

Defining Wildlife Habitat Areas for Tailed Frogs

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ABSTRACT

The tailed frog (*Ascaphus truei*) is designated “at risk” or “of special concern” in British Columbia, Washington, Oregon, and California, yet none of these jurisdictions provide riparian buffers around small, non-fish-bearing streams where tailed frogs are found. We are investigating the movement patterns and dispersal abilities of tailed frogs in south coastal British Columbia. Results of larval research illustrate that larvae in streams flowing through old-growth forests moved about 7.5 times as far as larvae in streams flowing through clearcuts. Pitfall trapping results reveal that, although most frogs were found in streamside arrays, some individuals moved as far as 100 m from the nearest stream. Little is known about the dispersal abilities of tailed frogs, despite the implications to forest management. Our results will provide information on the potential benefits of streamside buffers and wildlife habitat areas to connectivity in fragmented landscapes.

Key words: *Ascaphus truei*, dispersal, headwater streams, mark-recapture, movement, tailed frog, wildlife habitat areas.

Tailed frogs live in small, fast-flowing streams with clear, cold water (Green and Campbell 1992, Leonard et al. 1993, Corkran and Thoms 1996), that often do not contain fish. Egg deposition sites are rarely found (Corkran and Thoms 1996), and when they have been found they were located close to the source of the stream (Brown 1975, Adams 1993), suggesting that movement of larvae is downstream. The species requires an unusually long time to develop, spending 1–5 years in larval form (Metter 1964, Metter 1967, Daugherty and Sheldon 1982a, Brown 1990, Wahbe 1996). Several studies have documented negative impacts of forest practices on tailed frog adults and larvae, including complete absence from clearcut areas (Metter 1968, Bury 1988, Bury and Corn 1988, Welsh 1990, Bury et al. 1991, Walls et al. 1992, Dupuis and Friele 1995). Some authors (e.g., Welsh 1990) have argued that recolonization of logged sites is critical to sustaining productive amphibian populations. Daugherty and Sheldon (1982b) found that 50% of reproductively mature *Ascaphus* remained in the same 20-m area of their previous capture, and concluded adult *Ascaphus* exhibit extreme site fidelity.

Headwater streams are classified as S4 (may contain fish),

S5 (no fish), and S6 (no fish) in the *Riparian Management Area Guidebook* of the British Columbia Forest Practices Code (B.C. Ministry of Forests and Ministry of Environment, Lands and Parks 1995). These are Class C streams as described in the British Columbia *Coastal Fisheries/Forestry Guidelines* (B.C. Ministry of Forests et al. 1993). Headwater streams are afforded no mandatory protection under current laws unless the integrity of fish-bearing streams is at risk.

Although the tailed frog is designated “at risk” or “of special concern” in Oregon, Washington, and British Columbia, none of these jurisdictions provide riparian buffers around small, non-fish-bearing streams (Bunnell et al. 1997). In each case, forest practices legislation tends to be enacted as blanket prescriptions. Currently, British Columbia has the means to apply such prescriptions through the *Managing Identified Wildlife Guidebook* of the Forest Practices Code (B.C. Ministry of Environment, Lands and Parks and Ministry of Forests 1999). Through this research, we will determine the movement patterns and dispersal abilities of larval and metamorphosed tailed frogs in old-growth forests and clearcuts. Our goal is to provide scientifically credible guidance for the establishment of wildlife habitat areas for in-stream biological diversity, with emphasis on tailed frogs. Given both the documented (e.g., Bunnell and Dupuis 1995) and undocumented richness of small streams, many other species undoubtedly would benefit.

STUDY AREA

Research was conducted near Squamish in southwestern British Columbia (Fig. 1), within coastal western hemlock (*Tsuga heterophylla*) forest. Sites were distributed within 4 drainages: the Squamish, Elaho, Ashlu, and Mamquam rivers, all tributaries to Howe Sound. Six headwater streams were selected, consisting of 2 treatments ($n = 3$): old-growth forest (>250 yr old) and clearcuts (5–10 yr old). Elevation of sites ranged from 500 to 1,000 m.

All streams in the Squamish Valley were selected after verifying presence of larvae (15-min searches), and reaches were chosen >50 m upstream from logging roads (except for Mamquam and Squamish clearcut sites, which were selected >50 m downstream from logging roads). Sites selected contained low-order streams without known resident game or anadromous fish.

METHODS

To determine the movement patterns of tailed frog larvae, area-constrained stream surveys were employed (Fig. 2; modified from Bury and Corn 1991, Shaffer et al. 1994) in the summers of 1994, 1995, and 1996. During these field seasons 80-year-old forest sites were also surveyed ($n = 3$). The dorsal fin of the tail was marked with V-shaped notches following Turner (1960) and Donnelly et al. (1994). Marks were “reach-specific” (e.g., 2 notches for larvae in reach 2). Area-constrained stream surveys and tailfin notches will also be used in the 1999 field season. Mark-recapture of larvae will be completed in 1999, using a modified stream sampling design. The design previously employed (Fig. 2; Wahbe

1996) will be modified in the field to include searches in larger stream sections (e.g., continuous 50 m).

Mark-recapture of metamorphosed tailed frogs using pitfall-trap/drift-fence arrays and visual implant fluorescent elastomers began in 1998 and will continue in 1999 and 2000. The construction and installation of all traps and fences was completed during the 1998 field season. Streamside and upslope arrays of pitfall traps with drift fences (Fig. 3) were modified from suggestions by B. Bury and L. Jones. In each of the

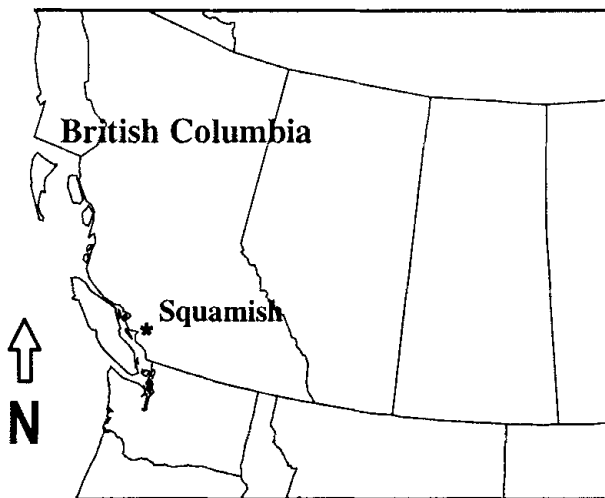


Figure 1. Map of British Columbia showing location of Squamish Valley.

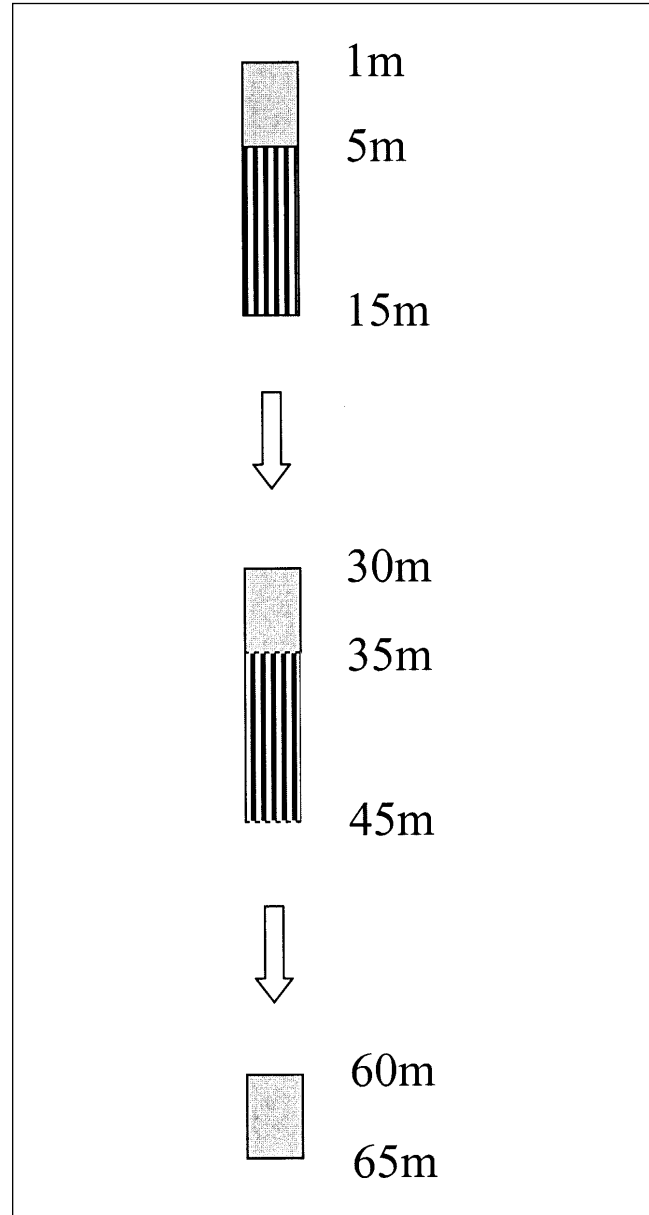


Figure 2. Stream sampling design. Initial marking occurs within 3 5-m reaches (solid boxes) separated by 25 m; sampling for recaptures also includes 2 additional 10-m reaches. Arrows indicate direction of stream flow.

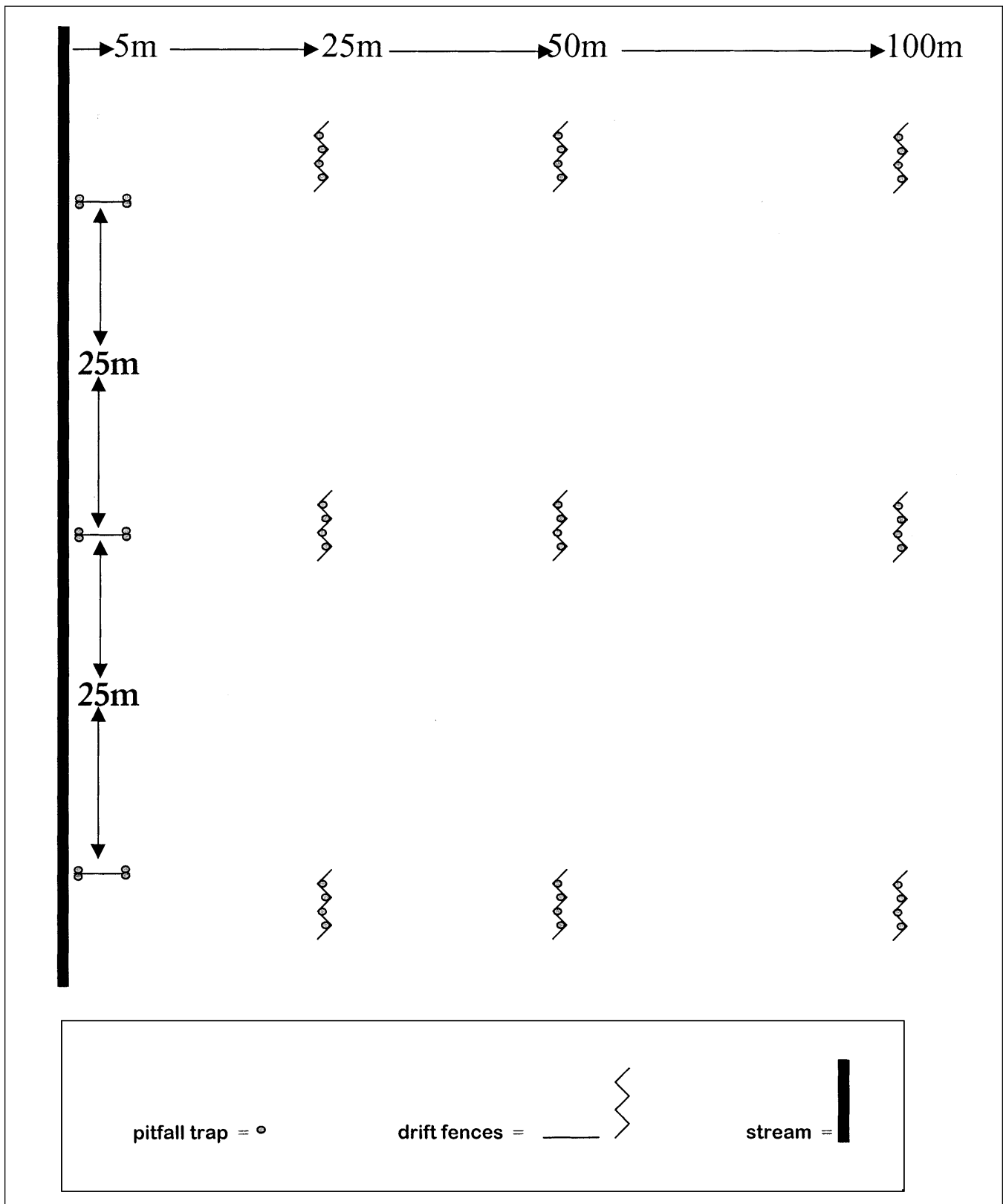


Figure 3. Streamside and upslope trap design (not to scale).

6 sites, 2 types of arrays (streamside and upslope) were constructed and installed (Fig. 3). There are 3 streamside arrays per site, each consisting of 4 pitfall traps and 1 drift fence. There are 9 upslope arrays per site, each consisting of 4 pitfall traps and 5 drift fences. Each of the 6 sites contains 48 5-m drift fences and 48 pitfall traps. There are a total of 240 m of drift fence and 288 pitfall traps in all 6 sites combined. Small mammal escape ropes were constructed and installed to reduce small mammal mortality (modified from Wind 1996).

All tailed frogs (as well as other amphibian species captured) were injected subcutaneously with visible implant fluorescent elastomers. Marks were unique to individuals. An animal care certificate and permit were obtained (University of British Columbia Protocol #A97-0035, British Columbia Environment Permit #C068233).

RESULTS

Larvae in streams flowing through old-growth sites moved on average 7.5 times further than larvae in streams flowing through clearcuts (Fig. 4; Wahbe and Bunnell in prog.). The maximum distance moved in old-growth sites was 64 m, while in clearcuts it was 3 m. The 1999 sampling period will allow final analyses of larval movement data.

Thirty-four tailed frogs were trapped over 21 nights of sampling (6,048 trap-nights). Sixty-eight percent of tailed frogs were trapped in old-growth sites (Fig. 5), where the rate of capture was twice as high as in clearcut sites (Fig. 6).

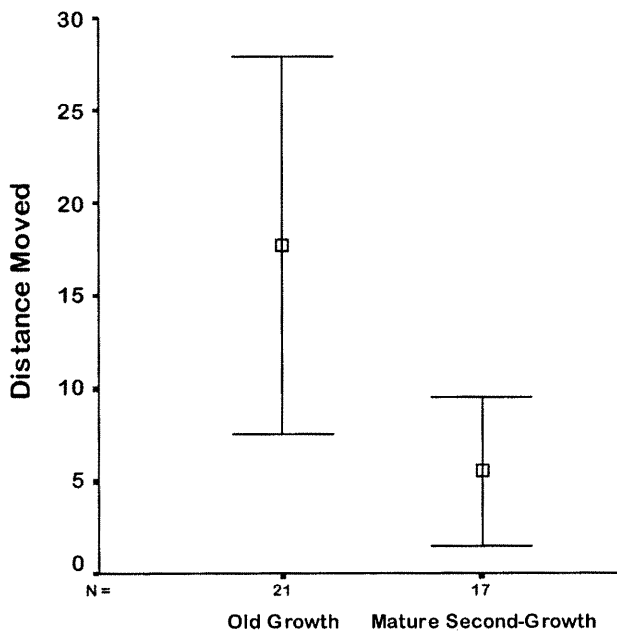


Figure 4. Average distance moved by tadpoles in each forest habitat type (1994, 1995).

Although most frogs were trapped in streamside arrays, some individuals moved as far as 100 m from the nearest stream. The individuals trapped at 100 m were newly metamorphosed tailed frogs moving away from the natal stream.

Of all tailed frogs trapped, 47% were reproductively mature adults and 38% were metamorphs (Fig. 7). Of the frogs moving parallel to streams, 88% were moving upstream (Fig. 8). Of the frogs moving perpendicular to streams (through upland forest), 56% were moving away from streams. With pitfall-trap/drift-fence array installations complete, mark-recapture of frogs will continue in 1999 and 2000.

DISCUSSION

Tailed frog larval movement hypotheses we are exploring include: 1) the stream channel barrier hypothesis, where log-jams in streams flowing through clearcuts create barriers to tadpole movement; 2) the algal productivity hypothesis, where streams with high algal biomass show low movement of tadpoles; and 3) the gradient/productivity hypothesis, where tadpoles in high gradient streams move less due to high productivity.

Given the uncommonly long larval stage of tailed frogs, movements by larvae may be particularly important to recolonization. After clearcutting, however, small streams often contain logging debris that could impede movement and recolonization by larvae from upstream egg deposition sites. Results to date show that larval dispersal abilities are significantly greater in streams flowing through old-growth forests than in streams flowing through clearcuts (Wahbe and Bunnell in prog.). All clearcut streams used in this study contained abundant logging debris, lending support to hypothesis

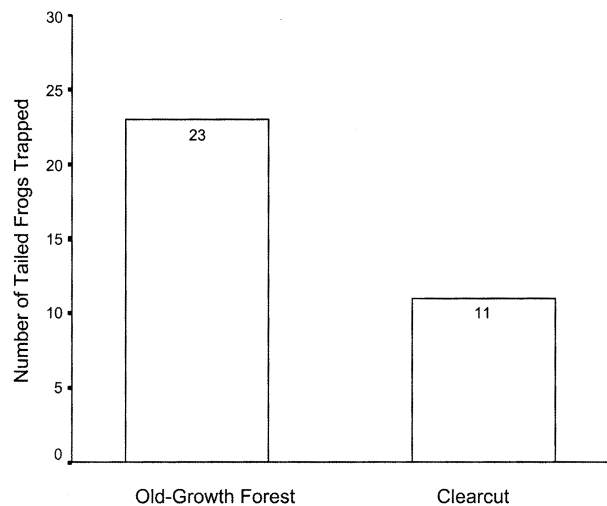


Figure 5. Total number of tailed frogs trapped in old-growth forests and clearcuts.

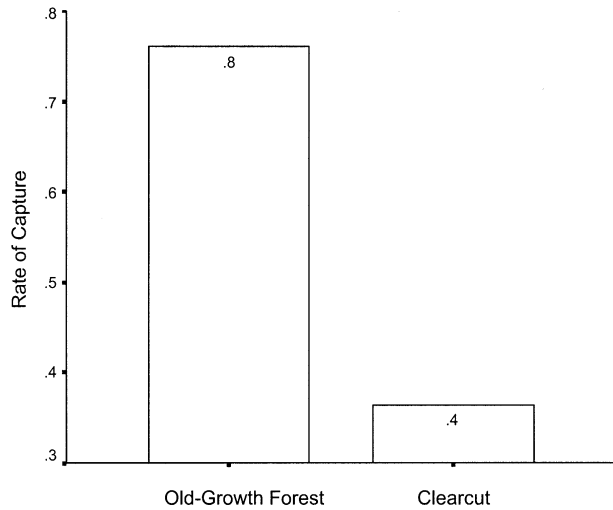


Figure 6. Captures per 100 trap-nights in old-growth forests and clearcuts.

1. Our data also support hypothesis 3, where high-gradient streams showed low movement of larvae. Hypothesis 2 will be tested during the 1999 field season.

Tailed frog post-metamorphic movement hypotheses we are exploring include: 1) the extreme philopatry hypothesis, where frogs remain within a restricted range, moving short distances along streams in both old-growth forests and clearcuts; 2) the stream dependency hypothesis, where frogs in clearcuts are more restricted to the stream than frogs in old-growth forests; 3) the age-specific movement hypothesis, where metamorphs and juveniles are responsible for most of

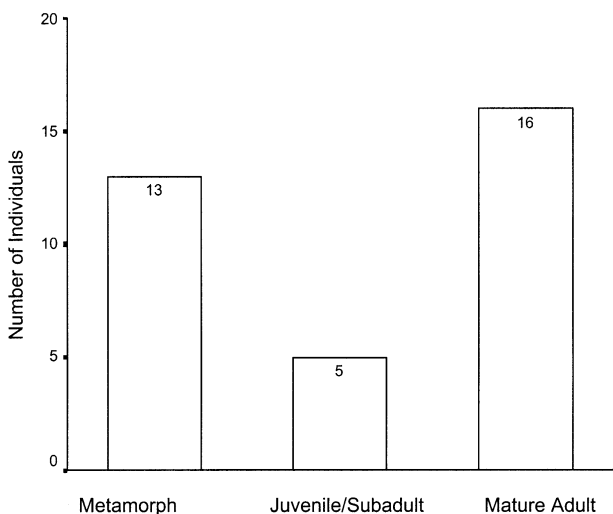


Figure 7. Number of tailed frogs trapped in each stage of development.

the upland movements, while adults remain relatively sedentary, moving primarily along the stream; and 4) the macro-climatic movement hypothesis, where movements of frogs in wet environments are less restricted than movements in dry environments. Hypothesis 4 will be tested through comparisons between tailed frog movements in British Columbia and tailed frog movements in southern Oregon.

Preliminary trapping results reveal that, although most frogs were found in streamside arrays, some individuals moved as far as 100 m from the nearest stream. This demonstrates that the dispersal abilities of tailed frogs are much greater than previously suggested (Daugherty and Sheldon 1982b), and rejects hypothesis 1. More importantly, the individuals at 100 m were newly metamorphosed tailed frogs, lending support to hypothesis 3, where early age-classes are responsible for upland movements. The majority of frogs found in streamside arrays were reproductively mature and were moving upstream, which supports suggestions that tailed frogs breed during the fall in upper reaches of streams. This also lends some support to hypothesis 3, where adults remain relatively sedentary, moving primarily along the stream.

MANAGEMENT IMPLICATIONS

Forest management decisions should consider the ecological integrity of sensitive habitats and species, and the connectivity of ecosystems to ensure continued dispersal and movement of ecologically sensitive species across the landscape. It is important to ensure the protection of streams because they provide tailed frogs with breeding sites, over-wintering sites, and potential dispersal corridors for gene flow between populations. It may be equally important to ensure

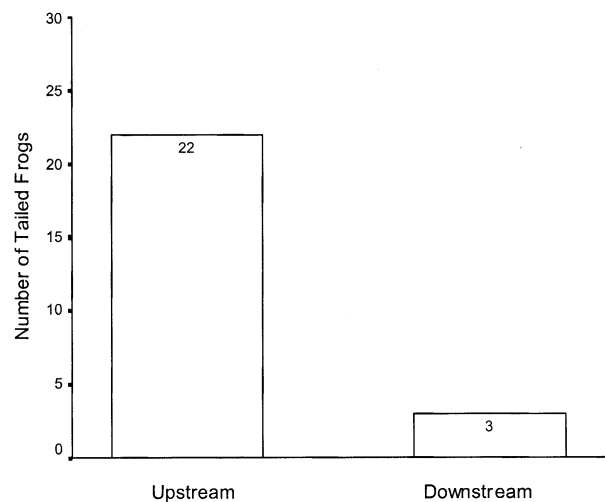


Figure 8. Number of tailed frogs moving upstream and downstream.

protection of the terrestrial habitat required by this species, and the value of riparian buffers needs evaluation.

Results of this research carry important conservation and management implications for tailed frogs and their habitats: cold, rocky streams, which are essential for many animals, including salmonid fishes. Our goal is to develop wildlife habitat areas or other alternative forest management designs to address the needs of identified wildlife.

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