ABSTRACT

Beginning in the mid-1940s, the Campbell River watershed has been subjected to major habitat and landscape changes associated with damming and subsequent flooding of riparian areas. Logging and fires within these old-growth riparian areas may also have resulted in the loss of habitat utilized by forest dwelling owls. Structures including snags, large-limbed trees associated with forest stands of varying age classes, where owls roost and nest, have likely been reduced and eliminated. This project was the third year of inventory for five species of owls found within the Campbell River watershed. From February to April 2000, 2002 and 2003, five areas near hydroelectric diversions were extensively surveyed for Northern Pygmy (NPOW; *Glaucidium gnoma*), Northern Saw-whet (NSOW; *Aegolius acadicus*), Western Screech- (WSOW; *Otus kennicottii*), Barred (BAOW; *Strix varia*), and Great Horned (GHOW; *Bubo virginianus*) Owls, using call play back methods. Small owls and large owls were surveyed for a total of three rounds each, and broken up such that small owls and large owls were surveyed for on alternating weeks. In the three study years, 57 owls were detected in 2000, 108 in 2002 and 57 owls detected in 2003. Throughout the three years of this study, 222 owls were detected over 798 call stations, with NSOW making up 59% of the detections, WSOW with 24%, BAOW with 11%, GHOW with 3%, and NPOW with 3%. The nest box program initiated in 2002 was again carried out in 2003 but no birds were found to occupy any of the 83 nest boxes. Trapping and radio telemetry was initiated in 2003, resulting in the banding of 8 NSOW and 5 WSOW. Radio transmitters were affixed to 2 NSOW and all 5 WSOW. Radio telemetry data collection is still in progress and results will be reported at a later date.

ACKNOWLEDGEMENTS

This project was funded by BC Hydro and Coordinated by Don Doyle of the BC Ministry of Water, Land and Air Protection (WLAP), and the BC Conservation Foundation (BCCF). Special thanks to Don Doyle of WLAP who provided insight and volunteered many cold nights to survey for owls. Also thank you to Pat Stephenson at BCCF who provided supplies and handled all administrative duties associated with the project. Would like to thank all those who participated in this study over the past three years: Paul Levesque, Michelle Mico, Sean Pendergast, Tom Van Enter, Aubrey Zeeman; as well as all those who volunteered: Rosie Barlak, Laura Cassin, Erica McClaren and Sue McDonald. Special thanks to Tania Tripp for providing valuable insight into survey techniques and help with surveying, and to Sean Pendergast for leading crews in the 2002 and 2003 field seasons, as well as providing editing and organizational support. Thank you also to Brian Cavanagh of SRM for all his GIS expertise.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

Over the past 60 years, the Campbell River watershed has been extensively modified with the construction of BC Hydro electric power facilities, hydro diversions, logging, and fires. These modifications have resulted in the creation of lakes, the diversion of rivers and young seral stages of coniferous and deciduous forests. Blood (1993) estimated that most of the Campbell River watershed has been logged or burned since 1930 (outside of Strathcona Park) and that approximately 50 km^2 of land have been flooded to accommodate the various hydroelectric diversions. Blood (1993) also suggested that the loss of riparian habitat associated with hydroelectric diversion creation has resulted in a population reduction of some species. Based on this information, BC Hydro initiated the Bridge River/Coastal Compensation Fund to help mitigate and learn about the effects of past flooding.

Owl populations within the Campbell River watershed have likely been affected from flooding. Figure 1 illustrates the five areas where watersheds were altered in the Campbell River drainage resulting in varying amounts of habitat modifications. Owls rely on prey diversity within riparian areas, as well as on forest edges (Houston *et al.* 1998; Resource Inventory Committee [RIC] 2001). Some owl species exhibit nest site fidelity (RIC 2001), making them especially sensitive to habitat alteration. Riparian areas usually encompass a wide variety of forest age classes, tree types, tree decay stages, and prey base. Dead trees and snags are especially important for owls as these structures make up their nesting and/or roosting sites by way of cavities created by woodpeckers.

Owls generally occur in low numbers throughout most of North America. Vancouver Island has two owl species that are classified as rare or uncommon (Campbell *et al.* 1990; Darling 2002) and therefore make good candidates for an enhancement and monitoring program. Within the Campbell River watershed, five species of owls are present: Northern Pygmy Owl (NPOW; *Glaucidium gnoma*), Northern Saw-whet Owl (NSOW; *Aegolius acadicus*), Western Screech-Owl (WSOW; *Otus kennicottii kennicottii*), Barred Owl (BAOW; *Strix varia*), and Great Horned Owl (GHOW; *Bubo virginianus*). Of these five species, the Northern Pygmy owl subspecies on Vancouver Island, *Glaucidium gnoma swarthi,* is considered to be at risk and classified on the Blue List (Darling 2002; British Columbia Conservation Data Center; BCCDC 2003)**.** The Western screech owl subspecies, *kennicottii* is also Blue Listed, and is considered threatened in the long-term by "large-scale forest harvesting at low elevations, urbanization in the southern portion of the range, loss of snag trees and possibly competition from Barred Owls (BCCDC 2003). Although NSOW are not considered to be as uncommon as the aforementioned owls, they are of particular interest as they are well suited for the nest box enhancement portion of this study due to the ease in which they will use nest boxes (Cannings 1993; RIC 2001).

Many owl species are secondary cavity nesters, using cavities created by Northern Flickers (*Colaptes auratus*), Pileated woodpeckers (*Dryocopus pileatus*), or naturally occurring cavities resulting from decay (Cannings 1993). Other owl species will also use manmade structures such as nest boxes and railway trestles for their nest sites (Cannings

1993; RIC 2001). For this reason, a nest box program was initiated in 2002 to monitor the use of the 83 nest boxes erected within the Campbell River watershed. Due to habitat modifications in the study areas, nest boxes were thought to be an alternative to the secondary natural cavities, perhaps resulting in an increase in the number of nesting owls within the Campbell River watershed.

In order to better understand the nesting habits of owls on Vancouver Island, a radio telemetry program was initiated in 2003, as per the recommendation of Mico and Van Enter (2000). Owls radio-tagged could be followed and potential nesting sites identified. Belthoff and Ritchison (1989) found nests of Eastern Screech Owls (*Otus asio*) in this manner and used this information to help better understand the fledging patterns of young owls.

The main objectives during the 2003 study were to: 1) replicate the surveys of 2000 and 2002 to help determine the relative abundance of owls in the Campbell River watershed; 2) continue with the nest box enhancement program of 2002; and 3) initiate a trapping and radio telemetry program.

METHODS

In the years 2000, 2002 and 2003, owl surveys were conducted for: NPOW, NSOW, WSOW, BAOW, and GHOW, all known to be found within the Campbell River Watershed. Call play-back methods were used, adopted from RIC (2001), to detect each of the five owl species. The surveys were divided between small owls (NPOW, NSOW, WSOW) and large owls (BAOW and GHOW) to decrease predation of large owls on small owls. As well, small owl surveys and large owl surveys were separated by at least one week.

Five study areas were surveyed: Strathcona Dam, Salmon River, Quinsam Lakes, John Hart Lake, and Heber River (Figure 1). Survey stations were placed along transects 800 meters apart for small owls and 1600 m apart for large owls. Each station was denoted with an alpha-numeric name: the alpha was from the study area site (Strathcona=ST; Salmon=S; Quinsam=Q; John Hart=JH; Heber=H) and the number was assigned based on series of transects beginning with the route number (1, 2, or3) and followed by the station number (for example H2-3 represents a station in the Heber along the 2nd transect line, at the third station for that transect). Twelve small owl stations and 6 large owl stations were within each study area, resulting in a total of 60 stations being surveyed in the five areas of the Campbell River Watershed. Survey stations were located approximately 5 km from hydroelectric diversions, and were located on logging roads to help facilitate late-night surveying. In 2003, 4 stations had to be relocated due to high creek noise (could not be surveyed).

Owl surveys commenced in late February and concluded in mid-April for all three study years, resulting in 7 one-week survey periods. Survey weeks were alternated between small owls and large owls, and the order of surveys within each study area were rotated in order to vary the time of night a survey was conducted at a particular station. Surveys began approximately one half hour after sunset and generally concluded 8 hours later. Surveys were not conducted if the weather was unsuitable (wind greater than 3 on the Beaufort scale, heavy rain or snow, or heavy fog) (RIC 2001; Takats *et al.* 2001).

At the start of each survey session, the following data was collected: temperature (°C), cloud cover (nearest 10 %), precipitation (none, light or moderate), snow cover (none, patchy, continuous) and precipitation type (rain or snow). The temperature and cloud cover were also recorded at the end of the survey session. At each individual survey station the following data were collected: survey start and finish time, wind (Beaufort scale of 0,1,2,3, >3), noise level (audible noise 1,2,3,4), and traffic count (number of cars that passed during the survey) (Takats *et al.* 2001).

Each survey station commenced with a 2 minute listening period to detect any spontaneously calling owl species. This was followed by a series of recorded owl calls being broadcasted. A TOA® transistor megaphone (APA-603, Kobe Japan) was used in combination with a portable CD player (Panasonic SL-S2000 XBS or Koss CDP 676) to broadcast the calls. The TOA® was held approximately 1 meter above the ground, and was rotated to broadcast a bout of calls in each of the cardinal directions. A call bout consisted of a series of calls from one owl species (approximately 15-20 seconds), followed by a 30 second period of silence for listening. After each of the cardinal directions were surveyed, a five minute listening period was conducted. The order which calls were played depended on whether small owls or large owls were being surveyed. The order of calls for small owls was NPOW, NSOW and then WSOW; for large owls the order was BAOW and then GHOW. Each small owl call station lasted approximately a maximum of 30 minutes, whereas large owl survey rounds lasted approximately 20 minutes.

If an owl was detected, the species detected was recorded, the direction (to the nearest degree), distance (to the nearest 10 m), call bout number (bout 1, 2, 3 or 4) and to what species the detection was in response to. Once an owl was detected, whether spontaneous or elicited, all further broadcasts at the station were halted, and the end time recorded. Detection rates were reported as the number of detections per 100 call stations. Over the three year study, the mean detection rates were calculated per species, as well as per study area.

Survey stations, detections and nest box placements were transferred to TRIM based 1:20,000 maps and digitized by the Ministry of Sustainable Resource Management (MSRM) into Geographic Information System format.

The 83 nest boxes erected in 2002 (see Pendergast 2002 for box details) in each survey area were checked between April 28 and May 2, 2003 using a TREETOP II peeper (Christensen Designs, Manteca, CA). Boxes that appeared to have water damage (mold on inside of box) were replaced with wood duck boxes received by the MWLAP. All nest boxes were checked as late in the season as possible to see if breeding activity occurred.

During 2003, as per the recommendations of Mico and Van Enter (2000), a radio-tagging and trapping program was initiated. Trapping sessions consisted of a mist net with an audio lure (using TOA® and CD player), broadcasting the call of the targeted owl species. At each trapping session, a taxidermy replica of the owl species was placed approximately 3 feet off the ground at the center of the net. A box trap was utilized in hopes to catch Barred Owls in the John Hart area, using live rock doves (*Columba livia*) as lures. Trapping sites were chosen based on information from previous years, such as species heard in the area and habitat type. At each trap site the following data were collected: nearest survey station, time of trapping, temperature at the start and end of trapping, wind (Beaufort), precipitation start and finish (drizzle, rain, snow) and what species of owl was being broadcast.

Nets were checked every half hour to every hour, and the check time was noted. Trapping was terminated if there was moderate rain, snow or wind >3 Beaufort. If an owl was caught, its placement in the net and the time it was captured was recorded. The owl was then banded with a USFWS band, and the following measurements were taken: bird weight, wing cord, flattened wing cord, culmen + cere, depth at cere and tail length. Blood samples were taken from the radial-ulna vein for future DNA analysis. A feather clip was also taken from the innermost primary for radio isotope analysis. Owls caught post-February 2003, were fitted with radio transmitters to determine their movement patterns, home range size and locate nest sites.

Two-gram backpack radio transmitters were used for NSOW (Holohil Systems Inc., Carp, ON) and 4.5 g transmitters for WSOW (Wildlife Materials Inc., Carbondale, IL). Braided nylon cord or Teflon ribbon was used to secure transmitters to the owls. Owls fitted with radio transmitters were tracked on a daily basis, at varying times of the day. Telemetry stations were set up in a radius around where the bird was trapped for triangulation. Telemetry was conducted using a 3-element Yagi antenna (Telonics Inc., Mesa, AZ) and a HR2000 Habit Osprey Receiver or a Lotek SR-400 receiver. A minimum of three points were taken for road telemetry triangulations. Walk-in telemetry was also done and visual observations of the birds were noted. Telemetry is still in progress and results will be reported at a later date.

RESULTS

Small and Large Owl Detections

In 2000, 2002 and 2003, a total of 222 owls were detected (57, 108, and 57 respectively). The majority of these detections were NSOW (59% or 130 detections), followed by WSOW (24% or 53 detections), BAOW (11% or 25 detections), and NPOW and GHOW, each with a 3% detection rate (or 7 detections each) (Figure 2). Of all the owls detected, 26% (or 58 detections) were spontaneous and 74% (or 164 detections) were elicited responses.

In the year 2000, 21 owls per 100 call stations were detected, with 82% of the detections being small owl species. In 2002, 42 owls per 100 call stations were detected (94% small owls) and in 2003, 21 owls per 100 call stations were detected (72% small owls). In all three years, NSOW were the most detected owl species with 11 detections per 100 call stations being NSOW in 2000, 30 detections per 100 call stations in 2002, and 8 detections per 100 call stations in 2003. The least detected owl species in 2000 and 2002 was GHOW (0% and <1% detections respectively). In 2003 NPOW was the least detected species (5% detections) (Figure 3).

Of the owls detected in 2000, 2002 and 2003, the majority detected were in response to call play back. In the 2000 study year, 7 detections per 100 call stations were spontaneous, in 2002, 10 detections per 100 call stations were spontaneous, and in 2003, 2 detections per 100 call stations were spontaneous. With call play back, these numbers increased to 13 detections per 100 call stations in the year 2000, 27 detections per 100 call stations in 2002, and 25 detections per 100 call stations in 2003 (Table 1).

TABLE 1. Detections of small and large owls throughout the 3 year study period, broken down by survey type and converted to detections per 100 call stations.

Survey Type	**Number of detections**
Total number of small owl detections on small owl surveys	**32**
Small owl detections to call play back on small owl surveys	**24**
Spontaneous small owls on small owl surveys	**8**
Total number of large owl detections on large owl surveys	**10**
Large owl detections to call play back on large owl surveys	**7**
Spontaneous large owls on large owl surveys	**3**
Small owl detections to call play back on large owl surveys	**5**
Spontaneous small owl detections on large owl surveys	**3**
Large owl detections to call play back on small owl surveys	**2**
Spontaneous large owl detections on small owl surveys	**0**
Total detections per 100 call stations	**25**

In 2002, NSOW were detected at nine different call stations throughout all 3 rounds of surveying, indicating possible territories. In 2000 and 2003, no owl species were heard during all 3 rounds of surveying at the same station (Table 2). However, 4 stations in 2000 had 2 repeat detections of NSOW (stations H1-7; JH1-2; JH3-1; ST1-2). In 2003, no NSOW were heard more than once at a particular station, however 3 WSOW were heard twice at the same station (stations S3-3; ST1-1; H1-8); 1 NPOW was heard twice at station JH2-4; and 1 GHOW was heard twice at the station ST2-3.

Small Owl Surveys

During small owl surveys, a total of 166 small owls were detected, as well as 14 large owls. NSOW were the most frequently detected small owl, with a detection rate of 63%, followed by WSOW (25%), and NPOW (12%). BAOW were detected at a rate of 8% during small owl surveys.

NPOW detection rates increased slightly over the three-year study period, from a 2% overall detection rate in 2000, 3% in 2002, to just over 5% in 2003. There were only two study areas within the Campbell River watershed where NPOW were detected. These included John Hart, with 5 detections, and Strathcona, with 2 detections (Figure 4).

All five study areas had NSOW detections, however the Heber had the highest cumulative detection rate of 70% and Strathcona had the lowest cumulative detection rate with 47% of detections being NSOW. No NSOW were detected in 2003 in Strathcona, dropping from a detection rate of 57% in 2002 and 67% in 2000. In the Heber, NSOW detection rates dropped from 88% in both 2000 and 2002 to an 18% detection rate in 2003. In the Salmon, 65% of cumulative detections were NSOW, 53% in John Hart, and 53% in Quinsam. No study area had an increase of NSOW detections over the three years (Figure 5).

The cumulative detection rate of WSOW was 24%, with the year 2000 having a 26% WSOW detection rate, 2002 with 19% and 2003 with 30%. Over the three years, Quinsam and Salmon had the highest rates of detection, 31% each, followed by the Heber and Strathcona with 26% and John Hart with 11% of the WSOW detections (Figure 6).

Sixty small owl stations were visited throughout all three years of surveying, resulting in 180 stations being surveyed in 2000, 172 in 2002, and 177 in 2003. Of these stations surveyed, 42 owls were detected in 2000 (23 per 100 call stations), 97 in 2002 (56 per 100 call stations), and 35 in 2003 (20 per 100 call stations). NSOW were the most frequent species heard, and NPOW were the least frequent small owl heard in all three years. WSOW accounted for 26% of detections in 2000, 20% of detections in 2002 and 37% in 2003. Large owls were also detected during small owl surveys, with BAOW being the most detected (5 detections in 2002 and 2003). GHOW were not detected in response to small owl calls in either 2000 or 2002, but 1 GHOW was detected in 2003 in response to a NSOW call in Strathcona. Of the large owls detected during small owl surveys, all were elicited responses (no spontaneous callers).

TABLE 2. List of the 18 call stations that had repeat detections of the same species on two or more rounds of surveying throughout the 2000, 2002, and 2003 study periods.

Year Detected	Species Detected	Station Number	# Rounds Detected
2000	NSOW	JH 1-2	2
2000	NSOW	JH 3-1	2
2000	NSOW	H 1-7	2
2000	NSOW	ST 1-2	2
2002	NSOW	JH 1-1	3
2002	NSOW	JH 1-2	3
2002	NSOW	JH 3-1	3
2002	NSOW	H 1-7	3
2002	NSOW	H 2-1	3
2002	NSOW	Q 1-8	3
2002	NSOW	S 2-1	3
2002	NSOW	S 2-2	3
2002	NSOW	S 2-3	3
2003	NPOW	JH 2-4	2
2003	WSOW	ST 1-1	2
2003	WSOW	S 3-3	2
2003	WSOW	H 1-8	2
2003	GHOW	ST 2-3	2

Large Owl Surveys

During large owl surveys, 20 large owls were detected with 75% BAOW, and 25% GHOW. Small owls were also detected during large owl surveys at a rate of 8 responses per 100 call stations, with 67% of these detections being NSOW and 33% WSOW. 20% of the large owl detections were spontaneous callers and 33% of the small owls detected during large owl surveys were spontaneous callers.

BAOW detection rates in 2000 were 18%, 5% in 2002, and 18% in 2003. All five study areas had BAOW detections in 2000, however only 3 areas had BAOW detections in 2002 and 2 areas in 2003. Strathcona and John Hart had the highest detection rates, averaging 13% and 23% respectively of detections, over the three years (Figure 7).

Great Horned owls were detected more frequently in 2003 than in 2002, and were not detected at all in 2000. Between 2002 and 2003, GHOW detections increased from 1% of all detections to almost 11% in 2003. Strathcona had the highest cumulative detection rate of GHOW with 21% , followed by the Quinsam at 17%, Heber River at 5%, and John Hart with 4%, over the three year study period. There were no GHOW detected in the Salmon study area during 2000, 2002 or 2003 (Figure 8).

Thirty large owl stations were visited in each of the three years, yielding 9 detections in 2000, 1 detection in 2002, and 10 detections in 2003. GHOW were not detected in 2000 or 2002, but 5 were detected in 2003. In 2000, there were 9 BAOW detections, followed by 1 BAOW response in 2002 and 10 in 2003. During large owl surveys, a total of 21 small owls responded to broadcasts; 3 in 2000, 12 in 2002 and 6 in 2003. Seven of these small owls detected (33%) were spontaneous callers, with the remaining in response to call play back.

Owl Detections by Survey Area

Of the five areas surveyed, John Hart Lake(Figure 9) had the highest number of detections (56), followed by the Salmon River with 49 detections (Figure 10), the Heber River with 43 detections (Figure 11), Strathcona Dam with 38 detections (Figure 12) and the Quinsam River with 36 detections (Figure 13). John Hart and Strathcona both had detections from all five species, whereas only NSOW, WSOW, and BAOW were detected in the Salmon River study area. The highest rate of NSOW detections was in the Heber (70% of detections) and the lowest rate of detections was in Strathcona (47% of detections). Of the owls detected in 2000, 2002 and 2003, the majority were detected in response to call play back. 24% of responses in 2000 were spontaneous, 27% in 2002, and 17% in 2003.

Trapping and Telemetry 2003

Trapping sessions were conducted from February 12 to April 30, 2003, resulting in 61 trapping sessions. Of these, 4 sessions involved a box trap, and the remaining 57 sessions involved a mist net and audio lure. Of the 57 sessions with mist net, 13 owls were caught: 8 NSOW and 5 WSOW. All WSOW and 2 of the NSOW were fitted with backpack radio transmitters to follow using radio telemetry. No owls were caught in the box trap.

Of the 5 WSOW caught, 3 birds have > 50 locations and two birds were not relocated after one week post-capture (Pendergast and Pendergast, in prep.). The first three WSOW were caught between February 13 and February 20, 2003, another was caught March 19, 2003 and the last WSOW was caught on April 29, 2003. Telemetry on all birds commenced the day after trapping. Of the 8 NSOW caught, only 2 were fitted with radio transmitters, and these individuals have been difficult to locate.

Nest Boxes

Of the 83 nest boxes put up in 2002, none had visible nesting birds inside of them. However, one nest box in the John Hart study area had nesting materials inside (grasses, etc.) and one nest box in the Salmon study area had what looked like downy feathers around the entry hole.

DISCUSSION

Northern Pygmy Owls

NPOW detection rates were generally low over the three year study, averaging just over 3% of all detections. Their low detection rates would support the notion that NPOW are rare or uncommon throughout British Columbia (RIC 2001; Darling 2002). Interestingly, in 2002 and 2003, two of the NPOW responses heard in each year were from the same station in John Hart (station JH2-4), which may suggest a possible territory.

However, the detection rates in the Campbell River watershed were quite different than those in other areas on Vancouver Island. In the Nimpkish Valley (Setterington 1998) and Clayoquot Sound (WILCON 1997), the NPOW represented 16% of all detections and 19% of all detections respectively (it should be noted that the Nimpkish Valley study was three years in duration and the Clayoquot study was one year). The lower occurrence of NPOW in the Campbell River watershed may be due to the assumption that NPOW prefer mature and old-growth coniferous mixed age forests that have a good number of potential nesting cavities (Darling 2002). The Campbell River watershed is mostly 30-80 year old second growth forest, lacking the remnant old growth trees that would provide the cavities needed. In contrast, the survey sites in Clayoquot and Nimpkish Valley were all located in undisturbed old-growth forests (WILCON 1997; Setterington 1998). Interestingly, the Heber River study site is made up of mostly old-growth forest and no NPOW were heard at this study site over the three year period. Two factors may have contributed to the low NPOW detection numbers, habitat fragmentation and loss (Darling 2002), as new roads are being built in the Campbell River watershed to accommodate continuous logging of timber in the area.

Another possible reason for the low detection rates of NPOW is the time of day the surveys were carried out. The call surveys conducted in this study did not begin until 0.5 hours after sunset and concluded approximately eight hours later. No surveys were conducted at dawn. The greatest calling intensity for NPOW is at dawn and dusk (RIC 2001). In contrast, surveys in Clayoquot were conducted one half-hour after dusk and two hours before dawn (WILCON 1997). NPOW are diurnal and feed early in the morning and in the late afternoon (RIC 2001), thus performing surveys around these times would likely be most effective to establish presence/not detected of NPOW in an area.

Northern Saw-whet Owls

Throughout the three years of the Campbell River owl surveys, NSOW proved to be the most abundant species accounting for 59% of all detections. This is in agreement with Cannings (1997) that Northern Saw-whet owls are the most numerous owls found in Southern Canada and the Northern United States. NSOW occupy a wide range of habitat types. These include: woodlands, dense forests, mixes of coniferous and deciduous trees and range in elevation from sea level to 2200 m (Campbell *et al.* 1990), thus allowing for their widespread distribution. In other studies on Vancouver Island, NSOW were not the most abundant species detected. In Clayoquot (Setterington 1998), NSOW detections made up only 8% of total detections, and in the Nimpkish Valley (WILCON 1997), NSOW made up 31% of total detections. The majority of our study areas were second-growth forests with some mixed transitional stages, providing suitable habitat for NSOW (RIC 2001), whereas Clayoquot Sound and the Nimpkish Valley were mostly old-growth forest. Perhaps NSOW thrive in areas of mixed forest age classes and types, where prey may be more abundant.

The variability of NSOW detections throughout the study areas may be explained by the fact that NSOW are most likely to be calling (and therefore detected) on clear, calm nights, with a bright moon and a temperature near 0°C (Cannings 1993). The survey period during 2002 proved to have more ideal weather conditions than 2003. The majority of nights in 2002 were clear, whereas throughout the 2003 study period only one week of clear and cool weather was recorded. Although no NSOW were detected in Strathcona during 2003, it is interesting to note that 4 NSOW were caught during trapping sessions within the survey area. This may suggest that birds were present but not always responding to call play back. NSOW are also thought to have a peak in detection rates between March and April (RIC 2001), and possibly the peak detection times vary from year to year allowing one year to have more responses in a given month than the following year. Another factor that may influence the presence of NSOW in a given area would be the availability of prey species. NSOW are known to have a diet of mostly small mammals (Cannings 1993), particularly deer mice (*Peromyscus sp.*) and voles (*Microtus sp.*). Prey species numbers are likely to fluctuate from year to year, thus having a direct impact on NSOW numbers (Houston *et al.* 1998; Darling 2002).

Western Screech Owls

WSOW detection rates averaged 24% over the three year study, with the 2003 study period having the highest detection rate with 30%. However, the detection rates in this study were lower than that in the Nimpkish study (Setterington 1998), which had a WSOW detection rate of 41%, and in Clayoquot (WILCON 1997), which had a detection rate of 54%.

WSOW are found in many forest types, but prefer mixed old-growth coniferous-deciduous forests near water (Cannings 1997; RIC 2001). In both the Nimpkish and Clayoquot studies, all survey transect lines were situated in old-growth forests, which fits with the suggestion that WSOW may more readily occupy old–growth stands, where nesting cavities, perch trees and prey may be more available. Within the Campbell River watershed, transect lines were mostly situated in 30 to 80 year old forests, with a small number of stations in the Heber River study site being situated within old-growth forest. This may account for the higher number of detection rates in the Heber, relative to the other four study areas.

The type of call being broadcast may influence responses as well. In this study, a male WSOW "bouncing ball" call was utilized. Herting and Belthoff (2001) suggest that WSOW assess the sex of potential intruders based on their song and react accordingly. If the taped call that is used in call play back is considered non-threatening (i.e. a female call) by a WSOW in the area, its likelihood of responding may decrease significantly. It is well documented that both sexes of WSOW will sing in response to call play back of conspecific songs within their territory (Herting and Belthoff 2001). WSOW respond more readily to conspecific calls but have also been known to respond to NPOW (Hardy and Morrison 2000) and NSOW (WILCON 1997) calls. A decrease in detection rate can also be attributed to the fact that male WSOW are more likely to call than females; therefore if males are not present in the area where a call is broadcast, a response is less likely to be elicited (Tripp 2001). Because vocalizations peak at certain times of the year, detection rates could also be misrepresented, as WSOW take more time to respond in the spring than in the winter (RIC 2001). Tripp (2003 *pers. comm.*) found that some WSOW may take up to fifteen minutes to respond to call play back within a study area. Increasing the five minute listening period in the future may enable more WSOW to be detected.

Barred Owls

Over the three-year study period, BAOW accounted for 11% of all detections. This is comparable to the Nimpkish study where BAOW also made up 11% of all detections (Setterington 1998). The comparable BAOW detection rates of the Nimpkish study and this study is interesting, as the Nimpkish is dominated by old-growth forest, whereas the Campbell River watershed is dominated by young second-growth forest. This may suggest that BAOW are able to adapt to a wide variety of forest age classes.

The BAOW has slowly been expanding its range throughout British Columbia and North America over the last twenty years (RIC 2001). In this study, BAOW numbers increased over the three years in two study sites, John Hart and Strathcona. These two areas also had decreased NSOW detections, suggesting an increase in BAOW may lead to a decrease in NSOW numbers. Perhaps the increase in BAOW in these two areas is reflective of the amount of fragmentation in the areas, with new logging roads being constructed in the John Hart area and the dam diversion and camp sites located in the Strathcona area. BAOW prefer mixed coniferous forests but can also be found in mixed coniferous and deciduous forests (Campbell *et al.* 1990). BAOW are also known to inhabit areas in close proximity to humans, and have been found on house awnings, apartment balconies, and along busy streets (Campbell *et al.* 1990). The wide variety of suitable habitat types make BAOW quite adaptable even in areas of extensive human disturbance. Their prey base consists mainly of mice and other small mammals, as well as small birds (RIC 2001). Like most raptors, if prey numbers are low, relative numbers of BAOW are also likely to be low. The decrease in numbers of BAOW detections during the 2002 study sessions may reflect a drop in prey numbers within the Campbell River watershed and surrounding areas.

BAOW are known to respond readily to call play back, especially during the breeding season (March to June) and the peak of response activity is 1 to 2 hours after sunset (RIC 2001). BAOW will often approach the area of call play back without vocalizing and waiting several minutes after a broadcast call ends before responding (RIC 2001). If a call is played and there is an insufficient listening period after the call, BAOW detections could be missed, if a bird was present in the vicinity but not yet vocalizing. It is possible that the five minute wait period used in this study may not be sufficient for detecting BAOW. They have been known to wait up to 12 minutes before responding (Campbell *et al.* 1990; RIC 2001). Survey listening periods may need to be increased to more effectively detect BAOW in the future.

Great Horned Owls

GHOW detection rates increased over the three year study period from 1% to 11%. As well, only one study area had detections prior to 2003, but three areas had GHOW detections in 2003. In comparison to other studies on Vancouver Island, GHOW detections made up 15% of all detections in Clayoquot (WILCON 1997) and 1% of all detections in the Nimpkish Valley (Setterington 1998). The wide range of detection rates within these three study areas could be attributed to differing habitat types or prey abundance.

GHOW are found in all types of forested areas, usually close to a water source (Campbell *et al.* 1990), and have the most variable nesting sites of any American owl (Houston *et al.* 1998). GHOW are found near artificially maintained habitats such as golf courses and parks (RIC 2001). Abundant numbers of campgrounds throughout the Campbell River watershed, as well as a seedling plantation near John Hart, could provide suitable habitat for GHOW. The five survey areas all encompass bodies of water and offer many different ages of timber, forest structures and prey base, making these areas again suitable for GHOW. The range and numbers of GHOW have expanded throughout the Pacific Northwest with the creation of new habitats through logging and rural development (Houston *et al.* 1998) and may provide some explanation for the possible increase of GHOW numbers over the three-year study period.

In times of a low prey base, GHOW are known to cease calling and therefore not respond to call play back (RIC 2001). Low prey numbers may provide insight as to why there were no detections in 2000 and relatively low detection rates over the three years of the study. The high detection rate in Strathcona may partially account for the lower detection rates of NSOW in the area. GHOW are known to have the most diverse prey base of any other North American raptor, and this diet encompasses small mammals as well as birds, including NSOW (Houston *et al.* 1998; RIC 2001). Having a wide prey base allows the GHOW to adapt to different forest types, as well as living alongside human disturbances.

Other

During the surveys in the Salmon study area, Common Snipe (COSN; *Gallinago gallinago* were also detected. COSN are documented to sound similar to owls (RIC 2001) and may be confused with WSOW calls to a surveyor who is unfamiliar of the difference between the two calls. COSN calls sound similar to the upward trill call of WSOW, which is a short and two-parted call (Tripp 2001). Surveyors that are unsure of the difference between the two calls should listen to them prior to surveys in order to differentiate between the two during surveys (C. Pendergast, *pers. obs.*)

Nest Boxes

Our low occurrence of owls using nest boxes was not surprising. This was expected because according to Dawson (*pers. comm.*) owls do not typically utilize man-made nesting structures until a suitable weathering and acclimation period has passed. There needs to be some time for the owls to become accustomed to the nesting structure as well as to find it in a forest where previously there were very few structures for nesting. It often takes 2-3 years or longer for owls to start using nest boxes (Dawson *pers. comm.*). A possible suggestion as to why the nest boxes were not used may be that there are suitable natural or man-made cavities within the Campbell River watershed.

Conclusions

It is imperative that this study continues for at least another year, as conclusions based on three years of data may not be adequate. Owls are known to breed in cycles, which cause year to year fluctuations in relative abundance of a given species. With the three years of data collected, the conclusions drawn may not be accurate, and incorrect management decisions may be made regarding certain species. Not only is presence/absence of a particular owl species important but also how its relative abundance changes from one year to the next. For example, NSOW were detected in Strathcona in 2000 and 2002, but none were detected in 2003. It would be difficult to conclude that NSOW were absent from the area entirely, especially since NSOW were caught in the area during the same time period. The fluctuations in numbers could be a result of many factors, which need to be explored further in order to draw accurate conclusions. Continuing with inventory would aid in discovering factors that affect relative abundance of different species of owls over time, if weather patterns and prey base were also monitored. Continuing with the nest box monitoring program would be useful in determining the habitat types that owls require for breeding to occur. Continuing with radio telemetry would help to identify habitat types necessary for nesting, roosting, and foraging.

SAMPLING PROTOCOL LIMITATIONS

The sampling protocol used in this three-year study period involves call playback during the breeding season and is a standard technique for all species, recommended by the Ministry of Sustainable Resource Management (RIC 2001). This method is very effective and still increases the chance of detections (RIC 2001; Takats *et al.* 2001). Over our three-year study, a noticeable increase from 6 spontaneous callers per 100 stations to 21 elicited responses per 100 stations resulted when call play back was utilized, for all species combined.

There is however one main limitation to the call play back method used in this and many other studies. As with most studies, we were trying to achieve a multi-species inventory and due to time and budget constraints, we had to survey multiple species each night. Calls were played in order based on the owl's relative size, with the smallest owl being played first. A problem that could arise with this form of surveying is that a WSOW may be less inclined to respond to a broadcast if a NPOW and a NSOW call have already been broadcast. This is also true for GHOW responding after a BAOW call during large owl surveys. This problem is difficult to resolve, short of broadcasting a single species call per night and extending the survey period three to four fold. This is not a practical solution due to present budget constraints. Thus, multi-species inventory remains the most cost effective method for now.

When all species in an area are being surveyed, call play back remains the best option. Only if one species in particular is being targeted does a single species method work. It may be important in the future to test for differences in detection rates between multi-species and single species inventory methods.

There may also be complications in detection types that arise when a multi-species inventory method is employed. For example, small owls responded to large owl call broadcasts, 4 NSOW responded to BAOW broadcasts, 3 NSOW responded to GHOW broadcasts, 5 WSOW responded to BAOW broadcasts, and 2 WSOW responded to GHOW broadcasts. Manley (1989) reported that WSOW respond to other owl calls, and even those from larger owl species. NSOW were also found to respond to NPOW broadcasts. This may elicit a response from an owl defending its territory, regardless of the species intruding.

There were a total of 11 large owls that responded to small owl broadcast surveys. It has been documented that large owls are drawn into small owl calls (Campbell *et al.* 1990; Pendergast 2002). Whenever possible, future surveys should attempt to maximize the times between small and large owl survey sessions. This may allow small owls to avoid unnecessary contact with larger owls and therefore reduce the risk of predation.

During the three years of surveys, subsequent broadcasts were stopped if an owl was detected at any time during the survey. Halting further broadcasts after an owl species was detected may not be the best way to survey for the presence of species. There may be different owl species present in the same area at the same time, but if broadcasts are stopped after the detection of one species, others may be missed. BAOW are known to fly towards NSOW calls without responding and take up to 10 minutes to respond (Campbell *et al*. 1990). By ceasing listening after a NSOW has been detected, a BAOW could be missed.

It has been suggested that the five minute waiting period following the broadcast of each of the owl species be shortened to three minutes (D. Doyle MWLAP, *pers. comm.*). In doing so, survey time would be greatly reduced, as most species tend to call between a half hour after sunset and midnight (RIC 2001). In looking at the 2003 data, a decrease in wait period could prove to discount a good proportion of calls heard. Of the 57 owls detected, 84% were detected within the first three minutes, and 16% were detected after the first three minutes. Decreasing the listen period would is not recommended.

FUTURE CONSIDERATIONS

- Continue with the nest box enhancement program. Monitoring nest boxes would help describe the differences in habitat between used and unused nest boxes, suggesting which habitat types are preferred.

- Continue with radio telemetry of individuals. Radio-tagged individuals could be followed and monitored intensively providing home range and foraging behaviour data, which is lacking for small owl species in BC.

- This was the third year of study to try and determine the relative abundance of owls within the Campbell River watershed. It is recommended that the study be continued for another two years, as three years of study are not adequate to identify trends within species present and their relative abundance.

- Initiate a single species inventory method for NPOW that would target their times of activity (ie. dusk and dawn) in order to determine their relative abundance more accurately and effectively.

- As BAOW numbers appear to have annual fluctuations, a BAOW radio telemetry program would be useful to locate their nesting sites. By finding the nesting sites, prey remains could be analyzed to determine what percentage of small owls comprises their diet. This would benefit the small owls in determining how much of an effect the BAOW has on small owl numbers.

LITERATURE CITED

Belthoff, J.R. and G. Ritchison. 1989. Natal Dispersal of Eastern Screech-Owls. The Condor: 91: 254-265.

Blood, D. and Associates. 1993. Upper Campbell River Wildlife Enhancement Plan. Rep. Prep. For B.C. Hydro and Power Authority, Environmental Resources. 65pp.

British Columbia Conservation Data Center (BCCDC). 2003. http://srmapps.gov.bc.ca/apps/eswp/results

Campbell, R.W., N.K. Dawe, I. McTagart-Cowan, J.M. Cooper, G.W. Kaiser, and C.E. McNall. Eds. 1990. The Birds of British Columbia. Vol. II. Non-passerines: Diurnal Birds of Prey Through Woodpeckers. Royal British Columbia Museum. Victoria, B.C.

Cannings, R.J. 1993. Northern Saw-whet Owl (*Aegolius acadicus*). In the Birds of North America, No.42 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Cannings, R.J. 1997. A Survey of the Western Screech Owl (*Otus Kennicottii macfarlanei*) in the Interior of British Columbia. Prepared for Ministry of Environment Lands and Parks, Victoria. 27 pp.

Darling, L. 2002. COSEWIC Status Report on Vancouver Island Northern Pygmy Owl *Glaucidium gnoma swarthi*. Prepared for Committee on the Status of Endangered Wildlife in Canada. Draft. 25 pp.

Gill, M. and R.J. Cannings. 1997. Habitat Selection of Northern Saw-whet Owls (*Aegolius acadicus brooksi*) on the Queen Charlotte Islands. Prepared for British Columbia Environment, Lands and Parks, Skeena Region.

Hardy, P.C. and M.L. Morrison. 2000. Factors affecting the detection of elf owls and western screech owls. Wildlife Society Bulletin. 28(2): 333-342.

Herting, B. and J.R. Belthoff. 2001. Bounce and Double Trill Songs of Male and Female Western Screech-Owls: Characterization and Usefulness for Classification of Sex. The Auk. 118 (4): 1095-1101.

Houston, C.S., D.G. Smith, and C. Rohner. 1998. The Birds of North America, No. 372.

Manley, D. 1998. Beaver Lodge Forest Lands Wildlife and Wildlife Habitat Inventory. Campbell River. Ministry of Environment, Lands and Parks.

Mico, M. and T. Van Enter. 2000. Campbell River Watershed Owl Survey, 2000. Prepared for B.C. Hydro, Vancouver, B.C.

Pendergast, S. 2002. Campbell River Watershed Owl Survey and Nest Box Initiation Program: February to April 2002. Prepared for BC Hydro Bridge River/ Coastal Compensation Fund.

RIC (Resource Inventory Committee). 2001. Standards for Components of British Columbia's Biodiversity No. 11. V 2.0. Prepared by Ministry of Resource Management, Environment Inventory Branch for the Terrestrial Ecosystems Task Force Resource Inventory Committee. 133 pp.

Setterington, M. 1998. Owl Abundance and Habitat in the Nimpkish Valley, Vancouver Island. Rep. Prep. For Canadian Forest Products Ltd., Englewood Logging Division, Woss, B.C. by Axys Environmental Consulting Ltd. November 4.

Takats, D.L., C.M. Francis, G.L. Holroyd, J.R. Duncan, K.M. Mazur, R.J. Cannings, W.Harris, D.Holt. 2001. Guidelines for Nocturnal Owl Monitoring in North America. Beaverhill Bird Observatory and Bird Studies Canada. Edmonton, Alberta. 32 pp.

Tripp, T. 2001. Research Proposal: Territorial singing behaviour as a potential long-term monitoring tool for the Western Screech Owl (*Otus kennicottii*). Submitted to UNBC Graduate Student Advisory Committee.

WILCON, Wildlife Consulting Ltd. 1997. Owl Inventory in Clayoquot Sound. Spring 1997.