Habitat Relationships of Dunn's Salamander

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Dunn's (*Plethodon dunni*) and Vandyke's (*Plethodon vandykei*) salamanders are two of seven stream-associated amphibian species covered in the Forests and Fish Report (FFR). Adaptive management provisions of FFR identify the need to better understand how forest management activities affect those species. Specifically, the FFR schedules for adaptive management (L1 and L2) identify the need for understanding the relationship between these species and large woody debris.

The link between Dunn's salamander and large woody debris (LWD; i.e., wood > 10 cm diameter) is ambiguous. Most studies indicate that Dunn's is associated with relatively coarse rocky substrates (Bury and Corn 1991, Bury *et al*. 1991, Corn and Bury 1991, Gilbert and Allwine 1991, Herrington 1988, Olson *et al*. 2000, Wilkins and Peterson 2000; see also Fitch 1936, Storm 1955), rather than wood or woody debris (see especially Olson *et al*. 2000; D. Olson, pers. comm.). Despite this apparent lack of relationship to wood or LWD, some evidence suggests that a relationship to wood exists. Recent description of the second Dunn's salamander nest ever recorded from a decayed log (Nauman *et al*. 1999; the first nest description was from rocky talus (Dumas 1955)) implies that LWD may be suitable reproductive habitat. Alternative reproductive habitat in LWD may represent a pattern similar to that seen in Van Dyke's salamander, where relatively recent discovery of additional nests in wet LWD in Washington State (Jones 1989, Blessing *et al*. 1999) has substantially altered thinking regarding habitat utilization in that species, namely that Van Dyke's salamander may be less tied to rocky substrates than one might deduce from earlier data. Furthermore, Hagar *et al*. (1995) suggested that LWD might be substituted for the coarse rock substrate requirement in some salamanders. For Dunn's salamander, such a pattern would have a high likelihood of occurring in parts of the northern limit of its geographic range (i.e., Washington state), where high precipitation levels keep LWD wet more consistently. In addition, Bunnell *et al*. (1997) noted that macroclimate, referring specifically to the effects of higher precipitation levels on PNW amphibians, has the potential to reduce negative effects that result from forest management. Thus, if effects resulting from forest management occur, we expect them to be most easily detected across precipitation gradients in southwestern Washington State.

We propose a study of Dunn's salamander designed to examine whether its use of habitat in Washington State is similar to patterns described elsewhere in its geographic range, but with a special focus on LWD. In particular, we will determine whether some relationship exists between the abundance of Dunn's salamander and LWD or alternative substrates. However, a relationship between LWD or alternative substrates and Dunn's salamander may require population saturation in the habitats in which they occur. Though population saturation has sometimes been claimed to be the norm for terrestrial salamanders (Hairston 1987), a number of reasons exist to believe that population saturation is not always be the case. Hence, under unsaturated conditions, a strong relationship between LWD and salamander abundance may not exist. Hence, alternatively, relationships to

LWD will be explored by examining whether shifts in wood use occur between meso-habitat locations, for example, stream banks versus uplands. If LWD levels on the managed landscape are sufficient to allow identification of some relationship to LWD, this study will be a precursor that can help indicate whether a manipulative study addressing LWD is needed and what its scope might be. In particular, if a relationship to LWD exists, this study should be able to identify LWD conditions under which the abundance of Dunn's salamander is high, a precondition necessary to guarantee the densities necessary to effectively conduct a manipulation. Even if either the levels of LWD on the managed landscape are not sufficient to determine the relationship of Dunn's salamander to LWD or alternatively no relationship to LWD is found, this study will provide basic data on the relationship of Dunn's salamander to other habitat elements.

Though the primary focus of this work as funded by CMER is related to Dunn's salamanders, this study also has opportunity to contribute to the understanding of Van Dyke's salamander, the second terrestrial salamander targeted by FFR. In particular, the aforementioned issues addressed for Dunn's salamander may also be addressed for Van Dyke's salamander, and opportunity will exist to determine the level of habitat partitioning and overlap between these two species. However, general lack of data on Van Dyke's salamander made it a poor candidate around which to design a study. Secondarily, this study will also provide information on other non-FFR target terrestrial salamanders in the FFR managed forest landscape.

This study will add several streams to the 14 streams that were sampled in the original 2001 study in which the Forest Service was a partner. The Forest Service in-kind contribution to this study (field crews and crew support) is a segment of a larger research agenda of stream-focused amphibian research that includes their Stream-associated Amphibian Microhabitat Study (SAMS) and their Riparian Ecosystem Management Study (REMS). The SAMS study program is an attempt to characterize microhabitats of stream-associated amphibian in a fashion sufficiently detailed to provide well-founded bases for management recommendations that may influence these amphibians, and the REMS has the larger focus of detailing dynamics to refine management approaches on an ecosystem scale.

Research Questions

To understand habitat relationships of Dunn's salamander, we ask the following research questions and examine the following hypotheses:

1) **Does some relationship exist between LWD and the densities of Dunn's or Van Dyke's salamanders?**

   Hypothesis 1: *No relationship exists between LWD and observed densities of Dunn's or Van Dyke's salamanders.*

We intend to examine microhabitat use patterns of Dunn's salamanders in stream-adjacent areas of stream basins of southwest Washington. We will measure Dunn salamanders densities along belt transects running from the stream edge to the uplands (perpendicular to the stream). For each Dunn's occurrence, we will determine microhabitat use as the substrate in which the animal was found. In addition, we will record meso-scale habitat as the habitat within that transect, and the landscape scale habitat as a habitat conditions over the 10 transects in a stream. We will record standard measures of habitat including substrate type and composition, and features of vegetation. We will pay special attention to wood and LWD, and also record temperature and moisture of both the habitat and at animal location as variation in temperature and moisture are basic to terrestrial salamander habitat needs (Spotila 1972).

Metrics of gross LWD or the appropriate LWD subgroup may vary in some systematic way with salamander density, so where possible, we use a directional null hypothesis that either no relationship or no negative relationship exists between LWD and salamander density. Rejection of such a null hypothesis would imply acceptance of the alternative hypothesis that a positive relationship of some kind exists. As indicated above, lack of a positive relationship to some class of wood may not eliminate a relationship to wood if salamanders do not saturate available habitat, and wood is differentially utilized between meso-habitats. Hence, potential for differential patterns of wood utilization between meso-habitats know to present different habitat conditions, stream banks versus adjacent uplands (Dong et al. 1998), will be examined. In this case, the null hypothesis being examined is that no difference exists in wood utilization between meso-habitats.

2) **Is there evidence that Dunn's can use rocky substrates as a substitute for coarse woody debris?**

Hypothesis 2: *No evidence exists for substitution between LWD and rock for Dunn's salamander.*

This hypothesis may be restated in the testable form:

No relationship exists between observed Dunn's salamander densities and the use of rock versus wood.

We intend to measure the amount and distribution of LWD and rocky substrates so that we can express Dunn's salamander density as a function of how these substrates may change. If we find a relationship between Dunn's salamander density and LWD, we will determine whether that relationship changes with the extent of available inorganic substrates. Again, as noted above, we may not detect a relationship between salamander density and LWD even though some relationship to wood may exist. In that case, we will examine how differences in meso-habitat conditions may result in different levels of use of LWD versus rocky substrates.

3) **Do observed densities of Dunn's salamander vary with distance from the stream, stream banks versus uplands, or stream size or type (collectively meso-habitat)?**

Hypothesis 3: *No relationship exists between the densities of Dunn's salamander in different meso-habitats.*

Testing this null hypothesis will be done to validate whether Dunn's salamander responds similarly in the Washington landscape to studies conducted in the Oregon portion of its geographic range, where is regarded as stream-associated (e.g., Gomez and Anthony 1996). As distance from the stream may be influenced by the availability of selected habitats or their quality, we will determine whether the previously measured habitat variables (i.e., LWD, rock, their subgroupings) or habitat conditions (temperature and moisture) vary with salamander density along the distance gradient from the stream.

Methods

<u>Study Area</u>: The study area is the Willapa Hills physiographic region of southwestern Washington, the relatively high rainfall forested landscape that encompasses the known distribution of Dunn's salamander in Washington State (Dvornich et al. 1997).

<u>Site Selection</u>: We will attempt to sample 15 streams in the Willapa Hills during the spring season of 2003. Because analysis of landscape-level data for Dunn's salamander in Oregon has revealed an association with larger wetter channels (Olson *et al*. 2000), we will intentionally broaden the selection of stream systems sampled beyond N-type streams. In particular, we will select sample locations in 2003 so that with the 14 streams completed in 2001, we will have a roughly equal sample of larger and smaller streams. Between-year variation in precipitation can strongly influence near-surface activity in terrestrial salamander, and hence, the number of animals per stream can vary enormously between lower and higher precipitation years. More animals can markedly affect the rate at which streams are sampled, hence, the 15 streams is an estimated not absolute target.

<u>Overall Design</u>: We will use the basic sampling design of REMS and SAMS, as Raphael et al. (2002) have shown that their Streambank Survey (SBS) method is effective for determining observed densities of near-stream target species in coastal Washington with reduced observer bias. In particular, SBS is most effective at sampling all taxa of terrestrial or plethodontid (lungless) salamanders, the group to which Dunn's and Van Dyke's Salamanders both belong. However, to accommodate the intent of this proposal, some aspects of the Forest Service protocol have been modified, as previously applied during the 2001 work. The primary modification involved addition of variables relating to woody debris (most importantly diameter and decay classes, but also species contributing the LWD). Other modifications included less ambiguous definitions of habitat, microhabitat, and geomorphic variables.

<u>Stream Units</u>: At each stream site, we will sample a series of 10 2-m wide belt transects that are arrayed perpendicular to the stream axis at intervals of 10 to 30 m intervals, depending on the size of available reach at the appropriate (late-rotation) stand age. Hence, a suitable stream reach must encompass at least 120 m at the appropriate stand age to allow a minimum of 15 m of equivalent stand conditions before the belt transect series begins and ends. Each transect will extend from the stream margin to the valley wall (i.e., top of actively eroded margin) on each side of the stream and 35 m into upland habitat above the valley wall on one side only for each belt. Where a distinct valley wall is lacking (typically in small streams), the conifer-tree line will demarcate the boundaries of the stream valley. Transects above the valley wall or tree line will be established on each side of the stream in an alternating pattern except when an obstruction (e.g., cliff) prevents placing a transect on the alternating side.

<u>Variables measured or scored</u>: We will characterize the physical and biotic habitat features of each of the belt transects by recording or measuring a suite of variables. Physical variables include geomorphologic features, inorganic substrates, cover, slopes, and aspects. Biotic variables will focus on vegetation structure and types, and organic

substrates, especially LWD. Data from these variables will be used for comparison to amphibian capture (use) data. We will also obtain regional climatic data to allow comparison among streams.

Amphibian Sampling: After characterizing the physical and biotic features of belt habitats, we will exhaustively sample the habitats within each belt for amphibians. The entire substrate surface will be visually searched, and cover objects will be thoroughly searched; excavation to depths of 30 cm will occur where openings in the substrate that may provide refuge exist. When animals are captured, they will be identified, measured, weighed, sexed, and data will be collected on their microhabitats and distances to the stream margin. Temperatures and moisture level of the animal/substrate will be recorded at each capture. If animals occur are associated with woody substrates, we will record diameter and decay class, and where possible, species contributing the wood. This method requires destructive sampling of woody debris in which amphibians may be concealed. However, the benefit is that we will have a clear understanding of amphibian distribution in relation to its environments with reduced survey method bias.

Analysis: Data will be analyzed at micro-, meso-, and landscape scales to identify patterns of terrestrial salamander habitat utilization. The design will enable selected comparisons between the scales of the animal (microhabitat) and the scale of the belt (mesohabitat) to suggest whether salamanders are using microhabitats that differ from the condition generally found in the meso-habitat. Selected comparisons will focus on local-scale meso-habitat contrasts (i.e., streambanks versus upland), and because data will be based on two different years, for which the data may differ as a function of climatic conditions (Cayan 1996), some between-year comparisons will also be conducted. By default, SAMS is a comparison of microhabitat use among species (which goes beyond those recognized by FFR) in the Willapa Hills and elsewhere, so the goals of SAMS are synergistic with this proposal.

Timetable

Sampling for this study is time-sensitive. Though two seasonal intervals exist during which sampling for terrestrial salamanders can be conducted (spring and fall), the fall interval is frequently an unreliable sampling interval because the unpredictability of the coincidence or lack thereof of the initiation of precipitation and temperature decline that reduces surface activity in terrestrial salamanders. Hence, surveys must be completed in spring (March-June), as it is the only period when Dunn's and Van Dyke's salamander are predictably near-surface active for a lengthy period of time, regardless of precipitation conditions that year. Freezing conditions over 48-hr previous to a potential sampling date eliminates that date from sampling or analysis.

Responsibilities

The Washington Department of Fish and Wildlife (Science Team) will coordinate the sampling, analyses, write-up, and subsequent products of the non-bearing portion of this project for the Landscape and Wildlife Advisory Group and the Amphibian Research Consortium. Representatives for co-operating landowners and the Forest Service will be included as authors on all peer-reviewed products deriving from this study; participation in analyses by co-operators will be welcome at whatever level they are able to participate.

Literature Cited

Blessing, B.J., E.P. Phenix, L.L.C. Jones, M.G. Raphael. 1999. Nests of Van Dyke's (*Plethodon vandykei*) from the Olympic Peninsula, Washington. Northwest Naturalist 80(2):77-81.

Bunnell, F. L., L. L. Kremsater, and R. W. Wells. 1997. Likely consequences of forest management on terrestrial, forest-dwelling vertebrates in Oregon. Report M-7 of the Centre for Applied Conservation Biology, Department of Forest Sciences, University of British Columbia, Vancouver, Canada.

Bury, R.B., and P.C. Corn. 1991. Sampling methods for amphibians in streams in the Pacific Northwest. Pp. 1-29. In: Carey, A. B., and L.F. Ruggiero (technical editors), Wildlife-habitat relationships: Sampling procedures for Pacific Northwest vertebrates. U.S. Forest Service, General Technical Report PNW-GTR-275.

Bury, R.B., P.C. Corn, K.B. Aubry, F.F. Gilbert, and L.L.C. Jones. 1991. Aquatic amphibian communities in Oregon and Washington. Pp. 353-362. In: Ruggiero, L.F.; K.B. Aubry; A.B. Carey; and M.H. Huff (technical coordinators), Wildlife and vegetation of unmanaged Douglas-fir forests. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, Oregon, General Technical Report PNW-GTR-285. [May]

Cayan, D. R. 1996. Interannual climate variability and snowpack in the western United States. Journal of Climate 9:928-948.

Corn, P.C., and R.B. Bury. 1991. Terrestrial amphibians communities in the Oregon Coast Range. Pp. 305-317. In: Ruggiero, L.F.; K.B. Aubry; A.B. Carey; and M.H. Huff (technical coordinators), Wildlife and vegetation of unmanaged Douglas-fir forests. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, Oregon, General Technical Report PNW-GTR-285. [May]

Dong, J., J. Chen, K. D. Brosofske, and R. J. Naiman. 1998. Modelling air temperature gradients across managed small streams in western Washington. Journal of Environmental Management 53:309-321.

Dumas, P.C. 1955. Eggs of the salamander *Plethodon dunni* in nature. Copeia 1955(1):65.

Dvornich, K. M., K. R. McAllister, and K. B. Aubry. 1997. Amphibians and reptiles of Washington State: Location data and predicted distributions, Volume 2. 146 pp. In: Cassidy, K. M., C. E. Grue, M. R. Smith, and K. M. Dvornich (editors), Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle.

Fitch, H.S. 1936. Amphibians and reptiles of the Rogue River Basin, Oregon. American Midland Naturalist 17(3):634-652.

Gilbert, F.F., and R. Allwine. 1991. Terrestrial amphibians communities in the Oregon Cascade Range. Pp. 319-324. In: Ruggiero, L.F.; K.B. Aubry; A.B. Carey; and M.H. Huff (technical coordinators), Wildlife and vegetation of unmanaged Douglas-fir forests. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, Oregon, General Technical Report PNW-GTR-285. [May]

Gomez, D. M., and R. G. Anthony. 1996. Amphibian and reptile abundance in riparian and upslope areas of five forest types in western Oregon. Northwest Science 70: 109-119.

Hairston, N. G, Sr. 1987. Community ecology and salamander guilds. Cambridge University Press, New York, New York.

Hagar, J.C., W. C. McComb, and C. C. Chambers. 1995. Chapter 9. Effects of forest practices on wildlife. Pp. 1-150. In: Beschta, R. L., J.R. Boyle, C.C. Chambers, W.P. Gibson, S.V. Gregory, J. Grizzell, J.C. Hagar, J.L. Li, W.C. McComb, T.W. Parzybok, M.L. Reiter, G.H. Taylor, J.E. Warila (contributors), Cumulative effects of forest practices in Oregon: Literature and synthesis. Oregon Department of Forestry, Salem, Oregon, USA. [March]

Herrington, R.E. 1988. Talus use by amphibians and reptiles in the Pacific Northwest. Pages 216-221. In: Szaro, R. C., K. E. Severson, and D. R. Patton (technical coordinators), Proceedings of the symposium on management of amphibians, reptiles, and small mammals in North America. U.S. Forest Service General Technical Report RM-166.

Jones, L.L.C. 1989. *Plethodon vandykei*(Van Dyke's salamander): Reproduction. Herpetological Review 20(2):48.

Nauman, R.S., D.H. Olson, L.L. Ellenburg, and B.P. Hansen. 1999. *Plethodon dunni* (Dunn's salamander): Reproduction. Herpetological Review 30(2):89-90.

Olson, D.H., S.S. Chan, G. Weaver, P. Cunningham, A. Moldenke, R. Progar, P.S. Muir, B. McCune, A. Rosso, E.B. Peterson. 2000. Characterizing stream, riparian, upslope habitats and species in Oregon managed headwater forest. International Conference on Riparian Ecology and Management in Multi-land Use Watersheds, American Water Resources Association Technical Publication Series TPS-00-2:83-88.

Raphael, M. G., P. A. Bisson, L. L. C. Jones, and A. D. Foster. 2002. Effects of streamside forest management on the composition and abundance of stream and riparian fauna of the Olympia Peninsula. Pages 27-40. In: Johnson, A. C., R. W. Haynes, and R. A. Monserud (editors). Proceedings from the Wood Compatibility Initiative Workshop, Number 3. U.S. Forest Service, General Technical Report PNW-GTR-563.

Spotila, J. R. 1972. Role of temperature and water in the ecology of lungless salamanders. Ecological Monographs 42:95-125.

Storm, R.M. 1955. Northern and southern range limits of Dunn's salamander, *Plethodon dunni*. Copeia 1955(1):64-65.

Wilkins, R. N., and N. P. Peterson. 2000. Factors related to amphibian occurrence and abundance in headwater streams draining second-growth Douglas-fir forests in southwestern Washington. Forest Ecology and Management 139:79-91.