Clearcut Timber Harvest and Movement Patterns in Tailed Frogs

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ABSTRACT

Despite many studies of tailed frog (*Ascaphus truei*) larvae, there has been little study of juvenile and adult habitat use, patterns of movement, and dispersal. Grids of pitfall traps and drift fences were established in "control" sites (mature stands >81 years, n = 3) and clearcut habitats (<5 years, n = 3) to determine whether: 1) movement became limited to upstream/downstream activity only within the immediate riparian area in clearcuts without riparian buffers; 2) tailed frog abundance was lower in clearcut stands than in mature stands; and 3) pre-reproductive juveniles were the main dispersers. In clearcut sites, the highest proportion (44%) of frogs moved downstream, and the lowest proportion (11%) moved away from the creek. There was no notable difference between movement towards the creek (20%) and upstream (24%). Within mature sites, the highest proportion of frogs (40%) moved upstream, followed by movement towards the creek (32%). The lowest proportions moved away from the creek (13%) and downstream (15%). Captures were highest within 5 m of creekside in both clearcuts (41%) and mature sites (35%), followed by captures at 45-m (26% and 31% respectively) and 25-m intervals (22% and 23% respectively), with the lowest number of frogs caught at 65 m (11% in both habitats). Abundance of frogs was lower in clearcuts (n = 63) than in mature sites (n = 88). Of the frogs caught in clearcuts, 78% were juveniles and 22% were reproductive-age adults. Within mature stands, 53% of captures were juveniles and 47% were adults. Marking techniques indicated that frogs caught within the study sites were predominantly new individuals moving through the area. These findings suggest that although movement direction differs in clearcuts, distance travelled from streamside does not significantly change, with juveniles being the main dispersers in clearcuts.

Key words: *Ascaphus truei*, clearcut, dispersal, forestry, mature stands, riparian, tailed frog.

Numerous studies have found amphibian populations to be negatively correlated with clearcutting (see deMaynadier and Hunter 1995 for review). In Canada, the tailed frog (*Ascaphus truei*), a provincially Blue-listed (vulnerable) species in British Columbia, has only been studied in the larval stage, with little information known about habitat use, movement, and dispersal after metamorphosis. This lack of information has been largely due to the difficulty of studying the species owing to its small size (<15 g) and elusiveness, being located in relatively inaccessible mountain streams, and with both tadpoles and adults hidden under rocks and logs during daylight hours (Nussbaum et al. 1983). This information is critical to addressing issues of habitat management, gene flow, and metapopulation dynamics. Without knowledge of movements within and between habitats, preservation of 1 habitat type (e.g., riparian habitats only) may not be sufficient if adjacent upland habitat is needed for population maintenance but left unprotected.

The objective of this study was to evaluate whether clearcut harvesting influences tailed frog movement relative to that which occurs in mature stands. The general hypotheses and predictions being tested are:

H_1: Movement patterns become limited to upstream/downstream movement within riparian zones in clearcut (altered) areas, in contrast to patterns of habitat use in mature stands.

H_2: Clearcutting will result in lower tailed frog abundance than in mature stands.

H_3: Pre-reproductive juveniles will be the main dispersers.

STUDY AREA

Three replicates each of clearcut habitats (<5 yr old) and mature second-growth sites (>81 yr) were established in the Chilliwack Valley of southwestern British Columbia to assess differences in movement patterns between the 2 habitat types. This area lies within the Coastal Western Hemlock biogeoclimatic zone of British Columbia (Meidinger and Pojar 1991), within the Cascade Range, approximately 120 km east of Vancouver. Study sites were selected based on feasibility of

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installing pitfall stations, alongside S5 or S6 streams[1] where preliminary surveys revealed tailed frog larvae.

METHODS

Sixteen pitfall stations were established in each study site, spaced 20 m apart in a 4 X 4 grid pattern (Fig. 1a). Each station consisted of clusters of 4 pitfall traps quartered by 4 guiding "drift" fences arranged in an "X" pattern such that direction of movement could be determined (upstream, downstream, towards or away from the stream). Stations closest to the streams were within 5 m of streamside. Pitfall traps were fashioned from 40-cm PVC pipes vertically dug into the ground with 25-cm-high plastic drift fences extending 5 m out from the centre of the trap station (Fig. 1b). A total of 384 pitfall traps and drift fences were used for the 6 study sites.

Traps were checked daily during a 3-day/3-night trapping period from May to September 1998, and were closed between trapping sessions. Increased precipitation during October and November allowed traps to be continuously left open and monitored approximately every 4 days. Traps were left open for an average of 50 nights at each site.

All frogs caught in pitfalls or while walking through the sites were weighed, measured, sexed, aged, and marked by injection of a coloured, nontoxic elastomer dye under the skin of the hind leg, and individually marked by toe-clipping. Pitfall frogs were released in the quadrant opposite the one where they were caught (the assumption being that this was the intended direction), and frogs encountered during "walk-throughs" were released at point of capture.

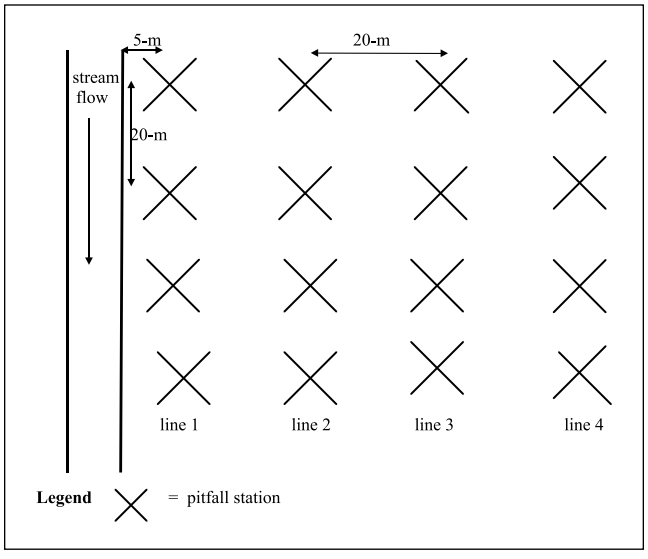

Figure 1a. Arrangement of pitfall trap stations in each study site.

[1] Streams outside of community watersheds, which are not fish streams: S5 streams are ≥3 m wide; S6 streams are <3 m wide (Stevens et al. 1995).

RESULTS

Pitfall traps were effective for sampling *Ascaphus* in both habitat types, with capture rates highest during the spring and fall months (Fig. 2). Captures generally decreased after June, coincident with the hot, dry period, then increased sharply in October, coincident with increased precipitation, and peaked in November. Between June and November, 88 frogs were caught in the mature stands and 63 in the clearcut sites. Two of the mature sites were not established in May, and exclusion of the 17 captures for this month in clearcuts indicates a substantially lower overall abundance in clearcuts. Breakdown by age class revealed that within mature stands 53% of frogs caught were pre-reproductive juveniles and 47% were adults, whereas in clearcuts 78% of frogs caught were juveniles and 22% were adults. Less than 10% of frogs were recaptured throughout the entire study.

Analysis of pitfall data indicated that within both habitat types, the lowest proportion of tailed frogs moved away from the streams (13% in mature sites, 11% in clearcuts; Fig. 3). Within mature stands, the highest proportion of frogs moved upstream (40%), in contrast to clearcuts, where the greatest proportion of frogs moved downstream (44%). In mature sites, 32% of captures were moving towards the stream and 15% were moving downstream. In clearcuts, 24% of captures were moving upstream and 20% were moving towards the stream.

The highest proportion of frogs was caught within 5 m of streamside in mature sites (35%) and clearcuts (41%), followed by captures at 45-m (31% and 26% respectively) and 25-m intervals (23% and 22% respectively), with the lowest number of frogs caught at 65 m (11% in both habitats; Fig. 4). In general, the percentage of frogs captured decreased as distance from streamside increased.

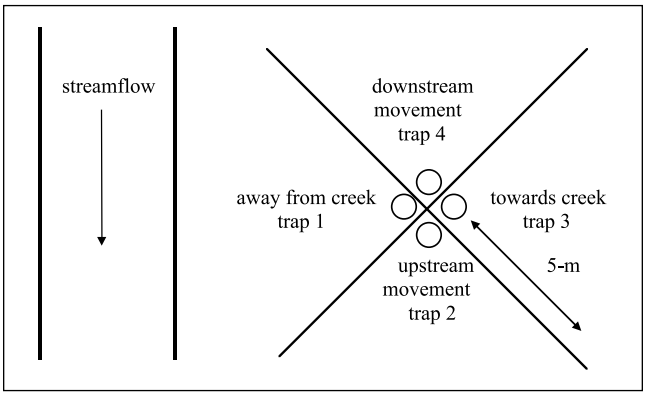

Figure 1b. Arrangement of pitfall traps at each pitfall station.

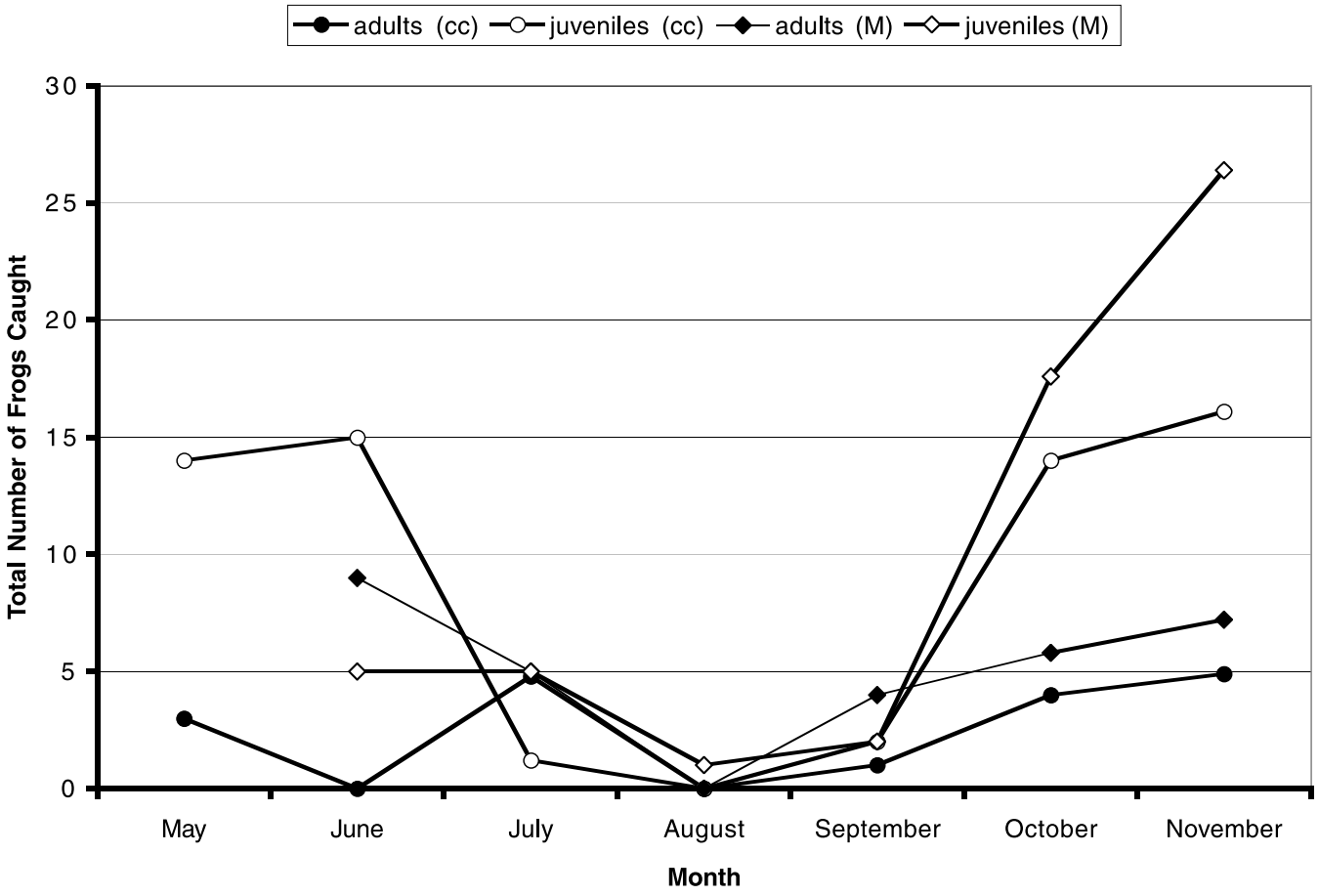

Figure 2. Monthly variation in tailed frog capture rates amongst age classes, and between clearcuts (CC) and mature stands (M).

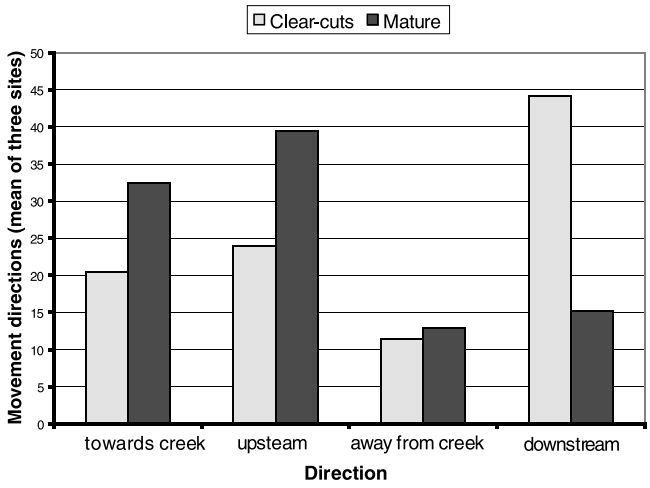

Figure 3. Mean proportion of tailed frogs moving in each direction.

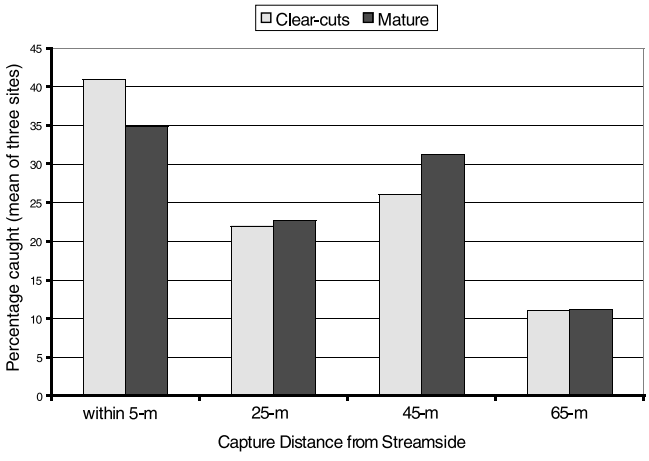

Figure 4. Mean proportion of tailed frogs caught relative to distance from streamside.

DISCUSSION

These results suggest that, regardless of habitat, tailed frogs prefer to move within the immediate riparian zone (<5 m from streamside) upstream and downstream. Our findings indicated that frogs in mature stands preferred upstream movement, supporting the findings of Metter (1964), who postulated that *Ascaphus* may move upstream to headwater creeks for summer refuge. Landreth and Ferguson (1967) found frogs moved downstream to larger creeks, possibly to facilitate breeding in more stable waterways rather than small headwaters prone to drying up. In this study this may have been the mechanism behind the large downstream movement in clearcuts. The clearcut site with the greatest overall number of *Ascaphus* had a large S3/S4 stream[2] within 25 m of the bottom of the trap grid, and a steep escarpment to climb within 500 m of the top of the grid. The low proportion of frogs captured moving away from streamside may suggest that tailed frogs are conservative in their movement efforts away from known sources of moisture (i.e., streams/riparian zones). This is supported by the high proportion of frogs caught within 5 m of the stream in both habitats. *Ascaphus* is the only North American frog specialized for and requiring cold, clear, fast-flowing mountain streams, and is physiologically more prone to desiccation than most other anurans (Daugherty and Sheldon 1982*a*, Nussbaum et al. 1983).

Based on a 63–73% recapture rate, Daugherty and Sheldon (1982*b*) found pre-reproductive *Ascaphus* to move greater distances than adults, which remained highly philopatric within 25 m of their original capture location. Recapture rates in this study were <10%, suggesting that frogs moving through the site were new individuals, or perhaps that trap shyness was occurring. Although distance travelled from streamside did not vary between clearcuts and mature sites, the high percentage of juveniles caught in our clearcut sites suggests that habitat alteration may favour juvenile dispersal, or perhaps indicates low survivorship to adulthood. Daugherty and Sheldon (1982*b*) found that movement activity did not vary with season, although our results indicated that frog activity was greatest during the spring and fall months.

MANAGEMENT IMPLICATIONS

This study indicates that, regardless of habitat alteration, *Ascaphus* tend to remain within the riparian area immediately adjacent to streamside. Within clearcut sites, movement largely occurred downstream and upstream, emphasizing the importance of stream habitats as movement corridors. Although survival to metamorphosis seems to be unimpeded in clearcuts, further studies are needed to assess juvenile rates of survival to breeding age, as our findings indicate that adult survivorship may be affected by clearcutting.

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[2] Streams or portions of streams within community watersheds, which are also fish streams: S3 streams are 1.5–5 m wide; S4 streams are <1.5 m wide (Stevens et al. 1995).