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Extension Note

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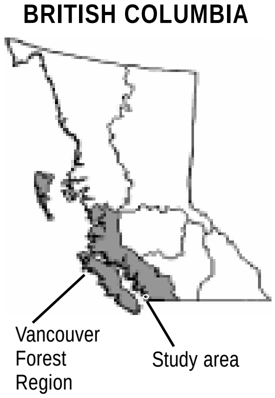
http://www.for.gov.bc.ca/vancouvr/research/research_index.htm

BRITISH COLUMBIA



Response of Amphibians to Partial Cutting in a Coastal Mixed-Conifer Forest: Management Practices for Retaining Amphibian Habitat in the Vancouver Forest Region

By Linda A. Dupuis and F. Louise Waterhouse

INTRODUCTION

There are few published studies about the short- and long-term effects of alternative silvicultural systems on amphibians and amphibian habitat. To address this gap, and to provide forest managers with insight to the habitat needs of amphibians, from 1994 to 1997 the Vancouver Forest Region of the British Columbia Ministry of Forests studied amphibian habitat in an area where other studies of alternative silvicultural systems are under way. The study took place in the Roberts Creek Study Forest, which is in the Vancouver Forest Region on the Sunshine Coast, just north of Vancouver (D'Anjou 2001). This Extension Note summarizes the amphibian research, and the results of a literature review of forest-management practices related to maintaining amphibians and amphibian habitat.

BACKGROUND

Amphibians—salamanders, frogs, and toads—are important fauna that contribute to biodiversity in forested ecosystems. When found in high abundance, they can significantly affect both food-web dynamics and nutrient cycling. By preying on insects, they convert items of low food value into prey size available to larger vertebrates (deMaynadier and Hunter 1995). In addition to facilitating energy flow by efficiently accumulating biomass, amphibians play a unique role in forest nutrient cycling by regulating populations of soil invertebrates responsible for the mechanical breakdown of organic material.

Amphibian skin and eggs are moist and semi-permeable, to enable respiration. Thus, amphibians require moist microhabitats to survive (Jaeger 1971; Spotila 1972), and they readily absorb chemicals from their surroundings. Amphibians are relatively sedentary, exhibiting strong site fidelity and poor dispersal capabilities (deMaynadier and Hunter 1995). Some amphibians are semi-aquatic, having aquatic larvae in ponds or streams, and terrestrial adult life stages. Other species are fully terrestrial. All these characteristics make amphibians valuable indicators of environmental change (Blaustein et al. 1993; deMaynadier and Hunter 1995).

Since the 1950s, amphibian populations have experienced significant declines globally, and continue to decline at an annual rate of 2 to 3% (Houlahan 2000). These declines are attributed to many factors, including habitat loss, habitat alteration and/or fragmentation, fertilizers, pesticides, climate change, acid precipitation, and thinning of the ozone layer. Some species' populations have been reduced by the introduction of exotic species such as predatory fish, bullfrogs, and pathogenic bacteria and fungi (Blaustein et al. 1994; Lips 1998).

Habitat alteration due to clearcut timber harvesting can affect terrestrial-breeding and semi-aquatic amphibians by reducing or eliminating moist microhabitats. More specifically, clearcut harvesting can decrease the amount of large downed wood, reduce canopy and vegetation cover in the short-term, and cause site degradation (Grialou et al. 2000; Dupuis 1997). Removal of vegetation cover, soil compaction, and soil rutting can restrict amphibian foraging activities and movement patterns (Spotila 1972). In particular, large pieces of dead wood are critical egg-laying sites, foraging substrates, and thermal refugia (Heatwole 1962; Aubry et al. 1988; Corn and Bury 1988; Davis 1996; Dupuis 1997). For semi-aquatic species, quality of the stream or pond habitat can be reduced by sedimentation (Beschta 1978), increased water temperatures (Holtby 1988), and accelerated water loss (Jones and Grant 1996).

Amphibians may benefit from partial canopy cover, understory cover retention, and the amount of large pieces of dead wood over longer harvest rotations. For example, Childs and Flint (1987) found that partial-cutting harvesting systems in Oregon reduced the duration of periods of high soil temperature, and that the canopy of shelterwood blocks decreased the incident solar radiation and caused cooler soil temperatures throughout the soil profile compared to clearcut blocks. But increased road density and stream crossings associated with alternative silvicultural practices may reduce the quality of amphibian habitat (deMaynadier and Hunter 1995).

STUDY METHODS

Study Objectives

The objectives of the study were:

1. Provide information about the assemblage of amphibians in the Roberts Creek Study Forest compared to that of the whole of the Vancouver Forest Region.

2. Summarize response of common amphibian species to three harvest treatments (clearcut, shelterwood, extended rotation).

3. Outline forest-management practices for retaining amphibian habitat in the Vancouver Forest Region, based on a literature review and on the results of the amphibian study at the Roberts Creek Study Forest.

Study Site

The study site is located within the Roberts Creek Study Forest which is approximately 40 km northwest of Vancouver, BC, within the Sunshine Coast Forest District of the Vancouver Forest Region. It lies within the Dry Maritime Coastal Western Hemlock (CWHdm) biogeoclimatic subzone at elevations of 300 to 600 m. Climate is characterized by warm, relatively dry summers and moist, mild winters with little snowfall. The forest is comprised mostly of mesic soils, and mature, fire-origin stands (110-130 years old) (D'Anjou 2001). These are dominated by Douglas-fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*), with some western redcedar (*Thuja plicata*) and red alder (*Alnus rubra*) patches. Overstory canopies range from closed with limited ground vegetation cover, to moderately open with moss/lichen mats dominated by feather mosses. Two permanent ponds, one east and one west of East Wilson Creek, and four non-fish-bearing creeks (Clack, Gough, Flume, and East Wilson Creeks), occur in the study forest (Figure 1).

The Roberts Creek Study Forest is a demonstration area in

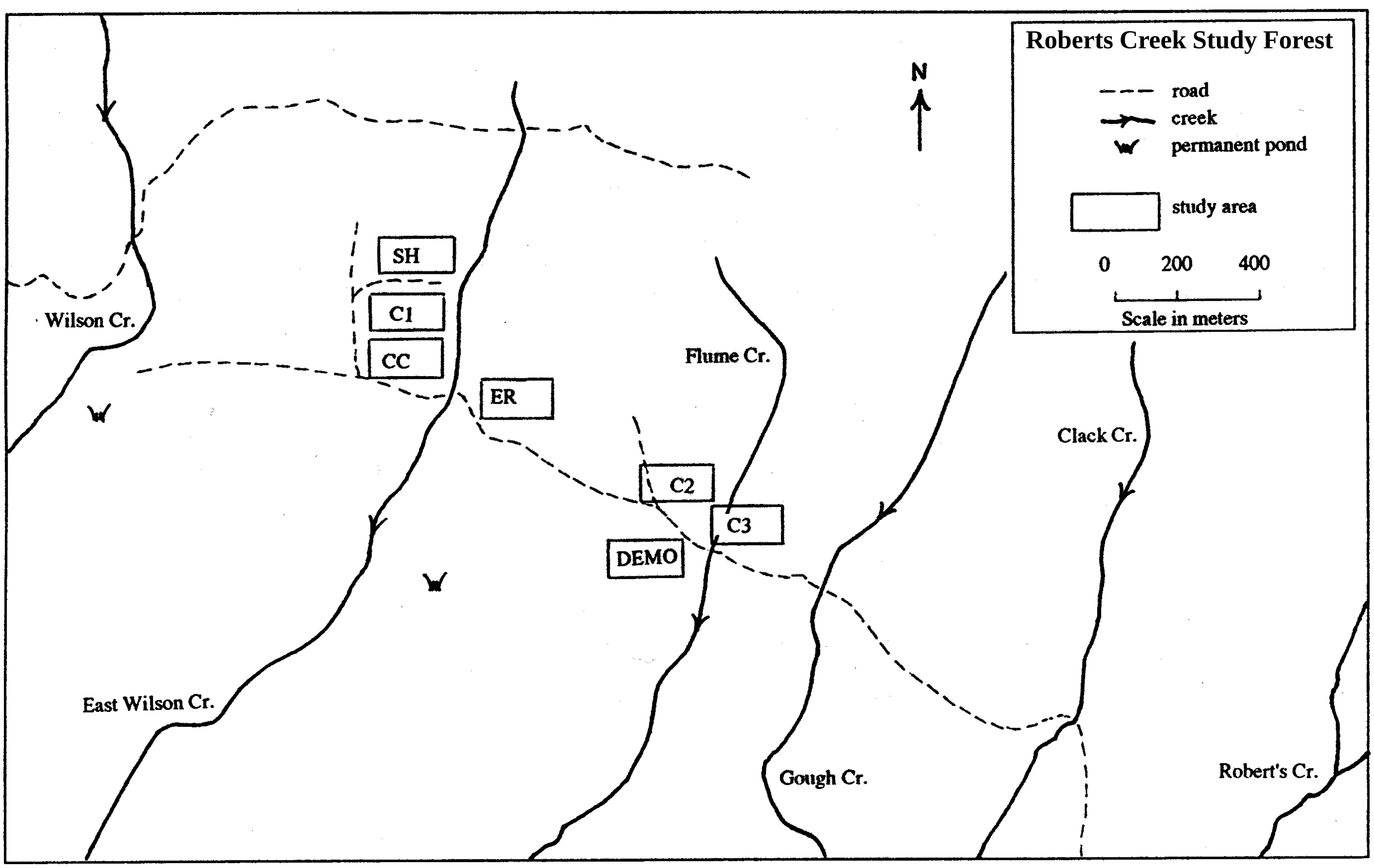


Figure 1. Location of amphibian study areas (treatments) in the Roberts Creek Study Forest.

which a set of unreplicated, experimental treatments are under way to demonstrate, evaluate, and develop silvicultural systems that meet a variety of biological, social, and economic objectives.

Experimental Design

At the Roberts Creek Study Forest three 10- to 12-ha harvesting treatments were used (D'Anjou 2001):

Clearcut: Conventional harvesting with reserves of Douglas-fir veterans or other large, mature trees.

Shelterwood: Two-pass, dispersed-overstory, shelterwood harvesting with reserves. Density target of first entry is 75–90 stems/ha, and 3–7 years later the density target of the second entry is 20–30 stems/ha; 90-year rotation.

Extended Rotation: Five entries, each removing 15–25% of existing volume; 55-year rotation.

These treatments were contrasted with three unharvested Controls of similar size.

In addition, a 7.7-ha Demonstration block of shelterwood harvesting with dispersed understory (57 stems/ha), which was harvested in the winter of 1994, was used for amphibian research.

The Clearcut, Shelterwood (first pass), and Extended Rotation (first entry) blocks were harvested in the winter of 1996/1997. Pre-treatment data on amphibians were collected in 1994 and 1995, for all but the Demonstration block. Post-treatment data were collected in 1995 and 1997 for the Demonstration block, and in 1997 for all the other study blocks. The timing, length, and intensity of all pre- and post-treatment sampling periods were governed by peak activity periods of amphibians (spring and fall) and funding and harvesting schedules.

Pitfall trapping (1994, 1995, 1997), time-constrained searches (1997), reconnaissance pond surveys (1997), and area-constrained stream searches (1995, 1997) were used to determine species assemblage and relative abundance of amphibians in the Roberts Creek Study Forest.

Four, randomly placed, pitfall-trap arrays were established in each treatment (Figure 2). Arrays consisted of three 5-m drift fences, radiating from a central point (Corn 1994). Pitfalls were placed at the end of each fence and in the converging center. A 30x50-cm plywood board covered each pitfall. For both pre- and post-treatment sampling periods, once per week (May/June/September 1994; April/May 1995; September/October 1997), amphibians were sampled by opening traps overnight for a 12-h period. In 1997, amphibians were sampled for an additional 24-h period with traps checked at 12-h and 36-h to gain information on less-common species. These additional 36-h sample data are not included in pre- and post-treatment comparisons. All individuals were measured and marked by means of unique toe-clips (Ferner 1979).

Figure 2. Pitfall trap array.

Time-constrained searches of four person-hours (Corn and Bury 1990) were used in 1997 to evaluate the effectiveness of the array design in determining species assemblage within each treatment.

Reconnaissance pond surveys were conducted only in local ephemeral ponds, and in a large, classified wetland north of the Roberts Creek Study Forest, to obtain a list of pond-breeding species with which to compare pitfall/coverboard array results. The four non-fish-bearing creeks in the Study Forest (Figure 1) were also surveyed for tailed frog tadpoles by means of area-constrained searches. Researchers estimated tadpole density within a creek by counting individuals encountered during active searches of three, systematically placed, 5-m reaches, of which the first was situated randomly in the creek. Incidental observations of terrestrial amphibians were recorded during area-constrained searches.

RESULTS AND DISCUSSION

Amphibian Assemblage in the Vancouver Forest Region: Results of the Literature Review

Published research about the effects of altered habitat on amphibians in the Vancouver Forest Region is lacking. However, it is known that the Vancouver Forest Region including Vancouver Island and the Queen Charlotte Islands has four frog, seven salamander, and one toad species.[1] Seven are endemic to the Pacific Northwest, and the northernmost ranges of five of the amphibian species occur within the Vancouver Forest Region (Table 1). Endemic amphibian fauna have specific ecological requirements and limited distributions (Walls et al. 1992). Thus the Vancouver Forest Region is a provincially significant area for amphibian conservation on public and private lands.

[1] In comparison, Northern and Central BC have six amphibian species, and the Southern Interior has three.
[2] See www.cosewic.gc.ca/COSEWIC/Default.cfm, website of the Committee of the Status of Endangered Wildlife in Canada (COSEWIC).
[3] See www.cosewic.gc.ca/COSEWIC/Default.cfm, website of the Committee of the Status of Endangered Wildlife in Canada (COSEWIC).
[4] See www.cosewic.gc.ca/COSEWIC/Default.cfm, website of the Committee of the Status of Endangered Wildlife in Canada (COSEWIC).
[5] Russ Haycock, Proprietor, Hyla Consulting, Vancouver, BC; personal communication, 1999. Bill Leonard, Wetlands Section, State Department of Ecology, Washington, USA; personal communication, 01 November 1994.
[6] Leo Frid, student, Department of Zoology, University of British Columbia, Vancouver, BC; personal communication, April 1999.

Table 1. Amphibians of the Vancouver Forest Region (adapted from Corkran and Thoms 1996 and COSEWIC reports). [a]

Species	Scientific name	Endemic to Pacific Northwest	Comments
Salamanders			
Roughskin newt [b]	*Taricha granulosa*	yes	
Long-toed salamander [b]	*Ambystoma macrodactylum*	no	
Northwestern salamander [b]	*Ambystoma gracile*	yes	
Western redback salamander [c]	*Plethodon vehiculum*	yes	Found on southern coast of BC mainland and on Vancouver Island only.
Ensatina salamander [c]	*Ensatina eschscholtzii*	yes	Found on southern coast of BC mainland and on Vancouver Island only.
Clouded salamander [c]	*Aneides ferreus*	yes	Possibly introduced to Vancouver Island.
Pacific giant salamander [b]	*Dicamptodon ensatus*	yes	Found south of the Fraser River (on the southern coast of the BC mainland).
Frogs and toads			
Tailed frog [b]	*Ascaphus truei*	no	Found in BC mainland mountains only.
Pacific treefrog [b]	*Hyla regilla*	no	
Red-legged frog [b]	*Rana aurora*	yes	Found on southern coast of BC mainland and on Vancouver Island only. Declining.
Spotted frog [b]	*Rana pretiosa*	no	Found on southern coast of BC mainland only.
Western toad [b]	*Bufo boreas*	no	Possibly declining on southern coast of BC mainland and on Vancouver Island.

[a] This table excludes the Queen Charlotte Islands, which has only two amphibian species: the native western toad, and the introduced Pacific treefrog. [b] Semi-aquatic lifehistory. [c] Terrestrial lifehistory.

The spotted frog, found only in the southern mainland of British Columbia is lost from more than 90% of its range; a total of 288 individuals exist in three isolated populations.[2] The spotted frog has nearly disappeared largely due to residential development, introduction of exotic species, and poor management of livestock.[3] The red-legged frog is also being displaced in the southern mainland and Vancouver Island, by the introduction of bullfrogs and fish,[4] as is the western toad. The latter species may be on the brink of extirpation in low-lying areas of southern British Columbia and of Washington, where historically it was common according to anecdotal evidence (Knopp 1997).[5] Tailed frogs (Figure 3) can be negatively affected by timber harvesting (Dupuis et al. 1995; Wahbe 1996; Richardson and Neill 1995), as can the Pacific giant salamander (Frid[6]) and the western redback salamander (Dupuis 1997).

Terrestrial Surveys

Terrestrial surveys of amphibians were undertaken with pitfall arrays and time-constrained surveys. A total of 126 amphibians, comprising seven species, were captured from

Figure 3. Tailed frog.

1994 to 1997 after twenty-eight pitfall trap nights (one trap night = 12 h) (Table 2).

Species diversity and richness were similar over the three-year trapping period, although capture rates varied seasonally. This was likely due to differences in amounts of precipitation (1.4 +/- 3.6 mm mean daily spring 1995 to 8.1 +/- 7.4 mm mean daily fall 1997) and days with precipitation during the spring and fall seasons of 1995 and 1997 (20% of the days in spring 1994 and fall 1995, to 71% of the days in fall 1997) (Environment Canada 1997). There were no recaptures. Time-constrained searches in 1997 were not successful at detecting pond breeders, but the first detection of a western toad in the study area was made (Table 2). By using the two survey techniques, all species expected to occur in the Roberts Creek Study Forest were encountered except the western redback salamander, for which there was only an unconfirmed

Table 2. Amphibian species of the Roberts Creek Study Forest, combined for all study sites.

	Terrestrial surveys			**Aquatic surveys**
	Pitfall arrays		**Time-constrained searches (total no. captures)**	
Species	**Pre-treatment (total no. captures from 12-h trap periods)**	**Post-treatment (total no. captures from 12-h trap periods)**		**Reconnaissance**
Frogs				
Red-legged frog	15	16 (21) [a]		1997: n=63 (total number of egg masses surveyed in classified wetland).
Tailed frog	4	4 (13) [a]	2	1995: n=239 total tadpoles in all surveyed creeks. 1997: n=215 tadpoles in all surveyed creeks.
Pacific treefrog	1		1 (heard)	1997: n=43 total number of egg masses, and n=9 total number of adults surveyed in ephemeral ponds.
Western toad			1 (heard)	
Salamanders				
Ensatina salamander	41	39 (129) [a]	47	n.a.
Long-toed salamander		1 (6) [a]		1997: n=82 total number of egg masses, and n=6 total number of adults surveyed in emphemeral ponds.
Northwestern salamander	2	1 (5) [a]		1997: n=12 total number of egg masses surveyed in classified wetland.
Roughskin newt	2		1	Common. [b]

[a] Total captures including both 12-h and 36-h capture periods used in 1997. [b] Pat Crommie, local resident; personal communication; April 1997.

detection. The lack of historical records of the western redback salamander on the Sunshine Coast suggests that the species may be scarce here primarily because it is at the extreme northern boundary of its range. Furthermore, western redbacks seem to be strongly associated with riparian habitats in managed stands, but not in old growth (Dupuis 1997). The single detection of the adult western toad (Table 2) and lack of detection of larval toads also suggest that toads are rare or uncommon at low elevations along the Sunshine Coast. Time-constrained searches and pitfall trapping both demonstrated that ensatina salamanders are a common terrestrial amphibian in the Roberts Creek area and likely dominate the amphibian community in this forest (Table 2). Two aquatic breeders, the tailed frog and the red-legged frog, also appear to be relatively common in the Roberts Creek area, but terrestrial captures were too low to provide insight on the effects of various silvicultural treatments.

Unlike most pond breeders, red-legged frogs were captured in relatively high numbers in their home ranges within the Roberts Creek Study Forest (Table 2). Red-legged frog adults are non-migratory and usually frequent small ponds and creeks next to moist, sheltering forests, although adults will wander far from standing water under suitable climatic conditions (Corkran and Thoms 1996). Thus, the distribution of small, forested watercourses in the landscape may be a more important terrestrial characteristic for the red-legged frog than are local habitat features. In support of this, red-legged frogs were observed in stream-side habitat along the more shaded tributaries (n=9; Flume and East Wilson Creeks) during the area-constrained searches for tailed frog tadpoles. During the breeding season tailed frog adults can forage several hundred meters from the water's edge (Nussbaum et al. 1983) but their movements are governed by ambient air temperature and humidity (Metter 1964), and possibly by ambient light levels (Hailman 1982). Tailed frog adults occurred in low numbers in arrays throughout the research forest (Table 2, Table 3). The majority of captures (78% of juveniles and adults, 21 / 27 for

Table 3. Number and types of amphibians captured per ten trap nights (one trap night = 12 h) at each study site, pre-treatment (1994/95) and post-treatment (1997).

Treatment	Year of treatment	Species captured				
		Ensatina (no./10 trap nights)	Red-legged frog (no./10 trap nights)	Tailed frog (no./10 trap nights)	Other species (no./10 trap nights)	Total (no./10 trap nights)
Control 1	1994/95	2	0	0	1	3
	1997	2	3	1	0	6
Control 2	1994/95	4	3	1	2	10
	1997	8	2	2	0	12
Control 3	1994/95	5	1	1	1	8
	1997	4	3	1	0	8
Demonstration	1994/95 [a]	0	1	0	0	1
	1997 [b]	14	2	0	2	18
Extended rotation	1994/95	5	2	0	0	7
	1997 [a]	9	1	1	0	11
Shelterwood	1994/95	1	1	1	0	3
	1997 [a]	1	4	0	0	5
Clearcut	1994/95	8	1	1	1	11
	1997 [a]	0	1	0	0	1

[a] One year after harvest. [b] Three years after harvest.

all data combined including incidental) were in the vicinity of Flume Creek in the search areas closest to the primary natal creeks (refer to Figure 1).

Pond-breeding salamanders generally inhabit clearings or forest stands with open canopies and some deciduous trees (Nussbaum et al. 1983). Five of the six pitfall captures of long-toed salamanders were in habitats with little or no canopy (demonstration block and shelterwood). Roughskin newts were encountered only in their terrestrial home range, west of East Wilson Creek (refer to Figure 1). This species in particular avoids dense conifer forests (Green and Campbell 1984) such as those that characterize the Roberts Creek Study Forest. Northwestern salamanders were limited to the forest stands east and west of Flume Creek.

Aquatic Surveys

The low capture rate associated with aquatic-breeding salamanders (Table 2) may be attributed to low levels of surface activity beyond the egg-laying site (Powell et al. 1997). Adults tend to spend much of their time in underground burrows once they have migrated from their breeding pond. The reconnaissance pond surveys indicated that the Pacific treefrog and long-toed salamander were very common in the study area, and that northwestern salamanders, red-legged frogs, and rough-skin newts were common in deeper water bodies nearby (Table 2). The regular occurrence of Pacific treefrog tadpoles in roadside ditches (Table 2) suggests that this species is common and widespread in the Roberts Creek Study Forest. Ponds are important sources of semi-aquatic species and should be managed to retain these species.

Tailed frog tadpoles were commonly found in the larger tributaries of the Roberts Creek Study Forest, and their numbers were low in the intermittent Flume Creek (average tadpole densities, in terms of no./m^2, for area-constrained searches conducted in 1995 and 1997 were: Clack Creek 3.70, Gough Creek 0.78, Flume Creek 0.30, East Wilson Creek 0.59). Clack Creek, which has the largest and most stable channel, harboured the highest density of tailed frog larvae. Because tailed frog larvae are confined to creeks for a two-to-five-year development period (Bury and Adams 1999), channel stability of stream habitats (coarse substrate, permanent flow) and low water temperatures (0 to 16°C) are critical for breeding adults and tadpoles (Dupuis 1999). Channel characteristics can be maintained with the retention of riparian buffers (Dupuis and Steventon 1999).

Response of Ensatina to Harvesting

The ensatina is more common in second-growth than in old-growth forests (Corn and Bury 1988; Aubry et al. 1988). This was the only species captured in sufficient numbers to allow examination of the effects that harvesting practices may have on amphibians (Table 3).

Ensatina numbers varied among the treatments and controls, regardless of harvesting regimes. For example, few ensatina were found in Control 1 or in the pre-harvest shelterwood treatments in the upper reaches of East Wilson Creek (Shelterwood and Control 1) (Figure 1). These sites may be less productive for ensatina than the other Controls (2 and 3), the pre-treatment Extended Rotation, and Clearcut blocks (Table 3). Given this natural spatial variability, and the lack of spatial replication, the pre- and post-treatment data can indicate only potential effects. When only the productive sites are considered, the pitfall/amphibian capture array results suggest that ensatina were negatively affected by clearcut harvesting, but not by the thinning cut in the Extended Rotation (Table 3). More specifically, surface activity of ensatina was not detected in the post-harvest Clearcut. Similarly, three years after harvest, the abundance of ensatina in the Demonstration block increased more than ten fold (Table 3). Assuming the pre-harvest Demonstration block was a productive site for ensatina, the absence of surface activity the first post-harvest year (Table 3) suggests that the partial harvesting of this site had a short-term, negative effect on ensatina.

Ensatina may be negatively affected by harvesting if yarding systems cause soil disturbances that impact surface activity and availability of sub-surface burrows.[7] In this study, more area was exposed to yarding in the Clearcut and Demonstration blocks than in the Extended Rotation block. Alternatively, although ensatina are considered relatively resilient to desiccation (Aubry et al. 1988), they may still be vulnerable to the dry microclimatic conditions of the ground following removal of the tree canopy (Chen et al. 1992). Terrestrial amphibians tend to remain in sub-surface burrows until favourable conditions arise above ground (Duellman and Trueb 1986). In support of this, post-harvest, time-constrained searches reported low diurnal activity in the exposed areas compared to the forested ones: an average of 10.5 ensatina encounters/four person-hours in the Control and Extended Rotation blocks (7 to 13 individuals), compared to 1.6 encounters in the Clearcut and Shelterwood blocks (0 to 3 individuals). Also, 56% of the 1997 captures in the Demonstration block occurred on two rainy and windless days, and individuals appeared to be clustered in the vicinity of moist microhabitats: 53% of captures were in the array closest to a permanent seepage site (approx. 5 m from seepage) compared to 6% in the most remote array (200 m from seepage). In summary, partially exposed cutblocks such as shelterwoods (Shelterwood and Demonstration treatments) may provide little opportunity for surface activity until the microclimate conditions of the stand are once again favourable. Re-sampling of the clearcut is required to determine whether ensatina activity is now re-established on this site, i.e., following vegetation re-growth.

These results suggest that partial cutting systems that use low stem removal and retain more overstory canopy cover, such as the extended rotation, are less likely to negatively affect the local abundance of ensatina. But, it is unclear from these results whether or not clearcut harvesting has a greater effect on the abundance of ensatina than heavier stem and overstory removal partial harvests,

[7] Barb Beasley, Research Co-ordinator, Long Beach Model Forest, Ucluelet, BC; personal communication, 23 January 2001.

such as those used in the Demonstration and the Shelterwood blocks, because it was not possible to collect pre-treatment data from the Demonstration block and because the Shelterwood treatment site was unproductive. In general, the window of opportunity for amphibian surface activity is likely narrowed in partially harvested or clearcut stands compared to unharvested stands, by drier, windier microclimatic conditions (Chen et al. 1992). In southwestern Oregon, Childs and Flint (1987) demonstrated that seasonal water loss was delayed in shelterwoods and other partial-shade treatments compared to clearcuts. In clearcuts, soil temperatures at a depth of 20 mm reached levels lethal for tree seedlings (35°C) by late May, which falls within the amphibian breeding season. This implies that, in the short term, some retention may be more beneficial for ensatina than no retention of stems.

Conclusions

Most species found within the Vancouver Forest Region are also found in the Roberts Creek Study Forest. Aquatic and terrestrial surveys combined suggest that pond-breeder distribution in the Roberts Creek Study Forest may be governed primarily by landscape-level attributes, namely wetlands and deciduous patches. Skelly et al. (1999) and Kolozsvary and Swihart (1999) conclude that most aquatic-breeding amphibian species have non-random distributions related to pond hydroperiod and/or forest canopy. Changes in abundance of ensatina with greater removal of canopy suggests that some partial harvesting systems, such as the extended rotation in this study, may be beneficial to terrestrial breeders in the short-term, possibly by reducing the severity of microclimatic change and the extent of soil disturbance.

Given that amphibian distribution is governed by a wide variety of factors including habitat structure, location of water bodies (streams and ponds), and history of land use, caution must be taken in extending the results of this study to other geographical areas. Also, amphibian abundance and richness is strongly linked to annual climate regimes; thus it is important to gather long-term data to adequately assess amphibian abundance and distributions, and their response to habitat disturbances.

MANAGEMENT PRACTICES FOR MAINTAINING AMPHIBIAN HABITAT

Stand-Level Considerations

The following forest-management considerations are gleaned from the literature, and are mostly applicable to stand-level management of amphibian habitat. Stand-level practices are likely to offer sufficient protection to terrestrial breeders, which, unlike aquatic-breeding amphibians, do not move over large distances.

1. The influence of physical structure on terrestrial amphibians has been well documented (Dupuis 1997; Aubry et al. 1988; Welsh and Lind 1988; Heatwole 1962). Because amphibians thrive much better in the cool, moist soil interface provided by decayed logs than under freshly fallen, suspended logs (Dupuis 1997; Davis 1996), altering the quality, position, and amount of downed wood will likely reduce their abundance. In addition, soil compaction may prevent amphibians from burrowing, and it may restrict their movement and foraging.[8] Retention of forest and soil structure may enable individuals to persist during harvesting (Aubry et al. 1988; Dupuis 1997), and to re-colonize following harvest. Under the Forest Practices Code of British Columbia, this can be achieved by:

- minimizing disturbance of existing dead, decayed wood (downed and standing) (BC Ministry of Forests and BC Ministry of Environment 1995a);
- using Wildlife Tree Patches, Old-Growth Management Areas, and Riparian Management Areas for recruiting dead wood of varying sizes and stages of decay over subsequent rotations (BC Ministry of Forests and BC Ministry of Environment 1999a and 1995b);
- restricting salvage activities within Wildlife Tree Patches, Old-Growth Management Areas, and Riparian Management Areas to retain woody debris for cover;
- allowing for future recruitment of large logs and retention of canopy cover, by using favourable harvesting options such as with extended rotations;
- minimizing soil compaction from heavy machinery (BC Ministry of Forests and BC Ministry of Environment 1995c; Dupuis 1997); and
- limiting prescribed burns that remove surface and subsurface materials (BC Ministry of Forests and BC Ministry of Environment 1995d) if amphibian management is an objective.

2. Amphibians benefit from forested riparian habitats in areas of canopy removal (Dupuis and Steventon 1999; Gomez and Anthony 1996; Dupuis 1997; Frid[9]). Riparian buffers can protect the aquatic life stages of amphibians in streams and wetlands from heat or sedimentation (e.g., Dupuis and Steventon 1999; Hawkins et al. 1983; Murphy et al. 1981). Larger riparian buffers are necessary to protect terrestrial-bound amphibians seeking stable, moist, microclimatic conditions, particularly in times of drought. Gibbs (1998) found that amphibians traveled across open (dry) landscapes via streambeds wherever possible. In this study, the dense understory and canopy cover of Flume Creek appeared to be important habitat for terrestrial-bound tailed frogs, red-legged frogs, and northwestern salamanders. Conversely, Clack and Gough Creeks appeared important for the aquatic phase of the tailed frog larvae, and thus may potentially act as source pools for this species in the Roberts Creek Study Forest. The Forest Practices Code recommends that Riparian Management Areas be established along streams and classified wetlands to minimize the effects of forestry activities on water quality, aquatic ecosystems, and stream channel dynamics, and to provide wildlife habitat (BC Ministry of Forests and BC Ministry of Environment 1995b). Consideration should be given to:

[8] Barb Beasley, Research Co-ordinator, Long Beach Model Forest, Ucluelet, BC; personal communication, 23 January 2001.

[9] Leo Frid, student, Department of Zoology, University of British Columbia, Vancouver, BC; personal communication, April 1999.

- maximizing widths of riparian management zones and limiting partial harvesting in these zones when managing for amphibians, particularly on S4, S5, and S6 streams that do not require reserve zones,
- using Wildlife Tree Patches and Old-Growth Management areas to augment Riparian Management Areas,
- buffering unclassified wetlands, where possible, especially if nearby larger wetlands/lakes have been stocked with fish or have predatory fish (Beasley et al. 2000),
- maintaining buffer integrity by ensuring that harvested edges of buffers are windfirm, and
- falling and yarding away from unbuffered streams to maintain slash-free channels (Dupuis and Steventon 1999).

The tailed frog and Pacific giant salamander currently are listed as Identified Wildlife (Species at Risk) in the Identified Wildlife Management Strategy Forest Practices Code of BC (BC Ministry of Forests and BC Ministry of Environment 1999b). Species at Risk have populations that are threatened and likely to face endangerment or already face endangerment, and they are also species that require special management beyond the coarse filter approach in the *Biodiversity Guidebook* (BC Ministry of Forests and BC Ministry of Environment 1995a). Under the Forest Practices Code they require protection at designated sites (Wildlife Habitat Areas). For procedures and measures for managing the tailed frog and the Pacific giant salamander, see *Managing Identified Wildlife: Procedures and Measures, Volume 1* and *Volume 2* (BC Ministry of Forests and BC Ministry of Environment 1999b and 2001 in process).

3. Gyug (1996) suggests that forest harvesting may have a significant influence on aquatic-breeding amphibians through the creation of small breeding ponds (i.e., <0.02 ha and at least 20 cm deep) that potentially act as population sinks. These small wetlands, which are created as a result of industrial activity (e.g., ditches, wheel ruts), become more attractive than natural ponds to amphibians because they warm early in the spring. Yet even under normal air temperature and precipitation levels, they can dry up before metamorphosis takes place. Furthermore, they usually lack thermal and predatory cover, in the form of downed wood or emergent vegetation, for developing larvae. If these sites were not created, the amphibians would breed in natural sites, which would lead to achieving better reproductive success than in the machine-made wetlands. Thus, this attraction to ponds in clearcuts may have long-term negative implications for population persistence (Gyug 1996; Waldick et al. 1999). Consideration should be given to:

- reducing the creation of shallow, human-made ponds by minimizing road density and site degradation, as per the *Soil Conservation Guidebook* (BC Ministry of Forests and BC Ministry of Environment 1995c); and
- buffering natural ponds to make alternative habitat available.

4. Permanent forest roads can represent relatively long-term changes in habitat (deMaynadier and Hunter 1995). Road building and use can lead to sedimentation of streams that affects foraging and movement of amphibians, such as tailed frog larvae, particularly in small streams that lack water power to flush fine organic and inorganic materials (Dupuis and Steventon 1999). Short-term effects from road building and utilization include soil compaction (Grialou et al. 2000), as well as creation of artificial ponds. In addition, roads can act as barriers to amphibians' movements, or potentially precipitate amphibian mortality through roadkill (deMaynadier and Hunter 1995; Gibbs 1998). To minimize the negative effect of roads on amphibian populations:

- reduce road densities and stream crossings during harvest planning;
- apply riparian buffers (BC Ministry of Forests and BC Ministry of Environment 1995b);
- minimize site disturbance during harvesting (BC Ministry of Forests and BC Ministry of Environment 1995c);
- use sediment-control measures in cut- and-fill slopes, e.g., by grass seeding, armouring ditchlines and culvert outfalls (Dupuis and Steventon 1999);
- minimize use of chemical applications (e.g., dust-palliative polymer stabilizers and soil binders that can be sprayed within ditch lines) because of their potential toxicity to amphibians due to the permeability of their skins;
- de-activate and revegetate roads as per the FPC, but minimize digging and disturbance to adjacent roadside habitat; and
- if pond breeding amphibians have known dispersal routes that cross roads, consider restricting use of these roads at critical dispersal times.

Landscape-Level Considerations

At the landscape level, amphibian species differ in their response to forest disturbance depending on ecological requirements (e.g., Dupuis and Bunnell 1999; Kolozsvary and Swihart 1999; Skelly et al. 1999; deMaynadier and Hunter 1999; Fergueson 1997). In general, the maintenance of aquatic-breeding amphibian biodiversity seems to require a combination of mature hardwoods and buffered wetland habitats (Mitchell et al. 1997), and protected habitats interconnecting home ranges and breeding grounds within the landscape (Burbrink et al. 1998; Seburn et al. 1997). For example, some migratory aquatic-breeding species appear to have an emigration preference for closed-canopy habitat immediately upon metamorphosis (deMaynadier and Hunter 1999). Retention of amphibian diversity at the landscape level will require that forest managers consider how the *Landscape Unit Planning Guide* and *Riparian Management Area Guidebook* (BC Ministry of Forests and BC Ministry of Environment 1999a and 1995b) are applied during landscape unit planning.

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WEBSITES OF INTEREST

Forest Practices Code of BC Guidebooks, BC Ministry of Forests
www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/guidetoc.htm

A list of guidebooks, with all available for online viewing or downloading.

Managing Identified Wildlife: Procedures and Measures, Volume 1, February 1999, **Forest Practices Code of BC Guidebook, BC Ministry of Forests**
www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/other/wild/

Managing Identified Wildlife: Procedures and Measures outlines specific management prescriptions for identified species or plant communities and describes the procedure for establishing, modifying, and removing a wildlife habitat area. Management prescriptions consist of wildlife habitat areas and general wildlife measures.

BC Conservation Data Centre (CDC), Wildlife Inventory Section, Resources Inventory Program, BC Ministry of Environment
www.env.gov.bc.ca/rib/wis/cdc

CDC systematically collects and disseminates information about BC's rare and endangered plants, animals, and plant communities. Information about the status, location, and level of protection of rare organisms and ecosystems is compiled and maintained in a computerized database.

Committee on Status of Endangered Wildlife in Canada (COSEWIC) www.cosewic.gc.ca/

COSEWIC is a committee of representatives from federal, provincial, territorial, and private agencies as well as independent experts that assigns national status to species at risk in Canada.

FrogWeb: Amphibian Declines and Deformities, National Biological Information System (USA)
www.frogweb.gov/adopt.html

Resource managers, scientists, educators, and the general public use FrogWeb to answer a wide range of questions related to the management and conservation of amphibians in the USA. Also provides some Canadian data.

AmphibiaWeb, Digital Library Project, University of California, Berkeley www.amphibiaweb.org

An online system that allows free access to information about amphibian biology and conservation.

BC Frogwatch Program, Wildlife Branch, BC Ministry of Environment www.elp.gov.bc.ca/wld/frogwatch

BC Frogwatch is a program to collect information about frog and toad populations in BC. Provides information on identifying amphibians, surveying for frogs and toads, and reporting findings.

Canadian Amphibian and Reptile Conservation Network
http://eqb-dqe.cciw.ca/partners/carcnet/intro.html

Information about the research, monitoring, and conservation of amphibians and reptiles in Canada.

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