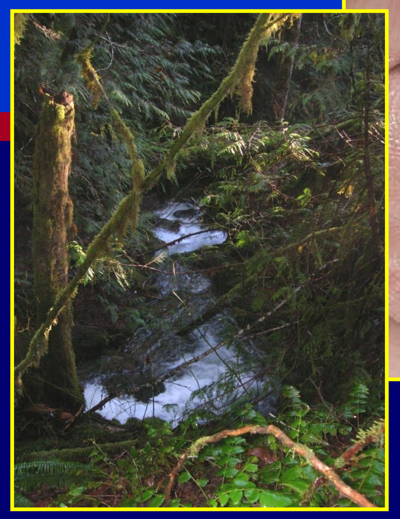
TORRENT SALAMANDER MOVEMENT ECOLOGY: PERSPECTIVE ON A "SEDENTARY" SPECIES

Washington Department of Fish and Wildlife

Forests and Fish Cooperative Monitoring Evaluation & Research Committee



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INTRODUCTION

Torrent salamanders (genus *Rhyacotriton*) might be characterized as the most sedentary amphibians in the Pacific Northwest. In 1973, Nussbaum and Tait (1977) searched a 26-m section of stream 7 times over the interval 22 June to 20 October that resulted in 191 recaptures of an unspecified number of uniquely marked Cascade Torrent Salamanders (*R. cascadae*). The longest moves they recorded (22 m) were made by two individuals and 70% of recaptures were found within 2 m of their original location. Using a grid system to locate captures, Welsh and Lind (1992) searched a 6.0 m by 2.1 m portion of a spring-stream interface on 7 occasions over the interval 1986-1988, and 39 of 237 Southern Torrent Salamanders (*R. variegatus*) encountered represented recaptures. Thirty-one larvae moved an average distance of 2.2 m/yr, whereas eight adults moved an average of 1 m/yr. Nijhuis and Kaplan (1998) searched a 6 m by 10 m streamside plot for post-metamorphic Cascade Torrent Salamanders on 26 nights from 12 March to 12 May 1995. Of the 214 individuals captured, 76 (36%) were recaptures. The mean daily distance moved by individuals recaptured at least twice (n = 24) was 0.4 m. Anecdotal mention has been made of finding adult torrent salamanders at locations greater than 50 m from water (Good and Wake 1992), implying that movements at that scale or greater were possible, but definitive data indicating a ability to move over distances greater than 22 m are lacking.

During a manipulative study examining amphibian response to different levels of shade, we opportunistically recaptured larval Olympic Torrent Salamanders (*R. olympicus*) that had escaped from stream enclosures. Here, we present the movement aspects of this information.

METHODS

Our data were derived from a Forests and Fish Adaptive Management project called the Buffer Integrity-Shade Effectiveness Study (hereafter Shade Study). Forests and Fish, a multi-stakeholder agreement finalized in 2000, addresses timber-managed landscapes across Washington State. The Shade Study was designed to examine the effects of maintaining different levels of shade on stream-associated amphibians (SAAs).

The data presented here were obtained from the Olympic portion of the Shade Study. This portion of the study encompassed seven perennial non-fish-bearing streams, all located on Washington Department of Natural Resources-managed lands in Jefferson and Mason Counties on the east side of the Olympic Peninsula. All streams had a generally southerly aspect, were located at elevations between 183 m (600 ft) and 549 m (1800 ft), and had gradients $\geq$ 10%. These streams were all underlain with mostly a coarse rocky substrate derived from basalt or competent sandstone parent material, and were all tributaries of larger streams that flow into the Hood Canal. Each study stream had a reference (or control) reach 50 m in length located upstream from a 50-m treatment reach. The distances between reference and treatment reaches on each stream varied from 50 m to 92 m.

A key response variable in this study was SAA growth. To monitor growth, we placed 4-6 larval individuals of one of the two target SAA species in plastic 50 cm x 37 cm x 16 cm in-stream enclosures containing a rocky substrate similar to that found outside the enclosure in the stream (FIGURE A). Enclosures had screened ends to allow stream flow through the enclosure and two additional PVC pipes to ensure maintaining flow through the enclosure. Enclosures were fitted with plastic tops with all but the margin cut out, which enabled litter and insects to fall into the enclosure in a manner similar to that in the adjacent stream.

FIG. A

For each SAA species monitored, one enclosure was placed in each of the reference and treatment reaches. Animals in enclosures were individually marked using a fluorescent Elastomer (soft plastic) dye (FIGURES B AND C). We obtained measurements on individuals in these enclosures every 1-2 weeks in the interval April-October over four years (2006-2009).

FIG. B

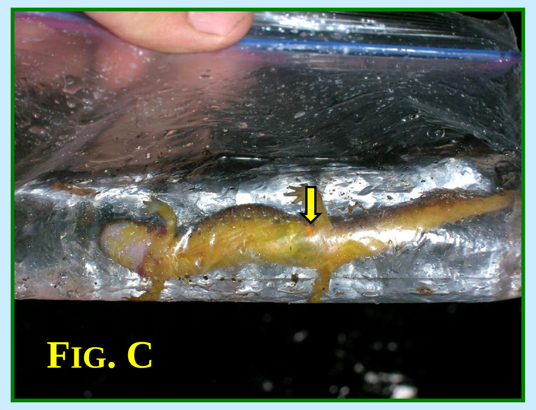

FIG. C

One part of assessing SAA response in this study involved conducting abundance surveys in the reference and treatment reaches. Abundance surveys comprised a rubble-rouse search of one 2-m interval for every 10 m of reference or treatment reach. These searches involved securing a net across the water column on the downstream end of the 2-m interval. We then captured all amphibians within the 2-m interval above the net by first removing all coarser substrates from the stream and sifting through the remaining fines. After each survey, we returned all substrates to the stream and removed the net. We conducted one abundance survey per stream per year, for a total of 28 surveys over 4 years.

Over the course of this portion of the study, one of the two focal species, the Olympic Torrent Salamander, had moderate to high levels of escapement from enclosures despite several modifications that were added during the study to limit their escapement. Modifications included spray foam to fill potential small holes in the margin of enclosure tops, bungee cords to better secure them, and the addition of a highly flexible inverted plastic fringe along the inner top margin. We recaptured many torrent salamanders originally placed in an enclosure during abundance surveys. However, at one stream, the level of escapement was so high that we also conducted focused rubble-rouse surveys of the 10 m around the enclosure in September 2008 and again in July and August 2009. Another stream that also had high escapement in 2009 also received focused rubble-rouse surveys of the 5 m around the enclosure 3 times over the interval of July-September. We recaptured escapees from enclosures both during these searches and during haphazardly applied light-touch searches of selected stream sections.

RESULTS

We opportunistically recaptured 91 marked larval Olympic Torrent Salamanders that had escaped enclosures. We were able to unambiguously identify 81 of those animals, with 11 representing multiple recaptures. We were able to determine last known location on an additional 7 individuals despite the fact that these could not be unambiguously identified. This provided distance data on 88 of 91 recaptures.

Of the 88 recaptures, we recorded 30 during abundance surveys. Of the remaining 58 animals, 35 were recorded during the focused rubble-rouse searches. The remaining 23 were found during the haphazard light-touch sampling efforts.

Movement distances of recaptures ranged from 0 m to 123 m (FIGURE D). Of the 65 recaptures made within the same year (season), 10 had moved between 24 and 122 m. Of 20 between-year recaptures, 9 moved between 24 and 123 m. The 19 animals that moved >22 m represented 22% of our identifiable recaptures.

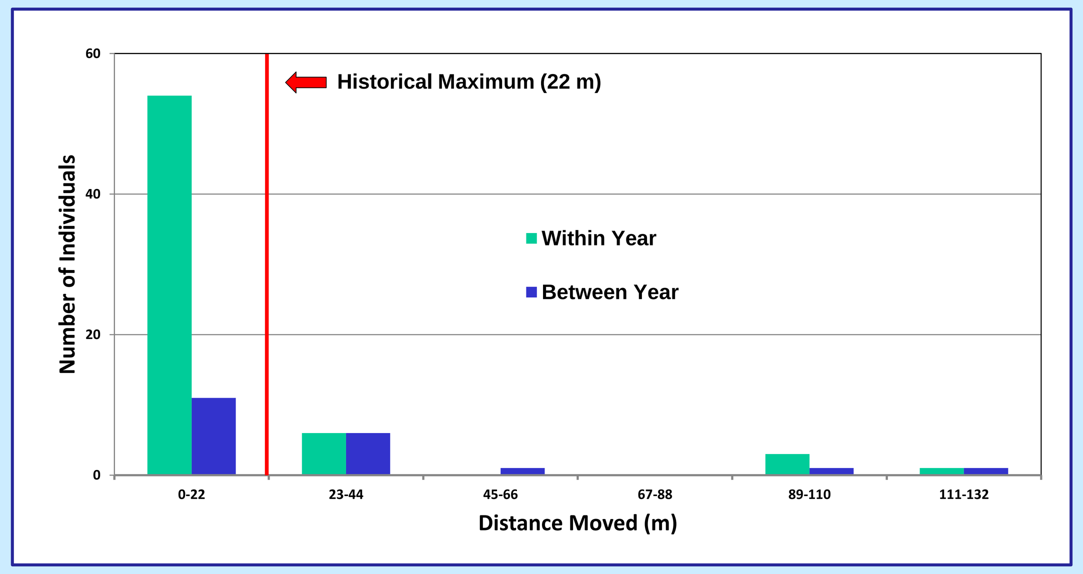

FIGURE D. ***Total Distance Moved by Recaptures***

Recaptures made within the same year (season) spanned intervals of 2 to 119 days. Recaptures made between years spanned intervals of 247 to 1048 days (2-4 calendar years). In the summer of 2008, one individual moved upstream 122 m in only 6 days during an interval of markedly decreasing stream flows.

Layout of reference and treatment reaches and the start point of abundance surveys resulted in an asymmetric search effort for escapees (FIGURE E).

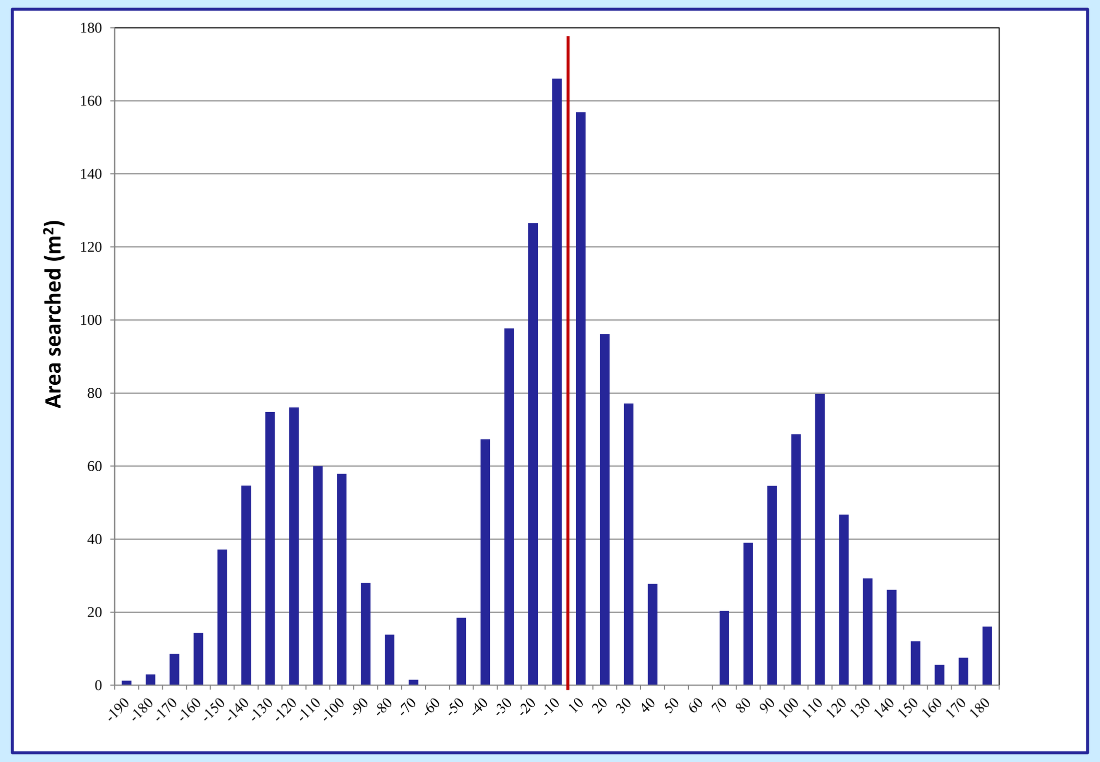

FIGURE E. ***Abundance Survey Search Effort***

In particular, effort devoted to abundance surveys (measured as surveyed area) was somewhat greater downstream from enclosures (907 m^2) than upstream from enclosures (764 m^2). Despite greater effort downstream, the number of captures of upstream-moving animals (n = 25) was 5 times that of downstream moving animals (n = 5), a significant difference (χ^2 = 13.4, P < 0.001). Gaps at intermediate distances upstream and downstream of enclosures reflects the unsampled reaches located between treatment and reference reaches in each stream.

CONCLUSIONS

Though our data represent escapees from stream enclosures, they show that torrent salamander larvae are able to move distances 2-101 m further than the maximum recorded in-stream movement for any life stage, a large increase over previous reports. Even more important, design of all previous studies with some ability to describe movements in torrent salamanders have not attempted to recapture individuals outside of a very limited footprint, making underestimation of the scale of movement unavoidable. These findings strongly suggest that movement scale in torrent salamanders merits investigation that makes particular effort to minimize a limiting scale in the sampling footprint. Additionally, our data also imply some potential for large movements over a short time interval.

Lastly, Nussbaum and Tait (1977) also reported an asymmetry in favor of upstream movement. This pattern may be a mechanism that compensates for downstream drift, if it occurs in this species. Downstream drift is also an unstudied phenomenon among torrent salamanders.

LITERATURE CITED

GOOD, D, AND D WAKE. 1992. Geographic variation and speciation in the torrent salamanders of the genus *Rhyacotriton*. *University of California Publications in Zoology* 126:1-91.

NUSSBAUM, R, AND C TAIT. 1977. Aspects of the life history and ecology of the Olympic Salamander, *Rhyacotriton olympicus* (Gaige). *American Midland Naturalist* 98(1):176-199.

NIJHUIS, M, AND R KAPLAN. 1998. Movement patterns and life history characteristics in a population of the Cascade Torrent Salamander (*Rhyacotriton cascadae*) in the Columbia River Gorge, Oregon. *Journal of Herpetology* 32(2): 301-304.

WELSH, H, AND A LIND. 1992. Population ecology of two relictual salamanders from the Klamath Mountains of northwestern California. Pp. 419-437. *Wildlife 2001: Populations*. Elsevier Applied Science, New York, New York.

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