of the Ash River basin. In their report, Burt and Roberts summarized previous studies in the Ash River watershed including Horncastle (1978), Triton (1995), and Lewis (2001), all of which were related to fish and/or hydrology.

Toth and Associates (2003) completed an inventory of wildlife resources and developed wildlife habitat restoration prescriptions for habitats within and adjacent to the drawdown zone of Elsie Lake. Upland habitats were also identified for restoration; however, none of this work has been completed. The work completed by Toth and Associates (2003) was

developed to address recommendations contained in the Bridge Coastal Fish & Wildlife Restoration Program Strategic Plan (BC Hydro 2001), which identified the following restoration objectives for Wildlife in the Ash River Watershed:

Objective 1: Rehabilitate reservoir drawdown zones to enhance productivity and wildlife habitat in Elsie Lake.

Objective 2: Conserve riparian and wetland habitats in the downstream portions of the Ash River watershed.

Objective 3: Create or enhance wetlands and riparian habitats for aquatic species (amphibians, waterfowl, cavity dependent species, small mammals).

Objective 4: Protect small groups of old or second growth trees in strategic locations for current and future nesting use by bald eagles or ospreys.

Objective 5: Improve the knowledge base on rare, endangered, and threatened species and habitat utilization in the Ash River watershed.

These objectives were developed to address several factors affecting wildlife diversity and productivity in the Ash River watershed including habitat loss, reduced productivity, and wildlife migration.

Burt and Roberts (2003) and Toth and Associates (2003) addressed some of the objectives made by BC Hydro (2001) by developing restoration objectives that included restoration prescriptions and conceptual designs for fish and/or wildlife habitat; however, these were never fully-developed or implemented. In 2004, the Ash River Water Use Plan (WUP; BC Hydro 2004) identified wildlife habitat as benefiting from the proposed conditions in the WUP through expected increases in riparian habitat around Elsie Lake Reservoir. However, the mechanism leading to improvements or the species groups that would likely benefit was not identified.

3 STUDY AREA

The Ash River watershed (~218 km²) is situated approximately 40 km northwest of Port Alberni in the central portion of Vancouver Island and is located between the Beaufort Range and Strathcona Provincial Park (Figure 2). The Ash River is located within the Regional District of Alberni-Clayoquot on central Vancouver Island. The Ash River flows south, between Strathcona Park to the west and the Beaufort mountain range to the east, into the Stamp and Somass Rivers, and eventually into the Alberni Inlet (BC Hydro 2004). The watershed occurs within the Coastal Western Hemlock (CWH) biogeoclimatic zone, and experiences cool summers, mild winters, and abundant winter rainfall (Pojar et al. 1991). Within the CWH zone, western hemlock and Douglas-fir are the predominant conifers. Other tree species include amabilis fir, yellow-cedar, big-leaf maple, red alder and black cottonwood (Pojar et al. 1991). Zonal ecosystems in the CWH include an abundance of western hemlock in the overstorey and understorey, a sparse herb layer, and a predominance of several moss species (especially *Hylocomium splendens* [step moss] and *Rhytidiadelphus loreus* [lanky moss]). There are two subzones and variants of the CWH in the Elsie Lake area, the CWHmm1 (moist maritime submontane) and the CWHxm2 (very dry maritime western).

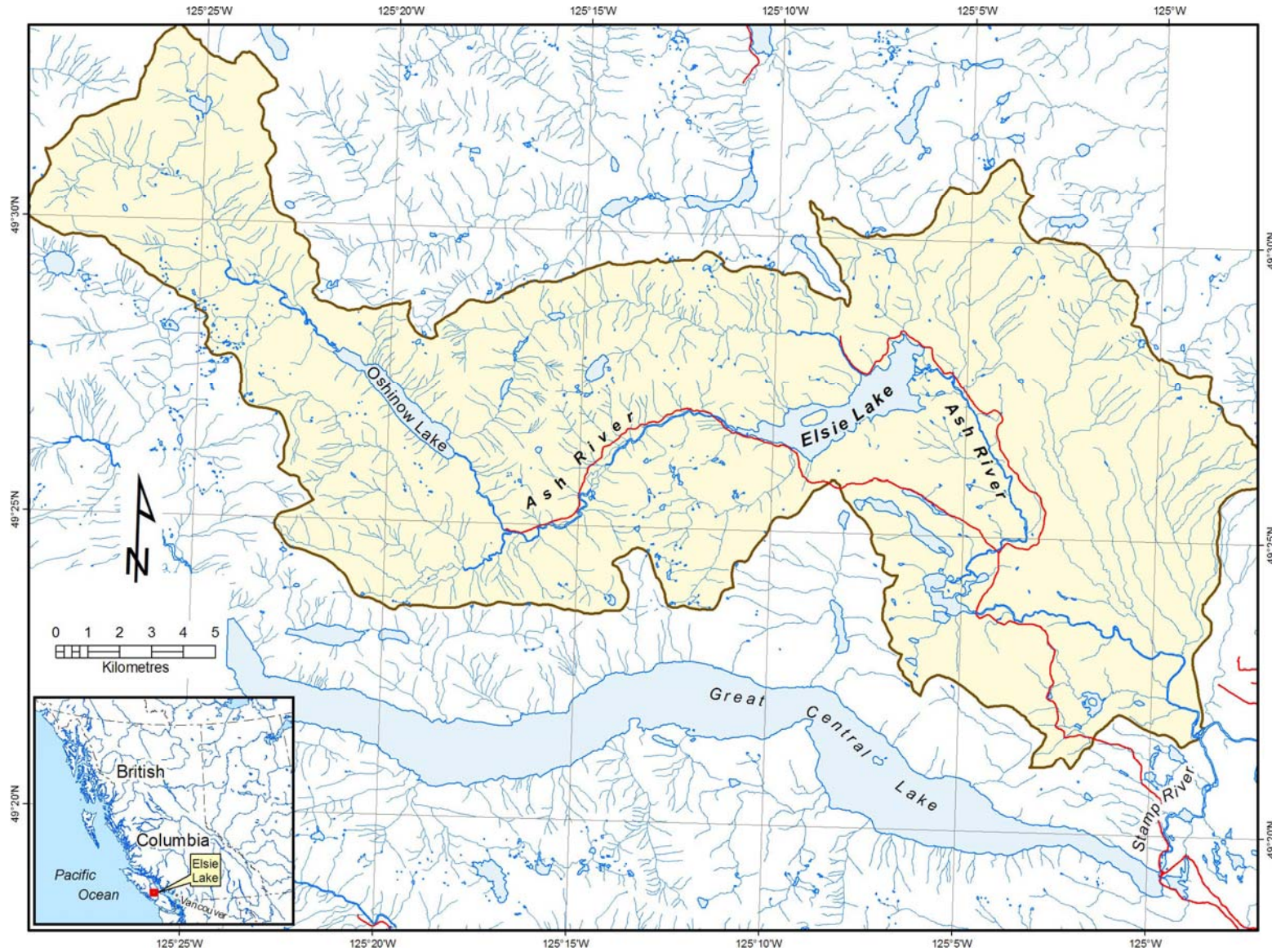


Figure 2. Location of the Ash River Watershed and Elsie Lake on Vancouver Island.

Elsie Lake is considered to be a nutrient poor, oligotrophic lake. Prior to impoundment, Elise Lake would have had a maximum depth of approximately 11.8 m, which is now closer to 30 m. Vegetative growth within the drawdown is limited, due in large part to pre-impoundment clearing of vegetation and continuous changes in reservoir water levels, which change daily throughout the growing season. The stress on vegetation communities within the drawdown zone of Elsie Lake, which is created by large annual changes in water level and daily water level changes throughout the growing season, is exacerbated by rates of deposition and erosion that are atypical of natural flooding events on shoreline habitats associated with unregulated lakes or rivers (Hawkes et al. 2007).

The normal operating minimum and maximum elevation of Elsie Lake is 315.47 m ASL and 330.71 m ASL, respectively, with a maximum operating range of 15.24 m (BC Hydro 2004). Site-specific investigations were limited to hose areas within and immediately adjacent to the drawdown zone of Elsie Lake. From 1 May to 31 October a minimum flow of 3.5 m³/s is released from Elsie Dam into the Ash River. From 1 November to 30 April, a minimum flow of 5 m³/s is released from Elsie Dam into the Ash River. Between 1 August and 30 September, two separate pulse flows of 10m³/s for two days, are released from Elsie Dam into the Ash River with each pulse timed to coincide with the period when steelhead (*Oncorhynchus mykiss*) are holding at the base of Dickson Falls. The timing of each pulse also coincides with natural increases in flows resulting from precipitation (BC Hydro 2004).

4 STUDY OBJECTIVES AND TASKS

The intent of this document is to assess the feasibility of wetland construction within the drawdown zone of Elsie Lake reservoir to mitigate for habitat impacts created by the impoundment of the Ash River. This report also provides a scientific basis and implementation guidelines for a wildlife habitat restoration program designed to improve ecosystem functions and enhance wildlife habitat in the Ash River Watershed. An assessment of existing habitat conditions was combined with fundamental strategies for restoration to create a prioritization process for habitat restoration initiatives. The primary area of interest is the area impacted by hydroelectric development, including the lands affected by impoundment, timber removal, road creation, and infrastructure related to the dams and penstock. This document draws heavily from Hawkes (2007) to offer the most useful restoration strategies for the Ash River watershed. In Objective 2 below, the focus is on guidelines to implement habitat restoration at the project and program levels. The third and final objective addresses next steps arising from this approach.

The study objectives and associated tasks are:

Objective 1: Establish a scientific basis for ecological restoration of wildlife habitat in the Ash River Watershed.

- Task 1: Explain the fundamentals of ecosystem-based habitat restoration.
- Task 2: Summarize available data on habitat and ecosystem requirements for wildlife species with provincial or federal conservation status (i.e., species that are red- or blue-listed or that have COSEWIC status).
- Task 3: Describe current conditions and ecological changes over the last century in the Ash River Watershed.

- Task 4: Identify and prioritize habitat restoration strategies for the Ash River Watershed, with an emphasis on the area affected by hydroelectric development.
- Task 5: Describe the development of a conceptual wetland design to replace wetland habitat that was lost when Elsie Lake was impounded.

Related to Task 5, are the following sub-tasks:

- Design and create a healthy, fully-functioning, self-sustaining wetland ecosystem along the shoreline of Elsie Lake.
- Promote the regeneration of native plants and reoccupation by native wildlife species in and near the wetland by providing suitable natural habitat.
- Maximize plant and wildlife biodiversity in the area based on site-specific conditions and on the species that are present or expected within the watershed.

Objective 2: Develop implementation guidelines for restoration projects in the context of, and consistent with, ongoing efforts.

- Task 1: Describe types of restoration projects for the Jordan River Watershed that are consistent with the goals of the BCRP.
- Task 2: Refine project selection guidelines.
- Task 3: Describe a process to implement habitat restoration projects, including phases for planning, funding, constructing, evaluating, and adaptive management of restoration efforts.

Objective 3: Discuss constraints to implementation and recommend next steps to fulfill the goal of the Ash River Watershed habitat restoration program.

5 THE BASIS FOR ECOLOGICAL RESTORATION

5.1 *Fundamentals of Ecological Restoration*

The long-term goal of restoration projects inside of watersheds is the establishment of a self-sustainable ecosystem that is in equilibrium with the surrounding landscape. Restoration is an effective tool for returning a degraded ecological system close to its pre-disturbed condition. It also serves as a tool for preventing environmental degradation provided that the source of the degradation has been corrected.

Ideally, habitat restoration is intended to restore the habitat value of an area beyond simply “revegetating” or planting vegetation within disturbed areas, but by attempting to create a sustainable and functioning ecosystem. A functioning ecosystem is not restricted to vegetation, but also includes chemical and physical components such as hydrological, soil, wildlife functions, and the interaction of all natural habitat components. Restoration may occur actively or passively. While passive restoration relies exclusively on the forces of nature to enhance and repair disturbed ecosystem functions, active restoration requires anthropogenic actions and physical alterations of the landscape.

5.1.1 **Generic Restoration Strategies**

The science of ecological restoration has defined strategies (Table 1) that provide guidance for restoration projects (Johnson et al. 2003). Depending on site-specific

characteristics and restoration project goals, more than one strategy may be appropriate for a site. In addition, multiple strategies may be employed at a site to maximize the benefit to the ecosystem. Restoration strategies can be categorized as passive (conservation and protection) or active (creation, enhancement, restoration). All strategies try to exploit an ecosystem's capacity to self-adjust to change.

Table 1. Five strategies of restoration ecology.

	Strategy	Definition	Comments
PASSIVE	Conservation	Maintenance of biodiversity (Meffe et al. 1994).	Conservation biology is a synthetic field that applies the principles of ecology, biogeography, population genetics, economics, sociology, anthropology, philosophy and other theoretically based disciplines to the maintenance of biological diversity. Conservation can allow development to occur as long as biodiversity and the structure and processes to maintain it are not affected. Restricted development is an approach to conservation.
	Creation	Bringing into being a new ecosystem that previously did not exist on the site (NRC 1992).	In contrast to restoration, creation involves the conversion of one habitat type or ecosystem into another.
ACTIVE	Enhancement	Any improvement of a structural or functional ecosystem attribute (NRC 1992).	As noted by Lewis (1990), enhancement and restoration are often confused. The intentional alteration of an existing habitat to provide conditions that previously did not exist and which by consensus increase one or more attributes is enhancement.
	Restoration	Return of an ecosystem to a close approximation of its previously existing condition (e.g., Lewis 1990, NRC 1992).	Includes any form of restoration with the intent of improving habitat to a state closely approximating a historical or pre-disturbance condition.
	Protection	Formal exclusion of activities that may negatively affect the structure and/or functioning of habitats or ecosystems.	Protection can also refer to protection of a species or group of species through management actions such as elimination of harm to a species directly or indirectly through damage of its habitat. Restricted development and land use ordinances can also be used to exclude unwanted activities as an approach to protection.

Six approaches have been described to meet the objectives of the five strategies listed in Table 1. Five approaches involve intervention. The sixth approach is based on the premise that through time, and with control of the sources of disturbance, it is possible for a degraded system to naturally recover. Intervention becomes necessary when a particular habitat type is degraded to the point that it no longer has the capacity for self-maintenance and repair.

1. **No Intervention:** In the no intervention approach, recovery is left to natural processes. The outcome of this approach is unpredictable and may not resemble pre-disturbance condition (Class D restoration, Cairns 1991). The two possible trajectories of the no-intervention approach are natural recovery or further degradation. Although represented as two distinct trajectories, further degradation may lead to an alternative steady state, which in turn would progress toward natural recovery. Natural recovery is difficult to grasp because it rarely happens within the lifetime of a scientist or manager and can really only be understood in terms of geological time.
2. **Conservation for Natural Recovery:** Conservation can be a practical and effective restoration approach. Conservation biology acknowledges that human-caused disturbances (e.g., logging, road building) has and will continue to occur. However, conservation is based on the premise that disturbances can continue to occur in a way (e.g., using science-based development strategies) that minimizes or avoids damage to the biodiversity of the system. Conservation represents a relevant approach for the Ash River Watershed because portions of the watershed contain habitat attributes important to the preservation of biodiversity and there will continue to be pressure on the system through natural resource extraction and the maintenance of the reservoir.
3. **Creation of New Ecosystem:** Creation of a new ecosystem involves the development of a new ecosystem that did not previously exist at the site (NRC 1992; Simenstad and Thom 1992). Creation of a new ecosystem is intended to emulate the present condition of an existing, functioning reference ecosystem. Creation of a new ecosystem involves elaborate reconstruction of both physical (e.g., topographic, hydrologic) as well as biotic (e.g., vascular plants) elements. Although created ecosystems may eventually become self-maintaining, there is considerable uncertainty in the outcome. Created ecosystems typically require ongoing management (Class C restoration, Cairns 1991; Simenstad and Thom 1992).
4. **Enhancement of Selected Attributes:** Attributes are characteristics that are correlated with, and can serve as, indicators of ecosystem structure and function. In general, enhancement refers to any improvement of a structural or functional attribute. Structural (state) and functional (process) attributes need to be considered at the population, community, ecosystem, and landscape levels (as appropriate). Enhancement differs from restoration in that only one or several attributes are improved rather than the whole system. Terrestrial wildlife habitat attributes can be integrated as elements of modified habitats within the Ash River watershed.
5. **Restoration to Improved, Pre-Disturbance, or Historical Condition:** Intervention through restoration is intended to improve existing conditions. Pre-disturbance condition is the condition thought to have previously existed in the watershed prior to the onset of disturbance (of any kind). From a practical standpoint, pre-disturbance condition is difficult to define precisely and is commonly referred to in the literature as the original, undisturbed condition (Jordan et al. 1997; NRC 1992; Cairns 1989). Historic condition is the condition known to have previously existed in the watershed, which for the Ash River watershed is limited. The goal of restoration to historic condition is to establish a community that is ecologically superior to the present degraded system and resembles the original system in certain carefully defined ways (Cairns 1988). Simenstad and Thom (1992) note that the opportunity for successful restoration to historic condition is high as long as the primary processes delineating the habitat type(s) are still effective at that site (e.g., functional riparian habitat, presence of snags and older forest, habitat corridors providing connectivity between

riparian and upland habitat). If some, or all, of these processes have been altered or lost, the prospects for restoration to historic condition are greatly diminished. Furthermore, knowledge of the pre-disturbance condition is essential to successful restoration.

6. **Protection to Maintain a Desirable State:** Although an indirect approach, protection of existing habitat attributes can be an effective intervention tool. Protection helps prevent degradation of existing areas that are presently in a desirable ecosystem state. Protection is distinct from conservation because protection assumes no further development, whereas conservation does not. Protection could take the form of preserving specific habitat polygons on the landscape to retain specific habitat features that are important to wildlife. Similarly, habitats that have the capability of becoming important to many or sensitive wildlife species can also be considered for protection.

Of the six approaches presented above, creation, enhancement and protection would benefit the structural and/or functional attributes important to wildlife in the Ash River watershed. Watersheds contain arrays of habitats and sites particularly suited for certain species and many species will be adapted to a unique set of environmental processes or conditions that provide refuge during periods of stress. However, these same species will also likely use sites that provide sub-optimal habitat suitability. Therefore, the importance of a single site for maintaining regional biodiversity is variable – ranging from highly critical during years of high environmental stress, to redundant during years of expanded habitat (NRC 1992). Enhancement actions must be therefore be developed at the landscape scale.

5.1.2 Role of Landscape Ecology

A general goal for ecological restoration is to move the ecosystem from a less desirable condition to a more desirable condition as quickly as possible. A general model for ecosystem state (Figure 3) is one way to visualize the present (disturbed) and historical (undisturbed) “states” of the ecosystem, as well as to identify restoration goals (Thom 1997). First, it is assumed that there is a positive relationship between the structure¹ and function² of an ecosystem (Johnson et al. 2003). Next, the system condition on both axes is divided into subjective categories based on existing function and structure to acknowledge two sources of uncertainty: 1) our inability to accurately quantify the relationship between structural and functional ecosystem components; and 2) our inability to accurately predict the dynamic nature of regular periodic and stochastic natural variability associated with structural conditions and functional conditions (Shreffler and Thom 1993; Hobbs and Norton 1996; Johnson et al. 2003). The three levels along each axis are qualitative indicator variables (e.g., square metres) related to the structural condition (e.g., the size of the pond-wetland interface) and the functional conditions (e.g., the number of ducks nesting at this interface). Therefore, an ecosystem under optimal conditions of structure and function can have values that vary over a predictable range because of natural dynamics. This range is the target the restoration project is predicated on, and the project can be considered a success if the structure and function of the restored ecosystem fall within this qualitative range.

¹ Ecosystem structure is defined as the types, distribution, abundances, and physical attributes of the plant and animal species comprising the ecosystem.

² Ecosystem function is defined as the role the plant and animal species play in the ecosystem, including primary production, prey production, refuge, water storage, nutrient cycling, etc.

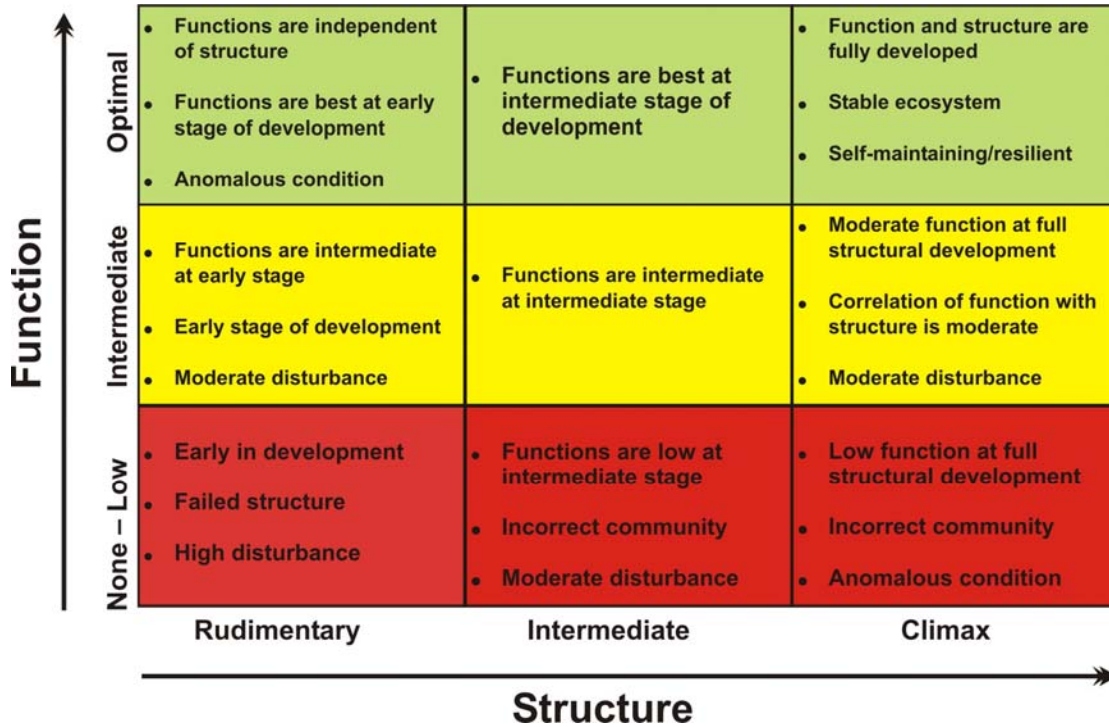


Figure 3. Generalized system-development matrix showing the 9 states a restored ecosystem can occupy during development (modified from Thom 2000). Cells in red represent undesired conditions; yellow – acceptable condition; green – desired condition.

The natural climax structure of an ecosystem, habitat, or community has a corresponding and predictable functional condition (Johnson et al. 2003). The top row in Figure 3 represents systems that can be described as having optimal functionality with varying levels of ecosystem structure, and in general, represents the desired ecosystem condition. The Ash River watershed system has been altered from prehistorical conditions, and the structure and function of the system differs from that present prior to hydrological modification and other anthropomorphic or natural changes. Although the Ash River watershed may have reached equilibrium in this altered state, ecological restoration initiatives would benefit wildlife and enhance the ecological condition of the watershed.

6 WILDLIFE OF THE ASH RIVER WATERSHED

The landscape of Vancouver Island is diverse and unique. The convergence of dry climates and wet climates, mountainous areas and lowlands, and terrestrial and marine environments has created one of the most biologically rich regions in Canada, harbouring many species which occur nowhere else in the country or, in some cases, the world. Human development and resource extraction, however, have fragmented the habitats of much of Vancouver Island and had significant impacts on a number of threatened or endangered species. Indeed, several of these imperilled species have been lost from the region which, for some, represented their only toehold in the country. The combination of biological uniqueness and development pressures has resulted in a particularly high number of species of concern occurring on southern Vancouver Island.

As a result of an increasing awareness of the plight of biodiversity in British Columbia and Canada, ranking schemes have been developed at both the national (Committee on the Status of Endangered Wildlife in Canada [COSEWIC]) and provincial (British Columbia Conservation Data Centre [BC CDC]) levels which assess the current status of threatened or endangered species and provide them with a sensitivity ranking (Table 2). These ranking schemes allow conservationists and biologists to focus their efforts on species that are rare or declining and facilitates further inventory of these species by highlighting their status.

Table 2. Explanation of the ranks used by COSEWIC and the BC CDC when assessing the status of endangered species in Canada and British Columbia, respectively.

National Status (COSEWIC)	
Extinct (X)	No longer known to exist anywhere
Extirpated (XT)	No longer known to exist in the wild in Canada, but known to exist elsewhere
Endangered (E)	Threatened with immediate extinction or extirpation through all or a significant portion of its range, owing to the act of humans
Threatened (T)	Likely to become endangered in Canada if conditions are not reversed
Special Concern (SC)	May become threatened or endangered because of a combination of biological characteristics and identified threats
Data Deficient (DD)	Available information is insufficient (a) to resolve a wildlife species' eligibility for assessment or (b) to permit an assessment of the wildlife species' risk of extinction
Not at Risk (NAR)	Not at risk of extinction given the current circumstances
Provincial Status (BC CDC)	
Red	Species is endangered or threatened under the <i>Wildlife Act</i> , is extinct, is extirpated, or is a candidate for these designations
Blue	Species is not immediately threatened, but is of concern because of characteristics that makes it particularly sensitive to human activities or natural events
Yellow	Species is uncommon to common, declining or increasing and but is not a candidate for the red or blue lists

The South Island Forest District is home to many species with federal or provincial status as "Species at Risk." There are currently 262 species of 15 groups identified by the BC CDC as occurring in the South Island Forest District. Provincially, 132 are blue-listed, 129 are red-listed, and 1 is yellow-listed. Federally, 39 are endangered, 12 threatened, 17 are special concern, 3 have been extirpated, 3 are not at risk, and 188 have yet to be assessed. Of the 262 species listed for the South Island Forest District, 152 in 13 groups occur in the CWH, CWHmm, or CWHxm biogeoclimatic zones, subzones, and variants. Of the 152 species, 91 are blue-listed, 60 are red-listed, and 1 is yellow-listed. Federally, 13 are endangered, 9 are threatened, 15 are special concern, 1 is extirpated, 3 are not at risk, and 111 have not been assessed.

Not all of the 152 species with provincial or federal conservation designation that occur in the CWH, CWHmm, or CWHxm are expected to occur in the Ash River Watershed. Of the 152 species, 131 either do, or have some probability of occurring in the Ash River Watershed. This includes 1 amphibian, 11 birds, 88 plants, 10 terrestrial gastropods, 13 insects (lepidopterans and odonates), 5 mammals, 1 turtle, and 2 fungi. Other species groups, such as fungi and most invertebrates, have not yet been ranked and it is expected that many more endangered species from these groups occur in this region.

6.1 Existing Conditions

The wetland habitat available around the perimeter of Elsie Lake is typical of that associated with hydroelectric development on the south coast of British Columbia. It consists largely of a mosaic of seasonally flooded shrubby and grassy plant communities which include a large number of exotic or invasive species, with extensive areas of bare soil and mud exposed during the low-water periods in the summer and early fall (Photo 1). Much of the perimeter is covered with a series of grassy meadows, containing a variety of native and introduced grasses, sedges (*Carex* sp.), small-flowered bulrush (*Scirpus microcarpus*), and rushes (*Juncus effusus*, *Juncus ensifolius*), as well as several prominent native and introduced forbs (*Rumex crispus*, etc.). Willows (*Salix* sp.) form a dense transitional habitat between the forested uplands and lower grassy meadows in many areas, with scattered individual willow shrubs also occurring throughout most open, grassy areas. Open water habitats are fairly devoid of vegetation due to the continually fluctuating water levels, although locally-established populations of some emergent and submergent species such as yellow pond-lily (*Nuphar lutea*), watershield (*Brasenia schreberi*), and common cattail (*Typha latifolia*) do occur in sheltered locations.



Photo 1. Seasonally flooded areas within the drawdown zone of Elsie Lake Reservoir.

Upland habitats are characterized by extensive young and second growth coniferous forests with a few isolated patches of older, maturing conifers. There are several rocky outcrops in the vicinity of Elsie Lake and logging road access is fairly extensive throughout that part of the watershed. Riparian forest is dominated by red alder and bigleaf maple and most creeks either drain directly into Elsie Lake or the Ash River. Certain areas immediately adjacent to Elsie Lake consist of fairly large spirea / hardhack marshes with a heavy cover of sphagnum and skunk cabbage.

In 2002 Toth and Associates (2003) documented 87 species of wildlife, including 16 mammals, 63 birds, and 8 amphibians and reptiles. They also produced a list of 154 plants, which included 16 trees, 48 shrubs, 67 herbs, and 21 bryophytes. Several of these species, as well as species documented during field visits for the current work are species of concern, and a number of other species of concern are expected to occur due to their habitat preferences and currently known distributions (Table 3). The habitats present within the Ash River watershed allow for the mixing of coastal and montane biota with those that are more typical of the dry southeastern portion of Vancouver Island (e.g., Northern Alligator Lizard, Bewick's Wren). The aquatic and riparian habitats also contribute significantly to the biodiversity attracting waterbirds (ducks, geese, swans, loons, herons), amphibians, and aquatic and semi-aquatic mammals (Muskrat, Beaver, River Otter). With the exception of Toth and Associates (2003), little work has been done in the watershed to fully document the biodiversity, particularly for groups other than vertebrates, so many additional species, including some with federal or provincial status, are expected to occur. Wetland construction and habitat restoration within the watershed is expected to enhance populations of a variety of species, including species of concern such as Red-legged Frog (*Rana aurora*) and Western Toad (*Bufo boreas*), by providing stable conditions which meet the species needs for breeding, feeding, and resting.

Table 3. Species with provincial (CDC) and/or federal (COSEWIC) status that are known or suspected to occur in the Ash River watershed. Provincial status includes red-listed, or endangered, species (SX, SH, S1, S1S2, S2), blue-listed, or threatened, species (S2S3, S3, S3S4, some S4), and yellow-listed, or secure, species (some S4, S5). Federal status includes Species of Concern (SC), Threatened species (T), Endangered species (E), Extirpated species (XT), and species that are Not at Risk (NAR).

Species	Life Form	Provincial Status (CDC)	Federal Status (COSEWIC)	Documented?
Great Blue Heron, <i>fannini</i> subsp.	Bird	Blue (S3B, S4N)	SC (May, 1997)	Yes
Northern Goshawk, <i>laingi</i> ssp.	Bird	Red (S2B)	T (Nov, 2000)	Yes
Sandhill Crane	Bird	Blue (S3S4B)	NAR (May, 1979)	Yes
Marbled Murrelet	Bird	Red (S2B, S4N)	T (Nov, 2000)	No
Band-tailed Pigeon	Bird	Blue (S3S4B)		Yes
Western Screech-Owl, <i>kennicottii</i> subsp.	Bird	Blue (S3)	SC (May, 2002)	Yes
Northern Pygmy-Owl, <i>swarhi</i> subsp.	Bird	Blue (S3)		Yes
Barn Swallow	Bird	Blue (S3S4B)		No
Pine Grosbeak, <i>carlottae</i> subspecies	Bird	Blue (S3B)		Yes
Common Water Shrew, <i>brooksi</i> subsp.	Mammal	Red (S2)		No
Townsend's Big-eared Bat	Mammal	Blue (S3)		No
Wolverine, <i>vancouverensis</i> subsp.	Mammal	Red (SH)	SC (May, 1989)	No
Ermine, <i>anguinae</i> subsp.	Mammal	Blue (S3)		Yes
Elk, <i>roosevelti</i> subsp.	Mammal	Blue (S3)		Yes
Western Toad ¹	Amphibian	Yellow (S4)	SC (Nov, 2002)	No
Red-legged Frog	Amphibian	Blue (S3S4)	SC (Nov, 2004)	Yes
Western Sulphur	Butterfly	Blue (S4)		No
Johnson's Hairstreak	Butterfly	Red (S1S2)		No
Western Pine Elfin, <i>sheltonensis</i> subsp.	Butterfly	Blue (S3)		No
Greenish Blue, <i>insulanus</i> subsp.	Butterfly	Red (SH)	E (Nov, 2000)	No
Boisduval's Blue, <i>blackmorei</i> subsp.	Butterfly	Blue (S3)		No
Blue Dasher	Dragonfly	Blue (S3S4)		No
Autumn Meadowhawk	Dragonfly	Blue (S3S4)		No
Western Thorn	Mollusc	Blue (S2S3)		No
Threaded Vertigo	Mollusc	Red (S2)		No
Pacific Vertigo	Mollusc	Red (S2)		No

Species	Life Form	Provincial Status (CDC)	Federal Status (COSEWIC)	Documented?
Broadwhorl Tightcoil	Mollusc	Blue (S2S3)		No
Black Gloss	Mollusc	Blue (S3S4)		No
Evening Fieldslug	Mollusc	Red (SH)		No
Dromedary Jumping-slug	Mollusc	Red (S2)	T (May, 2003)	No
Warty Jumping-slug	Mollusc	Blue (S2S3)	SC (May, 2003)	No
Scarletback Taildropper	Mollusc	Blue (S3S4)		No
Blue-gray Taildropper	Mollusc	Red (S1)	E (Apr, 2006)	No
Oregon Forestsnail	Mollusc	Red (S1S2)	E (Nov, 2002)	No
Puget Oregonian	Mollusc	Red (SX)	XT (Nov, 2002)	No
Pacific Sideband	Mollusc	Blue (S3S4)		Yes

7 PURPOSE AND NEED FOR RESTORATION

7.1 Foot print Impacts

Negative impacts on wildlife have been associated with the construction of Elsie Lake Storage Dam in the Ash River watershed (BC Hydro 2001). The negative impacts identified in the Ash River Watershed Strategic Plan (BC Hydro 2001) indicate that there has been an overall loss of riparian and wetland habitats and in adjacent upland forest. The impacts assessed include a reduction of available habitat for amphibians, water shrews and other mammals and their predators, browse and overwintering habitat for ungulates, and breeding habitats for some neotropical migrants.

Prior to impoundment (i.e., pre-1958), Elsie Lake had a surface area of approximately 133 ha. After impoundment (1958) the surface area of Elsie Lake increased by 512 ha to 645 ha. Currently, Elsie Lake is approximately 7 km long and 1 km wide and the Ash River flows into the west end of the lake and exits on the east end.

The impoundment of Elsie Lake resulted in a net-loss of wetland and shallow littoral zones, and bands of deciduous or mixed-wood forests around the perimeter of Elsie Lake. Through an analysis of historical aerial photographs (see below), we quantified the total amount of habitat lost as a result of damming Elsie Lake. We also looked at how the adjacent upland habitats have changed over time (primarily as a result of clear-cut logging) to gain an understanding of the magnitude of habitat alteration that has occurred in the Ash River watershed, at least in the area adjacent to Elsie Lake, over the years. The level of habitat alteration both within the current drawdown zone and the adjacent upland habitats have had significant impacts to the overall condition of the Ash River watershed.

7.2 Limiting Factors

The following limiting factors will be addressed:

- 1. Habitat Changes:** Regulation has affected both the productivity of riparian zones in the Ash River watershed and the abundance and distribution of wildlife. River regulation has also created changes to the distribution, abundance, and occurrence of riparian-associated tree and shrub species and has substantially affected the quality and availability of riparian habitat (see next point).
- 2. Loss of Habitat:** The loss of wetlands in flooded valley bottoms represents a net loss of riparian habitat in the Ash River Watershed.
- 3. Reduced Productivity:** Creating wetland habitat and improving habitat features in upland habitats in the Ash River watershed will provide habitat for pond-breeding amphibians, waterbirds, terrestrial mammals, insects, and bats. The addition of wetland habitat in the Ash River watershed will increase the productivity of the Ash River watershed for wildlife.

This project will also address the wildlife restoration objectives identified in the Ash River Watershed Strategic Plan (BC Hydro 2001). Specifically, the following objectives will be met:

Objective 1: Rehabilitate reservoir drawdown zones to enhance productivity and wildlife habitat use in Elsie Lake

Objective 3: Create or enhance wetlands and riparian habitats for aquatic species (amphibians, waterfowl, cavity dependant species, and small mammals)

Objective 5: Improve the knowledge base on rare, endangered and threatened species and habitat utilization in the Ash River watershed.³

7.3 History of Development in the Ash River Watershed

Elsie Lake and the adjacent upland habitats have undergone significant change in the last 50 years. Fire, logging, and the impoundment of the Ash River have been and continue to be, the three primary causes of habitat alteration. Much of the timber between Elsie and Dickson lakes has been harvested since 1972, with various areas of active logging still occurring (Griffith 1993; Toth and Associates 2003). The main land use activities in the area include forestry, road construction, hydro generation, recreation and mining activities. As little merchantable timber exists in the area, forest management objectives are currently geared toward intensive management and protection, with some active timber harvest occurring at higher elevations (Toth and Associates 2003). Second growth forest cover is dominated by Douglas-fir and western hemlock, with a significant component of both Amabilis-fir and Western Redcedar. Small patches of remnant mature timber are located on rock outcrops above Elsie Lake and in the steep canyon and ravine sections of the lower Ash River.

7.4 Habitat Change in the Ash River Watershed

Habitat changes associated with impoundment (i.e., within the drawdown zone of Elsie Lake) can be assessed in terms of daily / annual changes resulting from normal reservoir operations (i.e., drawdown and refilling) or on a longer temporal basis with respect to the differences between pre-impoundment and post-impoundment conditions. Annually, the reservoir elevation of Elise Lake can change as much as 15.96 m (min = 7.46 m; \bar{x} = 12.93 m; 1984 – 2006; Figure 7). The hydrograph for Elsie Lake shows that the highest water levels generally occur during May and the lowest levels occur during October. As the reservoir recharges in fall and winter, there may be daily increases in reservoir elevation as large as 4.17 m and daily decreases of 0.43 m. These regularly occurring large and small scale daily changes, as well as the consistent annual cycle of increasing and decreasing water levels contributes substantially to the lack of well-developed vegetation communities in the drawdown zone of Elsie Lake reservoir, which could have implications for wildlife that use habitats within and adjacent to the drawdown zone. The constant fluctuation of water levels also makes it virtually impossible for wetland habitats to become established within the drawdown zone of Elsie Lake reservoir.

Extensive logging has occurred in the Ash River watershed over the past ~70 years. An example of the type of coniferous forest that would have covered upland habitats adjacent to Elsie Lake is shown in Figure 4. These scanned historical photos (obtained from the Alberni Valley Museum) show the coniferous forest pre-impoundment (actual date unknown) and show that the watershed consisted of old growth Douglas-fir, western hemlock, and spruce.

³ Toth and Associates Environmental Services (2003) report on the presence of riparian-associated species in the Ash River Watershed. We will add to this wherever possible.



Figure 4. Historical photos of the Ash River watershed adjacent to Elise Lake prior to 1955 (actual dates of photos not available).

To emphasize the extent to which the impoundment of the Ash River increased the total surface area of Elsie Lake, fire station lookout photos taken in 1955 (pre-impoundment) and 1959 (post-impoundment) were obtained. Not only do these photos show the extent of mature coniferous forest cover, but they also show the resultant changes to those upland habitats through timber extraction and reservoir creation (Figure 5 and Figure 6).

To assess the extent to which logging and the impoundment of the Ash River⁴ have altered the landscape in and adjacent to Elsie Lake, an assessment of habitat change was completed through an evaluation of historical aerial photographs of Elsie Lake and the adjacent upland. Aerial photographs from 1949 and 1957 show Elsie Lake and the adjacent upland prior to impoundment and the aerial photographs from 1964 and 2001 show Elsie Lake and the adjacent upland immediately after impoundment (1964) and in its current (2001) condition (Appendix A). Habitat polygons were delineated on the aerial photographs from each year and categorized according to several general habitat types listed in Table 4. The hand drawn polygons were digitized in ArcGIS and the total area of each habitat type for each time series was calculated. The relative change in habitat category was calculated against the baseline condition of 1949, which represented the pre-impoundment condition and also provided the smallest spatial view of the watershed.

⁴ Fire was not considered as the extent to which fire altered the landscape was not readily quantifiable.

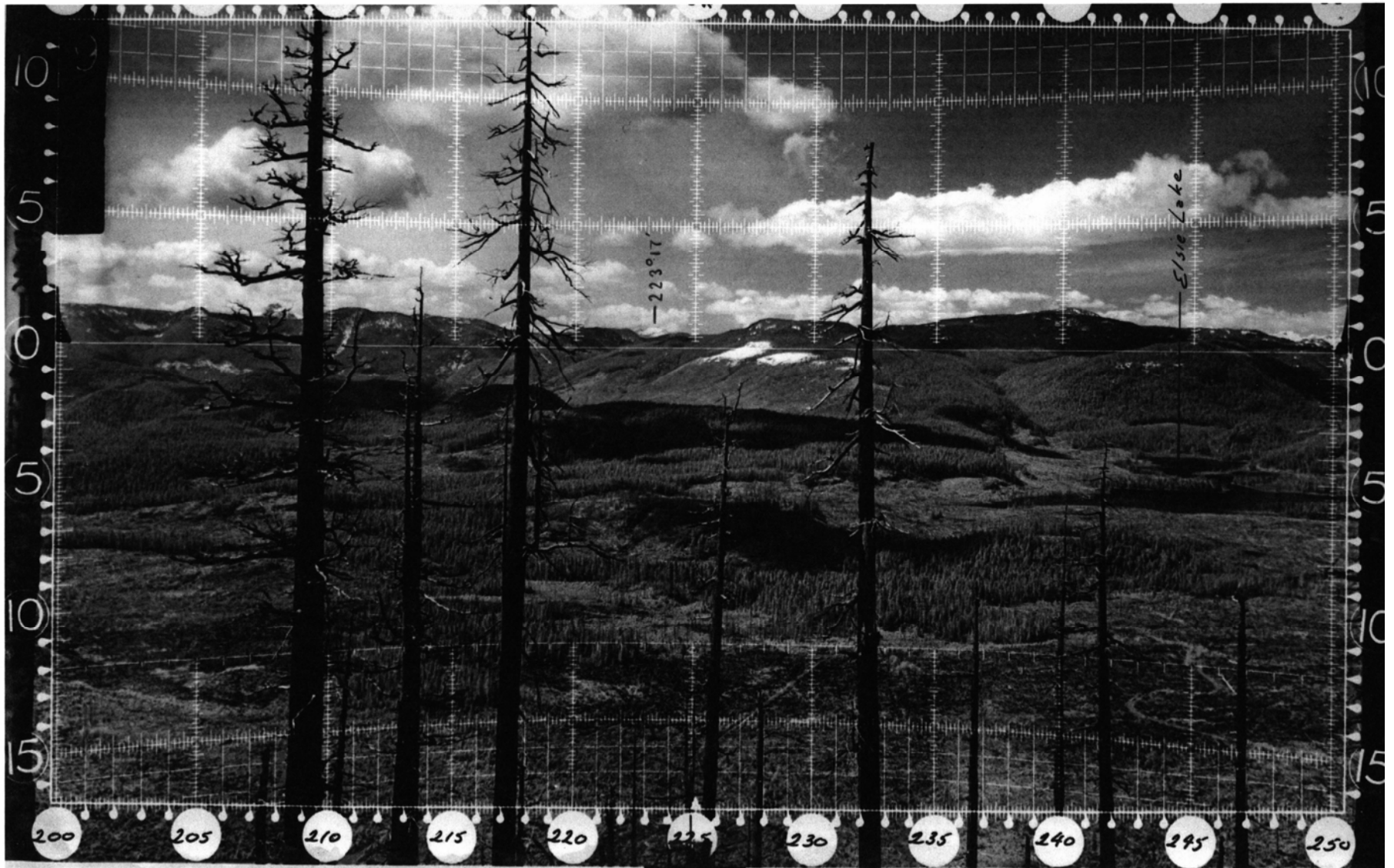


Figure 5. Oblique angle photograph of Elsie Lake taken from the Lanterman Fire Lookout in 1955, prior to the impoundment of Ash River. Elsie lake can be seen on the right side of the photo.

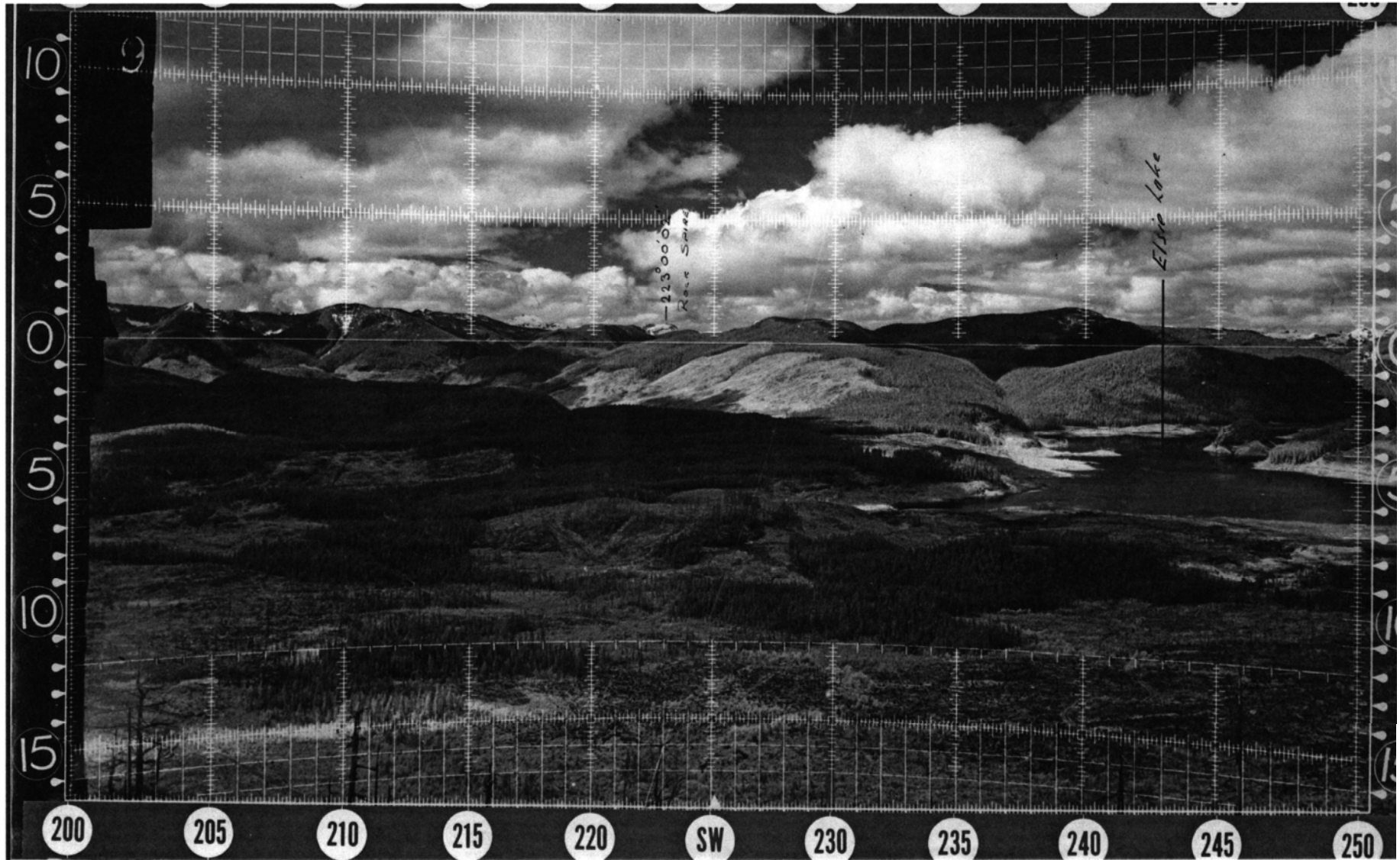


Figure 6. Oblique angle photograph of Elsie Lake taken from the Lanterman Fire Lookout in 1959, prior to the impoundment of Ash River. Elsie lake can be seen on the right side of the photo.

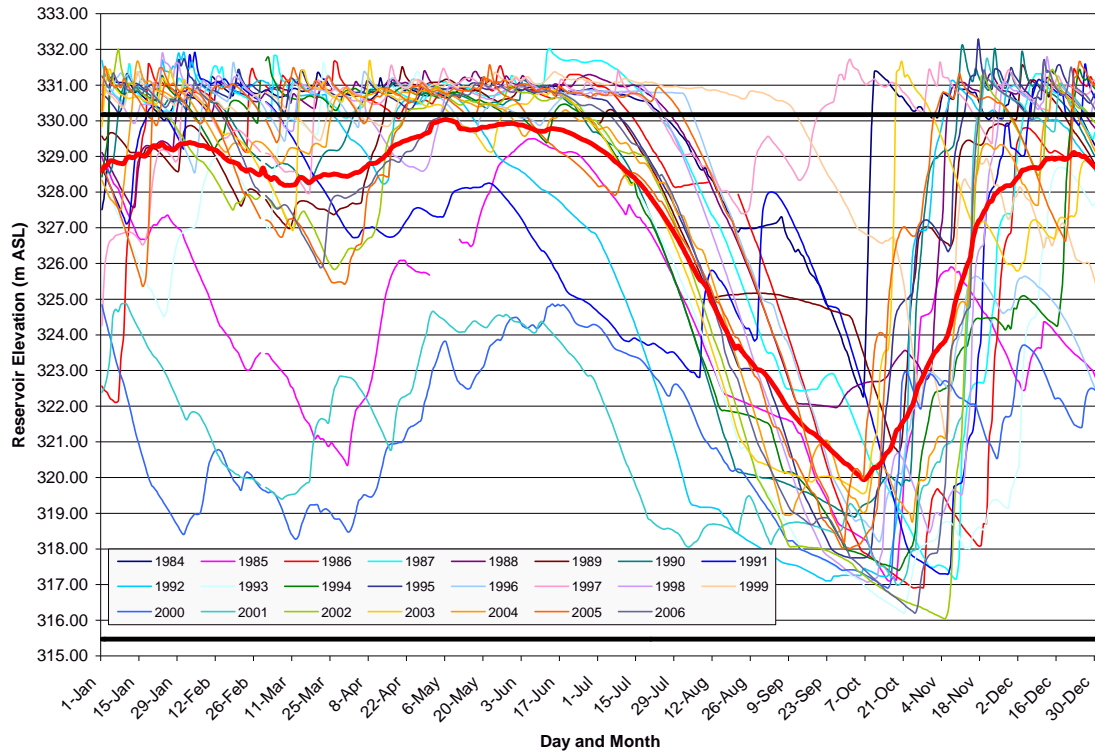


Figure 7. Annual reservoir levels for Elsie Lake for the period 1984 – 2006. The solid black lines represent the minimum (315.47 m ASL) and maximum (330.71 m ASL) operational reservoir elevations. The solid red line represents the average reservoir elevation across the 23 year period.

Table 4. List of habitat types delineated for the habitats adjacent to Elsie Lake Reservoir for 1949, 1957, 1964, and 2001.

Habitat Code	Expanded Code	Definition
CC	Clear Cut	Recently logged coniferous forest
DA	Disturbed Area	Human-disturbed areas (roads, gravel pits, excavations)
EL	Elsie Lake	Elsie Lake surface area
FO	Forest Opening	Natural clearing in a forest
MCF	Mature Coniferous Forest	Mature coniferous forest: 80 – 100 yr stand age
MWF	Mixed Wood Forest	Mature mixedwood (deciduous and coniferous; 80 – 100 yr stand age)
OCF	Old Forest	Old coniferous forest: project to be > 100 year stand age
OF	Open Coniferous Forest	Open coniferous forest with < 60% canopy closure
OW	Open Water	Areas of open water (e.g., ponds, wetlands)
RF	Regenerating Forest	Recently re-planted coniferous forest < 10 years old
RI	River	Rivers and other linear watercourses
SH	Shrubs	Shrub habitat - no trees
WR	Wetland - Riparian	Wetlands and riparian habitats adjacent to creeks and rivers
YCF	Young Coniferous Forest	Young coniferous forest > 10 years < 80 years stand age

Over time, the Elsie Lake / Ash River watershed has undergone some significant habitat changes. Prior to impoundment (1949, 1957), the watershed around Elsie Lake consisted of 10 broad habitat types (Table 5), the largest of which was maturing coniferous forest (MCF; Table 5). Following impoundment (1966, 2001) the number of broad habitat types changed to 9, with only forest openings (FO) not present. In 2001, 11 broad habitat types were identified with the addition of regenerating and young coniferous forest resulting from natural succession of previously logged or burned stands of trees.

Prior to impoundment, Elsie Lake had a surface area of approximately 115 ha (the differences between 1949 and 1956 are related to the time of year when the aerial photos were captured). Post-impoundment (1964; 2001) the surface area of Elsie Lake increased by more than 500 ha, resulting in the loss of approximately 60 ha of foreshore and lake-edge related wetland and riparian habitats. Other types of habitats that were impacted include mixed forest, coniferous forest, deciduous forest, shrub habitat, and sedge flats. The total area of open water has also decreased substantially and is related largely to the increase in surface area of Elsie Lake.

Other significant habitat changes that have occurred in the Elsie Lake / Ash River watershed include a significant reduction in MCF and a more than 50% reduction in older coniferous forests (OCF), with only several small remnant patches of old forest remaining (MAP). Changes in total forest cover are related to the level of timber extraction that has occurred over the years and not necessarily to river impoundment, reservoir creation, and reservoir maintenance.

Table 5. Habitat types (Table 5) in the Elsie Lake / Ash River watershed and their spatial extent for two years pre-impoundment (1949, 1957) and two years post-impoundment (1964, 2001).

Habitat Type	Year				Total Ha
	1949	1957	1964	2001	
CC	569.36	1099.74	1083.79	--	2752.89
DA	0.26	--	17.16	1.98	19.4
EL	108.08	122.76	632.49	622.15	1485.48
FO	6.80	--	--	--	6.8
MCF	1417.01	840.40	245.36	99.70	2602.47
MWF	33.36	10.63	13.21	12.61	69.81
OCF	102.50	152.27	84.52	46.43	385.72
OF	--	--	--	92.12	92.12
OW	23.93	13.78	3.89	1.40	43
RF	--	--	93.64	110.62	204.26
RI	3.36	21.33	--	--	24.69
SH	--	--	--	1.35	1.35
WR	85.52	89.29	176.16	12.23	363.2
YCF	--	--	--	1349.62	1349.62
Total Area / year	2350.18	2350.20	2350.22	2350.21	

8 RESTORATION PLAN FOR THE ASH RIVER WATERSHED

8.1 Restoration Strategy Prioritization

While there are many restoration activities that can be applied to modify habitat within the Ash River watershed ranging from minor actions such as installing nest boxes to major modifications such as prescribed burns, an integrated plan must consider all species and, we believe, should have a goal of improved biodiversity rather than single species management. Therefore, we have chosen the approach of identifying restoration opportunities for rare, endangered or threatened species that could potentially reside in the Ash River watershed if habitats were created or improved and to assess the effect of those restoration activities on other, more common, resident species. This approach allowed us to focus restoration activities on those actions that have the greatest opportunity to improve biodiversity and identifies the ancillary benefits/impacts on non-target species in the watershed. This approach also departs radically in principle from the a la carte menu of restoration activities with each restoration action implemented justified on the basis of its benefit to one or more species.

To prioritize restoration initiatives for the Ash River watershed it was necessary to assess the benefit that each restoration initiative would have on wildlife and wildlife habitat. Restoration initiatives that were beneficial to a larger number of species, including rare and endangered species, were considered higher priority than those that benefited one or few species. Additionally, the relationship between restoration initiative and likelihood of mitigating for the impacts of river impoundment on wildlife was considered. Those restoration initiatives that benefited many species and directly addressed the footprint impacts associated with reservoir creation received higher prioritization than those activities that benefited one or few species and only indirectly addressed footprint impacts.

8.2 Restoration Strategies

The restoration plan is limited by the modest extent of land under BC Hydro control and the adjacency of forest company lands that receive repeated treatments of clear-cut logging. Impacts of clear-cut logging on wildlife assemblages have been well-studied, and will not be discussed here. Suffice it to say, restoration actions on BC Hydro property in the Ash River watershed would be greatly enhanced by implementation of greatly improved ecological forest practices in the adjacent lands to retain and maintain the structure and function of the upland forest habitats.

The restoration plan for the Ash River watershed is premised on the three actions that will likely benefit the greatest number of species: 1) habitat protection, 2) riparian habitat conservation and enhancement, and 3) habitat creation. Of these actions, habitat creation has been deemed as the action with the greatest potential to mitigate footprint impacts resulting from impoundment of the Ash River. This is because habitat creation can be implemented on a larger scale more quickly than habitat enhancement. Furthermore, we are not interested in converting habitat types into those that did not previously exist in the Ash River watershed. Our goal is to create habitats that did previously exist, which is why habitat creation is being favoured over habitat enhancement.

8.2.1 Habitat Protection

The difference between conservation and protection was discussed above and will not be restated here. Bear in mind that conservation measures discussed below have a significant overlap with protective measures. We limit protection to specific, identifiable habitat features within the landscapes rather than to entire habitats. While we espouse the protection of riparian

habitats throughout the province, we acknowledge that various activities necessarily take place within riparian zones. Moreover, protection of entire riparian areas is not necessary in the Ash River watershed because biodiversity goals can be met through the conservation measures described in the next section. However, it is essential to protect certain components within the riparian environment if we are to achieve the level of biodiversity envisioned in this plan.

Several features of the habitat are relatively unique and need to be protected to provide habitat to a number of rare, endangered or threatened species and associated common species. These features include the tallest trees within the BC Hydro property, seeps and extensive areas of moss mats. Surveys for these features within the area of impact should be completed, and when found these features should be marked in the field, georeferenced, and their extent mapped.

8.2.1.1 Seeps

Seeps are sources where fresh water from underground reaches the surface and forms small streams or small pools of water. Seeps are typically located along or at the bases of hillsides where groundwater flows to the surface and provide a small, year-round source of water. Seeps are particularly important to wildlife during the summer and fall periods when they may be the only source of fresh water and food in an animal's home range. Also, during the winter, groundwater is typically warmer (a constant 10-13°C) than air and ground temperatures and usually remain unfrozen when other local water sources have turned to ice. At those times, seeps are used heavily by wildlife. During winters with deep snow, seeps provide snow-free travel lanes where wildlife can move and feed. Birds and mammals benefit from the herbaceous vegetation that grows and persists around seeps in the winter when other food is scarce. Insects in and around the seeps provide a year-round source of high-protein food. Small mammals often find abundant forage near seeps. Bears and other berry-eating animals such as Band-tailed pigeons forage on the fruit-producing plants that grow well in moist conditions. Songbirds benefit from the fruit and insects around seeps, often nesting in the dense vegetation surrounding the seep. Amphibians and reptiles benefit from the moist conditions created by seeps. Because seeps generally do not support fish populations, amphibian eggs deposited there survive without losses to fish predation. Amphibians also benefit from plant and insect food near seeps. The most important management practice for seeps is protection from activities that can degrade the seep, such as clear-cutting or pollution. Habitat associated with seeps can be enhanced by releasing or planting beneficial trees and shrubs around the seep and encouraging the growth of herbaceous vegetation around the seep's perimeter.

8.2.1.2 Moss Mats

Mosses have the ability to grow on sterile substrates, such as bare rock, and by breaking down such surfaces into the precursors of soil, trapping dust and soil blown by the wind and adding their own decay products, mosses are soil builders. Moss also traps the seeds of other plants which in some cases results in a change of the community from one of mosses to one of higher plants. Mosses provide food for some types of thrips and shelter for many different kinds of organisms; algae, protists, insects, spiders, molluscs and many others may be found in and under moss mats. Some rotifers and tardigrades live only when associated with some mosses.

8.2.1.3 Tall Trees and Rocky Outcrops

Tall trees are important landscape features that are used by various groups of wildlife such as raptors, birds, and mammals, including bats. A bat colony has been documented at the east end of Elsie Lake near the largest earthen dam (Toth and Associates 2003). In 2007, a small, undetermined species of *Myotis* was observed sunning itself on the edge of rock crevice in this area (Photo 2). Bats will use larger, older trees as roost sites, and in some places, tall, old trees

are important hibernacula for bats. The retention of tall trees within BC Hydro's area of operations may benefit bats through the preservation of roosting sites. Similarly, the rocky outcropping where the *Myotis* bat was observed in fall 2007 and from where bats have previously been reported needs to be retained and protected. The retention of tall trees will continue to benefit other wildlife groups and is an easily obtained restoration goal for the Ash River watershed.



Photo 2. *Myotis* bat observed at the east end of Elsie Lake during a fall 2007 site visit.

8.2.2 Riparian Habitat Conservation and Enhancement

Riparian areas are transitional zones that link aquatic and terrestrial habitats. Because of the unique ecology of riparian zones (Pabst and Spies 1999) restoration has proven challenging (Chan et al. 1997; Emmingham et al. 1997a, 1998; Emmingham and Hibbs 1997; Emmingham and Maas (1994). The loss of riparian forests due to flooding of the reservoir and the re-establishment of upland-type forests in the riparian zone of the reservoirs severely limits effective riparian habitat in the Ash River watershed. Attributes of riparian forests most needed to be re-established are large diameter trees, dead and dying trees, snags, trees with large live crowns, abundant coarse woody debris, multi-storied and multi-species canopies and increased diversity and cover of understory species (Sedell et al. 1997; Tappeiner et al. 1997). As the current forests in the riparian zone adjacent to Elsie Lake advances toward maturity and ultimately to old-growth, many of those features will develop naturally. However, those characteristics can be maintained, improved or created by using silvicultural techniques, thereby increasing the pace of riparian development and improving habitat suitability for many species. Methods used to achieve the desired characteristics include thinning of hardwood- and conifer-dominated stands (Hibbs et al. 1989; Emmingham 1996; Hibbs and Chan 1997; Tappeiner et al. 1997; Baily and Tappeiner 1998), release of desirable understory trees (Emmingham and Maas 1994; Maas and Emmingham 1995; Emmingham et al. 1997b), recruitment of large woody debris (Mcdade et al. 1990), planting/release of big-leaved maple and fruit-producing shrubs, and establishment of understory riparian shrub communities (Baily et al. 1998).

Riparian development in the majority of the Ash River watershed will ultimately be achieved through conservation as mature forests advance into the more diverse old-growth stage.

However, the silvicultural prescriptions identified above should be applied sparingly and throughout the upper watershed to significantly enhance the relatively uniform, closed-canopy forests that currently comprise the riparian habitats. In addition to the silvicultural prescriptions recommended above, a survey of nest sites for Western Screech-owls and Northern Pygmy-owls should be conducted and if found to be limiting, a supply of snags and nest boxes should be created. While it may be possible to attract tree-nesting ducks and other hole-nesting avian species that may be limited due to nest site availability, establishing that nesting sites are limited needs to be done first and a dedicated group willing to take on the long-term commitment of maintaining nest boxes needs to be conscripted before funds are spent on construction and erection of nest boxes for non-endangered species or the effort will be rewarded with short-term benefits at best. The same goes for snag creation. Because most snags are relatively short-lived, if they are found to be limiting to snag-dependent species, snag creation needs to be done periodically rather than all at once and never again. If snags are limiting those species, adequate numbers of snags are not being produced by the forest community which is not likely to change until the community itself matures into old-growth conditions.

Another aspect of riparian habitat enhancement/creation lies with opportunities to revegetate the drawdown zone of Elsie Lake reservoir. More than likely, revegetation would be restricted to the upper portions of the drawdown zone where flooding would occur for the least extent of time. Revegetation would likely need to be limited to experimental plots at first until the success and medium-term survival of planted species could be ascertained. A wide variety of native species should be tested – especially flood-tolerant species such as sedges, grasses, herbs such as Oregon iris, shrubs such as snowberry, black twinberry, red-osier dogwood and Sitka willow, and trees such as black cottonwood, big-leaf maple and red alder. If successful, planting of suitable plants could be expanded to all suitable portions of the reservoirs. Plant establishment and overall success will be a function of the extremes of reservoir management. If operating boundaries are altered, new species and additional areas may become suitable for revegetating the upper portions of the drawdown zone.

8.2.3 Habitat Creation

To provide habitat for a number of rare, endangered or threatened species and improve habitat for a host of more common species, a greater diversity of habitats are required. Providing increased habitat heterogeneity would require more than simply applying silvicultural prescriptions to the existing forested landscape. There are a number of opportunities to provide more open habitats that, combined with the open water of the reservoirs will enhance habitat for many species. The primary open habitats that will benefit many species are wetlands. Ponds and associated meadows, marshes and even forest ponds are critically important wildlife habitat for a wide variety of species and would mitigate for the loss of functional wetlands caused by river impoundment. Wetland creation in the areas affected by the reservoirs is challenging because of the significant water-level fluctuations and the need for relative stability of water levels in a properly functioning wetland.

The primary focus of this project was to assess the feasibility of constructing a wetland in the drawdown zone of Elsie Lake to create habitat that is currently limiting in the Ash River watershed. The feasibility assessment followed that described in Hawkes (2007) for the Jordan River watershed on southeastern Vancouver Island. Using that approach, we identified one area of the drawdown zone near the east end of Elsie Lake that could be manipulated through the construction of berms and movement of soil, rocks, and woody debris to create approximately 5.4 ha of wetland habitat (Photo 3).



Photo 3. Area at the east end of Elsie Lake where a wetland could be constructed within the drawdown zone.

To determine the available area that could be converted into a constructed wetland or wetland complex, a preliminary topographical survey was completed on 4 October 2007 to estimate the profiles of a constructed wetland in the area deemed to have the best overall feasibility. Two profiles were obtained, one from east to west, the other north to south. From these profiles, we plotted the channel bed, bottom topography and approximated the height and shape of two berms that would be required for water retention (Figure 8). The east-west profile consists of a total linear distance of approximately 180 m and the north-south profile consists of a total linear distance of approximately 300 m, producing an area of approximately 5.4 ha that could be converted into a wetland complex at the east end of Elsie Lake.

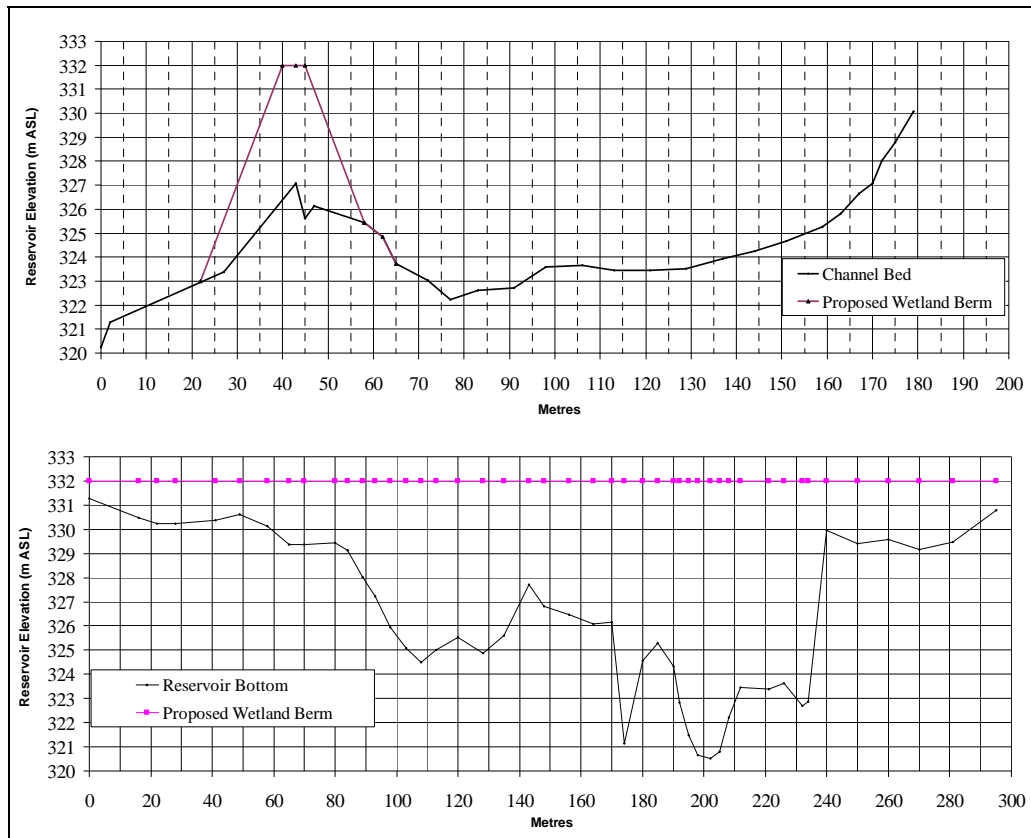


Figure 8. East-west (top panel) and north-south (bottom panel) profiles of the proposed wetland construction site at the east end of Elsie Lake. The brown and pink lines represent berm height and shape.

Maximum berm height was determined from the preliminary surveys and by evaluating the proportion of time that Elsie Lake reservoir exceeded certain elevations for the period 1984 through October 2007. These data were then used to determine the minimum height at which a berm could be built at to ensure that Elsie Lake reservoir did not spill into the created wetland habitat, at least not with any regular frequency. The percent exceedance table (Figure 9) shows that the elevation of Elsie Lake reservoir exceeds 332.0 m ASL approximately once every six years, and when that happens, it is for 1 or 2 days only, which would have little impact on the constructed wetland or wetland complex.

m ASL	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
315.5 - 316.0	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
316.0 - 316.5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
316.5 - 317.0	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	98.1%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	95.9%	100.0%	100.0%	100.0%	98.1%	100.0%
317.0 - 317.5	100.0%	100.0%	98.3%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	95.1%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	99.2%	99.7%	92.3%	100.0%	100.0%	100.0%	95.9%	100.0%
317.5 - 318.0	100.0%	98.0%	95.8%	98.1%	100.0%	100.0%	100.0%	97.8%	91.0%	92.1%	99.2%	100.0%	100.0%	100.0%	96.4%	100.0%	94.5%	97.5%	90.1%	100.0%	100.0%	100.0%	94.0%	100.0%
318.0 - 318.5	100.0%	97.2%	93.2%	95.9%	100.0%	100.0%	100.0%	95.6%	86.9%	88.2%	93.4%	96.2%	100.0%	100.0%	94.0%	100.0%	90.7%	95.3%	86.8%	100.0%	100.0%	100.0%	90.7%	100.0%
318.5 - 319.0	100.0%	94.9%	90.4%	95.1%	100.0%	100.0%	100.0%	95.1%	83.9%	83.3%	92.1%	94.8%	99.2%	100.0%	92.6%	100.0%	96.9%	89.0%	83.0%	100.0%	100.0%	96.4%	89.3%	99.3%
319.0 - 319.5	100.0%	92.7%	87.3%	94.0%	100.0%	100.0%	100.0%	98.0%	94.5%	82.2%	79.2%	91.0%	94.0%	96.7%	100.0%	100.0%	80.3%	75.9%	82.2%	100.0%	98.6%	94.5%	85.2%	98.3%
319.5 - 320.0	100.0%	91.8%	85.6%	93.2%	100.0%	100.0%	100.0%	93.7%	94.0%	78.7%	75.9%	89.6%	92.9%	95.6%	100.0%	88.2%	100.0%	72.1%	71.0%	81.1%	100.0%	93.4%	93.7%	83.8%
320.0 - 320.5	100.0%	91.0%	83.7%	92.1%	100.0%	100.0%	85.5%	92.3%	77.9%	74.2%	87.9%	91.5%	93.4%	100.0%	85.5%	100.0%	65.6%	63.6%	79.7%	95.1%	89.6%	92.6%	82.7%	95.5%
320.5 - 321.0	100.0%	89.6%	83.1%	91.0%	100.0%	100.0%	81.9%	91.8%	77.3%	73.2%	85.8%	91.0%	92.3%	100.0%	82.7%	100.0%	59.6%	59.5%	79.5%	88.5%	86.3%	91.2%	81.9%	93.4%
321.0 - 321.5	100.0%	86.5%	82.8%	89.9%	100.0%	99.2%	81.4%	91.0%	76.8%	71.8%	84.9%	90.4%	91.5%	100.0%	81.4%	100.0%	53.0%	56.2%	78.6%	86.8%	83.3%	90.4%	81.1%	92.7%
321.5 - 322.0	100.0%	82.8%	82.0%	89.0%	100.0%	98.4%	80.5%	89.9%	76.0%	71.2%	84.1%	89.9%	90.4%	100.0%	80.5%	99.5%	48.4%	52.6%	77.8%	85.5%	81.1%	89.0%	80.3%	91.6%
322.0 - 322.5	100.0%	77.2%	81.1%	88.2%	98.9%	97.8%	80.0%	89.0%	75.4%	70.4%	78.6%	88.8%	88.8%	100.0%	80.0%	98.9%	44.0%	46.6%	77.3%	84.9%	80.3%	88.2%	79.7%	99.6%
322.5 - 323.0	99.5%	71.3%	78.9%	83.6%	94.0%	97.0%	79.5%	88.5%	74.9%	69.6%	76.4%	87.9%	86.9%	100.0%	79.2%	98.1%	33.9%	41.6%	78.7%	84.4%	79.5%	87.7%	78.9%	89.9%
323.0 - 323.5	98.6%	67.0%	78.0%	79.5%	88.5%	96.2%	78.9%	86.8%	74.3%	69.0%	75.1%	86.6%	83.3%	100.0%	78.4%	97.3%	23.2%	35.6%	76.2%	83.6%	79.0%	86.8%	78.1%	88.9%
323.5 - 324.0	98.1%	58.0%	76.9%	77.8%	85.2%	95.3%	78.4%	84.1%	73.5%	68.5%	73.7%	84.1%	81.7%	100.0%	77.8%	96.2%	17.5%	32.3%	75.6%	82.7%	78.1%	85.8%	77.3%	88.2%
324.0 - 324.5	97.5%	52.4%	76.3%	77.0%	83.9%	94.8%	77.8%	77.5%	73.0%	67.4%	72.3%	83.3%	79.5%	100.0%	77.3%	95.9%	11.2%	29.3%	74.5%	81.6%	77.6%	84.7%	76.4%	86.1%
324.5 - 325.0	96.7%	47.9%	75.2%	75.9%	83.1%	94.2%	77.0%	74.0%	72.4%	66.0%	66.0%	82.5%	77.9%	99.7%	76.7%	95.3%	3.3%	17.5%	74.0%	81.1%	76.8%	83.8%	75.3%	84.7%
325.0 - 325.5	95.6%	43.7%	74.4%	75.3%	82.5%	88.5%	76.4%	69.0%	71.3%	63.3%	63.7%	80.5%	72.7%	99.7%	75.9%	95.1%	13.2%	73.2%	80.3%	74.9%	82.5%	74.0%	84.0%	84.0%
325.5 - 326.0	94.8%	39.4%	73.5%	74.2%	81.7%	78.9%	75.3%	65.2%	70.5%	61.6%	61.1%	79.2%	68.3%	99.7%	75.3%	94.2%	13.2%	72.6%	79.7%	74.3%	79.7%	73.2%	73.2%	82.9%
326.0 - 326.5	93.7%	31.8%	73.0%	73.7%	80.6%	77.8%	74.8%	61.9%	69.9%	59.7%	60.3%	67.7%	57.9%	71.2%	62.5%	70.4%	12.9%	70.4%	77.3%	73.5%	76.4%	72.1%	82.2%	82.2%
326.5 - 327.0	92.3%	29.3%	71.8%	73.2%	80.1%	76.7%	74.0%	59.2%	68.9%	57.3%	59.5%	76.7%	64.2%	99.2%	73.4%	90.4%	12.9%	66.6%	75.3%	72.4%	72.9%	70.4%	81.2%	81.2%
327.0 - 327.5	89.3%	23.4%	70.1%	72.1%	79.0%	72.3%	73.2%	51.8%	65.8%	53.4%	58.9%	74.8%	63.4%	95.3%	72.3%	84.7%	12.9%	63.6%	71.8%	71.6%	65.8%	66.5%	80.5%	80.5%
327.5 - 328.0	85.5%	17.5%	69.0%	69.6%	77.6%	67.9%	72.3%	43.3%	63.7%	50.1%	57.8%	72.3%	62.8%	94.2%	71.8%	81.6%	12.9%	59.5%	63.6%	70.5%	58.6%	66.6%	79.4%	79.4%
328.0 - 328.5	84.2%	14.1%	67.9%	68.5%	75.7%	58.6%	71.2%	35.6%	61.5%	45.5%	56.7%	71.5%	62.0%	91.8%	70.7%	78.4%	12.9%	53.2%	61.1%	66.7%	53.2%	60.0%	78.4%	78.4%
328.5 - 329.0	83.1%	11.0%	63.4%	67.7%	73.8%	55.6%	68.8%	28.5%	57.7%	40.5%	55.3%	70.4%	61.5%	88.2%	70.1%	74.5%	12.9%	50.1%	56.7%	63.1%	43.8%	55.6%	77.4%	77.4%
329.0 - 329.5	81.4%	7.6%	61.7%	66.6%	71.6%	50.1%	60.0%	26.3%	52.5%	34.2%	54.2%	69.0%	59.8%	80.5%	65.2%	71.8%	12.6%	46.3%	52.6%	58.7%	38.6%	51.2%	76.3%	76.3%
329.5 - 330.0	79.8%	5.1%	64.9%	66.4%	68.8%	38.8%	51.5%	22.2%	47.8%	32.9%	50.7%	67.7%	57.9%	71.2%	62.5%	70.4%	12.6%	40.0%	47.7%	42.3%	34.5%	46.6%	74.9%	74.9%
330.0 - 330.5	77.0%	51.0%	61.9%	64.2%	28.5%	46.6%	18.4%	43.2%	28.8%	45.2%	65.8%	51.1%	65.2%	57.8%	65.2%	70.0%	11.0%	34.8%	40.3%	33.3%	29.8%	43.0%	70.0%	70.0%
330.5 - 331.0	62.6%	44.2%	50.4%	58.2%	22.7%	37.0%	12.9%	31.1%	26.0%	32.1%	60.3%	38.8%	55.3%	48.8%	54.5%	70.0%	6.0%	21.9%	28.2%	21.0%	22.7%	33.2%	61.0%	61.0%
331.0 - 331.5	9.8%	13.8%	20.0%	23.0%	7.7%	8.2%	6.8%	9.8%	5.8%	4.1%	16.7%	8.5%	21.9%	8.6%	22.7%	70.0%	1.6%	4.9%	6.3%	2.5%	6.6%	7.1%	11.8%	11.8%
331.5 - 332.0		1.1%	8.2%		0.5%	1.4%	0.8%	2.2%	0.3%	0.5%	2.5%	0.3%	1.4%	1.6%	70.0%	0.5%	0.8%	0.5%	0.3%	0.8%	0.3%			
332.0 - 332.5			0.3%			0.5%					0.3%								0.3%					
332.5 - 333.0																								

Figure 9. Percent exceedance (proportion of time that the reservoir exceeds a given elevation above sea level) for Elsie Lake Reservoir for the period 1984 through 2007. Red cells indicate 100% exceedance of a given elevation, orange indicate a percent exceedance of < 100% but > 10% and green indicates a percent exceedance value of < 10%.

The one major difference between the feasibility of constructing a wetland adjacent to Elsie Lake versus constructing one adjacent to Diversion Reservoir in the Jordan River watershed is that the area selected in the Ash River watershed is situated entirely within the drawdown zone of Elsie Lake. This means that the existing water licence should cover any proposed wetland construction at Elsie Lake.

8.3 Restoration Plan Summary

Restoration initiatives in the Ash River watershed should be considered in one of three categories: 1) habitat protection, 2) riparian habitat conservation and enhancement, and 3) habitat creation. The feasibility of habitat creation (wetland creation) has been proven based on the establishment of a suitable construction location within the drawdown zone (which likely precludes the need for a separate Water Licence). The concept for the wetland build could be adapted from that presented in Hawkes (2007).

The following lists specific activities to pursue within each of the aforementioned categories along with suggested actions:

8.3.1 Habitat Protection

1. Construct and erect bat boxes at the east end of Elise Lake to supplement roost site if necessary.
2. Identify and protect the tallest trees within the BC Hydro property.
3. Locate and protect seeps.
4. Locate and protect extensive areas of moss mats.

8.3.2 Riparian Habitat Conservation and Enhancement

1. Allow mature forests to advance to “old-growth” conditions.
2. Apply silvicultural prescriptions including thinning, release of desirable understory trees, recruitment of large woody debris, planting/release of big-leaved maple and fruit-producing shrubs, and establishment of understory riparian shrub communities sparingly to uniform stands of second-growth forests.
3. Survey for nest sites of Western Screech-owls and Northern Pygmy-owls and provide snags and/or nest boxes if needed.
4. Provide nest boxes for other hole-nesting birds if needed and a volunteer group is willing to maintain them in the future.
5. Plant experimental plots in the upper draw-down zone with a wide variety of native flood-tolerant plant species and monitor their success. Expand plantings if successful.

8.3.3 Habitat Creation

1. Construct one or more perched wetlands adjacent to Elsie Lake Reservoir.
2. Consider creating one or more small upland meadows through clearing/burning areas of poor wildlife habitat.
3. Coordinate habitat creation efforts with other efforts (current and future) funded by BCRP.

9 CONCLUSIONS AND RECOMMENDATIONS

There is at least one area in the drawdown zone of Elsie Lake where a constructed wetland could be built. Because of its location (entirely within the drawdown zone), it is likely that BC Hydro's existing water licence would fulfill the water licence requirements for the proposed construction. The site identified has several appealing features including nearby road access, existing water courses entering from two different locations, relatively easy topography to work with, and it occurs entirely within the drawdown zone of Elsie Lake Reservoir (i.e., it is below the maximum normal operating elevation for Elsie Lake).

The next step would be to complete a more thorough topographical survey of the identified area and generate a conceptual plan similar to that produced by Hawkes (2007). This next step is recommended because not only would it provide a conceptual build for the selected site, but a construction budget could be generated to determine the financial feasibility of the project. Based on the budget estimated for the Jordan River watershed wetland project (which was for a smaller proof of concept wetland build), the costs for the wetland in Elsie Lake Reservoir may be too great for BCRP alone. However, it may be possible to partner with several organizations such as Ducks Unlimited, the Provincial and/or Federal Governments, Local Logging operations, and even the local community to obtain enough funding to cover the engineering, contracting (building) planting, and maintenance of the wetland.

Applying other Restoration strategies will increase the productivity of the Elsie Lake / Ash River watershed for wildlife and should be pursued. This includes the mapping of unique / significant habitat features, the protection of important areas like existing wetlands and ponds, planting of portions of the drawdown zone with native plants (e.g., sedges, willows, dogwood) to increase vegetative cover, improve wildlife habitat within the drawdown zone, and provide bank/drawdown zone stabilization. Related to revegetating the drawdown zone, it may be practical to map the distribution of the vegetation communities in the drawdown zone so that those communities that show a high level of vigorous growth under the physiologically strained conditions associated with growing in a drawdown zone can be established around the reservoir. Excellent examples of how this might be achieved can be obtained from BC Hydro Water Use Planning (projects CLBMON-10; Hawkes et al 2007 and CLBWORKS-1: a vegetation community inventory and revegetation program being implemented in Kinbasket Reservoir).

Woody debris management should also be considered for the Elsie Lake Reservoir. Large rafts of woody debris tend to pile up at the high water mark after the reservoir has reached its annual maximum elevation. These rafts of woody debris prevent vegetation from colonizing the drawdown zone, particularly in the higher elevations. In some cases it may be possible to use heavy equipment to pile the woody debris, followed by burning. However, the normal practice for woody debris removal, at least in some reservoirs (e.g., Kinbasket) has been to pile, burn, and then bury the ash in the drawdown zone. Given the archaeological sensitivity of the Elsie Lake Reservoir and the Ash River watershed, woody debris burial is not recommended. Instead, the ash from the burn piles should be left in place. In other, less accessible areas, it may be more practical to use boats and barges to move the woody debris to an area where it can be burned.

10 ACKNOWLEDGEMENTS

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12 APPENDICES

Appendix A. Ortho-rectified aerial photos of Elsie Lake and the adjacent upland habitats used to calculate habitat changes in the Elsie lake watershed pre-impoundment (1949; 1957) and post-impoundment (1964; 2001).

Map 1: 1949 aerial photo and habitat delineation for Elise Lake and adjacent upland.

Map 2: 1957 aerial photo and habitat delineation for Elise Lake and adjacent upland.

Map 3: 1964 aerial photo and habitat delineation for Elise Lake and adjacent upland.

Map 4: 2001 aerial photo and habitat delineation for Elise Lake and adjacent upland.

NB: Habitat change calculations were based on a baseline condition determined from the 1949 aerial photos, which represented the smallest aerial coverage from all four years.

Appendix B. Financial Statement Form.



BRIDGE COASTAL RESTORATION PROGRAM			Project No. 06.W.JOR.01	
	BUDGET		ACTUAL	
INCOME	BCRP	Other	BCRP	Other
Total Income by Source				
Grand Total Income (BCRP + Other)				
EXPENSES				
Project Personnel				
Wages				
Consultant Fees				
Technicians				
Materials & Equipment				
Equipment Rental				
Materials Purchased				
Travel Expenses				
Permits				
Administration				
Office Supplies				
Photocopies & Printing				
Postage				
Travel & Living				
Total Expenses				
Grand Total Expenses	-			
BALANCE				
(Grand Total Income - Grand Total Expenses)	\$ -		\$ -	