

# Surveys of Species at Risk and their Associated Habitats in the Clowhom Watershed – Year 3

FWCP Project No. 16.W.COM.01

Final Report – August 1, 2016



**Prepared for:** Fish and Wildlife Compensation Program  
6911 Southpoint Drive, Burnaby, BC, V3N 4X8

**Prepared by:** Michelle Evelyn and David Stiles, Project Leaders  
Halcyon Professional Services & Sunshine Coast Wildlife Project  
650 Gower Point Road, Gibsons, BC, V0N 1V8

**Chris Currie**  
3839 Penticton Street, Vancouver, BC, V5R 1X6

**Aimee Mitchell**  
Athene Ecological, 4-2422 Hawthorne Ave, Port Coquitlam, BC, V3C 6K7

*Prepared with financial support of the Fish and Wildlife Compensation Program on behalf of its program partners BC Hydro, the Province of BC, Fisheries and Oceans Canada, First Nations and public stakeholders*

## EXECUTIVE SUMMARY

Wetlands and riparian areas are essential to a multitude of wildlife species. These sensitive ecosystems are also among those most affected by dam construction and hydro operations. The installation of BC Hydro's Clowhom Dam on the Sunshine Coast in the 1950s flooded two existing lakes to create Clowhom Reservoir, resulting in substantial loss of lowland riparian forests and wetlands. The Clowhom Basin Watershed Plan has prioritized the need to map and assess remaining wetland and riparian areas in the watershed, survey associated species at risk, and identify and carry out restoration and enhancement activities to benefit these habitats and species.

Our team has been working in Clowhom for the past three years. The objectives of our multi-year project are: (1) to identify, assess and map wetlands and riparian ecosystems; (2) to undertake comprehensive surveys of species at risk and their associated habitat; (3) to work with partners to develop, implement, monitor and adaptively manage multi-species restoration, management and enhancement plans; and (4) to carry out an active outreach, education and community engagement program. Through these activities, we aim to identify sensitive habitats; locate new occupied sites for threatened and endangered species; highlight locations for future inventory efforts; prioritize sites for habitat conservation, restoration, and enhancement; increase and improve habitat for wildlife; reduce direct threats to species; increase community participation in wildlife and habitat stewardship activities; and improve public awareness of FWCP and its program partners.

Between April 2015 and March 2016, project activities included: surveys of pond-breeding amphibians at 14 wetland sites, including 26 hours of shoreline perimeter searches and over 500 amphibian trap hours; surveys for Western Screech-Owls at 55 call-playback stations; monitoring of 4 occupied Screech-Owl territories and habitat assessment within these territories; surveys for Northern Goshawks at 29 call-playback stations; environmental DNA surveys for Pacific Water Shrew at 8 wetlands and for Coastal Tailed Frog at 8 streams; time-constrained surveys of Tailed Frogs at 2 sites; monitoring of Barn Swallow nesting activity at 5 sites; and acoustic surveys of bats at 3 wetlands. In addition to wildlife survey activities, we also identified priority sites for wetland restoration and enhancement, undertook detailed ecological assessments at these candidate sites, and developed restoration plans. Finally, we carried out an active public engagement program, reaching over 4,000 Sunshine Coast residents through presentations, workshops, school programs, outreach tables, a landowner stewardship program, a bat and owl box building program, and community habitat enhancement work parties.

Our surveys demonstrate that the wetlands and riparian zones of Clowhom watershed support a rich diversity of wildlife. To date, we have documented 127 vertebrate species in the basin, including 12 federally listed species at risk, 14 provincially red and blue-listed species, 9 Pacific Birds Habitat Joint Venture Priority Bird Species in BC, 11 Partners in Flight Species of Continental Importance in the Pacific Avifauna Biome, and 4 species listed as Identified Wildlife under the BC Forest and Range Practices Act.

Key threats to wetland- and riparian-associated wildlife in Clowhom include impacts from hydro operations, forest harvesting, and roads and transmission lines. Hydro activities at the Clowhom dam result in dramatic and unpredictable water level fluctuations in wetlands near the reservoir, and appear to be negatively impacting amphibian breeding success in these wetlands. Widespread forest harvesting in the watershed has led to a loss of mature forest, and related structural features upon which many species depend. The proximity of roads and transmission lines to wetlands and riparian zones has increased risks of road mortality, invasive species, human disturbance, and potential negative impacts of right of way maintenance activities.

This report includes a series of recommended actions to conserve, restore and enhance habitat and mitigate direct threats to wildlife in the Clowhom basin. We have provided site-specific management recommendations for 15 Clowhom wetlands, species-specific management recommendations for seven species, and threat-related management recommendations for each of the key threats. We have also mapped priority areas for conservation of wildlife in the watershed, including species at risk occurrences, wetlands with high wildlife habitat values, Red-legged Frog and Western Toad breeding sites, Barn Swallow nesting areas, and four proposed Western Screech-Owl habitat protection areas. Finally, we have identified three potential wetland restoration sites in the watershed, where we propose to improve 2.5 ha of wetland habitat during the 2016-2017 project year to benefit amphibian species at risk along with a diversity of other wildlife species.

# TABLE OF CONTENTS

<b>EXECUTIVE SUMMARY .....</b>	<b>2</b>
<b>1.0 INTRODUCTION.....</b>	<b>6</b>
<b>2.0 GOALS AND OBJECTIVES .....</b>	<b>6</b>
<b>3.0 STUDY AREA.....</b>	<b>7</b>
<b>4.0 METHODS .....</b>	<b>9</b>
4.1 Surveys of Pond-breeding Amphibians .....	9
4.2 Western Screech-Owl Surveys.....	11
4.3 Northern Goshawk Surveys.....	14
4.4 Bat Surveys .....	16
4.5 Environmental DNA Surveys .....	17
4.6 Barn Swallow Habitat Enhancement and Nest Monitoring.....	19
4.7 Owl and Bat Habitat Enhancement .....	20
4.8 Public Outreach and Engagement .....	22
<b>5.0 RESULTS .....</b>	<b>24</b>
5.1 Pond-breeding Amphibians .....	24
5.2 Western Screech-Owls .....	28
5.3 Northern Goshawks .....	33
5.4 Bats.....	34
5.5 Coastal Tailed Frogs .....	36
5.6 Barn Swallows .....	38
5.7 Other Wildlife .....	40
<b>6.0 DISCUSSION.....</b>	<b>42</b>
6.1 Pond-breeding Amphibians .....	42
6.2 Western Screech-Owls.....	47
6.3 Northern Goshawks.....	58
6.4 Bats.....	59
6.5 Coastal Tailed Frogs .....	60
6.6 Barn Swallows .....	61
6.7 Other Species at Risk.....	62
6.8 Proposed Wetland Restoration Plan for Clowhom Watershed .....	63
<b>7.0 SUMMARY RECOMMENDATIONS.....</b>	<b>68</b>
<b>8.0 ACKNOWLEDGEMENTS .....</b>	<b>73</b>
<b>9.0 REFERENCES.....</b>	<b>74</b>

# LIST OF FIGURES

Figure 1: Location of the Clowhom Watershed, Sunshine Coast, BC.....	7
Figure 2: Locations of Survey Activities, 2015-2016 Project Year .....	8
Figure 3: Monitoring Water Levels and Surveying Amphibians in Clowhom Wetlands .....	9
Figure 4: Wetlands Surveyed for Pond-breeding Amphibians in the Clowhom Watershed, 2015.....	10
Figure 5: Assessing Habitat in an Occupied Western Screech-Owl Territory.....	12
Figure 6: Northern Goshawk Call-Playback Survey Location near Historical Sighting at Red Tusk .....	14
Figure 7: Northern Goshawk Call-Playback Survey Locations, 2015 .....	15
Figure 8: Locations of Bat Acoustic Surveys in Clowhom Watershed, 2015 .....	16
Figure 9: Locations of Environmental DNA Sample Collection, 2015 .....	18
Figure 10: Barn Swallow Nesting Condo Installed atop the Clowhom Dam .....	19
Figure 11: Sunshine Coast Community Members Build Bat Houses and Owl Nest Boxes .....	20
Figure 12: Owl Nest Box Installation in the Clowhom Watershed.....	21
Figure 13: Bat House Installation in the Clowhom Watershed.....	21
Figure 14: Community Engagement Activities Included Shoreline Planting Work Parties.....	22
Figure 15: Detections of Pond-Breeding Amphibians in Clowhom, April 2013 to March 2016.....	24
Figure 16: Red-legged Frog Detections in the Clowhom Watershed, 2013-2015 .....	26
Figure 17: Western Toad Detections in the Clowhom Watershed, 2013-2015.....	27
Figure 18: Western Screech-Owl Responds to a Call-Playback Survey in Clowhom Watershed .....	28
Figure 19: Western Screech-Owl and Barred Owl Detections, September 2013 to March 2016 .....	31
Figure 20: Detections of Juvenile Northern Goshawk and Plucking Post 2015 .....	33
Figure 21: Little Brown Bat Detections in the Clowhom Watershed, 2014 and 2015 .....	35
Figure 22: Detection of Coastal Tailed Frog Tadpole in Bear Creek .....	36
Figure 23: Known Barn Swallow Nesting Locations in the Clowhom Watershed .....	38
Figure 24: At Least Two Barn Swallow Pairs Nested in the Wooden Condo atop the Clowhom Dam.....	39
Figure 25: One Barn Swallow Pair Nested inside a Temporary Storage Space.....	39
Figure 26: Red-tailed Hawk, one of 91 Bird Species Detected in the Clowhom Watershed .....	40
Figure 27: Roosevelt Elk, one of 20 Mammal Species Detected in the Clowhom Watershed .....	40
Figure 28: Long-toed Salamander in the Clowhom watershed .....	42
Figure 29: Western Toad in Clowhom Watershed, July 2015.....	43
Figure 30: Clowhom Reservoir levels (m) during amphibian breeding season 2013-2015 .....	45
Figure 31: Four Proposed Western Screech-Owl Habitat Protection Areas in Clowhom .....	48
Figure 32: Western Screech-Owl Nesting in an Old Bigleaf Maple in Kai Territory .....	49
Figure 33: Photograph of Kai Western Screech-Owl Territory.....	50
Figure 34: Map of Kai Western Screech-Owl Proposed Habitat Protection Area .....	51
Figure 35: Photograph of Fisher Western Screech-Owl Territory .....	52
Figure 36: Map of Fisher Western Screech-Owl Proposed Habitat Protection Area .....	53
Figure 37: Large Bigleaf Maple in Middle Western Screech-Owl Territory .....	54
Figure 38: Map of Middle Western Screech-Owl Proposed Habitat Protection Area.....	55
Figure 39: Photograph of Nagy Western Screech-Owl Territory.....	56
Figure 40: Map of Nagy Western Screech-Owl Proposed Habitat Protection Area.....	57
Figure 41: Possible Northern Goshawk plucking post found in the Clowhom watershed, July 2015 .....	58
Figure 42: Barn Swallow Adults and Juveniles .....	61
Figure 43: Three Proposed Wetland Restoration Sites in the Clowhom Watershed .....	64
Figure 44: Proposed Wetland Restoration Site #1 ("Liner Wetland").....	65
Figure 45: Proposed Wetland Restoration Site #2 ("Red-legged Frog Wetland").....	66
Figure 46: Proposed Wetland Restoration Site #3 ("Km 20 Wetland") .....	67

## LIST OF TABLES

Table 1: Surveys of Pond-breeding Amphibians in Clowhom Watershed, 2015 .....	10
Table 2: Public Outreach and Engagement Activities, Year 3 (2015-2016).....	23
Table 3: Western Screech-Owl Call-Playback Survey Results, September 2013 to March 2016 .....	29
Table 4: Summary of Western Screech-Owl Observations, September 2013-March 2016.....	32
Table 5: Results of Bat Acoustic Surveys in Clowhom Watershed 2015.....	34
Table 6: Identified Creeks with Suitable Habitat for Coastal Tailed Frogs in Clowhom .....	37
Table 7: Vertebrate Species Detected in Clowhom Watershed, April 2013 - March 2016 .....	41
Table 8: Vertebrate Species at Risk Documented in the Clowhom Watershed, 2013-present.....	62
Table 9: Species-Specific Management Recommendations for 7 Key Species at Risk in Clowhom .....	68
Table 10: Site-Specific Management Recommendations for 15 Clowhom Wetlands.....	71
Table 11: Threat-Related Management Recommendations for the Clowhom Watershed .....	72

## 1.0 INTRODUCTION

Wetlands and riparian zones are essential to wildlife. Across North America, 80% of breeding birds and 50% of species at risk rely on wetlands for some portion of their lifecycle (Tori et al. 2002). In British Columbia, more than 30% of species-at-risk are wetland-dependent (Austin et al. 2008). Wetlands and riparian areas are also among those most affected by the construction and operation of hydro facilities.

On British Columbia's Sunshine Coast, the construction of the Clowhom Dam in the 1950s flooded two existing lakes and 315 ha of land, including 41 ha of riparian habitat and 9 km of streams, to create the Clowhom Reservoir which measures 800 ha at full pool. This substantial landscape change had significant impacts on wetland and riparian wildlife in the Clowhom watershed.

The Clowhom Basin Watershed Plan identifies an urgent need to map and assess wetland and riparian habitats, survey associated species at risk, and plan and carry out restoration and enhancement activities to benefit these habitats and species. To this end, "*riparian and wetland mapping and restoration*" and "*amphibian surveys*" were highlighted as two of the five top priorities for Fish and Wildlife Compensation Program funding in the Clowhom basin (FWCP 2011).

In 2013, with support from FWCP and other funding partners, we initiated a multi-year project to assess and map wetland and riparian habitats, survey associated wildlife species-at-risk, and identify and carry out restoration and enhancement activities in the Clowhom watershed. During the third year of the project (April 2015 - March 2016), we continued these efforts by conducting surveys of high priority wildlife species of conservation concern along with their associated habitat, and developing detailed plans to mitigate threats and to restore and enhance wetlands in the basin.

Our survey activities complement those carried out by shíshálh First Nation's Resource Management Department which conducts seasonal wildlife census activities in the large wetland complex at the end of the reservoir under the direction of BC Hydro as part of the Watershed Use Planning process (Bates 2007, 2008; Bates et al. 2009, 2011; Bates & Ferguson 2010, 2014; Ferguson et al. 2012).

## 2.0 GOALS AND OBJECTIVES

The objectives of this project are to:

1. Identify, assess and map wetlands and riparian ecosystems in the Clowhom watershed in order to identify sensitive habitats and prioritize sites of future species at risk inventories.
2. Undertake comprehensive surveys of species at risk and their critical habitat in the Clowhom watershed in order to identify new occupied sites for threatened and endangered species, evaluate threats, and prioritize sites for habitat restoration, enhancement, and conservation.
3. Work with partners to develop, implement, monitor and adaptively manage multi-species restoration, management and enhancement plans in order to increase and improve habitat for wildlife and reduce direct threats to populations of species at risk.
4. Carry out an active outreach, education and engagement program in order to increase community participation in wildlife and habitat stewardship activities, and improve awareness of the Fish and Wildlife Compensation Program along with its program partners.

### 3.0 STUDY AREA

The 390 km<sup>2</sup> Clowhom watershed, is situated at the head of Salmon Inlet, northeast of Sechelt and west of Squamish (Figure 1). It falls within the Coastal Western Hemlock biogeoclimatic zone, including moist maritime and very wet maritime subzones (CWH mm and CWH vm). Elevations range from 30 to 2400 m and vegetation classes range from dense forest to alpine. Footprint impacts from dam construction included loss of 41 ha of riparian habitat, 6 km of mainstem, 3 km of lower tributary channels, and flooding of 430 ha of existing lake, including 17 km of shoreline habitat (FWCP 2011). In addition to BC Hydro activities, this industrial watershed is also impacted by logging operations (Interfor), along with four IPP run-of-the-river operations (Veresen Incorporated's Clowhom Power operations on Clowhom River, and Regional Power's Bear Hydro operations on Bear Creek).

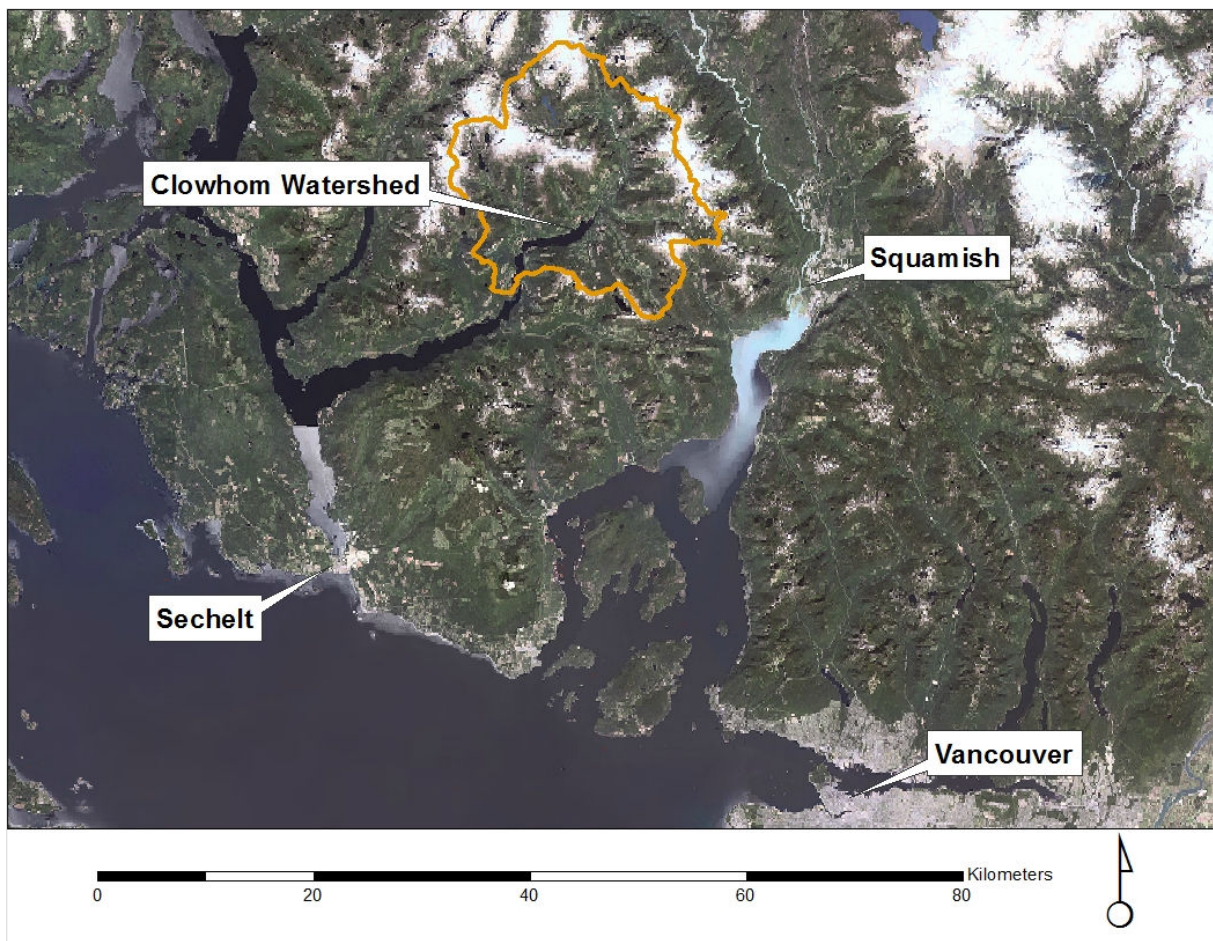
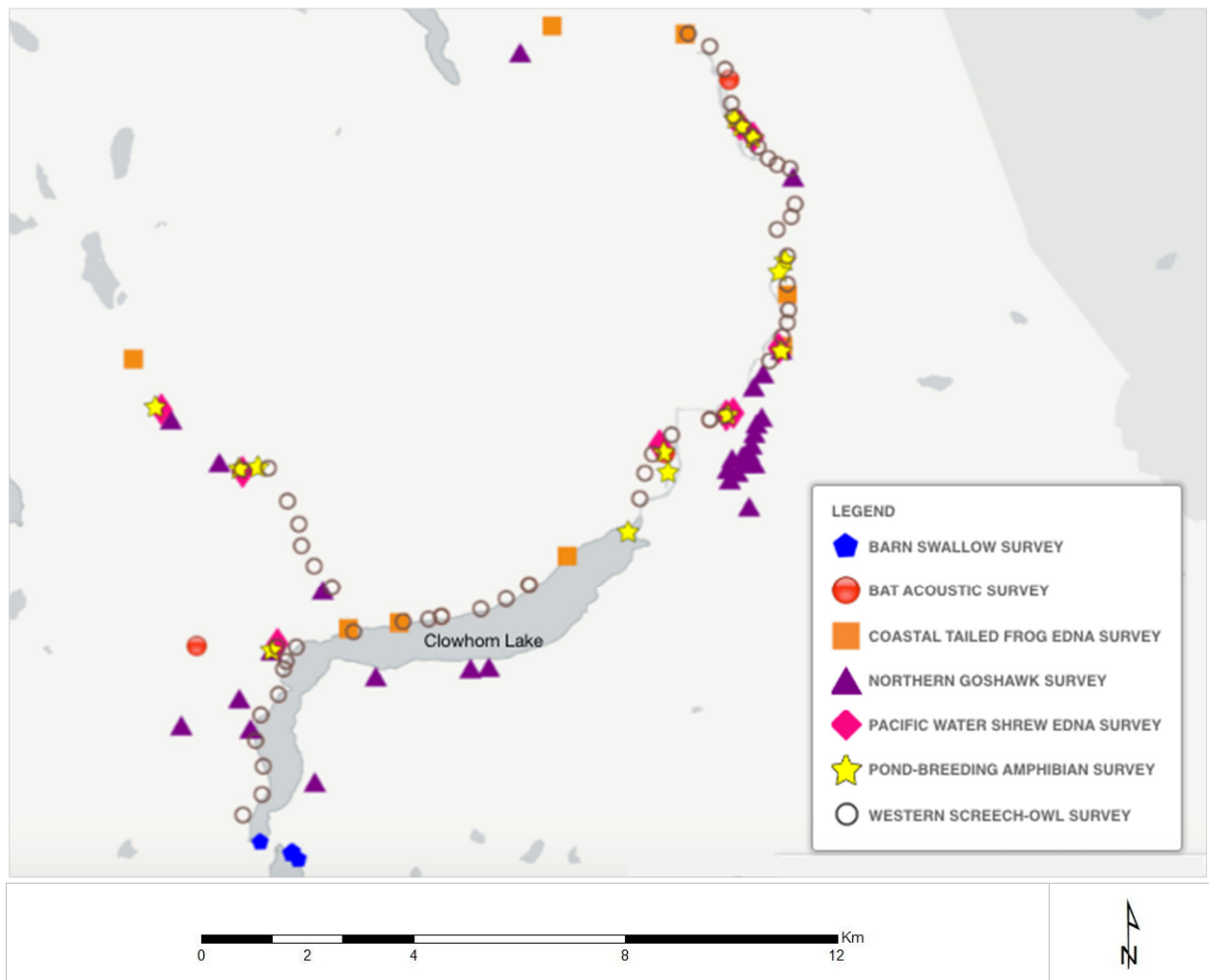


Figure 1: Location of the Clowhom Watershed, Sunshine Coast, BC

Between April 2015 and March 2016, project activities included surveys of amphibians, owls, goshawks, bats, tailed frogs, water shrews, and swallows. Most surveys were concentrated in the areas along the Clowhom Reservoir, Clowhom River valley and Bear Creek valley (Figure 2). Surveys of pond-breeding amphibians occurred in 14 wetlands. Western Screech-Owls were surveyed at 55 call-playback stations, and habitat assessment and territory delineation occurred within 4 known occupied Screech-Owl territories. Northern Goshawk surveys were carried out at 29 call-playback stations, while bat surveys were conducted at 3 acoustic monitoring stations. Environmental DNA (eDNA) sampling for Coastal Tailed Frog and Pacific Water Shrew occurred at 8 streams and 8 wetlands, respectively. Barn Swallow nesting activity was monitored at 5 sites located at BC Hydro Clowhom Dam and in nearby properties.



**Figure 2: Locations of Survey Activities, 2015-2016 Project Year**

## 4.0 METHODS

### 4.1 Surveys of Pond-breeding Amphibians

To identify priority sites for conservation of two amphibian species at risk (Red-legged Frog and Western Toad), and to evaluate overall amphibian diversity, distribution and abundance in the Clowhom watershed, we surveyed pond-breeding amphibians using a combination of methods, following Resource Information Standards Committee (RISC) procedures (1998b) and methods outlined in Olson et al. (1997).

**Perimeter Surveys:** Water bodies were surveyed by systematically searching shoreline habitat for egg masses, larvae, juveniles and adult amphibians.

**Live Trapping:** Passive soft-sided collapsible funnel traps were set unbaited at the shallow edges of waterbodies attached to emergent vegetation or coarse woody debris. Floats were placed inside the traps to ensure that any air-breathing animals that could potentially enter would not be harmed (e.g., water shrews).

**Incidental Encounters:** We also documented incidental detections of amphibians spotted while traveling to and from sites in the watershed, or detected during surveys of other wildlife groups.

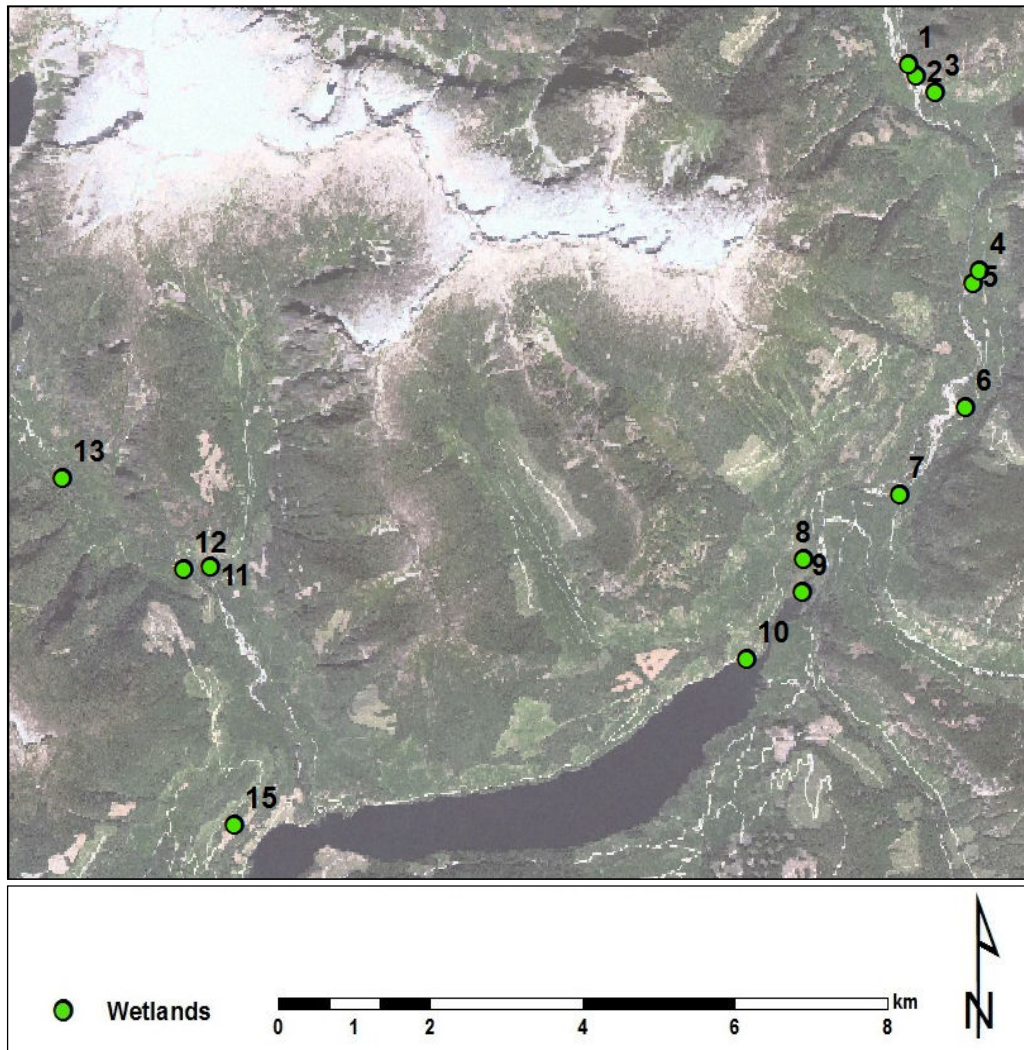
Surveys were conducted in April, May, June, and July 2015 to evaluate amphibian activity and monitor water levels in the wetlands of the Clowhom watershed (Table 1, Figure 4). In April, perimeter surveys were conducted at 14 of 15 identified wetlands. Subsequent shoreline and live trapping surveys in May, June and July focused specifically on known breeding sites for Red-legged Frogs (Wetlands 6 and 9) and Western Toads (Wetlands 7, 9, and 10) that had been active in previous years.



**Figure 3: Monitoring Water Levels and Surveying Amphibians in Clowhom Wetlands**

**Table 1: Surveys of Pond-breeding Amphibians in Clowhom Watershed, 2015**

Dates	Locations	Survey Methods	Total Effort
20-23 April 2015	Wetlands 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15	Perimeter Surveys	4050 m surveyed, 14 survey hours
29-31 May 2015	Wetlands 7, 8, and 9	Perimeter Surveys	1500 m surveyed, 3 survey hours
16 June 2015	Wetland 7	Perimeter Survey	500 m surveyed, 2 survey hours
6-7 July 2015	Wetlands 7, 8, and 9	Perimeter Surveys / Live Trapping	1500 m surveyed, 3.5 survey hours 180 trap hours
22 July 2015	Wetlands 6, 7, 9, and 10	Perimeter Surveys / Live Trapping	1950 m surveyed, 4 survey hours 360 trap hours



**Figure 4: Wetlands Surveyed for Pond-breeding Amphibians in the Clowhom Watershed, 2015**

## 4.2 Western Screech-Owl Surveys

This was our third year conducting surveys of Western Screech-Owls in the Clowhom watershed. Activities included call-playback surveys, territory delineation, and habitat assessment.

### Call-Playback Surveys

To continue to monitor areas previously used by Western Screech-Owls, and to seek to identify any new occupied sites, we conducted nocturnal call-playback surveys following RISC standards (Hausleitner 2006). Survey stations were established in Year 1 of the project and are located roughly every 400-500 m along transects in suitable riparian habitat located along the Clowhom, Powder, and Bear Creek Forest Service Roads. Areas of inappropriate or low quality habitat, such as cliffs, large cutblocks, or dense coniferous forest, have been excluded.

Call-playback surveys were conducted at 55 stations in March 2016. Surveys took place from one half hour before sunset to one half hour after midnight. Upon arriving at a station one minute of silence was followed by a one-minute playback of a male Western Screech-Owl “bouncing ball” territorial call followed by three minutes of silence during which the surveyors listened intently for any response. This process was then repeated, pointing the caller in each of the four cardinal directions. Calls were produced with a FoxPro NX4 electronic caller. Upon seeing or hearing any owl, the call-playback was stopped and observations were recorded as to the species, distance, direction, type and duration of the response. Weather, noise and habitat conditions were also documented at each station.

### Monitoring Screech-Owl Activity in Known Territories

Guided by the records from our call-playback surveys over the past three years, we monitored areas with previous Western Screech-Owl observations. Our goal was to delineate territories, determine the status in each territory, and identify nest groves. Monitoring of known territories took place in April 2015, July 2015, and March 2016.

To minimize disturbance to the owls, we first used passive monitoring to search for birds. At dawn and dusk, male Screech-Owls commonly visit the boundaries of the nest grove and broadcast their presence with a territorial call. We entered each known Screech-Owl territory prior to dawn or dusk and listened quietly for male territorial announcements. If no spontaneous calling was heard, we played one or two bouts of the male bouncing ball call in an effort to illicit a response.

Once a bird was detected, the incoming and outgoing directions and distances were closely observed. GPS locations were taken for all owl observations and used to delineate the territory and nest grove. Nest searches were conducted by walking transects in the nest grove area and checking potential nest cavities for signs of occupation, such as feathers, whitewash, or owl pellets. At sites where pair status was confirmed and observations indicated active nesting, we attempted to assess juvenile fledging status in July 2015. This also involved passive monitoring and playing a bout or two of call-playback if no spontaneous calling was heard.

## **Habitat Assessment in Known Territories**

To evaluate habitat within each of the four known Western Screech-Owl territories in the Clowhom watershed, we carried out habitat assessments in nest and roost groves, and took detailed measurements of all identified nest and roost trees within the territory cores.

Habitat assessments were conducted within 20 x 20 m plots around nest and roost trees, as well as random selections outside of nest and roost groves. In accessible territories, we surveyed four plots: two within the nest/roost grove (core) and two outside within a management zone comprised of foraging habitat. In territories that were difficult to access due to steep, unstable slopes and extensive slash, we surveyed two quadrats. Survey plots were situated 300-400 m apart from each other.

In each plot we recorded information about forest structure and landscape position, including structural stage, dominant tree species, dominant understory tree species, average height and diameter at breast height (DBH) of dominant tree species, understory density, percent canopy cover, abundance of coarse woody debris, elevation, distance to water, slope and slope position (Tripp et al. 2015). Data collected at nest and roost trees included tree species, height, DBH, cavity height, and primary cavity nesting species present.



**Figure 5: Assessing Habitat in an Occupied Western Screech-Owl Territory**

## **Delineating Proposed Habitat Protection Areas for Western Screech-Owls**

Based on our field observations of nest cavities, nest and roost groves, as well as call-playback responses and behaviour of Western Screech-Owls in the watershed, we delineated four proposed habitat protection areas for Western Screech-Owls within the Clowhom watershed using the following guidelines:

- Observations greater than or equal to 1.5 km apart within the same survey session were considered different territories.
- Core habitats include roost or nest groves, and were delineated based on mapping forest patches with low understory, open canopy cover and suitable trees for nesting (Hobbs 2014).
- Nest groves were defined by either buffering a known nest cavity or using behavioural cues of owls calling at the boundaries of the grove at dawn or dusk.
- Roost groves were defined by incorporating trees observed as day roosts; these areas were not declared nest groves because of a lack of confirmation of a nest cavity or nesting behaviour (e.g., single male or failed nesting attempt if a pair was detected earlier in year).

Proposed Western Screech-Owl habitat protection areas in Clowhom range from 80 to 120 hectares in size, depending on the quantity of suitable and available habitat which was assessed via analysis of orthophotos and forest cover data layers, including the RESULTS Forest Cover Polygons and cutblock boundaries provided through Government of BC's Geographic Warehouse (source: <http://geobc.gov.bc.ca/>).

We used the Identified Wildlife Management Strategy (IWMS) (2004b) for the Interior Western Screech-Owl, Ministerial Orders (i.e., Government Action Regulation (GAR) Orders for Interior Western Screech-Owl - Ministry of Forests, Lands and Natural Resource Operations 2015), and consultation with species experts (J. Hobbs, pers. comm. 2015 and John Surgenor and Bevan Ersnt, Ministry of Forests, Lands and Natural Resource Operations, pers. comm. 2015) to help guide our designation of proposed protected areas.

The size of proposed protected areas was informed by the known home ranges of Western Screech-Owl in other locations (IWMS 2004b, Davis and Weir 2008, Hausleitner and Duilisse 2011). Territory ranges of up to 112 ha have been reported in the interior subspecies (Davis and Weir 2006, 2007). Even larger Wildlife Habitat Areas have been proposed for Western Screech-owls within the Flathead area due to harsher conditions (Hobbs 2013). Every effort was made to include wetland habitats within the proposed protected areas (Jared Hobbs, pers. comm. 2015).

### 4.3 Northern Goshawk Surveys

This was our second year conducting Northern Goshawk call-playback surveys in the Clowhom watershed. Surveys were carried out in the vicinity of two historic goshawk records dating back to the 1990s (Clowhom Lake and Red Tusk), along with areas identified by the Northern Goshawk Suitability Model (Mahon et al. 2008) and subsequent reconnaissance surveys as containing moderate to high suitability habitat.

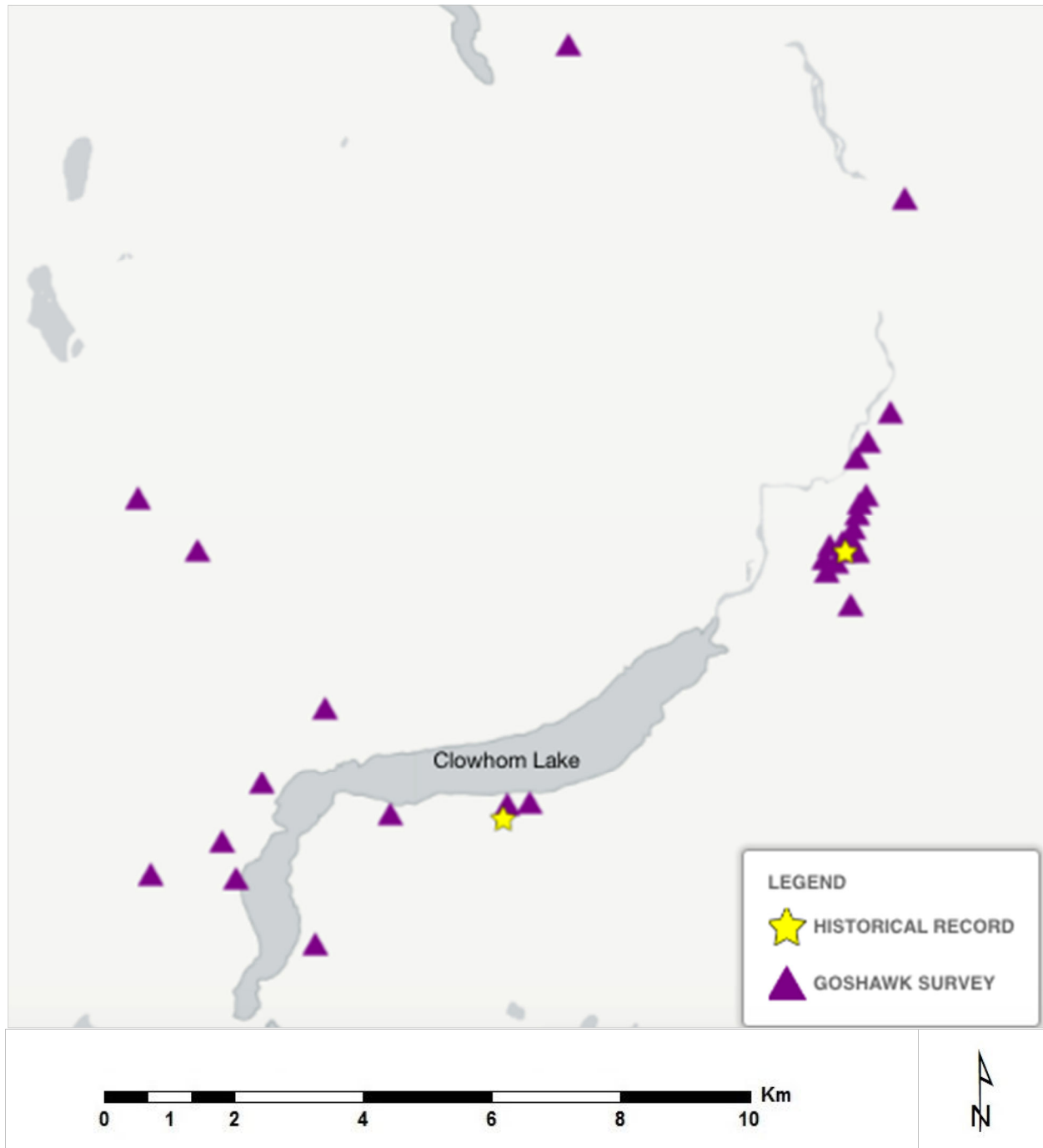
Where forest patches were large enough, stations were placed along transects every 300 to 400 m, depending on the terrain and level of acoustic obstruction. In areas with very steep topography and dense vegetation, distances between stations were decreased. In all, we carried out call-playback surveys at 29 survey stations, including sites on or near the Clowhom, Nagy, Powder, and Bear Creek Forest Service Roads, and along a transect up Red Tusk (Figures 6 and 7). Surveys were conducted in late May and in July 2015.

Call-playbacks were conducted using a FoxPro NX4 Caller following RISC standards (RISC 2001) and using protocols and data forms designed by the Recovery Team. A Northern Goshawk call was broadcast for six bouts of 10 seconds each, followed by 30 seconds of silence in which to detect birds. Each of the six broadcasts was played in a different direction, rotating the megaphone 120° between bouts. At the end of the broadcasts an additional one minute was spent actively looking and listening for goshawks. The adult alarm call was used in May, while the juvenile begging call was used in July.

At each survey location, we also carried out a habitat assessment. We evaluated goshawk nesting and foraging habitat quality, availability of nesting platforms and flyways, and documented natural and anthropogenic disturbances and landscape context of each site.



**Figure 6: Northern Goshawk Call-Playback Survey Location near Historical Sighting at Red Tusk**



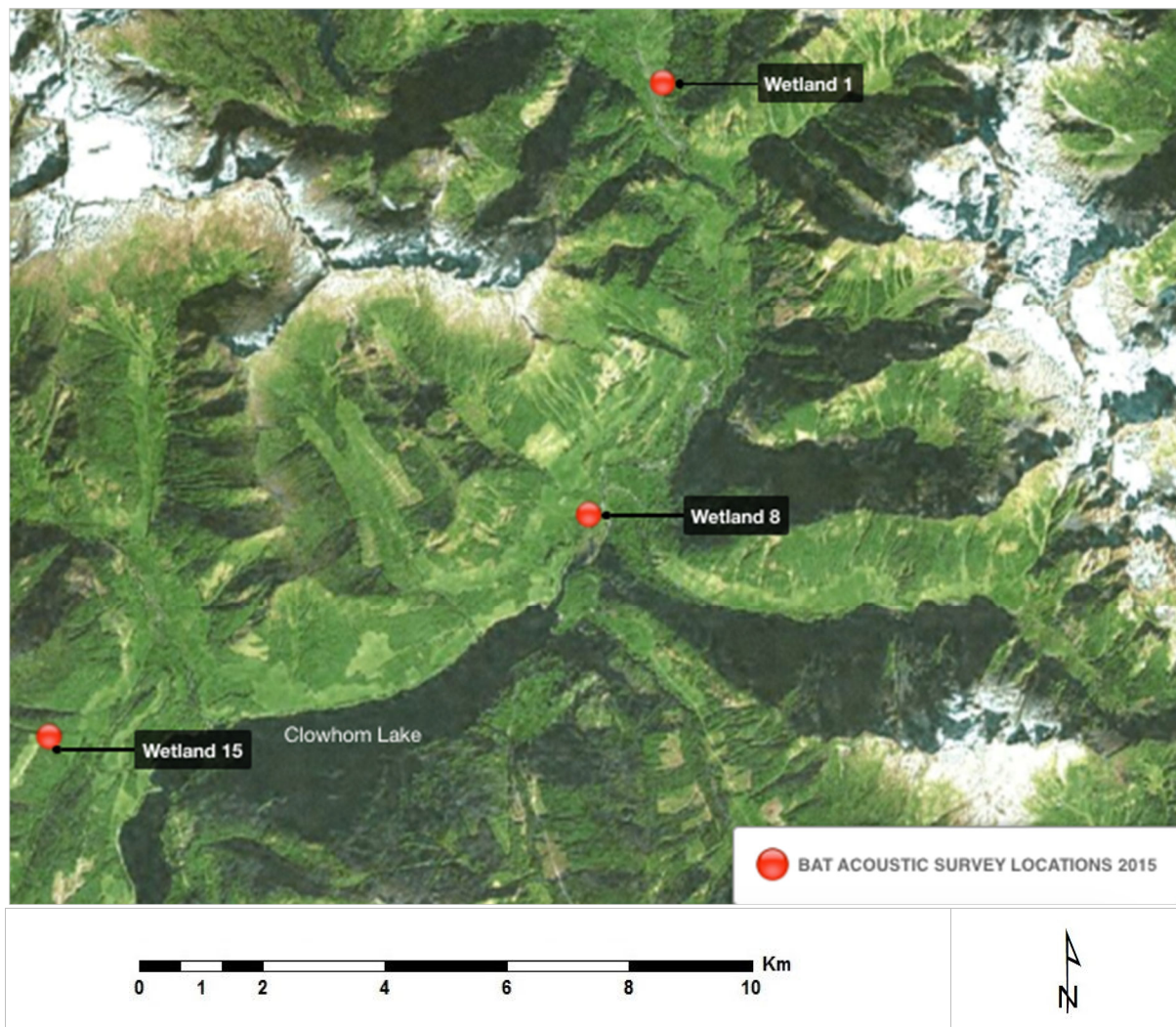
**Figure 7: Northern Goshawk Call-Playback Survey Locations, 2015**

## 4.4 Bat Surveys

To evaluate bat activity and community composition, we carried out acoustic surveys. Bats produce echolocation calls to assess their environment and search for food. While these calls are outside the range of human hearing, they can be recorded using equipment that digitizes the sound. The particular properties of each species' echolocation calls (frequency range, call shape, use of harmonics, etc.) can then be used to identify which species was recorded.

The technology, however, does have limitations. Calls are only diagnostic during the search phase, which varies according to the amount and type of "clutter" in the environment; bats may alter their calls when navigating obstacles. Some species have echolocation calls that are practically indistinguishable from each other, and in these cases identification can often only be narrowed to two or more species.

Acoustic bat surveys were carried out in May, July and September 2015. We recorded the echolocation calls of bats using overnight deployments of Anabat Express Bat Detectors at three sites in the Clowhom watershed (Wetlands 1, 8, and 15) (Figure 8).



**Figure 8: Locations of Bat Acoustic Surveys in Clowhom Watershed, 2015**

## 4.5 Environmental DNA Surveys

Environmental DNA (eDNA) surveys involve collection of water samples from aquatic habitats potentially inhabited by the target species. Collected water samples are pumped through filters which are tested for the presence of the species' DNA using a quantitative Polymerase Chain Reaction (qPCR) assay using species-specific primers that target a small section of the mitochondrial DNA cytochrome b gene (Goldberg et al. 2011).

This method has proven to be highly accurate, efficient, and cost effective. The technique is extremely sensitive so can detect species even when they exist in very low densities (Ficetola et al. 2008, Goldberg et al. 2011, Thomsen et al. 2012). Numerous studies have demonstrated the detection of species using eDNA techniques where traditional survey methods have failed to find them. We continued to use eDNA sampling to search for sites occupied by two aquatic species at risk in the Clowhom Watershed – the Coastal Tailed Frog and the Pacific Water Shrew.

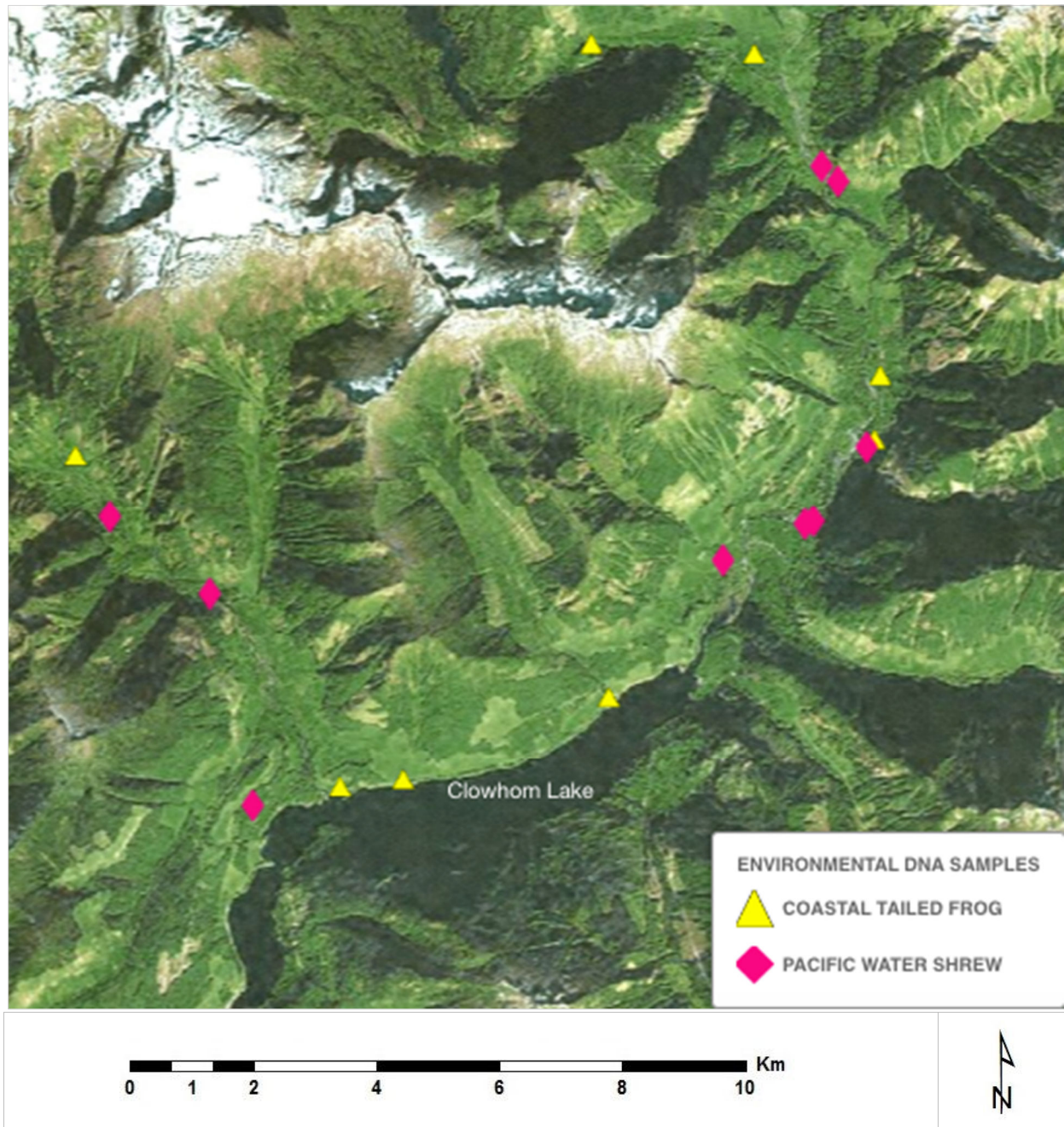
**Sample Collection:** We collected water samples for eDNA in October 2015. Eight streams across the basin were sampled for the presence of Coastal Tailed Frog DNA, and eight wetlands were sampled for Pacific Water Shrew DNA (Wetlands 2, 3, 6, 7, 8, 12, 13 and 15) (Figure 9).

At each site, water samples were collected in sterile polypropylene bottles, each labelled with the site name, collection time, date, and name of collector. To prevent contamination from boots and other gear, biologists did not enter the water during sampling and wore clean, sterile nitrile gloves. Sample bottles were triple rinsed with site water before being filled with water from the surface of the water body. Sample bottles were placed in an insulated cooler with ice packs to prevent DNA degradation in the field prior to subsequent off-site filtration and preservation.

To reduce the likelihood of false negatives and increase detection probability, we collected duplicate 2 L samples at Coastal Tailed Frog survey sites and triplicate 3 L samples at Pacific Water Shrew sampling sites. Two of the surveyed wetlands (Wetlands 7 and 8), were larger than 0.12 ha. Because of their larger size, we collected samples from two different locations within each of these wetlands.

**Sample Filtration:** Water samples were stored in coolers and filtered within 24 hours of collection in order to minimize degradation of DNA. Each sample was poured into a 250 mL sterile polypropylene filter funnel with a 0.45 µm pore diameter cellulose nitrate membrane and filtered through the membrane using a peristaltic pump to create a vacuum. Once filtration was complete, the filter was removed using sterile gloves and sterile tweezers. Each filter membrane was placed in its own 2 mL sterile polypropylene cryogenic vial filled with 95% molecular-grade ethanol, individually labelled, and placed inside labelled whirl-pak storage bags for shipping. At the end of each day, and when switching between Tailed Frog and Water Shrew samples, one control sample of distilled water was processed using the same filtration protocol. These control samples served as a contamination test for both the filtration and laboratory analysis procedures. All of the preserved membranes were shipped to environmental DNA labs for subsequent extraction and laboratory analysis.

Please note that at the time of writing this report, the laboratory analysis of the eDNA samples has not been completed. Therefore, results of the eDNA surveys are not included in this report, but will be included in the Year 4 report.



**Figure 9: Locations of Environmental DNA Sample Collection, 2015**

## 4.6 Barn Swallow Habitat Enhancement and Nest Monitoring

At the Clowhom Generating Station, Barn Swallows had been witnessed nesting inside of the hoist tower on top of the dam. In 2015, when the hoist tower required retrofitting for safety reasons, we worked with BC Hydro to mitigate impacts by designing and building a nesting structure, following recommended best practices to provide alternate habitat for Barn Swallows at the site (Evelyn & Stiles 2015).

To provide additional alternative nesting opportunities for Barn Swallows, we designed and built a nesting structure that was installed by BC Hydro Construction Services on the roof of the hoist tower (Figure 10). The nesting structure was designed to follow recommended best practices for Barn Swallow nesting enhancement (Ferguson 2014b). The wooden structure measures 10' by 8' by 4' and includes large front and side entrances and smaller picture windows. It is closed in the back (facing the prevailing winds) except for a small open strip at the bottom to permit air flow. The structure offers a variety of potential nesting locations for the birds (narrow ledges, shelves, corners, framed ceiling compartments, external eaves).

The nesting structure has been situated on the roof of the hoist tower, matching the orientation of the tower itself. The front side of the nesting structure faces northeast, with the solid back wall facing the prevailing southwesterly winds. The front edge is flush with the front edge of the hoist tower, facing the reservoir, to allow an open flight path, permitting easy entrance and exit to the nesting structure for Barn Swallows.

Existing unoccupied swallow nests from previous nesting seasons were carefully removed from the tower, retaining as much of the nest material as possible, and placed within the new nesting structure prior to installation. Barn Swallows return to the same nesting area in successive years and frequently refurbish and reuse old nests. Old nests provide important cues contributing to nest site selection by adult and juvenile swallows. As such, it was hoped that relocation of the old nests into the nesting structure would encourage its use by swallows seeking nest sites.

The condo was installed in early March 2015 and monitoring of Barn Swallow nesting activity in the wooden structure, along with other buildings in the vicinity, took place in May 2015.



**Figure 10: Barn Swallow Nesting Condo Installed atop the Clowhom Dam**

## 4.7 Owl and Bat Habitat Enhancement

To inform community members about owl and bat conservation issues, encourage community participation in wildlife habitat enhancement efforts, and increase nesting and roosting habitat for owls and bats where suitable wildlife trees are lacking, we continued to work with community members of all ages to build owl nest boxes and bat houses. Fifty wildlife homes were constructed by community volunteers and local students (Figure 11). They were built and installed using construction plans and recommended best practices provided by reliable sources (e.g., Kaufman 2002, Cornell Lab of Ornithology 2013, Bat Conservation International), with modifications based on recent advice from experts. Bat houses included three different designs: maternity box, rocket box, and 'Uncle George' style houses. Owl nest boxes were specifically designed for Western Screech-Owls but would also suit other bird species, including Northern Saw-whet Owls.



**Figure 11: Sunshine Coast Community Members Build Bat Houses and Owl Nest Boxes**

The owl boxes and bat houses were installed at various sites on the Sunshine Coast. Ten were installed in the Clowhom watershed (Figures 12 and 13) and another 40 were installed by landowners and community members in parks and on private properties as part of a “*Homes for Wildlife*” community engagement and wildlife stewardship and monitoring program.



**Figure 12: Owl Nest Box Installation in the Clowhom Watershed**



**Figure 13: Bat House Installation in the Clowhom Watershed**

## 4.8 Public Outreach and Engagement

Public outreach and community engagement are important aspects of this project. We carried out a variety of different activities designed to engage Sunshine Coast residents in conservation of species at risk, and increase awareness of the wildlife stewardship efforts of Fish and Wildlife Compensation Program and its program partners BC Hydro, the Province of BC, Fisheries and Oceans Canada, First Nations and public stakeholders.

Between April 2015 and March 2016, we carried out 34 community outreach events, reaching over 4,000 community members of all ages (Table 2). We hosted outreach tables at 16 public events, passing out information, answering questions, and encouraging community members to sign up for the landowner stewardship program. We offered 7 workshops, including sessions on bat house building, owl nest box building, care of native bees, and monitoring of amphibians and bats. We provided special school programs for 9 classes, talking to the students about species at risk, and we organized 4 community work parties to enhance Sunshine Coast shoreline habitat by removing invasive weeds and planting native vegetation (Figure 14).

We also published 4 media articles, provided project updates on our website and Facebook page, and published and distributed a winter newsletter, which featured 5 pages of information on the Clowhom project. During all of our public outreach activities, and on all of our outreach materials, such as informational pamphlets and landowner stewardship agreements, we have been pleased to acknowledge FWCP's support of our wildlife and habitat stewardship efforts.



**Figure 14: Community Engagement Activities Included Shoreline Planting Work Parties**

**Table 2: Public Outreach and Engagement Activities, Year 3 (2015-2016)**

DATE	LOCATION	ACTIVITY	AUDIENCE	NUMBER
12-Apr-15	Coopers Green Park, Halfmoon Bay	Work Party - Shoreline Naturalization	Community Volunteers	10
13-Apr-15	Madeira Park Elementary, Madeira Park	Kids Program - Native bees	Grades K-7 Students	75
19-Apr-15	Redrooffs Trail, Halfmoon Bay	Work Party - Shoreline Naturalization	Community Volunteers	10
26-Apr-15	Earth Day Festival, Roberts Creek	Outreach Table	Community Members	500
05-May-15	Georgia Beach, Gibsons	Work Party - Shoreline Naturalization	Grades K-7 Students	25
06-Jun-15	Mixal Lake, Pender Harbour	Kids Program - Turtles	Pender Harbour Scouts	5
06-Jun-15	Egmont Day, Egmont	Outreach Table	Community Members	100
13-Jun-15	Garden Bay	Workshop - Bat Monitoring	Community Volunteers	20
22-Jun-15	Henderson Beach, Roberts Creek	Work Party - Shoreline Naturalization	Grade 6/7 Students	30
01-Jul-15	Canada Day Festival, Sechelt	Outreach Table	Community Members	500
04-Jul-15	Sargeant Bay Festival, Halfmoon Bay	Outreach Table	Community Members	50
12-Jul-15	Halfmoon Bay Fair, Halfmoon Bay	Outreach Table	Community Members	150
25-Jul-15	Sea Cavalcade, Gibsons	Outreach Table	Community Members	500
26-Jul-15	Sea Cavalcade, Gibsons	Outreach Table	Community Members	500
15-Aug-15	Creek Daze, Roberts Creek	Workshops & Outreach Table	Community Members	250
15-Aug-15	Sunshine Coast BioBlitz, Nelson Is.	Outreach	Scientists, Conservationists	15
16-Aug-15	Sunshine Coast BioBlitz, Nelson Is.	Outreach	Scientists, Conservationists	15
22-Aug-15	Synchronicity Festival, Langdale	Outreach Table	Community Members	150
23-Aug-15	Synchronicity Festival, Langdale	Outreach Table	Community Members	150
03-Oct-15	One Straw Festival, Roberts Creek	Workshops & Outreach Table	Community Members	200
14-Nov-15	Sechelt Legion, Sechelt	Workshops - Homes for Wildlife	Community Members	30
15-Nov-15	Sechelt Legion, Sechelt	Workshops - Homes for Wildlife	Community Members	30
02-Dec-15	West Sechelt Elementary	Kids Program - Owl Nest Boxes	Grade 6/7 Students	30
04-Dec-15	Davis Bay Elementary, Davis Bay	Kids Program - Owl Nest Boxes	Grades K-2 Students	25
04-Dec-15	Davis Bay Elementary, Davis Bay	Kids Program - Bat Houses	Grade 3/4 Students	25
05-Dec-15	Christmas Fair, Gibsons	Outreach Table	Community Members	125
06-Dec-15	Christmas Fair, Gibsons	Outreach Table	Community Members	125
08-Jan-16	Halfmoon Bay Elementary, Halfmoon Bay	Kids Program - Bat Houses	Grade 6/7 Students	30
26-Jan-16	Spider Homeschooling Program, Roberts Creek	Kids Program - Owl Nest Boxes	Grades K-3 Students	15
26-Jan-16	Spider Homeschooling Program, Roberts Creek	Kids Program - Bat Houses	Grades 4-7 Students	15
17-Feb-16	Cedar Grove Elementary	Kids Program - Owl Nest Boxes	Grade 1/2 Students	30
01-Mar-16	Brooks Wetland, Halfmoon Bay	Workshop - Amphibian Monitoring	Community Volunteers	5
04-Mar-16	Art Centre, Sechelt	Presentation - Clowhom Watershed	Natural History Soc. members	100
12-Mar-16	Seedy Saturday, Roberts Creek	Workshops & Outreach Table	Community Members	200
				<b>4040</b>

## 5.0 RESULTS

### 5.1 Pond-breeding Amphibians

Over the past three years, we have documented six species of pond-breeding amphibians within the wetlands of Clowhom watershed: Red-legged Frog (*Rana aurora*), Western Toad (*Anaxyrus boreas*), Pacific Chorus Frog (*Pseudacris regilla*), Northwestern Salamander (*Ambystoma gracile*), Long-toed Salamander (*Ambystoma macrodactylum*), and Roughskin Newt (*Taricha granulosa*) (Figure 15). During the 2015-2016 project year, we detected five of these six species (all except the Red-legged Frog).

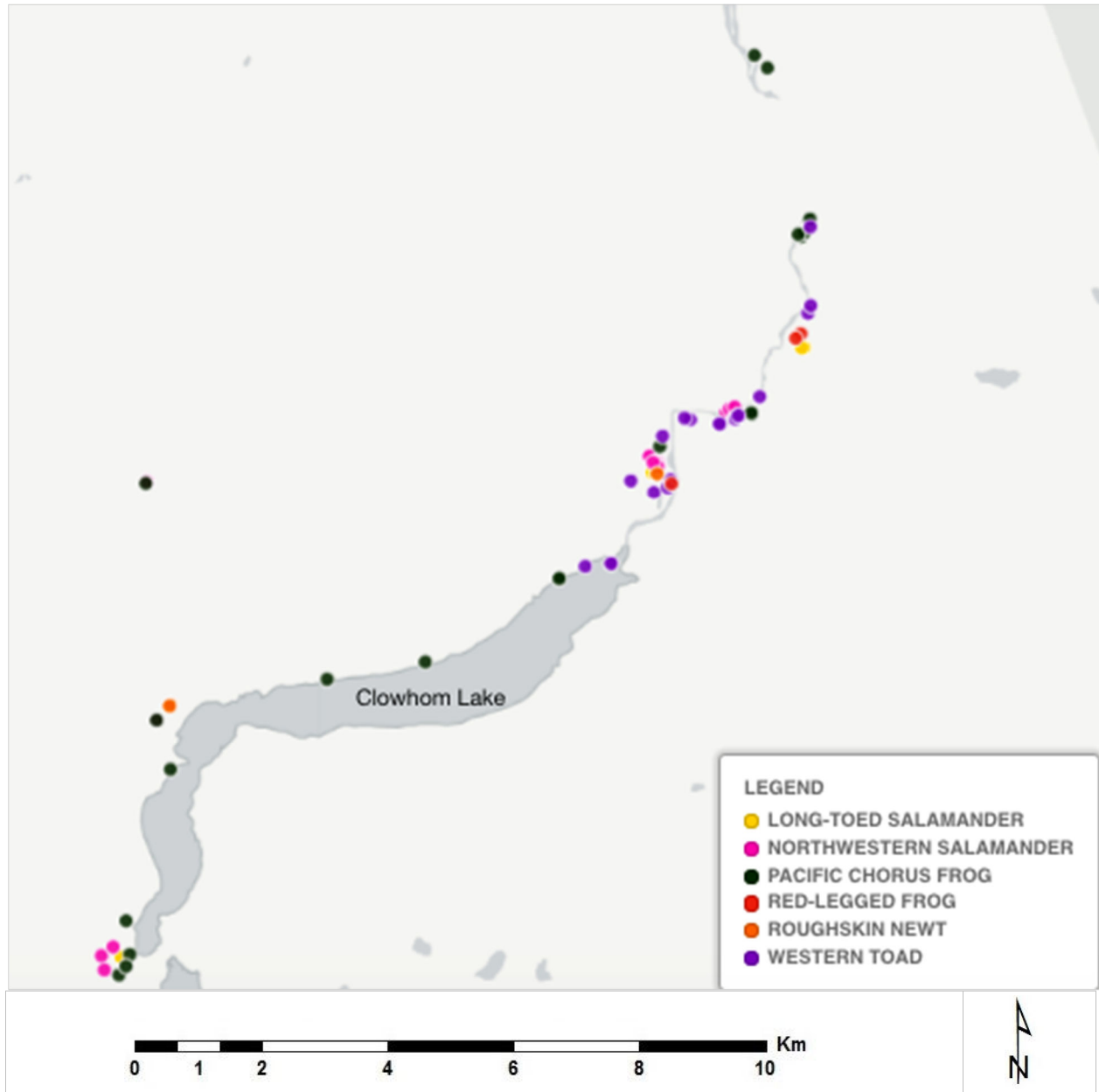


Figure 15: Detections of Pond-Breeding Amphibians in Clowhom, April 2013 to March 2016

Of the six pond-breeding amphibian species detected in the Clowhom watershed, two are officially listed as species at risk: Red-legged Frog and Western Toad. Both are blue listed in BC and species of special concern in Canada.

### **Red-legged Frog**

To date, Red-legged Frogs have only been observed at two spots in the Clowhom watershed (Wetlands 6 and 9) (Figure 16). The species laid eggs in these two wetlands in the spring of 2014, but no further observations of this species have been made since then, despite repeated surveys.

There were no detections of this species at any site in the Clowhom watershed during the 2015-2016 project year. The region experienced drought conditions during the spring and summer of 2015. Water levels were extremely low in Wetland 6 and the previously used breeding pond in Wetland 9 was completely dry.

### **Western Toad**

To date, Western Toad breeding activity has been observed at three locations within the Clowhom watershed (Wetlands 7, 9 and 10) (Figure 17). All three of these sites were used during the 2013 breeding season. However, since 2014, Toads have only been detected at one of these three known breeding sites (Wetland 7).

In April 2015, we detected two adult Western Toads and several large toad egg strings at Wetland 7, including over 2000 eggs close to hatching. At that time, water levels were high in the wetland because beaver activity had plugged a culvert. However, by May 2015, we observed dozens of toad tadpoles that had dried out in a ditch when they failed to follow the receding water after the culvert had been cleared.

In June 2015, we detected 3 adult toads near Wetland 7, and in July 2015 we found 1 adult toad on the road near km 19 of the Clowhom Mainline. Over the past three years, adult toads have been detected at a variety of spots along the Clowhom valley bottom (Figure 17), suggesting that the species may be breeding at additional spots in the watershed that we have yet to detect.

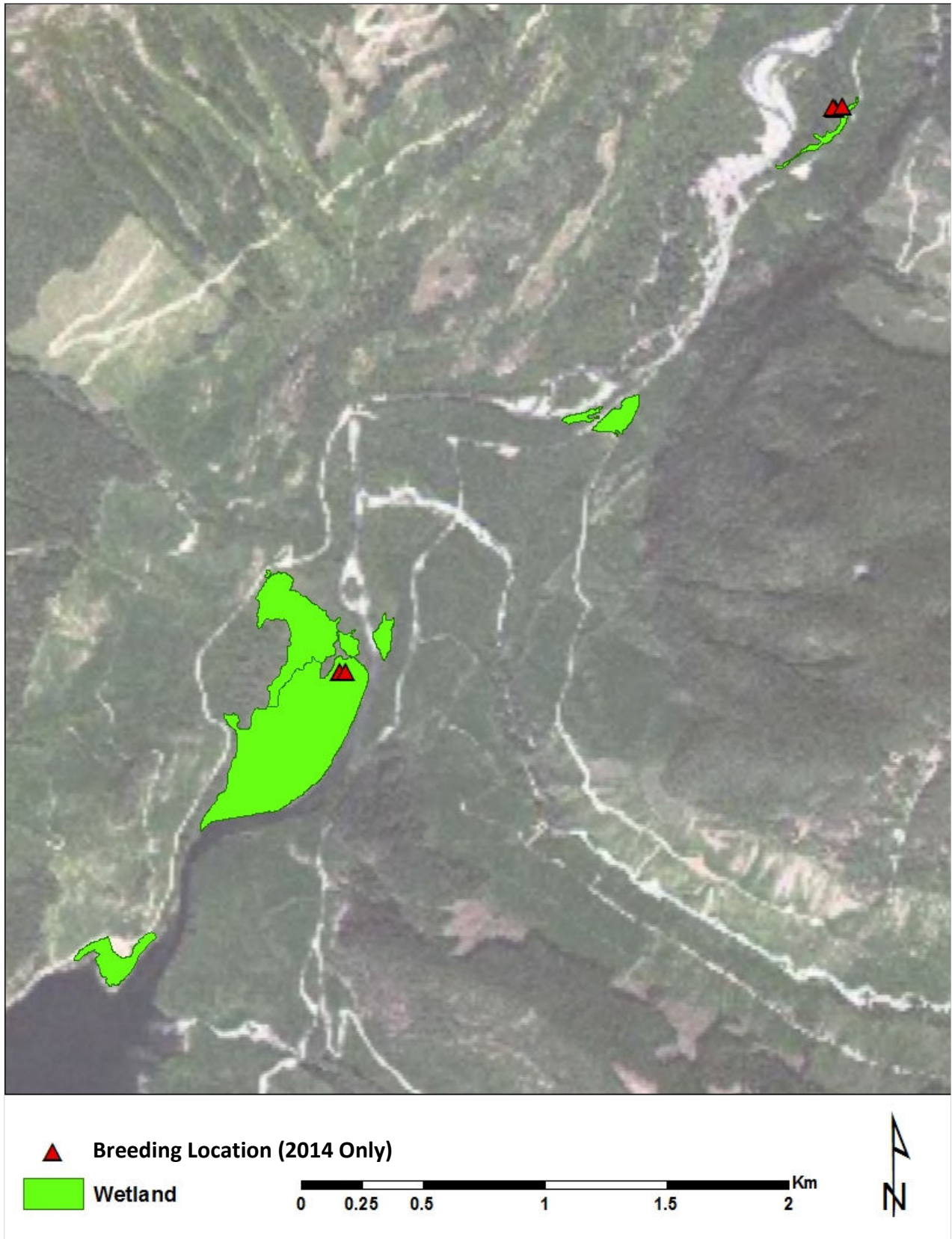


Figure 16: Red-legged Frog Detections in the Clowhom Watershed, 2013-2015

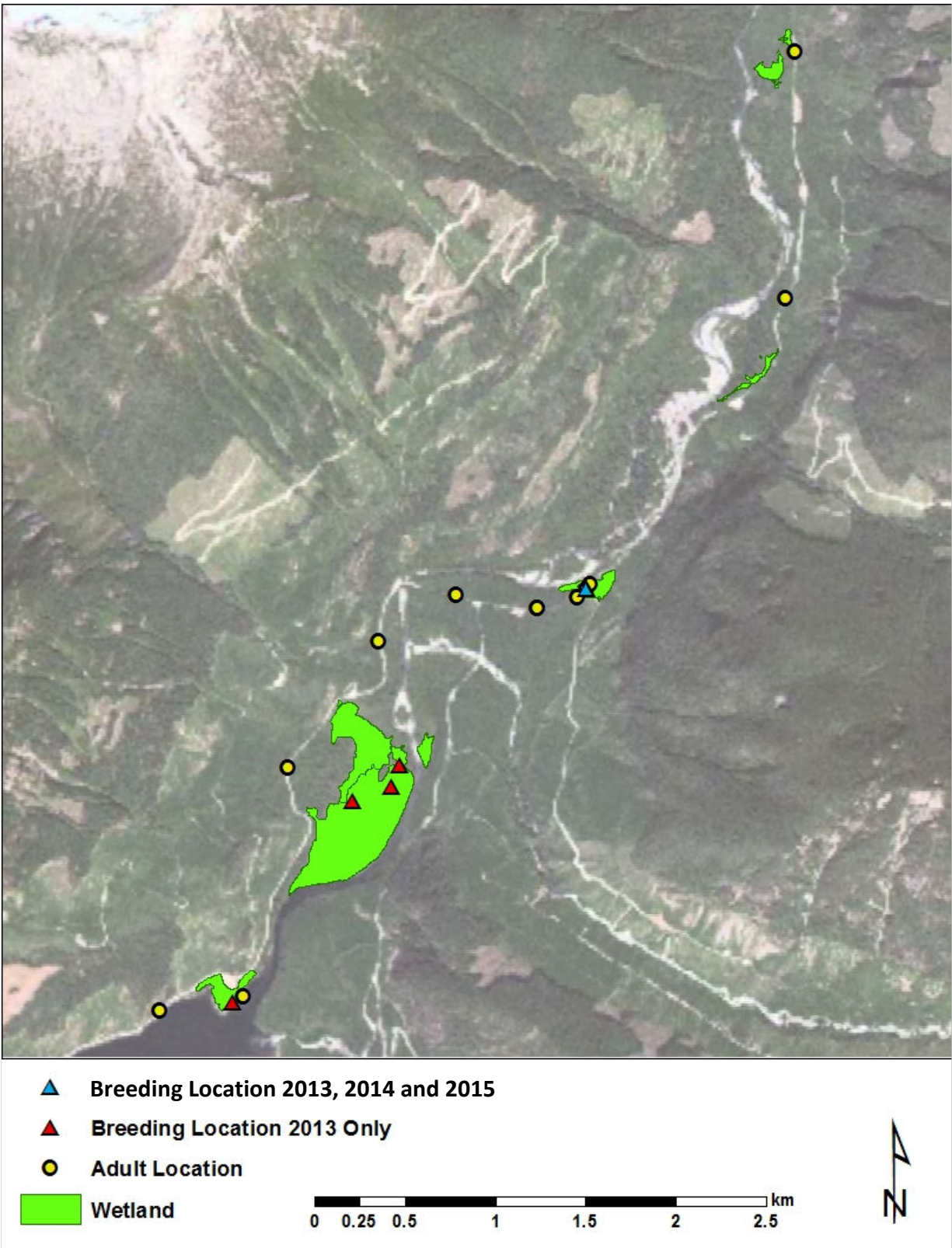


Figure 17: Western Toad Detections in the Clowhom Watershed, 2013-2015

## 5.2 Western Screech-Owls

Over the course of our surveys over the past three years, we have documented 26 Western Screech-Owl detections at 14 of 83 call-playback stations, while Barred Owls have been detected at 10 stations (Table 3, Figure 19).

Based on information from active and passive monitoring of owls over the past three years, we have delineated four Western Screech-Owl territories within the Clowhom watershed (Kai, Fisher, Middle, and Nagy). We were able to confirm that three of these four known territories (Kai, Fisher, and Middle territories) were occupied in 2015 (Table 4). In surveys in March 2016, a Western Screech-Owl pair was observed in Fisher territory.

In addition to the four known territories, we have identified one more potential territory present in the watershed. This site lies between the Kai and Fisher territories, near survey stations 007 and 007b. Individual Western Screech-Owls have been detected at this site on two occasions (March 2014 and April 2015). These observations may represent an additional occupied territory in the watershed, or they may represent failed attempts by juveniles to establish a territory. Further surveys are required to determine if there is indeed an additional occupied territory in this area.



**Figure 18: Western Screech-Owl Responds to a Call-Playback Survey in Clowhom Watershed**

**Table 3: Western Screech-Owl Call-Playback Survey Results, September 2013 to March 2016**

Survey Site	Location	UTM		Surveyed Dates			Western Screech-Owl Detections	Barred Owl Detections
		Datum: NAD 83		2013	2014	2015		
		UTM Zone: 10U						
		Easting	Northing					
001	Clowhom	471441	5518535	Y	Y	Y		
002	Clowhom	471618	5518011	Y	Y	Y		
003	Clowhom	471630	5517474	Y	Y	Y	Sept 2013 March 2014	
004	Clowhom	471659	5516947	Y	Y	Y		
004b	Clowhom	471649	5517121		Y	Y		
005a	Clowhom	471528	5516422	Y	Y	Y	May 2014 (2)	May 2014
005b	Clowhom	471621	5516708		Y	Y	May 2014 (2)	
006	Clowhom	471267	5515973	Y	Y	Y		
006b	Clowhom	471517	5516196			Y	April 2015	
007	Clowhom	470659	5515107	Y	Y	Y	March 2014	
007b	Clowhom	470400	5514903		Y	Y	April 2015	
008	Clowhom	470097	5514848	Y	Y	Y		
009	Clowhom	469673	5514939	Y	Y			Sept 2013
010	Clowhom	469367	5514554	Y	Y	Y		
011	Clowhom	468986	5514184	Y	Y	Y	March 2016 (2)	
012	Clowhom	468848	5513806	Y	Y	Y	March 2014 May 2014 (2) July 2015	
013	Reservoir	468745	5513302	Y	Y	Y	April 2015 March 2016	
014	Reservoir	468492	5512850	Y	Y			
015	Reservoir	466572	5511652	Y	Y	Y		
016	Reservoir	466135	5511378	Y	Y	Y		
017	Reservoir	465636	5511204	Y	Y	Y		
018	Reservoir	465105	5511094	Y	Y	Y	Sept 2013	July 2015
018b	Reservoir	464863	5511046		Y	Y	May 2014	
019	Reservoir	464618	5511008	Y	Y	Y	Sept 2013 (2) April 2015 March 2016	
019b	Reservoir	464437	5510999			Y		
020	Reservoir	464114	5510944	Y	Y	Y		
021	Reservoir	463162	5510752	Y	Y	Y		
022a	Reservoir	461792	5510063	Y		Y		
022b	Reservoir	461853	5510215		Y	Y	March 2014	April 2015
022c	Reservoir	462039	5510468		Y	Y	May 2014 (2)	
022d	Reservoir	461674	5510476			Y		
023	Reservoir	461684	5509563	Y	Y	Y		
024	Reservoir	461347	5509164	Y	Y	Y		Sept 2013
025	Reservoir	461238	5508671	Y		Y		Sept 2013
026	Reservoir	461400	5508196		Y	Y		
027	Reservoir	461352	5507647		Y	Y		
028	Reservoir	460979	5507240		Y	Y		March 2016
029	Clowhom	461036	5506728		Y			
030	Clowhom	461382	5506579		Y			
031	Clowhom	471711	5518760	Y	Y	Y		

**Table 3 (continued): Western Screech-Owl Call-Playback Survey Results**

Survey Site	Location	UTM		Surveyed			Western Screech-Owl Detections	Barred Owl Detections
		Datum: NAD 83		2013	2014	2015		
		UTM Zone: 10U						
		Easting	Northing					
031b	Clowhom	471776	5519022			Y		
032	Clowhom	471865	5519228	Y	Y			
033	Clowhom	471686	5519708	Y	Y	Y		March 2016
033b	Clowhom	471458	5519789			Y		April 2015
034	Clowhom	471265	5519919	Y	Y	Y		
034b	Clowhom	471068	5520138			Y		March 2016
035	Clowhom	470976	5520333	Y	Y	Y		
035b	Clowhom	470776	5520527			Y		
036	Clowhom	470617	5520729	Y	Y	Y		
036b	Clowhom	470557	5520957			Y		
037	Clowhom	470533	5521229	Y	Y			
038	Clowhom	470449	5521644	Y	Y	Y		
039	Clowhom	470147	5522075	Y	Y	Y		
040	Clowhom	469721	5522332	Y	Y	Y		
041	Clowhom	469272	5522796	Y	Y			
042	Clowhom	468828	5522794	Y	Y			
043	Clowhom	468357	5522618	Y	Y			
044	Clowhom	467474	5522662	Y				
044b	Clowhom	467304	5522635		Y			
045	Clowhom	467110	5522515	Y				
045b	Clowhom	467171	5522291		Y			
046	Powder	469855	5514511		Y			
047	Powder	469719	5514074		Y			
048	Powder	469577	5513654		Y			
049	Powder	469316	5513171		Y			
050	Powder	469247	5512699		Y			
051	Powder	469118	5512316		Y			
052	Clowhom	461617	5506877		Y			
056	Clowhom	462014	5506745		Y			
057	Bear	462735	5511626		Y	Y		
058	Bear	462396	5512042		Y	Y		
059	Bear	462144	5512446		Y	Y		
060	Bear	462104	5512857		Y	Y		
061	Bear	461890	5513315		Y	Y		
062	Bear	461532	5513949		Y	Y		
063	Bear	461018	5513922		Y	Y		
064	Bear	460598	5514084		Y			
065	Bear	460175	5514152		Y			
066	Bear	459827	5514583		Y			
067	Bear	459650	5514927		Y			
068	Bear	459537	5515420		Y			
069	Bear	459216	5515711		Y			
070	Bear	458954	5516023		Y			

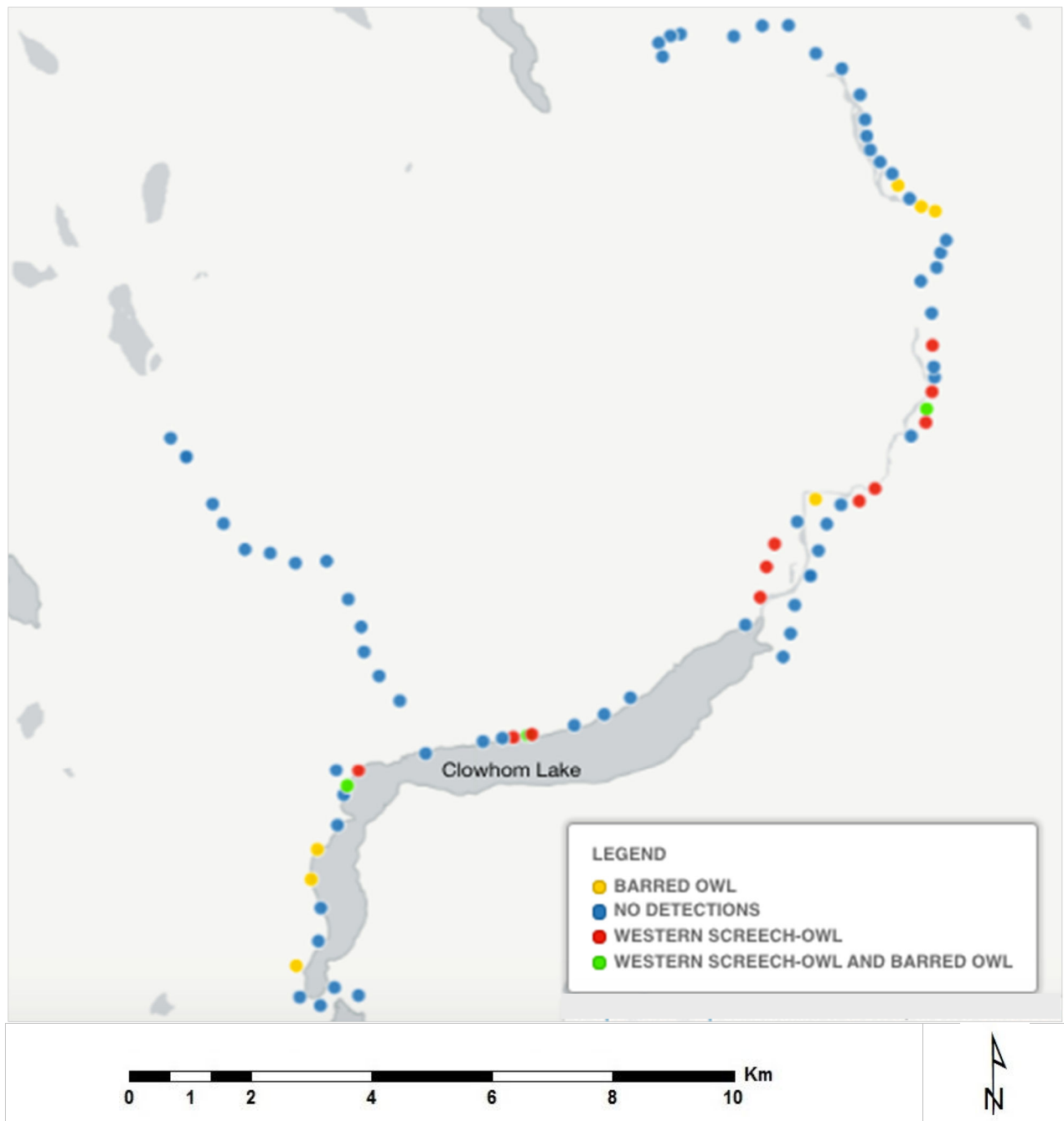


Figure 19: Western Screech-Owl and Barred Owl Detections, September 2013 to March 2016

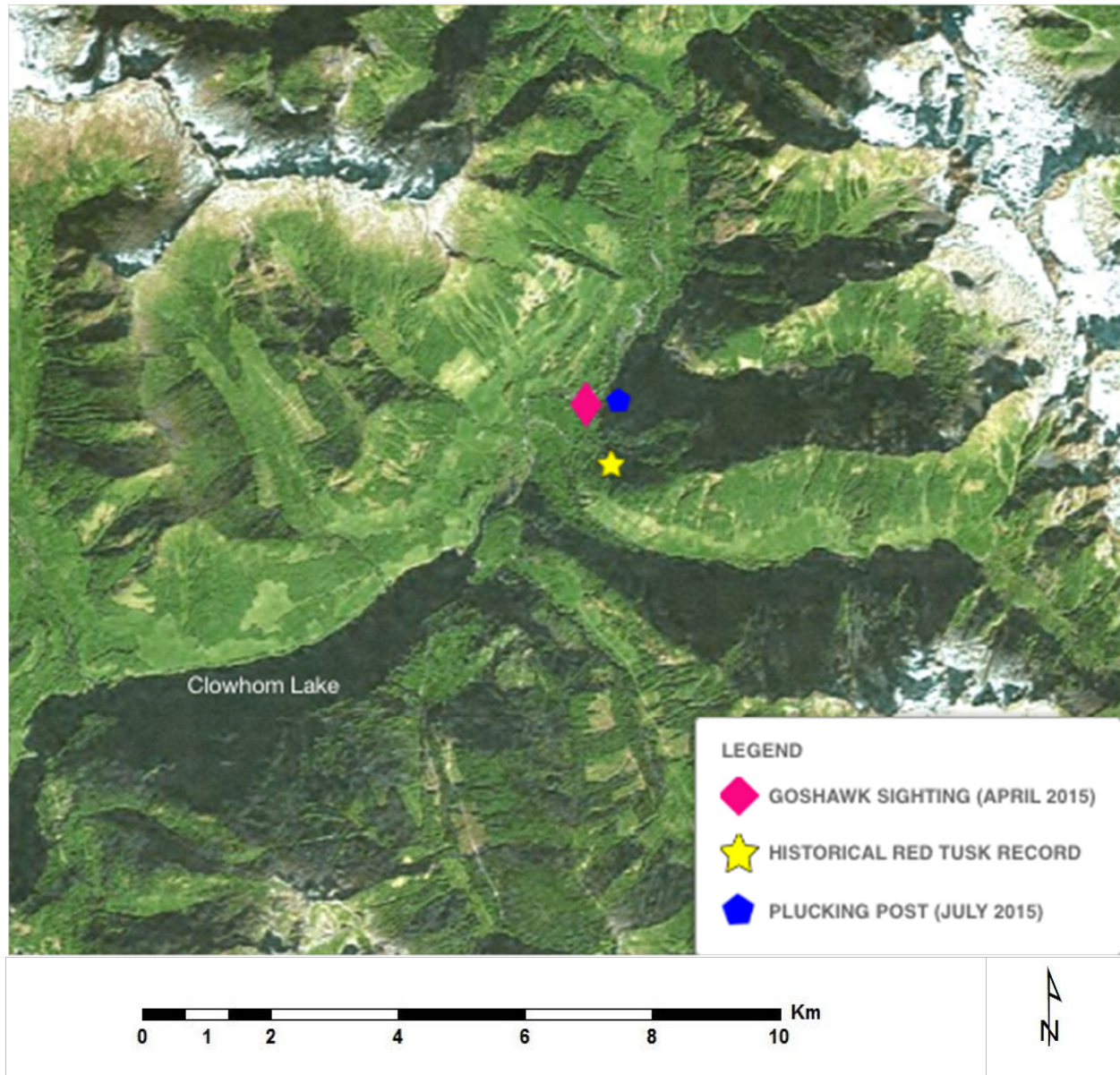
**Table 4: Summary of Western Screech-Owl Observations, September 2013-March 2016**

Screech Owl Territory and Summary of Observations	Documented Breeding Stage		
	2014	2015	March 2016
<p><b>Kai Territory (near stations 003 to 006)</b></p> <p>Male detected in September 2013            Pair and nest located near station 005b in early May 2014            Barred Owl also detected at station 005 in early May 2014            Pair observed at and near the nest in late May 2014            Adult observed making prey delivery to nest cavity in late June 2014            Confirmation of successful fledging of 1 juvenile in mid-July 2014            Adult detected in April 2015 at station 006b near Wetland 6</p>	Fledged	Occupied	Possible Detection
<p><b>Fisher territory (near stations 011 to 013)</b></p> <p>Male detected in March 2014            Pair detected in early May 2014            Only male observed in late May 2014            'Nest Grove' was delineated based on male calling at boundaries            Male was displaying behaviour of having an active nest            Several potential nest cavities were also located at this time            No detection of male or juveniles in late June or mid-July 2014            Male detections in April and July 2015            Pair detected in March 2016</p>	Nested	Occupied	Paired
<p><b>Middle Territory (near stations 018 and 019)</b></p> <p>Male detected in September 2013            Two males (Or possibly a pair with female making similar call) detected in March 2014 in different directions            No detections in early May 2014 after multiple sunset targeted surveys            Detections of male in late May, late June, and mid-July 2014            Detection of male in April 2015            Detection of male in March 2016            Attempts to survey in forest patch are difficult due to steep, dangerous terrain</p>	Occupied	Occupied	Occupied
<p><b>Nagy Territory (near stations 022b and 022c)</b></p> <p>Male detected in March 2013            Pair detected in early May 2014            Male and female detected in late May 2014 but male acting like a single bird            This may have been a failed nesting attempt and female was still in the territory            Male detected in late June 2014            No detections of any owls since June 2014 despite repeated surveys</p>	Paired	No Detections	No Detections
<p><b>Red Tusk Possible Territory (near stations 007 and 007b)</b></p> <p>Male detected in April 2014            Male detected in March 2015            Not enough observations to determine if this is a consistently occupied territory            Additional targeted surveys are required in this area</p>	Occupied	Occupied	No Detections

### 5.3 Northern Goshawks

We recorded no responses to Northern Goshawk call-playback surveys at any of the 29 call-playback stations surveyed in 2014 and 2015.

However, we did record an incidental detection of a juvenile Northern Goshawk in April 2015 at Wetland 7, and in July 2015 found a possible Northern Goshawk plucking post while doing a call playback transect in the Red Tusk area. Both of these sightings were in the vicinity of the historical Red Tusk Northern Goshawk record (Figure 20).



**Figure 20: Detections of Juvenile Northern Goshawk and Plucking Post 2015**

## 5.4 Bats

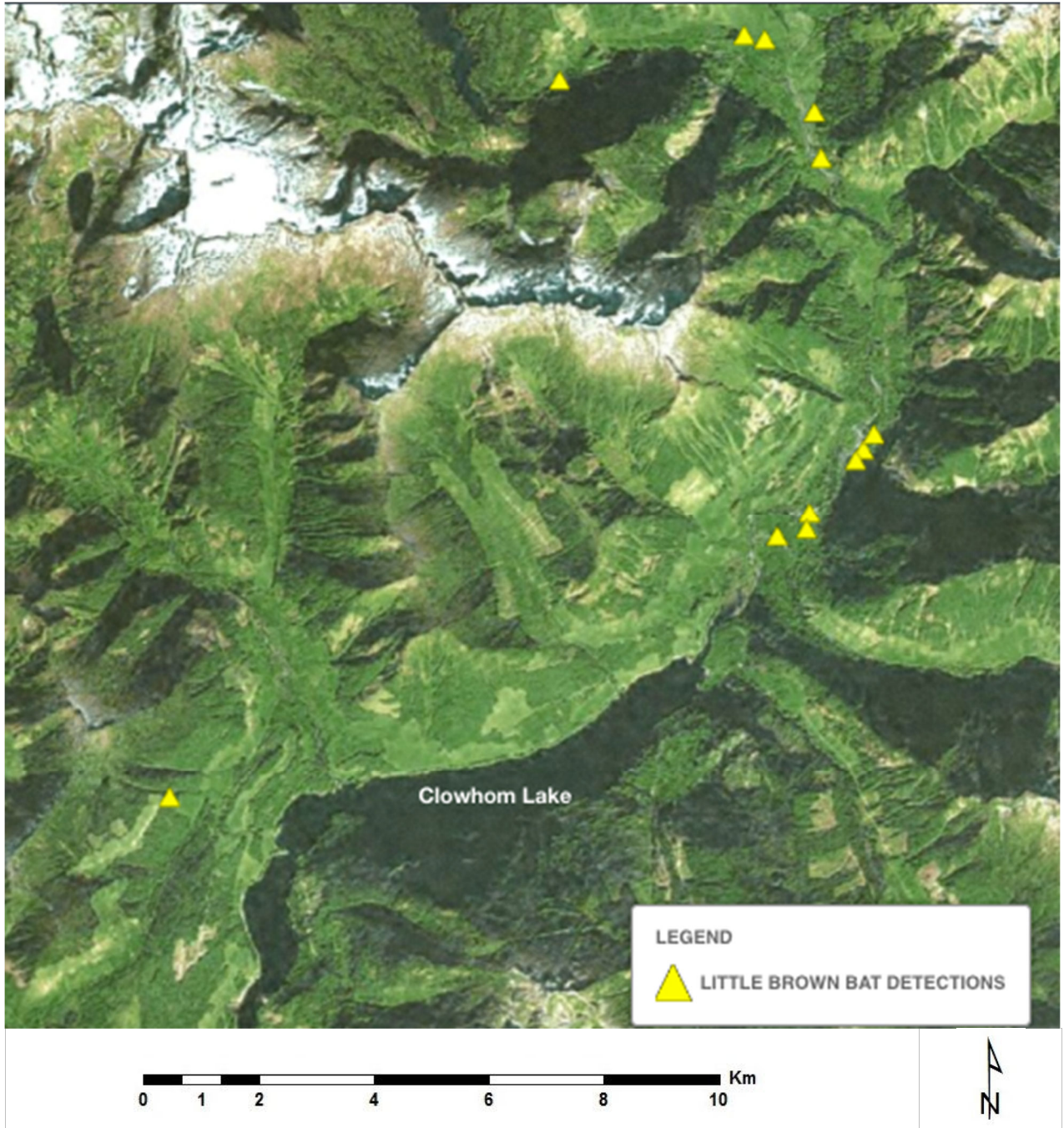
During our acoustic surveys in 2015, we recorded a minimum of five different bat species at the three sites surveyed (Wetland 1, Wetland 8 and Wetland 15) (Table 5). All three survey location had more than one bat species present. Most species were detected at more than one location, with the exception of Long-eared Myotis, detected only at Wetland 1.

Of particular interest is the federally endangered Little Brown Bat (*Myotis lucifugus*), a species that has been devastated by the arrival of White Nose Syndrome in eastern North America. During mist net and acoustic surveys over the past two years, this species at risk was detected at 14 sites in the Clowhom watershed (Figure 21).

**Table 5: Results of Bat Acoustic Surveys in Clowhom Watershed 2015**

Location	UTM		Species Recorded
	Datum: NAD 83		
	UTM Zone: 10U		
	Easting	Northing	
<b>Wetland 1:</b> Off Clowhom Mainline Km 24	470638	5520706	<b>MYLU</b> - Little Brown Bat ( <i>Myotis lucifugus</i> ) <b>MYEV</b> - Long-eared Myotis ( <i>Myotis evotis</i> ) <b>LACI</b> - Hoary Bat ( <i>Lasiurus cinereus</i> ) <b>LANO</b> - Silver-haired Bat ( <i>Lasionycteris noctivagans</i> ) <b>MYCA / MYYU</b> - California or Yuma Myotis ( <i>Myotis californicus</i> or <i>Myotis yumanensis</i> ) <b>MYLU / MYVO</b> - Little Brown or Long-legged Myotis ( <i>Myotis lucifugus</i> or <i>Myotis volans</i> ) <b>EPFU/LANO</b> - Big Brown Bat or Silver-haired Bat ( <i>Eptesicus fuscus</i> or <i>Lasionycteris noctivagans</i> )
<b>Wetland 8:</b> Northern part of large wetland complex, end of the Clowhom Reservoir at confluence with Clowhom River	469222	5514238	<b>MYLU</b> - Little Brown Bat ( <i>Myotis lucifugus</i> ) <b>LACI</b> - Hoary Bat ( <i>Lasiurus cinereus</i> ) <b>LANO</b> - Silver-haired Bat ( <i>Lasionycteris noctivagans</i> ) <b>MYCA / MYYU</b> - California or Yuma Myotis ( <i>Myotis californicus</i> or <i>Myotis yumanensis</i> )
<b>Wetland 15:</b> Up Nagy FSR, on first spur, under the transmission lines	461604	5510429	<b>MYLU</b> - Little Brown Bat ( <i>Myotis lucifugus</i> ) <b>MYCA / MYYU</b> - California or Yuma Myotis ( <i>Myotis californicus</i> or <i>Myotis yumanensis</i> ) <b>MYLU / MYVO</b> - Little Brown or Long-legged Myotis ( <i>Myotis lucifugus</i> or <i>Myotis volans</i> ) <b>EPFU/LANO</b> - Big Brown Bat or Silver-haired Bat ( <i>Eptesicus fuscus</i> or <i>Lasionycteris noctivagans</i> )

\*Species grouped together represent recordings that could not be identified to any greater detail due to similarities in the calls of the two species (e.g., MYCA/MYYU, MYLU/MYVO, and EPFU/LANO).



**Figure 21: Little Brown Bat Detections in the Clowhom Watershed, 2014 and 2015**

## 5.5 Coastal Tailed Frogs

In the past two years, we have documented at least 40 sites in the Clowhow watershed that have habitat that appears suitable for Coastal Tailed Frogs. Environmental DNA (eDNA) surveys confirmed that the species was present in all 9 of the creeks sampled in 2014 (Table 6). An additional 8 sites were surveyed using eDNA in 2015 and those results are pending.

In addition to the eDNA surveys, this year we also carried out hand searches for Coastal Tailed Frogs at two sites. Three tadpoles were detected above the upper Bear Hydro Power Station in July 2015, and a large adult male Tailed Frog was spotted at Km 31 near the Clowhom Power upper head pond in September 2015.



**Figure 22: Detection of Coastal Tailed Frog Tadpole in Bear Creek**

**Table 6: Identified Creeks with Suitable Habitat for Coastal Tailed Frogs in Clowhom**

Survey Site	UTM		Surveys Results	
	Datum: NAD 83		eDNA Survey	Hand Survey <sup>1</sup>
	UTM Zone: 10U			
	Easting	Northing		
<b>Sites Surveyed for Tailed Frogs</b>				
ASTR02 - "Elizabeth Creek"	470249	5521873	Positive	N/A
ASTR04 - "Thermometer Creek"	471656	5519736	Positive	N/A
ASTR07 - "Dipper Nest Creek"	469337	5514725	Positive	N/A
ASTR18 - "Maybe Creek"	471164	5515913	Positive	N/A
ASTR23 - "Valley Creek"	461613	5513855	Positive	N/A
ASTR25 - "Nagy Creek"	461761	5509992	Positive	N/A
ASTR37 - "Bear Creek"	459787	5514681	Positive	3 tadpoles
ASTR16 - "Tadpole Creek"	458934	5516053	Positive	35 tadpoles
ASTR05 - "Detection Creek"	471645	5517269	Positive	1 metamorph
ASTR06 – "Forgotten Creek"	471544	5516263	Pending <sup>2</sup>	N/A
ASTR13 – "Km 8"	464056	5510945	Pending <sup>2</sup>	N/A
ASTR15 – "Dan's Stream"	463060	5510826	Pending <sup>2</sup>	N/A
ASTR21 – "Rivendell"	467310	5512210	Pending <sup>2</sup>	N/A
ASTR29 – "Mysterioso"	467113	5522508	Pending <sup>2</sup>	N/A
ASTR33 – "Jameson Creek"	467109	5522515	Pending <sup>2</sup>	N/A
ASTR37 – "Clowhom River"	466592	5521914	N/A	1 adult frog
ASTR09	468725	5513206	N/A	No detections
ASTR20	469014	5514213	N/A	No detections
ASTR25B	461349	5510224	N/A	No detections
ASTR27	461348	5510224	N/A	No detections
ASTR29	469679	5522334	N/A	No detections
ASTR35	470809	5515279	N/A	No detections
ASTR36	469596	5515197	N/A	No detections
<b>Sites with Suitable Habitat Not Yet Surveyed for Tailed Frogs</b>				
ASTR01	470092	5522112	N/A	N/A
ASTR03	470364	5521758	N/A	N/A
ASTR08	468821	5513922	N/A	N/A
ASTR10	464985	5511069	N/A	N/A
ASTR11	464382	5511003	N/A	N/A
ASTR12	464216	5510986	N/A	N/A
ASTR14	463920	5510892	N/A	N/A
ASTR17	460813	5514044	N/A	N/A
ASTR22	465161	5511110	N/A	N/A
ASTR26	461254	5509930	N/A	N/A
ASTR26B	460774	5509914	N/A	N/A
ASTR28	469837	5522274	N/A	N/A
ASTR30	469453	5522581	N/A	N/A
ASTR30B	469255	5522795	N/A	N/A
ASTR31	467503	5522669	N/A	N/A
ASTR32	467259	5522587	N/A	N/A
ASTR34	466357	5521945	N/A	N/A

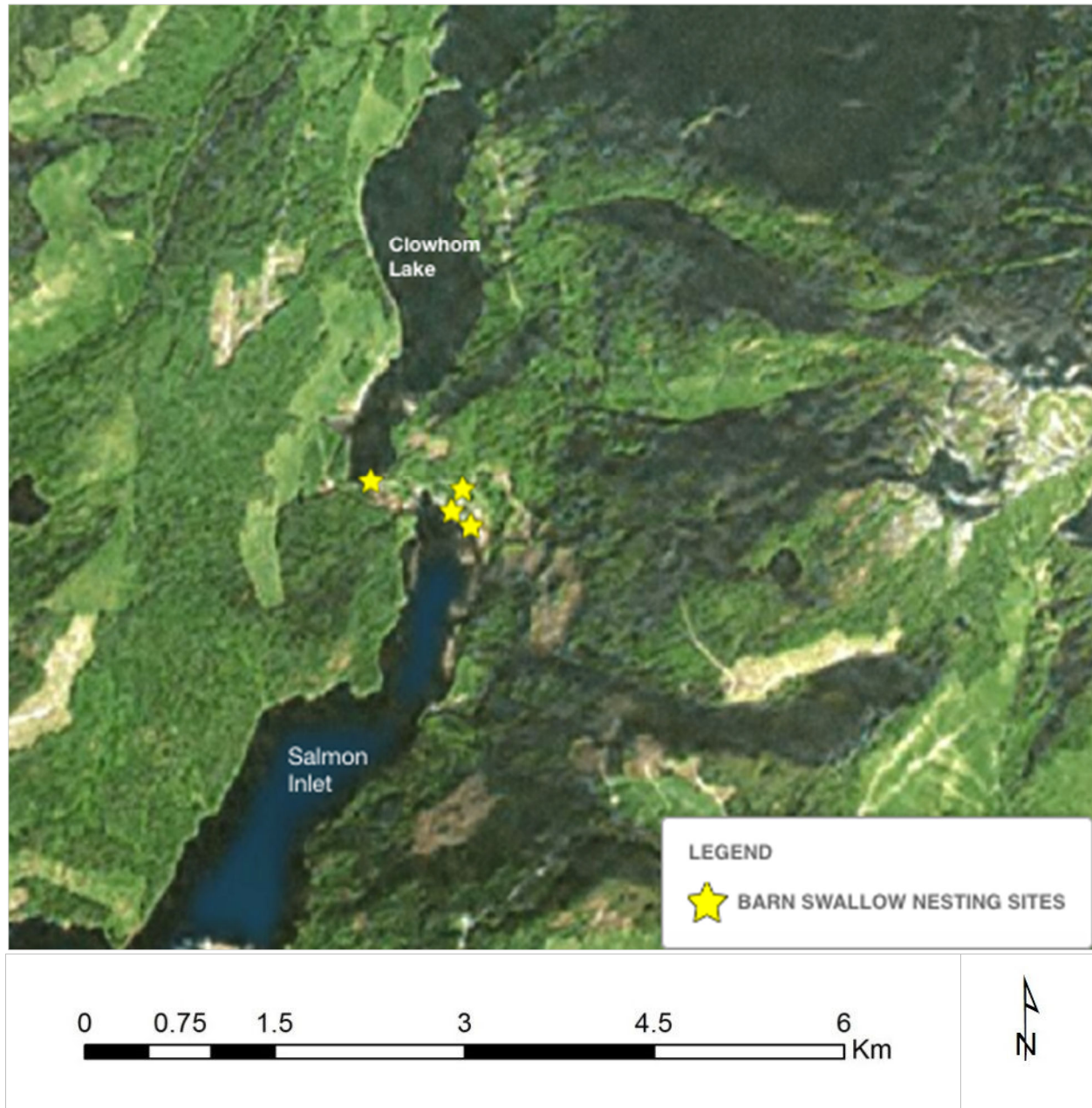
<sup>1</sup>Time-constrained searches all took place in July 2014, except for the detection at Tadpole Creek which was the result of an informal hand search in August 2014 in conjunction with eDNA sample collection, and Bear Creek and Clowhom River, where informal hand searches took place in July and September 2015.

<sup>2</sup>Environmental DNA lab results from samples collected in October 2015 are still pending.

## 5.6 Barn Swallows

In May 2015, we observed five active Barn Swallow nests near the Clowhom Dam and surrounding properties (Figure 23). Two pairs nested inside our newly installed manmade Barn Swallow condo atop the Clowhom dam (Figure 24), including one pair that appeared to be using one of the relocated nests. Another pair was observed nesting inside the concrete hoist tower.

Two pairs of swallows nested in structures close to the dam; one in a makeshift storage space with two containers as walls (Figure 25), and the other in a floating building on a log boom. A BC Hydro bunk house that had been the site of swallow nests in 2014, was not used by nesting swallows in 2015.



**Figure 23: Known Barn Swallow Nesting Locations in the Clowhom Watershed**



**Figure 24: At Least Two Barn Swallow Pairs Nested in the Wooden Condo atop the Clowhom Dam**



**Figure 25: One Barn Swallow Pair Nested inside a Temporary Storage Space**

## 5.7 Other Wildlife

In addition to the species that have been the focus of our targeted surveys, we have also detected numerous other animals in the Clowhom watershed. Over the past three project years we have recorded 127 vertebrate species (91 bird species, 8 amphibians, 20 mammals, 6 fish, and 2 reptiles) (Table 7). They include 33 species of conservation concern, including 14 provincially listed species at risk, 12 federally listed species, 9 Pacific Birds Habitat Joint Venture Priority Bird Species in BC, 11 Partners in Flight Species of Continental Importance in the Pacific Avifauna Biome, and 4 species listed as Identified Wildlife under the BC Forest and Range Practices Act.



**Figure 26: Red-tailed Hawk, one of 91 Bird Species Detected in the Clowhom Watershed**



**Figure 27: Roosevelt Elk, one of 20 Mammal Species Detected in the Clowhom Watershed**

**Table 7: Vertebrate Species Detected in Clowhom Watershed, April 2013 - March 2016**

<b>FISH</b>		
<b>Coastal Cutthroat Trout</b> <sup>B,SC</sup>	Dolly Varden	Threespine Stickleback
Rainbow Trout	Western Brook Lamprey	Sculpin sp.
<b>AMPHIBIANS</b>		
<b>Coastal Tailed Frog</b> <sup>B,SC, IW</sup>	<b>Western Toad</b> <sup>B,SC</sup>	Ensatina
Pacific Chorus Frog	Northwestern Salamander	Rough-skinned Newt
<b>Red-legged Frog</b> <sup>B,SC, IW</sup>	Long-toed Salamander	
<b>REPTILES</b>		
Terrestrial Garter Snake	Northern Alligator Lizard	
<b>MAMMALS</b>		
American Beaver	<b>Little Brown Bat</b> <sup>E</sup>	Cougar
Douglas Squirrel	Long-legged Myotis	Grey Wolf
North American Water Vole	Yuma Myotis	North American River Otter
Snowshoe Hare	Big Brown Bat	American Black Bear
Silver-haired Bat	Hoary Bat	<b>Roosevelt Elk</b> <sup>B</sup>
California Myotis	Big Free-tailed Bat	Columbia Black-tailed Deer
Long-eared Myotis	Bobcat	
<b>BIRDS</b>		
Canada Goose	Vaux's Swift	Townsend's Solitaire
<b>Trumpeter Swan</b> <sup>PBHJV</sup>	<b>Rufous Hummingbird</b> <sup>PIF</sup>	Swainson's Thrush
<b>Wood Duck</b> <sup>PBHJV</sup>	<b>Belted Kingfisher</b> <sup>PBHJV</sup>	Hermit Thrush
<b>Mallard</b> <sup>PBHJV</sup>	<b>Red-breasted Sapsucker</b> <sup>PIF</sup>	American Robin
Green-winged Teal	Hairy Woodpecker	<b>Varied Thrush</b> <sup>PIF</sup>
<b>Harlequin Duck</b> <sup>PBHJV</sup>	Northern Flicker	American Pipit
<b>Bufflehead</b> <sup>PBHJV</sup>	Pileated Woodpecker	Cedar Waxwing
Hooded Merganser	<b>Olive-sided Flycatcher</b> <sup>B, T, PIF</sup>	Orange-crowned Warbler
Common Merganser	Western Wood-Pewee	Yellow Warbler
Ruffed Grouse	<b>Willow Flycatcher</b> <sup>PIF</sup>	Yellow-rumped Warbler
Sooty Grouse	Hammond's Flycatcher	<b>Black-throated Gray Warbler</b> <sup>PIF</sup>
<b>Common Loon</b> <sup>PBHJV</sup>	<b>Pacific-slope Flycatcher</b> <sup>PIF</sup>	Townsend's Warbler
Pied-billed Grebe	Cassin's Vireo	MacGillivray's Warbler
<b>Great Blue Heron</b> <sup>B, SC, PBHJV, IW</sup>	Hutton's Vireo	Common Yellowthroat
Turkey Vulture	Warbling Vireo	Wilson's Warbler
Osprey	Red-eyed Vireo	Spotted Towhee
<b>Bald Eagle</b> <sup>PBHJV, PIF</sup>	Gray Jay	Savannah Sparrow
Cooper's Hawk	<b>Steller's Jay</b> <sup>PIF</sup>	Song Sparrow
<b>Northern Goshawk</b> <sup>R, T, IW</sup>	Common Raven	White-crowned Sparrow
Red-tailed Hawk	Tree Swallow	<b>Golden-crowned Sparrow</b> <sup>PIF</sup>
<b>Peregrine Falcon</b> <sup>B, SC</sup>	<b>Violet-green Swallow</b> <sup>PBHJV</sup>	Dark-eyed Junco
Killdeer	Northern Rough-winged Swallow	Western Tanager
Spotted Sandpiper	<b>Barn Swallow</b> <sup>B, T</sup>	Black-headed Grosbeak
Wilson's Snipe	Black-capped Chickadee	Red-winged Blackbird
Mew Gull	<b>Chestnut-backed Chickadee</b> <sup>PIF</sup>	<b>Western Meadowlark</b> <sup>R</sup>
<b>Band-tailed Pigeon</b> <sup>B, SC, PIF</sup>	Red-breasted Nuthatch	Brewer's Blackbird
Eurasian Collared-Dove	Brown Creeper	Brown-headed Cowbird
<b>Western Screech-Owl</b> <sup>B, T</sup>	Pacific Wren	Pine Siskin
Northern Pygmy-Owl	American Dipper	American Goldfinch
Barred Owl	Golden-crowned Kinglet	
<b>Black Swift</b> <sup>B, E</sup>	Ruby-crowned Kinglet	
<p><sup>B</sup> = Blue-listed in BC, <sup>R</sup> = Red-listed in BC, <sup>IW</sup> = Identified Wildlife under the BC Forest and Range Practices Act,  <sup>E</sup> = Federally Endangered, <sup>T</sup> = Federally Threatened, <sup>sc</sup> = Federal Species of Special Concern  <sup>PBHJV</sup> = Pacific Birds Habitat Joint Venture Priority Species in BC  <sup>PIF</sup> = Partners in Flight Species of Continental Importance in the Pacific Avifauna Biome</p>		

## 6.0 DISCUSSION

### 6.1 Pond-breeding Amphibians

The Sunshine Coast supports six amphibian species that breed in water bodies such as ponds, lakes, wetlands, marshes, sloughs, ditches and slow-moving streams: Red-legged Frog (*Rana aurora*), Western Toad (*Anaxyrus boreas*), Pacific Chorus Frog (*Pseudacris regilla*), Northwestern Salamander (*Ambystoma gracile*), Roughskin Newt (*Taricha granulosa*), and Long-toed Salamander (*Ambystoma macrodactylum*) (Figure 28). Our surveys confirm that Clowhom watershed is home to all six of these species.

Of particular conservation concern are the two pond-breeding amphibians officially designated as species at risk: Western Toad and Red-legged Frog. Both species are provincially blue-listed and federally listed as species of special concern (COSEWIC 2002a, COSEWIC 2002b). The Western Toad is one of the few Canadian amphibians on the IUCN Red List of Threatened Species (category “Near Threatened”) (IUCN 2014). The Red-legged Frog is classified as Identified Wildlife and afforded special protection under the BC Forest and Range Practices Act (IWMS 2004d).



Figure 28: Long-toed Salamander in the Clowhom watershed

## **Western Toads**

In 2013, we documented Western Toad breeding sites at three locations in the Clowhom watershed (Wetlands 7, 9 and 10). However, in the years since, breeding has been observed at only one of these three sites (Wetland 7).

**Wetland 7:** This location appears to be the most reliable Western Toad breeding site discovered thus far in the watershed. Unlike the other two sites, it is not connected to the Clowhom Reservoir and thus is unaffected by water level fluctuations associated with BC Hydro operations. Transmission lines run through this wetland, and maintenance of the hydro right of way at this site has promoted high habitat quality by creating open, warm wetland pools (Evelyn et al. 2014).

This year, beaver activity had plugged a road culvert, keeping water levels high in the wetland in April 2015. But by late May 2015, the culvert had been cleared and we observed over 100 tadpoles and salamander larvae, that had dried out in a puddle, likely because they failed to follow the receding water. They included Western Toads, Chorus Frogs, and Northwestern Salamanders. To avoid this problem in the future, we recommend installation of a beaver baffle in the culvert at Wetland 7. The level of the baffle should be set to protect the road from flooding while maintaining the water level high enough that there is less chance the wetland will dry out before amphibians can complete their metamorphosis.

The number of toad larvae observed in Wetland 7 over the past three years (approximately 2,000 eggs or tadpoles each year) suggests there may be only a few toads breeding in the wetland (one female Western Toad can produce 5,000 to 16,500 eggs in a single breeding season) (COSEWIC 2002b).

Road mortality is a potential concern at this location as the breeding site is located right beside the Clowhom Main Forest Service Road. However, road traffic is light and over the past three years we have not detected any roadkill or observed any toadlets on the road. It is possible that juvenile toads are dispersing away from the breeding pond in the direction away from the roadway. We will continue to monitor the site to try and track the path of dispersing toadlets. If road mortality ever becomes a problem, possible mitigation options include signage, fencing, and/or a road crossing structure.

To avoid harming toads at this breeding site, we recommend that maintenance of the transmission line right of way should take place earlier than April or later than August to avoid disturbing the habitat when developing toads may be present.



**Figure 29: Western Toad in Clowhom Watershed, July 2015**

**Wetland 9:** This downstream portion of the large wetland complex at the mouth of the Clowhom River and experiences frequent and unpredictable water level fluctuations as the result of BC Hydro operations (Evelyn et al. 2014). No Western Toads were detected in Wetland 9 this year. In late April 2015, the site was very dry and there was no water observed in the previously used toad breeding ponds within the wetland.

**Wetland 10:** This location is a small sedge marsh at the edge of Clowhom Reservoir. Like Wetland 9, the site is subject to periods of inundation and drawdown due to BC Hydro operations (Evelyn et al. 2014). There was no evidence of Western Toad breeding at the site this year. By late April 2015, the pool in this wetland was dry and not suitable for breeding. We recommend installation of a wildlife-friendly pond liner in the existing pond at this site, in order to maintain water levels longer into the amphibian breeding season (please see section 6.8 of this report).

### **Red-legged Frogs**

We have detected very few Red-legged Frogs in Clowhom wetlands compared with wetlands in other regions of the Lower Sunshine Coast where this species is common and abundant. To date, Red-legged Frogs have been detected at only two sites in the basin: Wetland 6 and Wetland 9.

**Wetland 6:** This is a small swamp within a largely intact patch of mature riparian forest. In 2014, Red-legged Frogs laid eggs in shallow pools within the site. This year, water levels were very low throughout the spring and summer and no red-legged Frog egg masses or tadpoles were detected.

**Wetland 9:** Situated at the mouth of the Clowhom River where it meets the reservoir, this large wetland complex contains a diversity of wetland subclasses, including marsh, bog, fen and riparian floodplain. The downstream section of the wetland complex has a dramatically fluctuating water table, subject to frequent inundation and draw down related to changing reservoir levels. Water levels can change by over a meter in a matter of days. This year Wetland 9 was very dry; by late April 2015 there was no water present in the previously used Red-legged Frog breeding pond within the site. Coastal British Columbia experienced extreme drought conditions in 2015, which undoubtedly reduced available breeding habitat for Red-legged Frogs along with other amphibian species in Clowhom this year.

Outside of Wetlands 6 and 9, Red-legged Frogs have not been detected in any of the other surveyed Clowhom wetlands, despite the fact that many other sites (i.e., Wetlands 1, 2, 3, 4, 5 and 14) appear to provide excellent potential breeding habitat for the species. Despite considerable survey effort, the last detection of this species in Clowhom was in May 2014. However, it is possible that Red-legged Frogs may yet be present in some of these wetlands but at very low densities making them difficult to detect. During the 2016/2017 project year, in addition to shoreline surveys and live trapping, we intend to use environmental DNA (eDNA) surveys to determine if Red-legged Frogs are present in small numbers in any of the wetlands in the watershed.

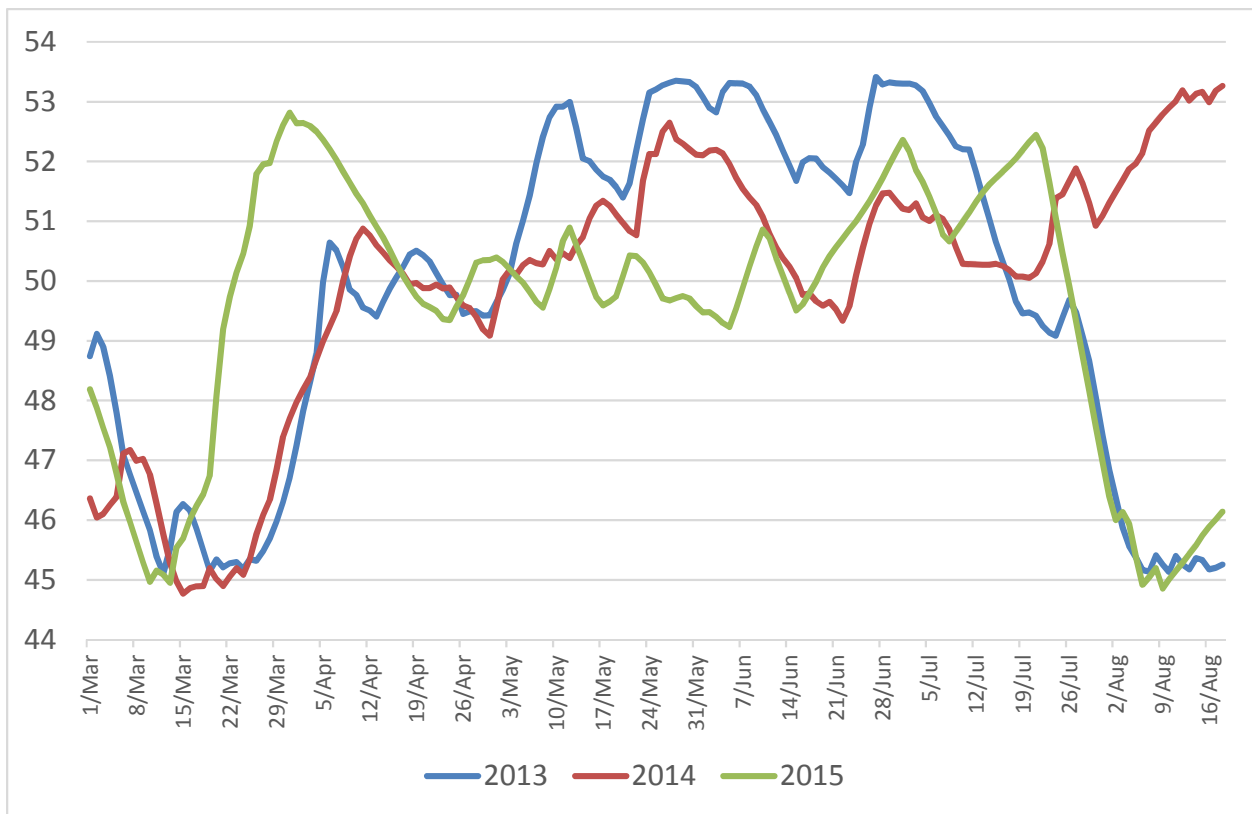
### **Impact of Water Level Fluctuations on Pond-breeding Amphibians in Clowhom**

One of the most significant threats facing amphibian populations in the Clowhom watershed is the dramatic and unpredictable variation in water levels due to hydro activity which can result in water levels rising or falling by a meter or more over the course of a single week (Figure 30). In 2015, Clowhom reservoir levels dropped more than 3 meters during amphibian egg-laying season from late March to late April.

In wetlands immediately adjacent to the Clowhom reservoir, rapidly changing water heights are directly impacting breeding sites for threatened Red-legged Frogs and Western Toads. Both Wetland 9 and 10 offer high quality amphibian habitat when water levels are sufficient. However, the frequent water level fluctuations appear to be negatively affecting breeding success.

If water levels are high when egg laying begins, amphibians are able to find suitable sites upon which to attach their egg masses. However, if water levels then drop before the eggs can hatch, the egg masses will become stranded on land and will die. Alternately, if the water is severely drawn down at the time of egg-laying then there are insufficient attachment points for egg masses, and amphibians are forced to lay in very shallow pools. Such pools are at risk of drying out before amphibian larvae have sufficient time to complete their metamorphosis.

Rapid increases in water levels can wash away egg masses and inundate breeding sites with cold water from the reservoir, impeding development of amphibian larvae. Inundation can also increase predation risks by enabling fish to move into the formerly fish-free areas where amphibians prefer to breed.



**Figure 30: Clowhom Reservoir levels (m) during amphibian breeding season 2013-2015**

## **Other Threats to Amphibians in Clowhom**

### **Forest Harvesting**

Timber harvesting is another factor that threatens amphibians in the Clowhom watershed. Most pond-breeding amphibian species spend the majority of the year outside of the water body and thus require suitable upland habitat adjacent to breeding sites in order to maintain viable populations. Many species depend on cool, moist forested upland habitat. Not only does forest harvesting negatively impact upland habitat, but it also can have detrimental impacts on the hydrology, function, and productivity of wetlands used by amphibians (Richardson 1994). Red-legged Frogs, in particular, require forested landscapes and are negatively affected by clearcut logging (IWMS 2004d).

To aid with the survival of Red-legged Frogs and other pond-breeding species, it is vital to conserve forested areas adjacent to known breeding ponds. Such forests provide the necessary cool, moist microclimatic conditions and essential habitat structural features used by emerging juveniles and foraging adults.

Coarse woody debris, including logs, stumps, and piles of bark, constitutes an essential microhabitat component for amphibians. It provides a cool, moist environment, shelter from predators, and a source of invertebrate prey (Whiles & Grubaugh 1998). At sites where coarse woody debris is limited, we recommend adding logs and pieces of wood, especially large-diameter pieces in various stages of decay, to help improve terrestrial habitat for amphibians (BC Ministry of Environment 2014).

### **Roads and Transmission Lines**

Another threat to amphibians in the Clowhom watershed is the impact of roads and transmission lines. Roads run adjacent to several amphibian breeding sites, and transmission lines cross at least eight wetlands. Potential impacts from roads and transmission lines include road mortality, pollution from road runoff, invasive species introduction, and harm to wildlife during right of way maintenance, brushing, and vegetation removal activities.

Road mortality can be a significant issue for amphibians, particularly mass breeding species such as Western Toads (Andrews et al. 2008). At present, the relatively light traffic and low density of migrating amphibians in most areas in the valley means that the impact is likely to be minimal. However, there is one site where mitigation measures may become necessary. At Wetland 7, the most consistent Western Toad breeding site detected to date is located right next to the road. Thus far we have not documented incidences of mortality of dispersing toadlets on the road but we will continue to monitor the site during future project years to determine if any mitigation measures are necessary.

Because transmission lines run over several Clowhom wetlands (including Wetland 7), these sites may be subject to periodic brushing and vegetation removal. This activity may be beneficial or detrimental to amphibians depending on how it is undertaken. If careful hand removal is practiced, clearing may be beneficial to amphibians by maintaining sunny exposures and warm temperatures for larval development. In fact, annual cutting is recommended to prevent vegetation growth from shading wetlands reducing habitat suitability. However, these maintenance activities should be timed to avoid critical developmental periods for amphibians. To avoid harming developing amphibians, we recommend that maintenance activities take place before March or later than August in order to avoid time period when developing young amphibians may be present in ponds. In addition, chemical herbicides should be avoided around these sites as they can be acutely toxic to amphibians (Relyea 2005).

Roads and transmission lines also risk bring introduced, invasive and native weedy species to the area. Invasive weeds detected in Clowhom wetlands include Canada Thistle (*Cirsium arvense*), Oxeye Daisy (*Leucanthemum vulgare*), and Himalayan Blackberry (*Rubus armeniacus*). At present they seem to be confined to the gravelly areas at the roadside and around the transmission poles. Further monitoring should be undertaken to track the spread of these species and determine if removal is necessary.

## 6.2 Western Screech-Owls

The coastal subspecies of Western Screech-Owl (*Megascops kennicottii kennicottii*) is federally threatened and provincially blue-listed. These owls have experienced dramatic population declines since the 1990s (Environment Canada 2011b). A rough estimate in the latest COSEWIC Status Report (2012) suggests that the coastal subspecies declined by 20 to 30% in Canada between 1995 and 2010. Numbers are poorly known, but there are estimated to be just 1,500-3,000 individual birds remaining in Canada. Population declines are thought to be related to loss of mature trees required for nesting and roosting, along with newly established populations of Barred Owls, which predate upon Screech-Owls.

The Clowhom watershed is one of the few places on the Sunshine Coast where Western Screech-Owls have been detected in recent years. These birds were relatively common in the region until the mid-1990s when they declined sharply (T. Greenfield, pers. comm.). By 2001, Preston and Campbell failed to detect any Screech-Owls in 156 survey stations (COSEWIC 2012). Prior to our recent detections in Clowhom, there had been only 12 documented sightings of Western Screech-Owls on the Lower Sunshine Coast in the past dozen years, of which the most recent was in 2011 (T. Greenfield, pers. comm.). Over the past three years of conducting hundreds of call-playback surveys throughout the region, our team has detected Western Screech-Owls at only two other sites on the Lower Sunshine Coast outside of Clowhom.

Over the past three years, we have detected Barred Owls at ten call-playback stations in Clowhom, including detections in three of the four known Screech-Owl territories in the watershed. More Barred Owls were detected in Clowhom in 2015-2016 than in any previous project year. This species has expanded its range into the BC south coast over the past 50 years and is now firmly established as a resident breeding species. Barred Owl depredation has been strongly implicated in the decline of Western Screech-Owls (Cannings and Angell 2001, Elliot 2006).

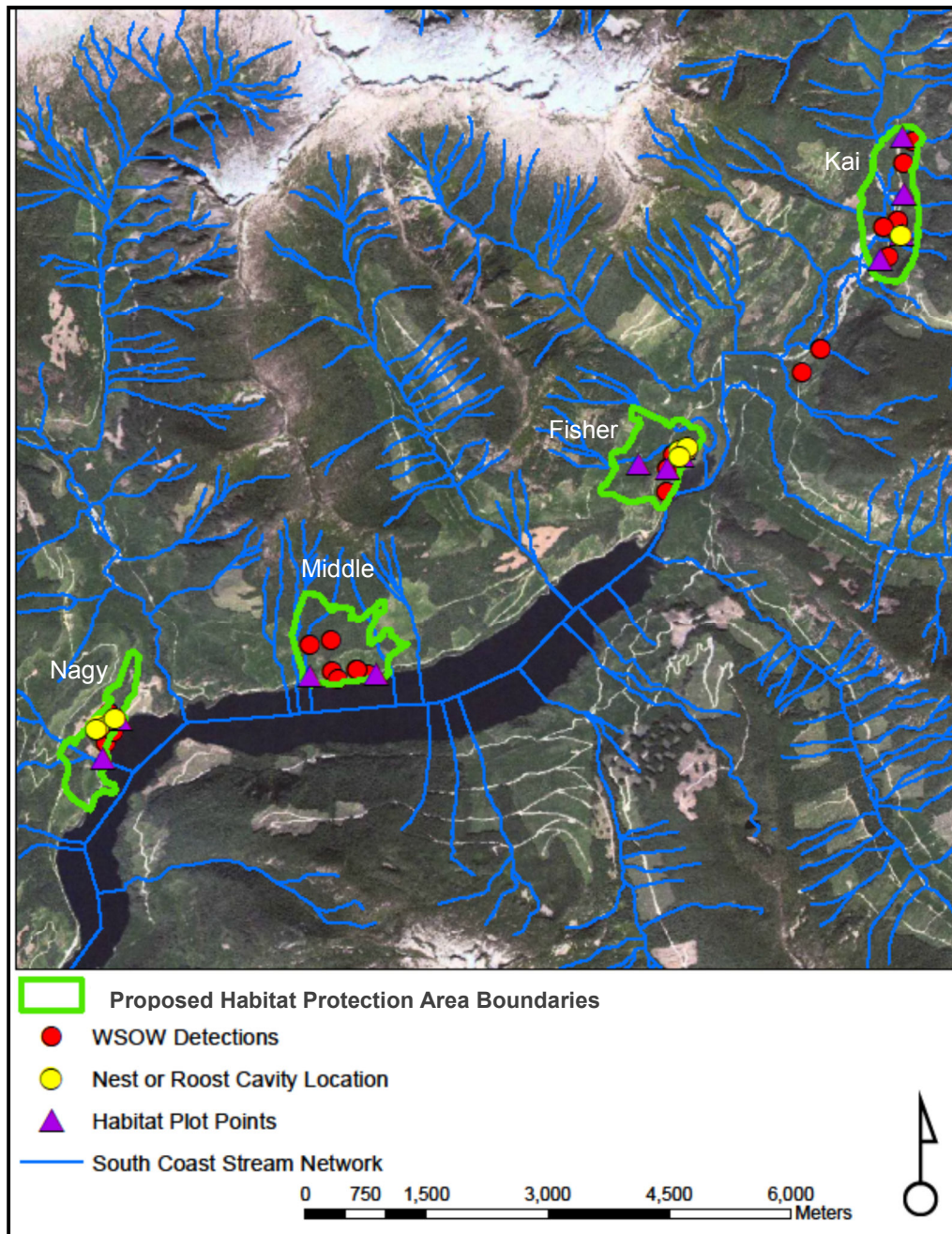
This year, we continued to monitor four known Western Screech-Owl territories in the Clowhom watershed and were able confirm occupancy in three of them. All four Screech-Owl territories included areas of mixed riparian forest, along with mature coniferous stands. This is consistent with observations from other regions where the subspecies is associated with low elevation, late successional riparian forest, typically including deciduous elements and large diameter cavity-forming trees for nesting (COSEWIC 2012). Such habitat is now extremely limited in Clowhom. The flooding of the lower valley to create the reservoir eliminated 41 hectares of riparian forest (FWCP 2011). Wide scale forest harvesting caused further losses of riparian and mature forest habitat, and removed dead trees and snags that could serve as potential nesting trees. As noted in our riparian mapping and assessment (Evelyn et al. 2015), low elevation riparian habitats that do remain have been disproportionately impacted, and little exists in its natural condition.

Past forest harvesting in the Clowhom watershed has substantially decreased the number of standing dead and dying trees, reducing availability of potential nest trees for Western Screech-Owls along with many other cavity-dependent wildlife species, including squirrels, flying squirrels, woodpeckers and bats. The size of Screech-Owl populations in some regions is believed to be limited by the number of available cavities (Belthoff & Richardson 1990), and the loss of cavity-bearing nest trees has been identified as one of the main causes of Western Screech-Owl population declines in recent years (COSEWIC 2012).

To ensure the survival of Western Screech-Owls in Clowhom, it is essential to maintain remaining areas of low elevation late successional riparian forest, mature coniferous stands, and associated large diameter cavity-forming trees, both within the four identified Screech-Owl territories, and in other areas of the watershed. As an interim enhancement measure, we have also installed some man-made Western Screech-Owl nest boxes within the Clowhom watershed, both in known territories and in areas that have suitable potential habitat. The species has been observed to readily accept nest boxes both for nesting and roosting (Cannings and Angell 2001, COSEWIC 2012). In the coming project years, we will monitor these boxes to determine if they are used by any owls. Our nest box additions are not suggested as in any way sufficient to counteract the effects of any further removal of forest habitat used by Western Screech-Owls. However, in areas where there is already a shortage of suitable cavity-bearing nest trees, the addition of nest boxes may be a worthwhile activity that could potentially help to improve nesting success and recruitment, and increase the viability of the Western Screech-Owl population in Clowhom.

### **Proposed Screech-Owl Habitat Protection Areas in Clowhom**

Based on information from active and passive monitoring of owls over the past three years, we have delineated four Western Screech-Owl proposed habitat protection areas corresponding to the four known territories within the Clowhom watershed (Kai, Fisher, Middle and Nagy) (Figure 31). These areas are described in greater detail on the following pages. In addition, one more potential occupied site exists between the Kai and Fisher territories. Individual Screech-Owls were detected at this site on two occasions (March 2014 and April 2015). These observations may signify an additional occupied territory in the watershed, or they may represent failed attempts by juveniles to establish a territory. Further surveys are required to determine if there is indeed a fifth occupied territory in this area.



**Figure 31: Four Proposed Western Screech-Owl Habitat Protection Areas in Clowhom**

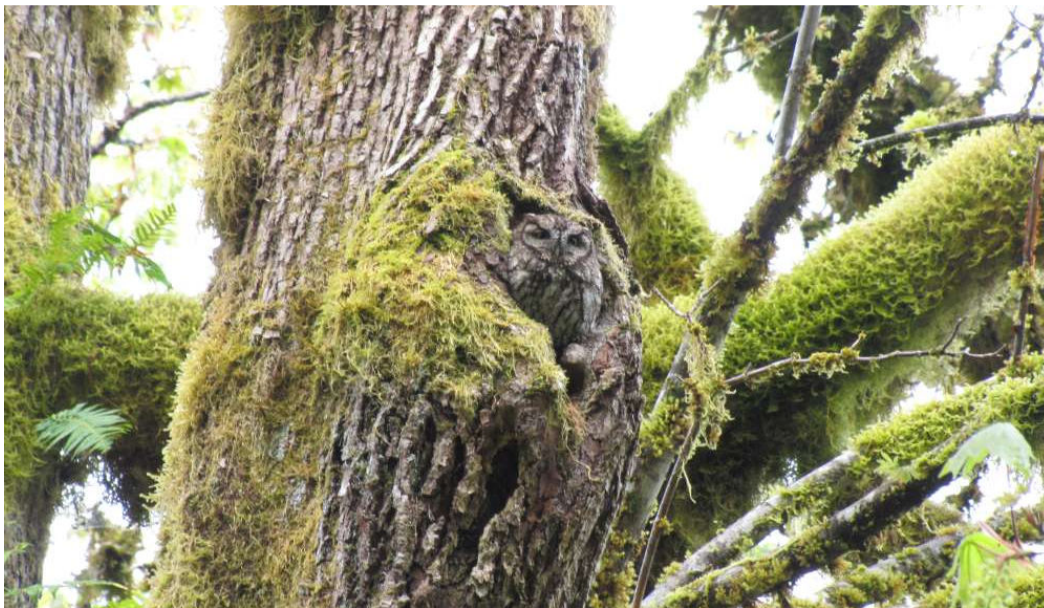
## **Kai Territory:**

The Kai Western Screech-Owl territory is situated along the Clowhom River, near km 19 of the Clowhom Main Forest Service Road (Figures 33 and 34). It runs along the flat floodplain of the river for roughly 2 km and is approximately 600 m wide. The territory includes the lower hillslopes of the eastern side of the valley from 80 m to 200 m elevation. Kai territory includes a diversity of vegetation communities and structural stages, but is dominated by mature, unharvested mixed riparian forests and mature coniferous stands. The riparian forests include the high bench floodplain along the Clowhom mainstem, along with several draws with small streams that run down the eastern slopes of the valley. Several wetlands are present in the territory (Wetlands 4, 5, and 6).

Trees species include large diameter Sitka Spruce and Bigleaf Maple, along with Western Hemlock, Western Red Cedar, and Black Cottonwood. Trees are widely spaced, providing excellent flyways. The understory is dominated by shrubs such as Stink Currant, Salmonberry, Devil's Club, and False Azalea. The drier coniferous stands that surround the riparian areas are dominated by Douglas-fir and Western Hemlock. In these stands, the understory is less developed than in the riparian zones due to the higher canopy closure; however, similar understory plant species are present, with Sword Fern and Deer Fern especially prevalent. There is a high amount of downed wood within the territory, providing habitat for Western Screech-Owl prey species, including amphibians, small mammals, and macroinvertebrates.

Human impacts within the territory include the forest service road and transmission line, which run through the entire length of the territory. In addition, there is a large opening left over from the concrete batch plant that was built during construction of the Clowhom Power run-of-river hydroelectric plant. Several areas at the periphery of the territory have been harvested within the past 30 years, and now consist of dense coniferous sapling forest.

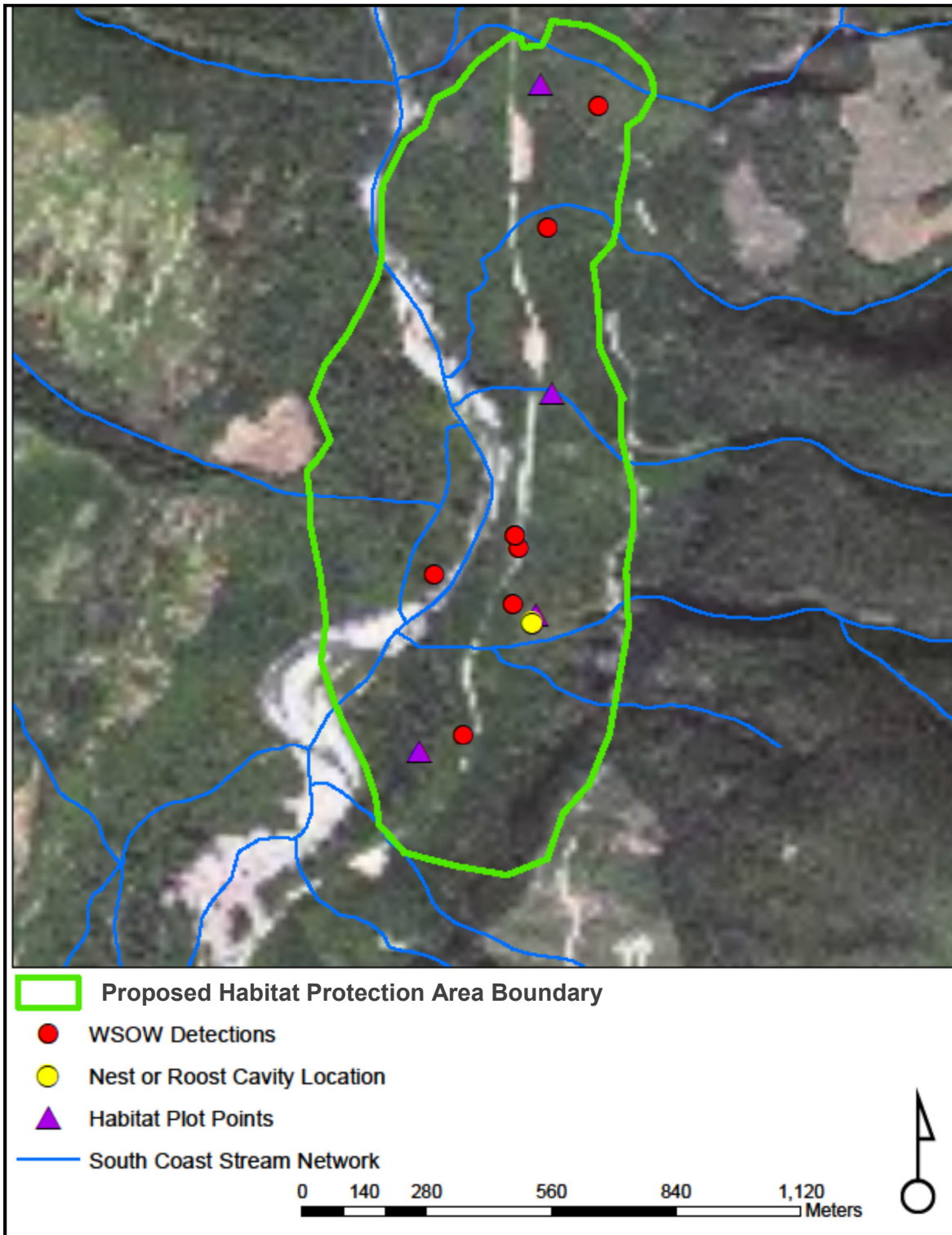
In 2014, the Kai Screech-Owl pair's nest grove was located in a Bigleaf Maple stand, with scattered Sitka Spruce, and a very diverse understory, with deep moss growing over an old debris flow of large wood and boulders. Trees appeared to be at least 80 years, possibly much older. Many cavities were observed both in the occupied nest grove, and in the forest of the lower floodplain, particularly in Bigleaf Maple and Black Cottonwood trees. The owl nested in a large cavity in an enormous, old Bigleaf Maple tree (Figure 32).



**Figure 32: Western Screech-Owl Nesting in an Old Bigleaf Maple in Kai Territory**



**Figure 33: Photograph of Kai Western Screech-Owl Territory**



**Figure 34: Map of Kai Western Screech-Owl Proposed Habitat Protection Area**

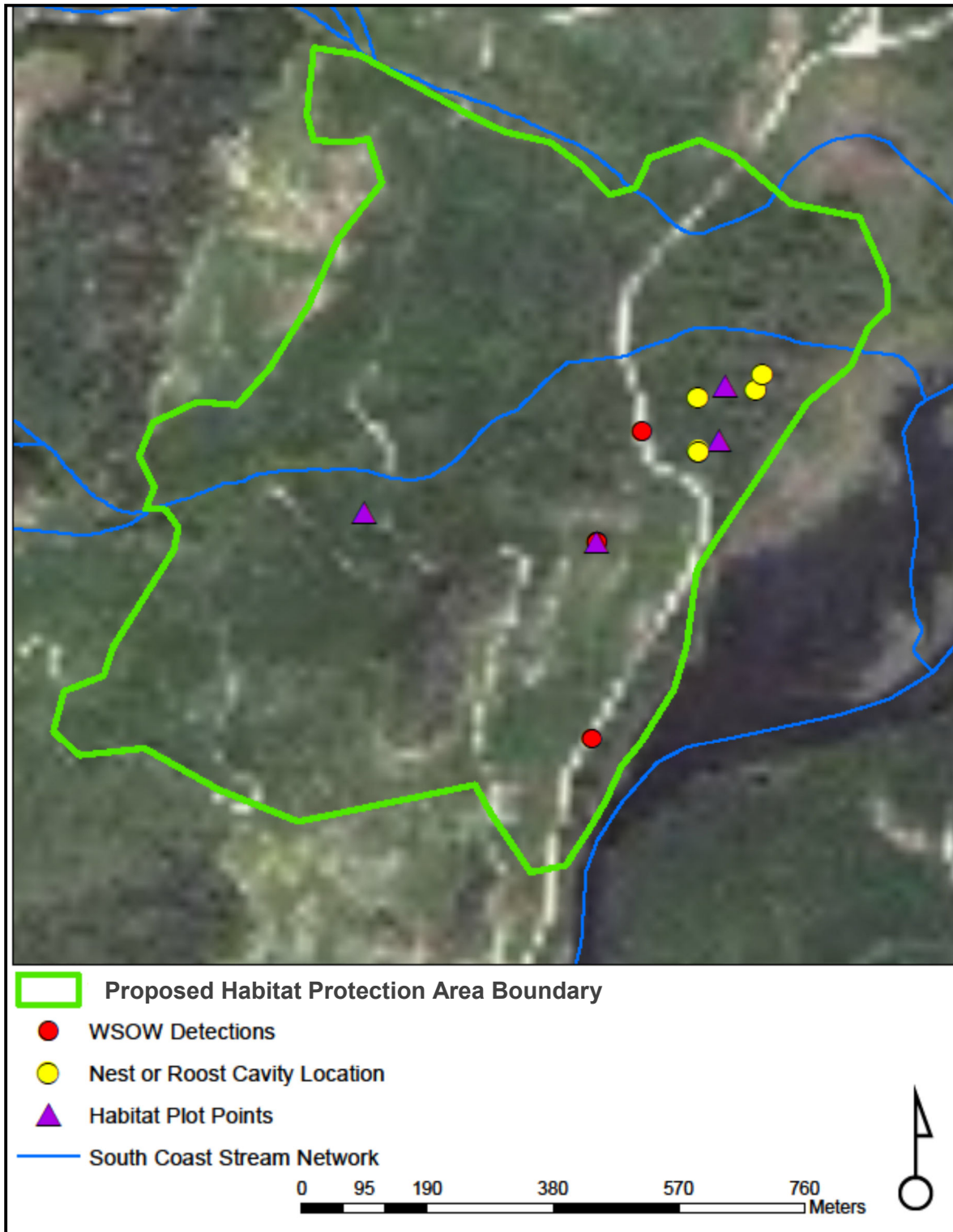
### **Fisher Territory:**

The Fisher territory is located at the north end of the Clowhom reservoir near the confluence with Clowhom River (Figures 35 and 36). It runs along the valley bottom for roughly 1 km and up approximately 700 m of the western slopes of the Clowhom valley. Elevations in the territory range from 60 to 160 m. The Fisher territory encompasses the riparian area of the large wetland complex (Wetland 8/9), along with its tributary streams, which are mostly mixed forests dominated by Bigleaf Maple, Western Hemlock, Western Red Cedar, Red Alder, and Sitka Spruce. Drier sites are dominated by Douglas-fir and Western Hemlock. The understory is diverse; some dry microsites with closed canopies possess very little understory vegetation, while other sites include shaded seepages covered in Skunk Cabbage and sedges, wildlife trees, and forest openings which promote tall berry-producing shrubs such as Salmonberry and various *Vaccinium* species. The high diversity of plant communities and open flyways within the territory provide excellent foraging areas and presumably an abundant prey base.

Similar to all of the Western Screech-Owl territories found within the valley, the Fisher territory is divided by the Clowhom Main Forest Service Road and the transmission line from the Clowhom Power hydroelectric facilities. Other human impacts in this territory include forest harvesting on the western hillslopes, and associated forest service roads (e.g., Fisher Main FSR).



**Figure 35: Photograph of Fisher Western Screech-Owl Territory**

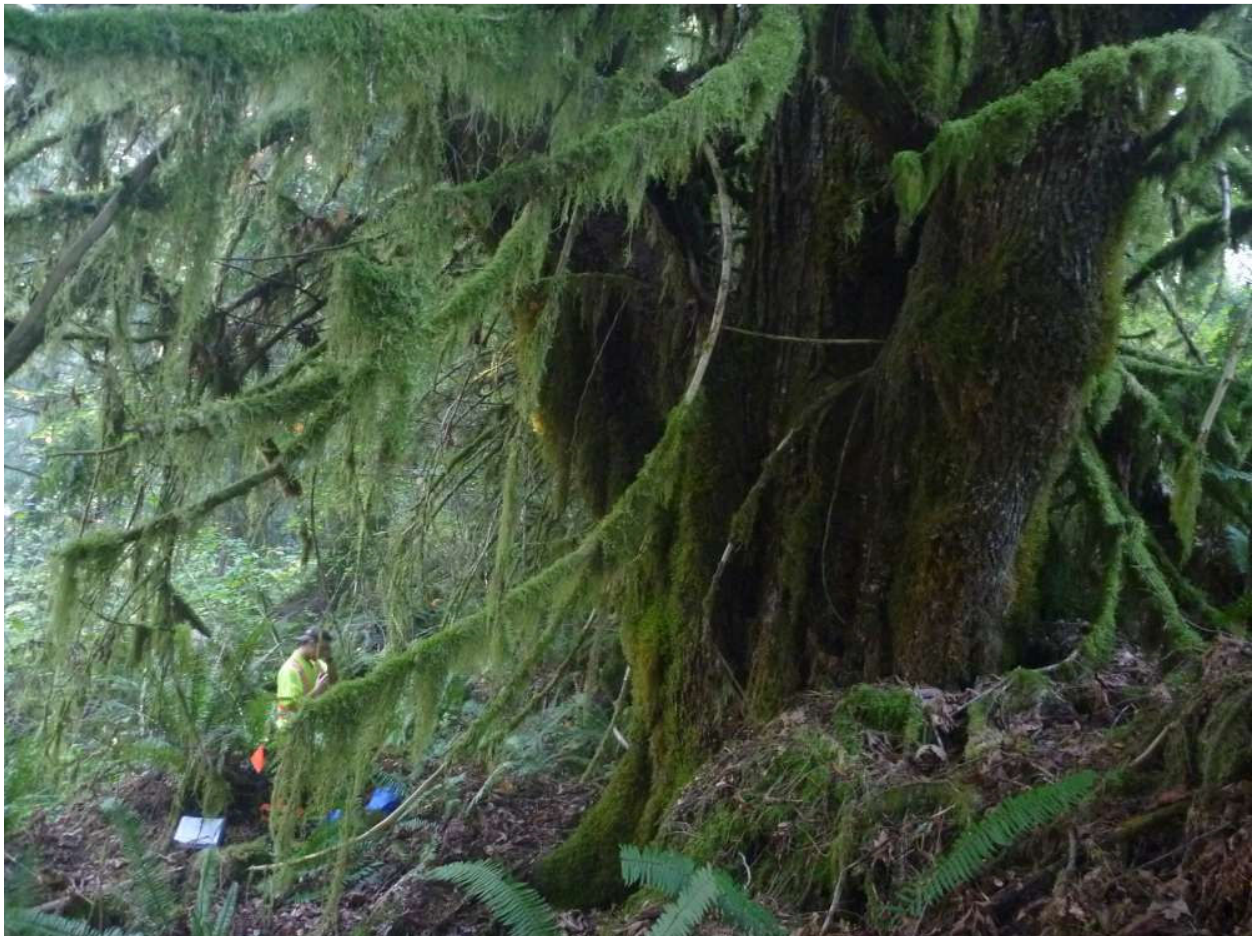


**Figure 36: Map of Fisher Western Screech-Owl Proposed Habitat Protection Area**

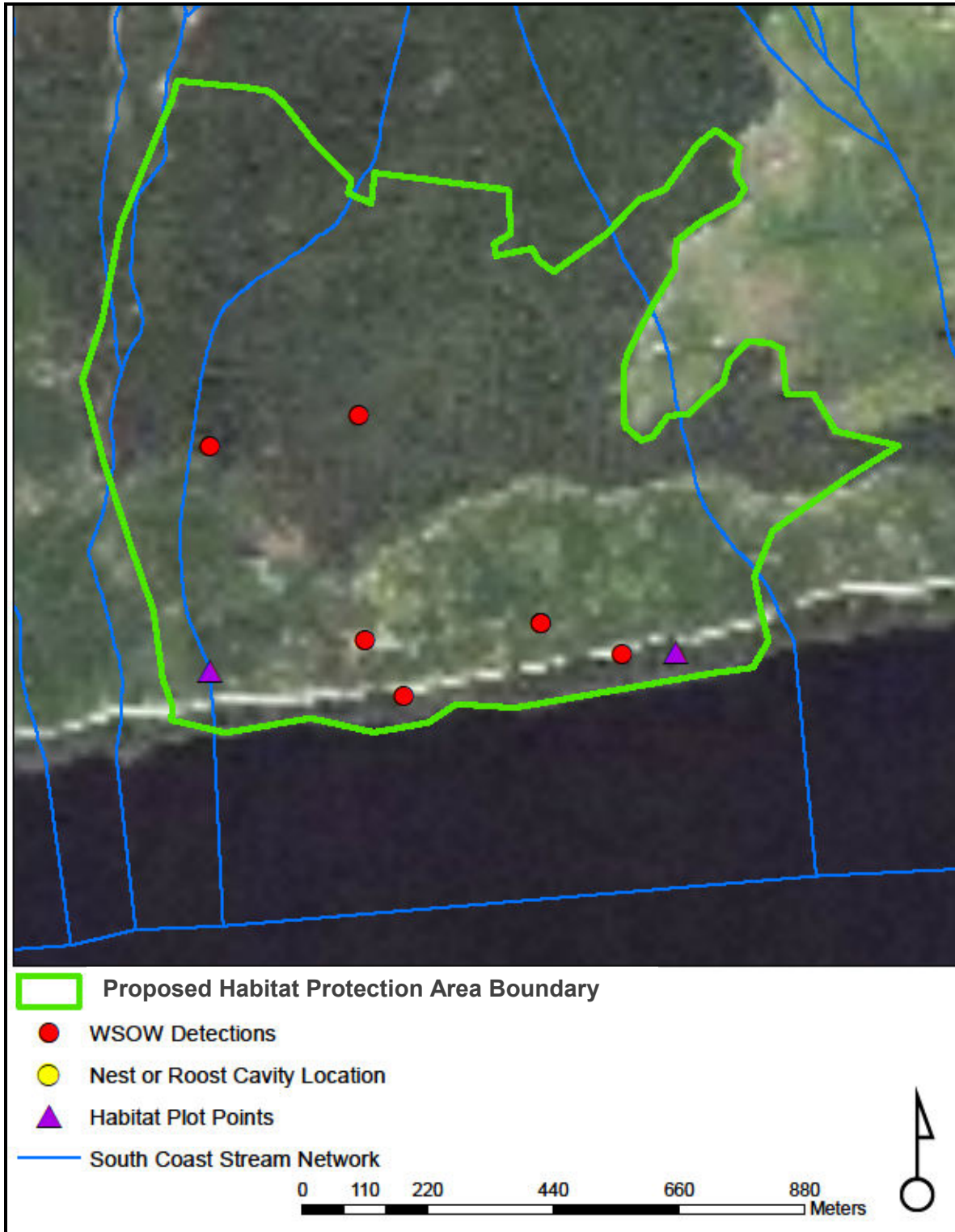
### **Middle Territory:**

The Middle territory is found near the middle of the west side of the Clowhom reservoir (Figures 37 and 38). It runs along approximately 1 km of shoreline, and extends up to 1 km upslope. Elevations range from 60 to 500 m. Much of the territory is steep, rocky, dry, Douglas-fir forest. The area between the shoreline and the Clowhom Main Forest Service Road provides a narrow strip of riparian forest with large Bigleaf Maple, Red Alder, Douglas-fir, and Western Red Cedar. There are large patches of young, densely-spaced planted pole/sapling forest along the lower slopes, as well as several recently harvested areas both within and surrounding the territory. Our surveys suggest that the Middle Screech-Owl pair are centered in a patch of mature coniferous forest on the mid-slope, between the regenerating forest on the lower slope and the recently harvested areas above.

The understory is patchy, and dominated by Salal and various *Rubus* species. In the mature stands, there are numerous wildlife trees (mainly western Red Cedar) with cavities that appear suitable for nesting Western Screech-Owls. The recently harvested patches may provide foraging opportunities for Screech-Owls, but also expose them to predation from Barred Owls which responded to call-playbacks in that area. The young regenerating forest provides generally poor habitat for Western Screech-Owls.



**Figure 37: Large Bigleaf Maple in Middle Western Screech-Owl Territory**



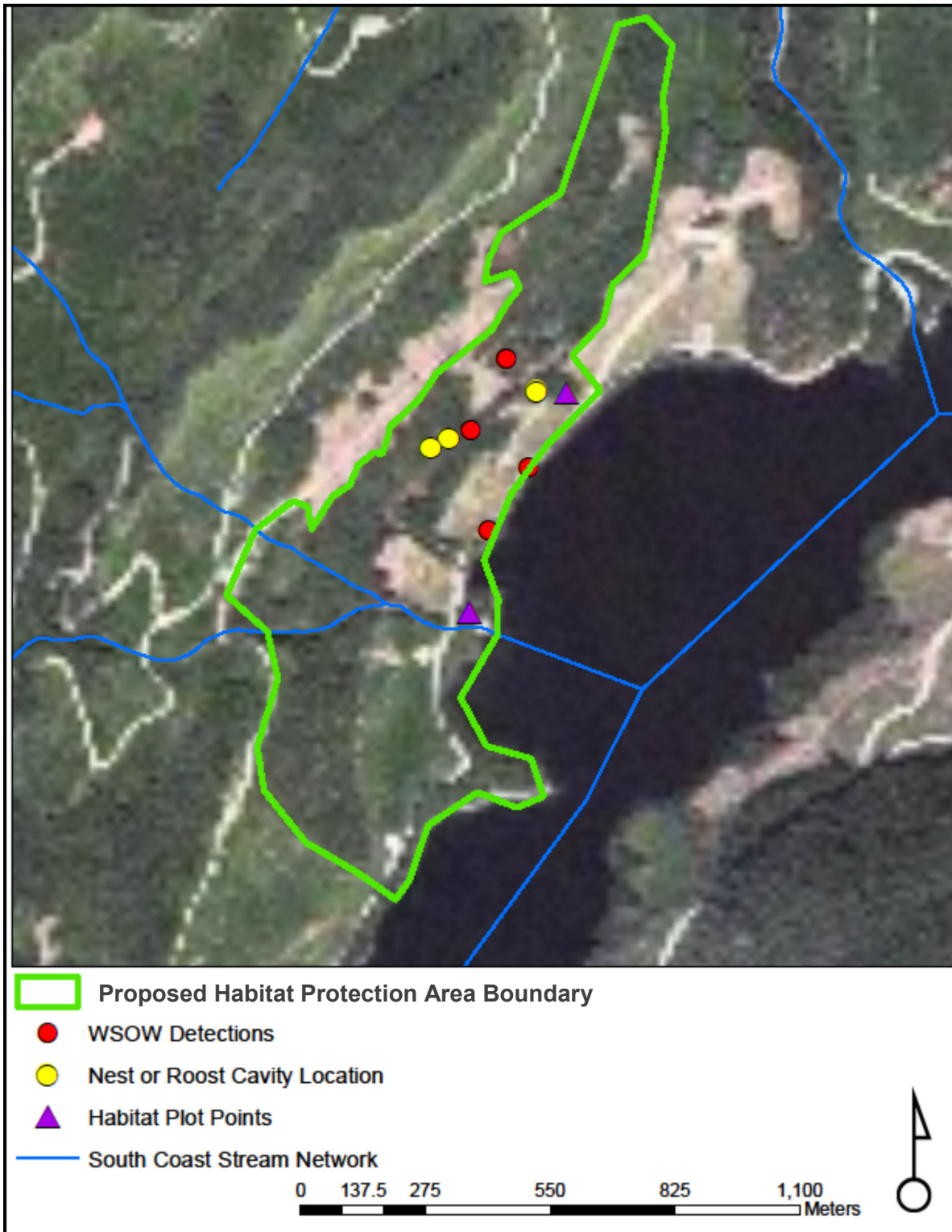
**Figure 38: Map of Middle Western Screech-Owl Proposed Habitat Protection Area**

### **Nagy Territory:**

The Nagy territory is situated along the edge of the Clowhom reservoir where Nagy Forest Service Road meets the Clowhom Main Forest Service Road (Figures 39 and 40). It runs along approximately 1 km of shoreline and extends 600 m upslope. Elevations range from 60 to 400 m. The area has been extensively harvested, and includes several active as well as decommissioned forest service roads, along with a transmission line. Nagy territory includes Wetland 15, and several small patches of mature forest (totalling 25 ha) composed primarily of Douglas-fir, with less abundant Western Hemlock, Western Red Cedar, and Red Alder. The understory is dominated by Salal, along with *Rubus* and *Vaccinium* species, with willows at the periphery; Sword Fern dominates the shaded areas with high canopy closure. As in the Middle territory, the young, dense regenerating forest stands provide poor habitat for Western Screech-Owls, while the recent cutblocks may increase foraging opportunities with the trade-off of higher predation risk.



**Figure 39: Photograph of Nagy Western Screech-Owl Territory**



**Figure 40: Map of Nagy Western Screech-Owl Proposed Habitat Protection Area**

### 6.3 Northern Goshawks

The coastal subpopulation of Northern Goshawk (*Accipiter gentilis laingi*) is provincially red-listed, federally threatened, and classified as Identified Wildlife under the BC Forest and Range Practices Act (COSEWIC 2013b, Environment Canada 2011a, IWMS 2004c, Northern Goshawk Recovery Team 2008). Fewer than 1000 mature individuals are estimated to remain in Canada (COSEWIC 2013b).

Northern Goshawks prefer extensive forests with large stands of mature trees, dense canopies, and an open understory (Environment Canada 2011a). The main threat to this species is forest harvesting which causes loss and fragmentation of nesting and foraging habitat, and reductions in prey diversity and availability (COSEWIC 2013b).

Suitable habitat for Northern Goshawks is extremely limited in the Clowhom watershed due to extensive and ongoing forest harvesting. However, this year we detected one juvenile goshawk in April 2015 near Wetland 7 and found a possible goshawk plucking post (Figure 41). Both of these sightings were near the historical Red Tusk Northern Goshawk site.

The juvenile goshawk may have been dispersing through the watershed from another site, or it is possible that goshawks are still present in the watershed. Further surveys are recommended to seek to determine if there are any Northern Goshawk nesting areas in the Clowhom basin.



**Figure 41: Possible Northern Goshawk plucking post found in the Clowhom watershed, July 2015**

## 6.4 Bats

Half of BC's bat species are officially listed as species at risk (BC Ministry of Environment 2016). Key threats to BC bats include habitat loss and degradation, deliberate or accidental human disturbance, environmental contamination, and disease. Although many species have broad geographic ranges, within their ranges distributions are often patchy, and local populations may be reduced or eliminated as the result of human activity. Many populations are undergoing alarming reductions. With very low reproductive output for a small mammal, typically rearing only one young per year, bats are extremely slow to recover from population declines.

The recent introduction of White Nose Syndrome (WNS) to North America has increased the level of threat. This fungal disease attacks the exposed skin of cave hibernating bats, disrupting blood chemistry, and causing a cascade of physiologic disturbances leading to death (Verant et al. 2014). The fungus has had devastating impacts in eastern and central North America, where it is implicated in the deaths of an estimated six million bats (Frick et al. 2010, Forbes 2012, Sleeman 2013).

In March 2016, White Nose Syndrome was detected in a little brown bat near Seattle, Washington (USGS 2016). This first ever detection of WNS on the west coast has increased the urgency of bat conservation efforts in British Columbia. Fourteen of BC's 16 bat species hibernate and would therefore be vulnerable to the pathogen.

Due to the imminent threat posed by White Nose Syndrome, the British Columbia Bat Action Team (BCBAT), a group of government and non-government biologists, researchers, veterinarians and naturalists, has prioritized the assessment of current bat populations and identification of important roosting and foraging habitat in the province. This baseline information will allow a more accurate assessment of the overall health of bat populations in BC, and will help enable targeted actions to combat population reductions due to both WNS and habitat loss and modification.

This was our second year surveying bats in the Clowhom watershed. Already we have documented a diverse bat community in the watershed, including at least eight species. Of particular interest is the Little Brown Bat (*Myotis lucifugus*). This species is one of Canada's most common and widespread bats. However, White Nose Syndrome has caused population declines up to 94% from Nova Scotia to Ontario, resulting in an emergency listing of Little Brown Bat as endangered under the Canadian Species at Risk Act (Forbes 2012, COSEWIC 2013a). This species roosts in rock crevices, caves, decaying trees and human structures including buildings and bat houses. It appears widespread throughout the Clowhom valley and is likely resident year-round. A priority activity for the 2016/2017 project year will be to seek to identify and monitor any Little Brown Bat roosts in the watershed.

Aside from any potential impacts from White Nose Syndrome, threats to bats in the Clowhom valley are largely limited to habitat loss and modification. All of the species observed in the watershed will use dead and decaying trees as roosts. These wildlife trees are limited in areas that have been harvested, and many of them are knocked down because they pose safety hazards to foresters. Hoary Bats and Silver-haired Bats are two obligate tree-roosting species that roost exclusively in large trees. Suitable roost trees for these species include large Cottonwoods, along with large diameter Douglas-firs possessing thick bark in which the bats can shelter. Such roosting habitat is limited to mature forests, which are rare in the watershed.

All bat species in British Columbia can only drink while in flight. Appropriate water sources must be relatively calm; moving water creates ultrasonic noise which interferes with a bat's echolocation ability. Bats also require open approach and exit flyways. This is particularly important for larger, less manoeuvrable bat species. As our wetland surveys have indicated, there are a limited number of small wetlands and ponds within the Clowhom valley (Evelyn et al. 2014). This increases the importance of those that do exist. Care should be taken to ensure that these pools are not negatively impacted by human activity. In particular, when brushing along roads and under transmission lines, it is important to make sure woody debris is moved to maintain open flyways in and out of pools.

## 6.5 Coastal Tailed Frogs

The Coastal Tailed Frog (*Ascaphus truei*) is an ancient and unusual species. It is the longest lived frog in North America, with the longest larval period, remaining in tadpole stage for up to 5-7 years. This species is blue-listed in BC, federally assessed as a species of special concern, and classified as Identified Wildlife under the BC Forest and Range Practices Act (IWMS 2004a, COSEWIC 2011b).

Coastal Tailed Frogs are habitat specialists, living in cool, fast-flowing mountain streams with step-pool morphologies and adjacent mature forest. They reproduce via internal fertilization and females attach eggs to the underside of large rocks or boulders in streams in the summer. Tadpoles have a flattened oral disc that serves as a sucker for clinging to boulders in the fast-flowing water, where they feed by scraping diatoms and algae from rocks. Adult frogs may live for more than 20 years, and rarely venture far from their natal streams. They require cool, moist microclimates and habitats with sufficient structural diversity to provide refuge sites and food. As such, dispersal between streams and drainages is extremely limited.

The combination of a long larval stage, limited dispersal ability and specialized habitat requirements make this species particularly vulnerable to habitat degradation (COSEWIC 2011b). Populations can be harmed as a result of human land use activities that remove riparian vegetation and/or alter stream flow, water temperature or turbidity. Key threats to the species include forest harvesting, road building, water intakes and diversions for run-of-river power projects, introductions of non-native fish, and disease

Maintaining mature riparian forests is essential to the long term viability of individual populations. Loss of canopy cover through harvest or other activities may benefit the larval stage temporarily due to an increase in primary productivity associated with higher light levels. However, the habitat is typically unsuitable for adult frogs, and these types of habitat modification often result in the reduction or extinction of local populations. In addition, healthy riparian forests stabilize stream banks, limiting in-stream disturbances such as sedimentation and debris flows. Sedimentation is particularly detrimental to the species, as it fills the interstitial spaces in stream substrates that the tadpoles require for cover.

Over the past two years we have identified many streams with potential suitable habitat for Coastal Tailed Frogs in the Clowhom watershed. We have assessed several of these streams using a combination of time-constrained searches and environmental DNA (eDNA) surveys. Laboratory analyses from the eDNA samples collected during the 2015-2016 project year are still pending. However, our results to date suggest that Tailed Frogs are fairly widespread in the watershed, but that populations within each stream may be quite variable, and may be small in many instances. Continued surveys are recommended to accurately assess the distribution, size and overall health of the Coastal Tailed Frog population within the watershed.

## 6.6 Barn Swallows

One of the world's most widespread and common birds, the Barn Swallow (*Hirundo rustica*) has experienced large population decreases that began in the mid-1980s in Canada. The Breeding Bird Survey showed an overall decline of 76% in the 40 years from 1970 to 2009, and a drop of 30% from 1999 to 2009 (COSEWIC 2011a). The causes of this decline are not well understood but are thought to be related to habitat loss, declines in insect populations, climate perturbations, parasites, invasive species and pesticides.

The Barn Swallow is federally designated as Threatened (COSEWIC 2011a) and provincially classified as Blue-listed. Its nests and eggs are protected under the federal Migratory Birds Convention Act (Government of Canada 1994) and the British Columbia Wildlife Act (Province of BC 1996). The species nests almost exclusively in or on human structures such as houses, barns, garages, sheds, and bridges, upon which it builds cup-shaped nests of mud mixed with grasses and lined with feathers and grass.

In March 2015, we built a Barn Swallow nesting condo that was installed on top of the Clowhom Dam to enhance habitat and mitigate the impact of required construction activities at the hoist tower, where swallows had previously been observed nesting (Evelyn and Stiles 2015). When we returned to the site in May 2015, we were delighted to observe at least two swallow pairs nesting in our newly installed manmade structure. We also documented additional Barn Swallow nests at several other human structures in the vicinity of the Clowhom Generating Station.

In order to prevent harm to this species at risk in Clowhom, Barn Swallow nests and nesting structures should not be disturbed during breeding season from April to September (Ferguson 2014a). In the coming years, we will continue to monitor Barn Swallow nesting activity as part of our FWCP-funded Clowhom project and in conjunction with larger province-wide monitoring efforts led by the BC Swallow Conservation Project.



Figure 42: Barn Swallow Adults and Juveniles

## 6.7 Other Species at Risk

Through the course of our targeted wildlife surveys, we have encountered numerous other species, including fish, amphibians, reptiles, birds and mammals. Over the past three years, we have documented 127 vertebrate species in the Clowhom basin (please see Table 7 on page 41 for the full species list). The list includes 15 species at risk (Table 8). For some of these species the records are particularly significant; Clowhom represents the only known breeding site for Western Toads and the only identified Western Screech-Owl nesting area on the Lower Sunshine Coast. These findings emphasize the importance of the watershed to the survival of threatened wildlife in this region.

**Table 8: Vertebrate Species at Risk Documented in the Clowhom Watershed, 2013-present**

Common Name	Scientific Name	COSEWIC Listing	BC Listing	BC Conservation Framework Priority
Coastal Cutthroat Trout	<i>Oncorhynchus clarkii</i>		Blue	2
Coastal Tailed Frog	<i>Ascaphus truei</i>	Special Concern	Blue	1
Northern Red-legged Frog	<i>Rana aurora</i>	Special Concern	Blue	1
Western Toad	<i>Anaxyrus boreas</i>	Special Concern	Blue	2
Great Blue Heron	<i>Ardea herodias fannini</i>	Special Concern	Blue	1
Northern Goshawk	<i>Accipiter gentilis laingi</i>	Threatened	Red	1
Peregrine Falcon	<i>Falco peregrinus pealei</i>	Special Concern	Blue	1
Band-tailed Pigeon	<i>Patagioenas fasciata</i>	Special Concern	Blue	2
Western Screech-Owl	<i>Megascops kennicottii</i>	Threatened	Blue	1
Black Swift	<i>Cypseloides niger</i>	Endangered	Blue	2
Olive-sided Flycatcher	<i>Contopus cooperi</i>	Threatened	Blue	2
Barn Swallow	<i>Hirundo rustica</i>	Threatened	Blue	2
Western Meadowlark	<i>Sturnella neglecta pop. 1</i>		Red	1
Little Brown Bat	<i>Myotis lucifugus</i>	Endangered	Yellow	2
Roosevelt Elk	<i>Cervus elaphus roosevelti</i>		Blue	2

## 6.8 Proposed Wetland Restoration Plan for Clowhom Watershed

In order to increase available wetland habitat and mitigate harmful impacts of water level fluctuations on amphibians and other wildlife, we are proposing to carry out a wetland restoration project in Clowhom.

Over the past two project years, we have investigated numerous potential locations for wetland restoration in the watershed. We conducted detailed ecological assessments at candidate sites, including evaluations of soils, hydrology, vegetation, and wildlife. We also considered potential future human impacts, climate change projections, and position within the watershed, taking into account wildlife dispersal distances and movement corridors.

As a result of these assessments, we have identified three high priority suitable sites for wetland pond construction (Figure 43). Maps of the proposed sites and descriptions of recommended wetland restoration activities are included on the following pages.

Our goal is to create stable habitats that will not be subject to the same harmful effects experienced by areas directly connected to the reservoir by constructing wetland ponds, of various sizes, in areas adjacent to those currently being affected. The new wetland ponds will be designed to provide a diverse mixture of habitats to support the greatest diversity of wildlife. By increasing quantity and quality of wetland habitats within the watershed, we aim to increase the resilience and stability of amphibian populations, along with populations of other wildlife species.

Given approvals from government, the Sechelt Nation, and other stakeholders in the watershed, we propose to carry out these restoration activities during Year 4 of this project (2016-2017).

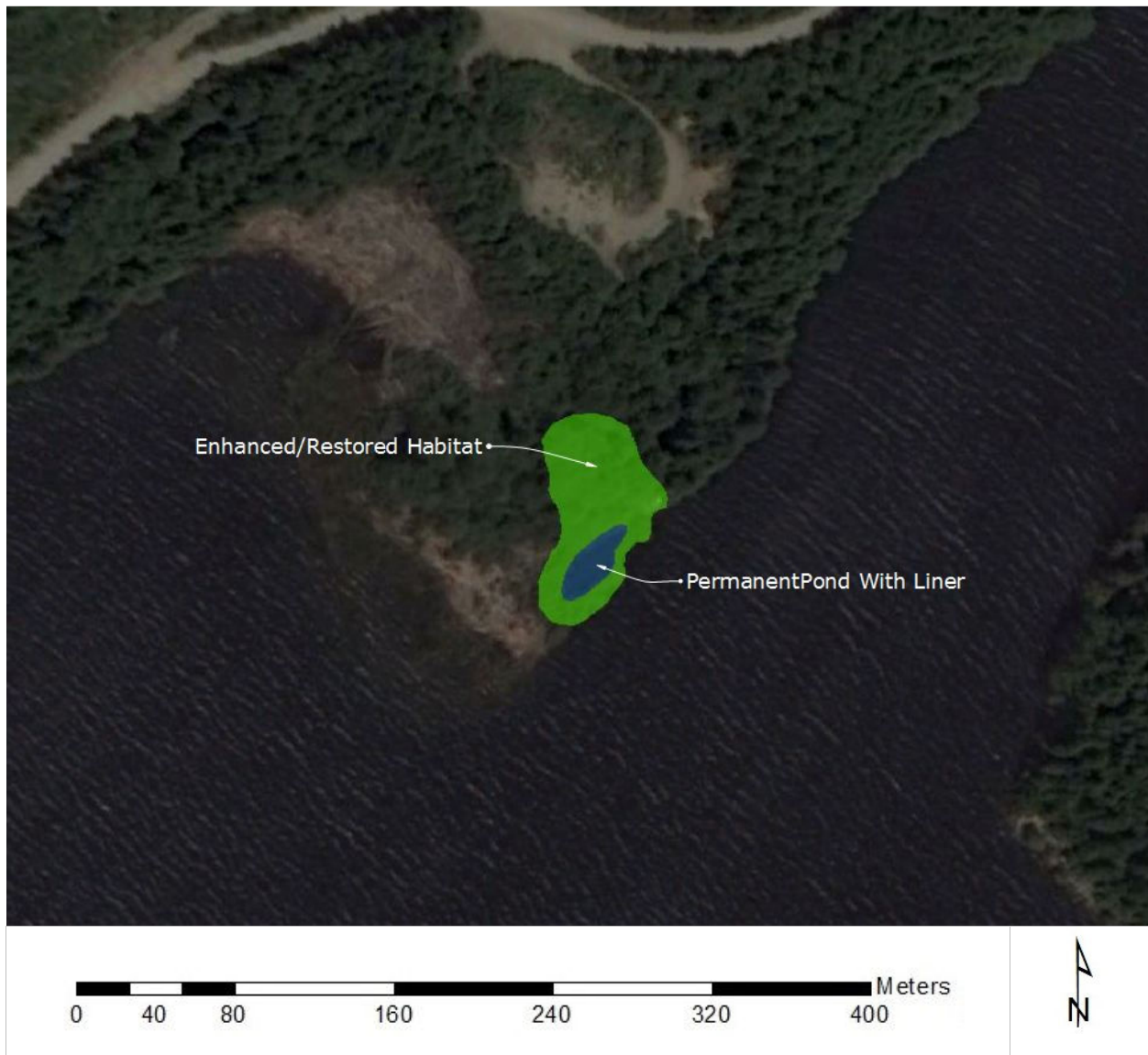


**Figure 43: Three Proposed Wetland Restoration Sites in the Clowhom Watershed**

### Site 1: Wetland Near North End of Clowhom Reservoir

This proposed wetland restoration site is part of the larger Wetland 10 wetland complex situated at the edge of the Clowhom Reservoir (Figure 44). The existing ephemeral pond at this site dries out before amphibians can complete their development, stranding and killing tadpoles. We observed Western Toads breeding here in 2013, but have not seen them since.

We propose to place a wildlife-friendly pond liner (approximately 300m<sup>2</sup>) in the existing depression to ensure that water remains long enough for Toads to complete their metamorphosis.



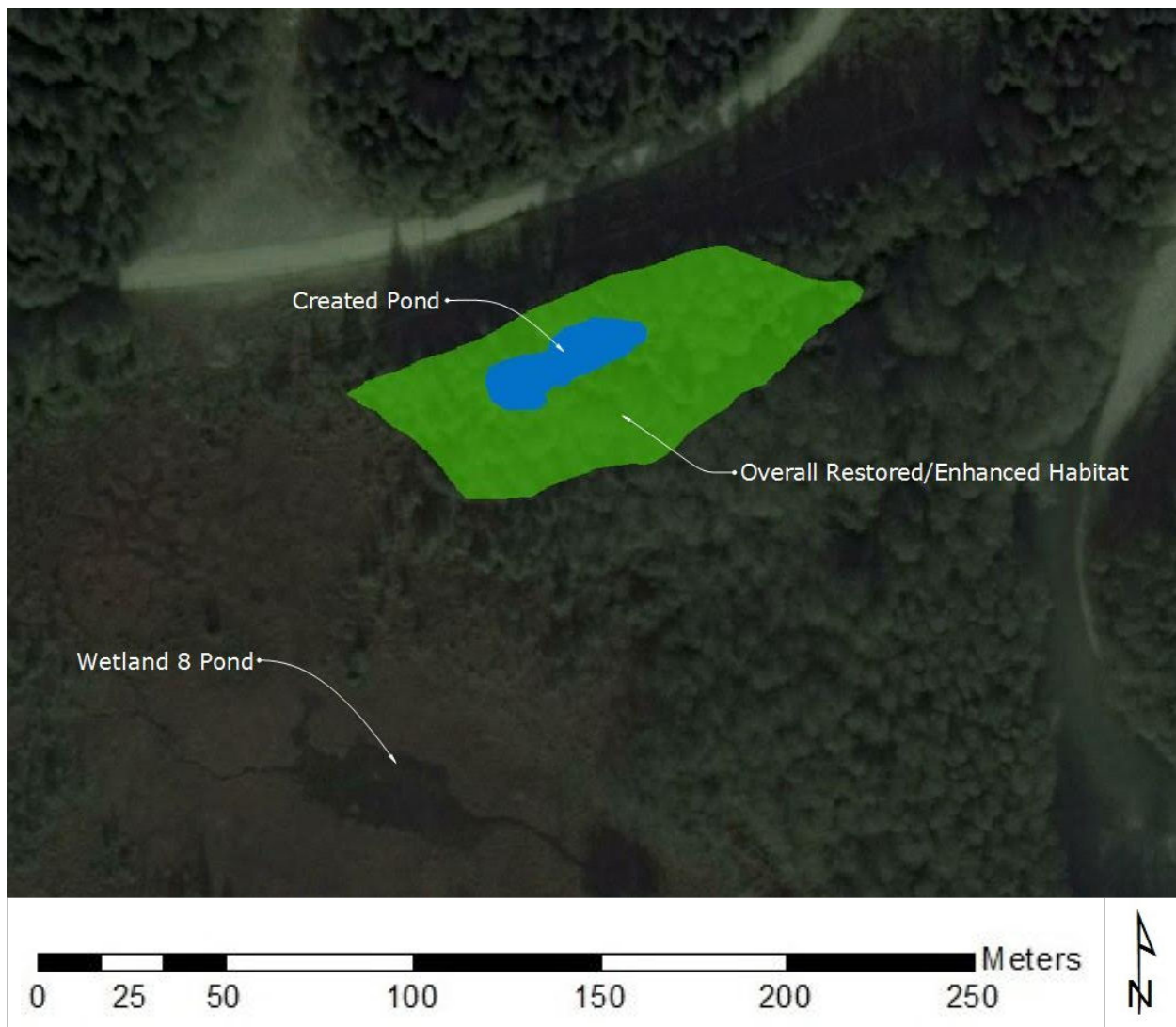
**Figure 44: Proposed Wetland Restoration Site #1 ("Liner Wetland")**

*(Total area of habitat to be enhanced/restored: 0.2 ha)*

## Site 2: Adjacent to the Large Wetland Complex at the End of the Reservoir

This proposed restoration site is in the forest between the large wetland complex at the north end of the reservoir (Wetland 8/9) and the transmission right of way (Figure 45). The nearby wetland site is strongly influenced by negative effects of sudden drawdown and/or raising of the Clowhom reservoir. To mitigate these effects, we propose to create fish-free ponds of sufficient depth, designed specifically to support breeding of Red-legged Frogs along with other amphibians.

The new ponds will be placed strategically to integrate with the larger wetland complex, to provide good connectivity to upland habitat for adults and dispersing juvenile frogs, and to avoid disturbance from the Clowhom River during large flood events (placed just outside the 100-year floodplain). In addition to helping amphibians, this restoration activity will also benefit a large number of riparian-associated species, including Water Shrews that have been detected 150 m away.



**Figure 45: Proposed Wetland Restoration Site #2 (“Red-legged Frog Wetland”)**

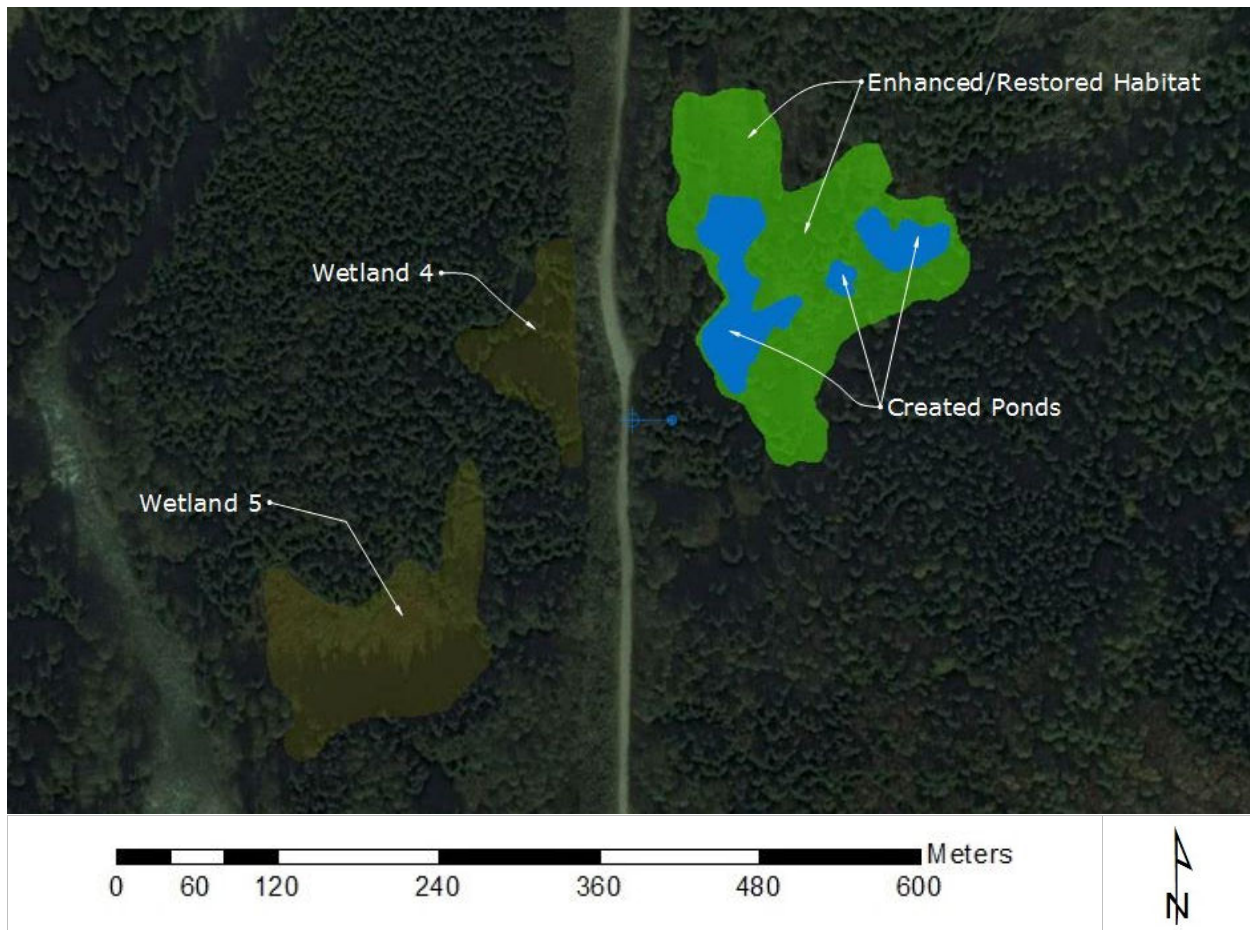
*(Total area new ponds to be created: 600 m<sup>2</sup>, total area wetland enhanced/restored: 0.5 ha)*

### Site 3: Near Km 20 on Clowhom Main Forest Service Road

This large, wet disturbed area was the site of the camp for the construction of the Veresen IPP. Situated at the toe of a slope, the area receives incredibly high and variable amounts of runoff from the adjacent steep rocky slopes. This flashy runoff often washes out the road. A deep ditch has been dug and berm constructed to deal with sudden flows. Past restoration efforts with the camp removal have failed because the majority of trees planted died or are in very poor health due to: (1) incorrect species selection (the site is typically very wet, so all the Douglas-fir died); (2) the understory shrubs are extremely vigorous and have shaded out most of the tiny saplings; and (3) the intermittent high flows and avulsing stream channels have washed saplings away, as evidenced by the protective netting piled up within old and new channels.

We propose to create a series of wetland pools at this site to provide more permanent aquatic habitat for amphibians, fish and other riparian-dependent species. This restoration activity will also help buffer the peak flows and reduce road wash-outs. Although there is an ephemeral stream channel that flows through the site, we will be working away from it.

This site is in an area where we have found numerous adult Western Toads, and the new ponds will provide ideal toad breeding habitat (excellent sun exposure, good upland habitat). The newly restored wetland pools will be integrated with the larger wetland complex, which includes Wetlands 4 and 5, approximately 75 m away (Figure 46).



**Figure 46: Proposed Wetland Restoration Site #3 (“Km 20 Wetland”)**

*(Total area new ponds to be created: 0.4 ha, area wetland enhanced/restored: 1.8 ha)*

## 7.0 SUMMARY RECOMMENDATIONS

A key goal of this project is to provide recommendations for priority actions that will help to conserve, restore and enhance habitat and mitigate threats to wildlife within the Clowhom watershed. This is an ongoing activity over the duration of this project, as we add more information, conduct further assessments, document species at risk, and evaluate sites and threats. The tables below have been updated since last year's report, and provide our latest summary advice to maintain and improve wildlife habitat and mitigate threats to species of conservation concern in the Clowhom watershed. Recommendations are presented on a site-specific, species-specific, and threat-related basis (Tables 9-11).

**Table 9: Species-Specific Management Recommendations for 7 Key Species at Risk in Clowhom**

Species	Enhancement / Mitigation Recommendations
Western Screech-Owl	<ul style="list-style-type: none"> <li>• Designate and protect four Western Screech-Owl habitat protection areas in the watershed (described in detail, Section 6.2 of this report)</li> <li>• Maintain large diameter cavity-bearing trees and snags to provide sufficient nesting and roosting opportunities</li> <li>• Install owl nest boxes to increase available nesting opportunities</li> <li>• Minimize disturbance to known roost and nest sites</li> <li>• Continue surveys to monitor activity in the four known Screech-Owl territories in Clowhom, clarify the status of the fifth potential territory, and seek to identify any additional territories in the watershed.</li> </ul>
Northern Goshawk	<ul style="list-style-type: none"> <li>• Continue surveys to identify any occupied territories, nests, nesting areas, post-fledging areas and foraging habitat in the watershed</li> <li>• Maintain areas of late-structural staged forests so that suitable breeding and foraging habitat continues to exist within the watershed</li> <li>• Should any active Northern Goshawk nest trees be identified, establish a wildlife habitat area (WHA) and implement general wildlife measures (GWMs) following the guidelines outlined in the BC Identified Wildlife Management Strategy (2004c)</li> </ul>
Barn Swallow	<ul style="list-style-type: none"> <li>• Avoid disturbing active and non-active nests during breeding season (April to September)</li> <li>• Avoid carrying out maintenance activities on structures used by nesting swallows (e.g., buildings, hoist tower, etc.) during breeding season</li> <li>• Avoid disturbing areas used by Barn Swallows for foraging and nest-building (e.g., wetlands, shorelines, areas of mud).</li> <li>• Retain existing nest structures and maintain access to them during breeding season (e.g., via open doors and windows)</li> <li>• Do not disturb or remove existing and previously used swallow nests</li> <li>• Avoid the use of chemical pesticides and herbicides whenever possible</li> <li>• Continue surveys to document and monitor Barn Swallow nesting areas</li> </ul>

**Table 9 (continued):  
Species-Specific Management Recommendations for 7 Key Species at Risk in Clowhom**

Species	Enhancement / Mitigation Recommendations
Red-legged Frog	<ul style="list-style-type: none"> <li>• Implement proposed Clowhom wetland restoration plan (described in detail in Section 6.8 of this report) to create new fish-free wetland ponds and provide stable habitats that will not be subject to the same deleterious effects experienced by areas directly connected to the reservoir</li> <li>• Maintain habitat quality at known breeding sites, including structural integrity of emergent vegetation to provide egg-laying sites and rearing habitat for developing tadpoles</li> <li>• Maintain important habitat features including coarse woody debris and understory vegetation surrounding wetlands</li> <li>• Maintain forest cover adjacent to breeding sites to provide suitable microclimatic conditions for emerging juveniles and foraging adults</li> <li>• Where transmission lines exist near wetlands, avoid carrying out right of way maintenance during breeding season from March to August</li> <li>• Avoid using chemical herbicides near wetlands</li> <li>• Monitor road impacts and, if necessary, take action to prevent road mortality</li> <li>• Maintain a network of suitable wetlands in close proximity, especially small, fish-free wetlands with high structural diversity of vegetation and surrounding forest that will maintain water until the end of August</li> </ul>
Western Toad	<ul style="list-style-type: none"> <li>• Implement proposed Clowhom wetland restoration plan (described in detail in Section 6.8 of this report) to create new wetland ponds and provide stable habitats that will not be subject to the same harmful effects experienced by areas directly connected to the reservoir</li> <li>• Maintain habitat quality at known breeding sites, including structural integrity of emergent vegetation to provide egg-laying sites and rearing habitat for developing tadpoles</li> <li>• Maintain forest cover adjacent to breeding sites to provide suitable microclimatic conditions for emerging juveniles and foraging adults</li> <li>• Maintain important habitat features including coarse woody debris and understory vegetation surrounding wetlands</li> <li>• Monitor road impacts and, if necessary, take action to prevent road mortality</li> <li>• Avoid carrying out transmission line maintenance during breeding season from April to August</li> <li>• Avoid using chemical herbicides near wetlands</li> </ul>

**Table 9 (continued):  
Species-Specific Management Recommendations for 7 Key Species at Risk in Clowhom**

Species	Enhancement / Mitigation Recommendations
Coastal Tailed Frog	<ul style="list-style-type: none"> <li>• Maintain forested riparian buffers</li> <li>• Maintain habitat structural features including coarse woody debris</li> <li>• Maintain sufficient water flow in occupied Tailed Frog streams</li> <li>• Maintain water quality characteristics of occupied streams, including temperature and clarity</li> <li>• Do not use pesticides near occupied streams</li> <li>• Maximize connectivity of riparian habitats</li> <li>• Minimize creation of new roads and stream crossings</li> <li>• Prevent fish introductions</li> <li>• Continue surveys to accurately assess the distribution, size and overall health of the Coastal Tailed Frog population within the watershed</li> </ul>
Little Brown Bat	<ul style="list-style-type: none"> <li>• Maintain and recruit large-diameter snags in middle stages of decay at a variety of elevations near water bodies to provide roosting sites for bats</li> <li>• Maintain open water with clear flyways into and out of water bodies to provide access for drinking bats</li> <li>• Install bat houses to increase roosting opportunities</li> <li>• Avoid the use of chemical pesticides and herbicides whenever possible</li> <li>• Undertake surveys to identify and monitor Little Brown Bat roosts to track the health of bat populations in the wake of the anticipated imminent arrival of White Nose Syndrome in BC</li> </ul>

**Table 10: Site-Specific Management Recommendations for 15 Clowhom Wetlands**

Wetland Number	Location	UTM		Conservation / Enhancement / Mitigation Recommendations
		Datum: NAD 83		
		UTM Zone: 10U		
		Easting	Northing	
1-3	Off Clowhom Mainline km 24	470635	5520703	Manage water levels; increase coarse woody debris; mitigate road impacts; plant riparian vegetation.
4	Off Clowhom Mainline km 20	471600	5517949	Mitigate road impacts.
5	Off Clowhom Mainline km 20	471485	5517732	No restoration needed.
6	Off Clowhom Mainline km 18.5	471516	5516185	This wetland has tremendous wildlife habitat value and supports several species at risk. This wetland, along with the adjacent mature riparian forest, are priority areas for conservation.
7	Off Clowhom Mainline km 17	470474	5514951	Install a beaver baffle in adjacent culvert; monitor and, if necessary, mitigate amphibian road mortality; monitor invasive species; take care when clearing brush under transmission line (hand removal), avoid chemical herbicides. This site is the only known consistent breeding site for Western Toads in the watershed.
8	North part of large wetland complex, end of the reservoir	469222	5514238	Monitor invasive weeds (remove if spread); maintain culverts; monitor to ensure that human use does not exceed current levels. This site has tremendous wildlife habitat value and supports a great diversity of species. Investigate establishment of Wildlife Management Area.
9	Main part of large wetland complex, end of the reservoir	469300	5513850	Water level management through sensitive timing of hydro operations; Excavate deep pools nearby that will hold water during drawdown. This site has tremendous wildlife habitat value and supports a great diversity of species. Investigate establishment of Wildlife Management Area.
10	Small bay at north end of Clowhom Reservoir, km 13.5	468522	5512698	Water level management through sensitive timing of hydro operations; install wildlife-friendly pond liner in existing ephemeral pond to ensure water remains long enough for amphibians to complete their development.
11	Bear Creek Mainline km 3.5	461334	5514003	Control invasive species; mitigate road effects; plant riparian vegetation.
12	Bear Creek Mainline km 3.5	460969	5513977	Plant riparian vegetation and provide large woody debris with smaller branches to improve habitat for amphibians.
13	Bear Creek Mainline km 6	459354	5515182	Monitor road impacts.
14	Off Clowhom Mainline km 2	460796	5506688	Remove invasive plants; monitor water quality.
15	Nagy FSR, 300 m from Clowhom Reservoir	461573	5510449	Monitor invasive species; take care when clearing brush under transmission line; avoid chemical herbicides; monitor water levels.

For detailed descriptions, habitat assessments, photographs, mapping, classification and discussion of threats and enhancement opportunities for the above 15 identified Clowhom wetlands, please refer to Evelyn et al. (2014, 2015).

**Table 11: Threat-Related Management Recommendations for the Clowhom Watershed**

Threat	Enhancement / Mitigation Recommendations
Hydro Operations	<ul style="list-style-type: none"> <li>• Practice responsible water level management through sensitive timing of hydro operations to minimize negative impacts of water level fluctuations on breeding amphibians and shoreline nesting birds between March to August of each year.</li> <li>• Increase area of wetland habitat by excavating a series of new wetland pools that will be unaffected by reservoir water levels, adjacent to the areas currently being affected (please see section 6.8).</li> <li>• Microhydro operators in the watershed should follow sound practices to ensure sufficient water flow and maintain appropriate water quality and temperature in occupied Tailed Frog streams.</li> </ul>
Roads and Transmission Lines	<ul style="list-style-type: none"> <li>• Monitor road mortality, and if necessary, mitigate through fencing, signage and/or road crossing structures</li> <li>• Avoid clearing right of ways during amphibian breeding season between March to August</li> <li>• Monitor invasive and introduced plants and control if they become a problem</li> <li>• Take care when clearing brush in wetlands under transmission lines to avoid harming amphibians and their habitat</li> <li>• Avoid using chemical herbicides, pesticides or other chemical applications near wetlands and riparian zones</li> <li>• Monitor water quality in wetlands adjacent to roads</li> <li>• Where necessary, undertake roadside planting of native vegetation to prevent pollution due to road runoff</li> </ul>
Forest Harvesting	<ul style="list-style-type: none"> <li>• Ensure that future forest harvesting decisions seek to conserve and maintain habitat values for wildlife species at risk around important breeding, hibernating, nesting and foraging sites, and within identified occupied territories</li> <li>• Maintain remaining areas of mixed riparian forest and mature forest patches in occupied Screech-Owl territories</li> <li>• Maintain forested riparian buffers around occupied Coastal Tailed Frog creeks</li> <li>• Maintain and recruit snags and cavity-bearing wildlife trees</li> <li>• Maintain and restore woody debris as shelter for amphibians</li> <li>• Add nest boxes and bat houses to increase nesting/roosting habitat for owls and bats</li> </ul>

## 8.0 ACKNOWLEDGEMENTS

Our deepest respect and appreciation to the shíshálh Nation for their support and allowing us to work on their lands.

We gratefully acknowledge the financial support of the Fish and Wildlife Compensation Program on behalf of its program partners BC Hydro, the Province of BC, Fisheries and Oceans Canada and public stakeholders. Thanks to FWCP and BC Hydro staff, including Trevor Oussoren, Lorraine Ens, Alexis Hall, and Susan Pinkus, for logistical support, collaboration, and sharing Clowhom reservoir water level data.

Additional funding for this project came from Environment Canada, Habitat Conservation Trust Foundation, Gencon Foundation, and Canada Summer Jobs. BC Conservation Foundation provided administrative services for some of our grants; special thanks to BCCF Executive Director, Deborah Gibson and Project Coordinator, Katie Calon.

We could not carry out this project without the support of Veresen Incorporated, Clowhom Power LP, Regional Power and Bear Hydro LP, who generously assist with boat transportation, along with accommodation, and use of their vehicles in the watershed. Our deepest appreciation to Robert Kulka, William McDonagh, Kyle Edwards, Kyle Saylor, Luke Till, Babar Khan, James Florance, and David Carter. Our thanks to Interfor's Alan Blattler for providing letters of support and use of the dock on Salmon Inlet.

We are extremely grateful for the support and guidance from numerous BC Ministry of Forests, Lands and Natural Resource Operations and BC Ministry of Environment staff members, including Kym Welstead, Myke Chutter, Ian Blackburn, Joshua Malt, Helen Schwantje, Leah Ramsay, Scott Barrett, Darryl Reynolds, and Purnima Govindarajulu.

We appreciate the experts who have shared freely of their knowledge and advice, including Dave Bates and Tony Greenfield for sharing knowledge of the Clowhom watershed; Greg Ferguson for advice about Barn Swallows; Erica McClaren for guidance on Northern Goshawks; Tasha Sargent for information about priority goals, habitats and species of the Pacific Birds Habitat Joint Venture; Cori Lausen for training in bat acoustic survey technique; and Jared Hobbs for guidance about Western Screech-Owl and environmental DNA surveys.

We are grateful to our outstanding project team, including Aimee Mitchell, Chris Currie, Dan Stewart, Kaiden Bosch, Rowan McEwen, and Dakota Stiles, for all of their hard work, professionalism, and long days in the field. Thanks to Lee-Ann Ennis for leading school and community outreach activities; to Maya Birkel for graphic design services; and to Lou Drummond, Mike Ough and Rick O'Neill for building beautiful owl and bat houses and construction kits.

We appreciate all of the wonderful Sunshine Coast community members, school classes and local organizations who assisted with wildlife habitat enhancement efforts this year. Thank you to the Sechelt Nation, Sunshine Coast Regional District, Town of Gibsons, and District of Sechelt for supporting wildlife conservation and habitat enhancement efforts on the Sunshine Coast.

Most photos in this document were taken by Aimee Mitchell, Chris Currie, and Dave Stiles. The few exceptions, provided courtesy of Creative Commons licences, are on page 61 (from left to right: Minette Layne, Katsura, Kev Chapman).

## 9.0 REFERENCES

- Andrews KM, Gibbons JW, Jochimsen DM (2008)** Ecological effects of roads on amphibians and reptiles: a literature review." *Herpetological Conservation* 3: 121-143.
- Austin MA, Buffett DA, Nicolson DJ, Scudder GGE, Stevens V (eds.) (2008)** Taking Nature's Pulse: The Status of Biodiversity in British Columbia. Biodiversity BC, Victoria, BC. 268 pp.
- Bates DJ (2008)** Clowhom Lake Water Use Plan – Clowhom Lake wildlife census – Year 2. Resource Management Department, shíshálh Nation, Sechelt, BC.
- Bates DJ (2007)** Clowhom Lake Water Use Plan – Clowhom Lake wildlife census – Year 1. Resource Management Department, shíshálh Nation, Sechelt, BC.
- Bates DJ, Ferguson G (2010)** Clowhom Lake Water Use Plan – Clowhom Lake wildlife census – Year 4. Resource Management Department, shíshálh Nation, Sechelt, BC.
- Bates DJ, Ferguson G (2014)** Clowhom Project Water Use Plan, Monitor of Aquatic Wildlife in Wetlands Affected by Dam Operations, Implementation Year 8. Resource Management Department, shíshálh Nation, Sechelt, BC.
- Bates DJ, Staats M, Ferguson G (2009)** Clowhom Lake Water Use Plan – Clowhom Lake wildlife census – Year 3. Resource Management Department, shíshálh Nation, Sechelt, BC.
- Bates DJ, Ferguson G, Coombes O (2011)** Clowhom Lake Water Use Plan - Clowhom Lake Wildlife Census– Wildlife Rotation 2 – Year 1. Resource Management Department, shíshálh Nation, Sechelt, BC.
- Belthoff JR, Ritchison G (1990)** Nest-site selection by Eastern Screech-Owls in central Kentucky. *Condor* 92: 982-990.
- BC Ministry of Environment (2014)** Guidelines for Amphibian and Reptile Conservation during Urban and Rural Land Development in British Columbia (2014). A companion document to Develop with Care 2012: Environmental Guidelines for Urban and Rural Land Development in British Columbia.
- BC Ministry of Environment (2016)** BC Species and Ecosystem Explorer. Available at: <http://a100.gov.bc.ca/pub/eswp/>.
- Cannings RJ, Angell T (2001)** Western Screech-Owl (*Otus kennicottii*). In: The Birds of North America, No 597 (A. Poole and F. Gill eds.). The Birds of North America, Inc., Philadelphia, PA.
- Cornell Lab of Ornithology Nestwatch Program (2013)** Nest Box Construction Plans: American Kestrel, Screech Owl, and Northern Saw-whet Owl.
- COSEWIC (2002a)** COSEWIC assessment and status report on the red-legged frog *Rana aurora*. Committee on the Status of Endangered Wildlife in Canada. Ottawa.
- COSEWIC (2002b)** COSEWIC assessment and status report on the western toad *Bufo boreas* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa.
- COSEWIC (2011a)** COSEWIC assessment and status report on the Barn Swallow (*Hirundo rustica*) in Canada. Committee on the Status of Endangered Species in Canada, Ottawa.
- COSEWIC (2011b)** COSEWIC Assessment and Status Report on the Coastal Tailed Frog *Ascaphus truei* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa.

- COSEWIC (2012)** COSEWIC assessment and status report on the Western Screech-Owl *kennicottii* subspecies *Megascops kennicottii* and the Western Screech-Owl *macfarlanei* subspecies *Megascops kennicottii macfarlanei* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa.
- COSEWIC (2013a)** COSEWIC assessment and status report on the Little Brown Myotis *Myotis lucifugus*, Northern Myotis *septentrionalis*, Tri-colored Bat *Perimyotis subflavus* in Canada – 2013. Committee on the Status of Endangered Wildlife in Canada. Ottawa.
- COSEWIC (2013b)** COSEWIC assessment and status report on the Northern Goshawk *Accipiter gentilis laingi* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa.
- Davis H, Weir R (2008)** Western Screech-owl Conservation along the Shuswap River. Submitted to the Bridge Coastal Restoration Program. Project # 05W.Sh.01
- Elliott K (2006)** Declining numbers of Western Screech-Owl in the lower mainland of British Columbia. *British Columbia Birds* 14: 2-11.
- Environment Canada (2011a)** Status of Birds in Canada – 2011. Northern Goshawk.
- Environment Canada (2011b)** Status of Birds in Canada – 2011. Western Screech-Owl *kennicottii* subspecies.
- Evelyn MJ, Stiles DA (2015)** Clowhom Intake Maintenance Gate Hoist Replacement Barn Swallow Mitigation Strategy. Prepared by BC Hydro by Halcyon Professional Services / Sunshine Coast Wildlife Project.
- Evelyn MJ, Stiles DA, Currie C, Mitchell A (2015)** Surveys of Species at Risk and their Associated Habitats in the Clowhom Watershed – Year 2. FWCP Project No. 14.W.COM.01. Final Report – August 2015.
- Evelyn MJ, Stiles DA, Currie C, Mitchell A (2014)** Surveys of Species at Risk and their Associated Habitats in the Clowhom Watershed – Year 1. FWCP Project No. 13.W.COM.01. Final Report - July 2014
- Ferguson G (2014a)** Beneficial Management Practices for Barn Swallow (*Hirundo rustica*). The British Columbia Swallow Conservation Project.  
<https://bcswallowconservationproject.files.wordpress.com/2014/05/beneficialmanagementpracticeforbarnswallowhirundorustica.pdf>
- Ferguson G (2014b)** Site suitability assessment for Barn Swallow (*Hirundo rustica*) nesting enhancement. The British Columbia Swallow Conservation Project.  
<https://bcswallowconservationproject.wordpress.com/swallow-best-management-practices/>
- Ferguson G, Bates DJ, Coombes O (2012)** Clowhom Project Water Use Plan - Monitor of Aquatic Wildlife in Wetland affected by Dam Operations Implementation Year 6. Reference: COMMON-1 Year 2 – Rotation 2: Clowhom Lake Wildlife Census Study Period: April 1, 2011 to March 31, 2012. Resource Management Department, shíshálh Nation, Sechelt, BC.
- Ficetola GF, Miaud C, Pompanon F, Taberlet P (2008)** Species detection using environmental DNA from water samples. *Biology Letters* 4: 423–425.
- Fish and Wildlife Compensation Program (2011)** Clowhom Watershed – Watershed Plan.

- Forbes, G (2012)** Technical Summary and Supporting Information for an Emergency Assessment of the Little Brown Myotis *Myotis lucifugus*. Committee on the Status of Endangered Wildlife in Canada. Ottawa.
- Frick, WF, Pollock JW, Hicks AC, Langwig KE, Reynolds DS, Turner GG, Butchkoski CM, Kunz TH (2010)** Collapse of a Common North American Bat Species - An Emerging Disease Causes Regional Population. *Science* 329, 679-682.
- Goldberg CS, Pilliod DS, Arkle RS, Waits LP (2011)** Molecular detection of cryptic vertebrates in stream water: a demonstration using Rocky Mountain tailed frogs and Idaho giant salamanders. *PLoS One* 6: e22746.
- Government of Canada (1994)** Migratory Birds Convention Act, 1994. Available: <http://lawslois.justice.gc.ca/PDF/M-7.01.pdf>
- Hausleitner D (2006)** Inventory Methods for Owl Surveys. Standards for Components of British Columbia's Biodiversity No.42. Prepared for Ecosystems Branch of the Ministry of Environment for the Resources Information Standards Committee. Victoria, B.C.
- Hausleitner D, Dulisse J (2011)** Movement and Habitat Use of Western Screech-owls in the West Kootney Region. 2010-11 Field Season Report. Prepared for the Fish and Wildlife Compensation Program and the Columbia Basin Trust.
- Hobbs J (2013)** Western Screech-Owl Conservation and Management in the Flathead River, 2012 Survey Final Report. Prepared for: Great Northern Landscapes Conservation Cooperative and BC Ministry of Forests, Lands and Natural Resource Operations.
- Hobbs J (2014)** Field verification of Western Screech-owl habitat at project site. Hemmera Memorandum: LNG Woodfiber.
- Identified Wildlife Management Strategy (IWMS) (2004a)** Coastal Tailed Frog *Ascaphus truei*. In: Accounts and Measures for Managing Identified Wildlife – Accounts V. 2004. Prepared by A Mallory. Biodiversity Branch, Identified Wildlife Management Strategy, Victoria, B.C.
- Identified Wildlife Management Strategy (IWMS) (2004b)** Interior Western Screech-Owl *Otus kennicottii macfarlanei*. In: Accounts and Measures for Managing Identified Wildlife – Accounts V. 2004. Prepared by R.J. Cannings. BC Ministry of Water, Land and Air Protection.
- Identified Wildlife Management Strategy (IWMS) (2004c)** “Queen Charlotte” goshawk *Accipiter gentilis laingi*. In: Accounts and Measures for Managing Identified Wildlife – Accounts V. 2004. Prepared by E. McClaren, BC Ministry of Water, Land and Air Protection.
- Identified Wildlife Management Strategy (IWMS) (2004d)** Red-legged Frog *Rana aurora*. In: Accounts and Measures for Managing Identified Wildlife – Accounts V.2004 Prepared by K. A. Maxcy. Biodiversity Branch, Identified Wildlife Management Strategy, Victoria.
- IUCN (2014)** The IUCN Red List of Threatened Species. Version 2014.1. <http://www.iucnredlist.org>
- Kaufman K (2002)** A Little Night Magic”. In Audubon Magazine January-February 2002.
- Mahon T, McClaren EL, Doyle FI (2008)** Parameterization of the Northern Goshawk (*Accipiter gentilis laingi*) Habitat Model for Coastal British Columbia. Nesting and Foraging Habitat Suitability Models and Territory Analysis Model. Northern Goshawk Recovery Team.

- Northern Goshawk *Accipiter gentilis laingi* Recovery Team (2008)** Recovery Strategy for the Northern Goshawk, *laingi* subspecies (*Accipiter gentilis laingi*) in British Columbia. BC Ministry of Environment.
- Olson DH, Leonard WP, Bury RB (1997)** Sampling Amphibians in Lentic Habitats: Methods and Approaches for the Pacific Northwest. Northwest Fauna Number 4. Society for Northwestern Vertebrate Biology, Olympia, WA.
- Province of British Columbia (1996)** Wildlife Act, [RSBC 1996] CHAPTER 488.  
[http://www.bclaws.ca/Recon/document/ID/freeside/00\\_96488\\_01](http://www.bclaws.ca/Recon/document/ID/freeside/00_96488_01)
- Relyea RA (2005)** The impact of insecticides and herbicides on the biodiversity and productivity of aquatic communities. *Ecological Applications* 15: 618–627.
- Resource Information Standards Committee (1998b)** Inventory Methods for Pond-breeding Amphibians and Painted Turtle. BC Ministry of Environment, Ecosystems Branch. Published by the Terrestrial Ecosystems Task Force Resources Information Standards Committee, Victoria, B.C.
- Resource Information Standards Committee (2001)** Standard methodologies for the inventory of biodiversity in British Columbia: Raptors. Version 2.0. BC Ministry of Sustainable Resource Management, Victoria, B.C.
- Richardson CJ (1994)** Ecological functions and human values in wetlands: a framework for assessing forestry impacts. *Wetlands* 14: 1–9.
- Sleeman J (2013)** White-Nose Syndrome Updates. USGS, National Wildlife Health Center. *Wildlife Health Bulletin* 2013-04. 2pp
- Thomsen PF, Kielgast J, Iversen LL, Wiuf C, Rasmussen M, Gilbert MT, Orlando L, Willerslev, E (2012)** Monitoring endangered freshwater biodiversity using environmental DNA *Molecular Ecology* 21(11): 2565-2573.
- Tori GM, McLeod S, McKnight K, Moorman T, Reid FA (2002)** Wetland conservation and Ducks Unlimited: Real world approaches to multispecies management. *Waterbirds* 25: 115-121.
- Tripp T, Robinson J, Taylor A. (2015)** Coastal Western Screech-owl Surveys and Habitat Assessment for Habitat Acquisition Trust, Victoria, BC. Madrone Environmental Services Ltd.
- United States Geological Survey (2016)** Bat with white-nose syndrome confirmed in Washington state. March 31, 2016. <https://www.usgs.gov/news/bat-white-nose-syndrome-confirmed-washington-state>
- Verant ML, Meteyer CU, Speakman JR, Cryan PM, Lorch JM, Blehert DS (2014)** White-nose syndrome initiates a cascade of physiologic disturbances in the hibernating bat host. *BMC Physiology* 2014, 14:1
- Whiles MR, Grubaugh JW (1996)** Importance of coarse woody debris to southern forest herpetofauna. *Biodiversity and coarse woody debris in southern forests*. USDA Forest Service, Asheville, NC, 94-100.