Amphibian assemblages in zero-order basins

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Introduction

Zero-order basins are contributors to 1st-order systems, including all drainage areas above **sustained** scour and deposition (Tsukamoto et al. 1982: **Figure 1**). In Pacific northwestern forested landscapes, limited protection is offered to these basins (Young 2000).

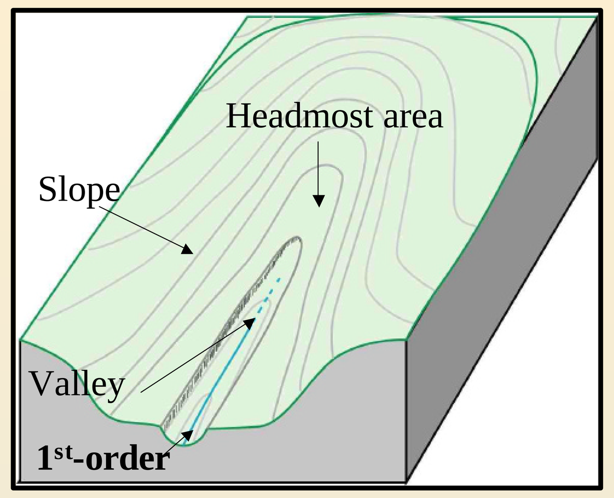

Figure 1. Zero-order basin geomorphology.

No study has characterized **amphibian communities** in zero-order basins, and management of biotic resources in these basins has not been explicitly established. To address these information needs, I investigated amphibian **distribution** in zero-order basins:

- along **longitudinal** and **lateral** gradients
- relative to three **geomorphic surfaces**

Methods

Study sites included **63 unmanaged** zero-order basins in headwater areas of the Coquille River Basin, Oregon, in lands administered by the Bureau of Land Management (**Figure 2**). I quantified amphibian densities using **hand capture**, in transects **stratified** by geomorphic surface (**Figure 3**).

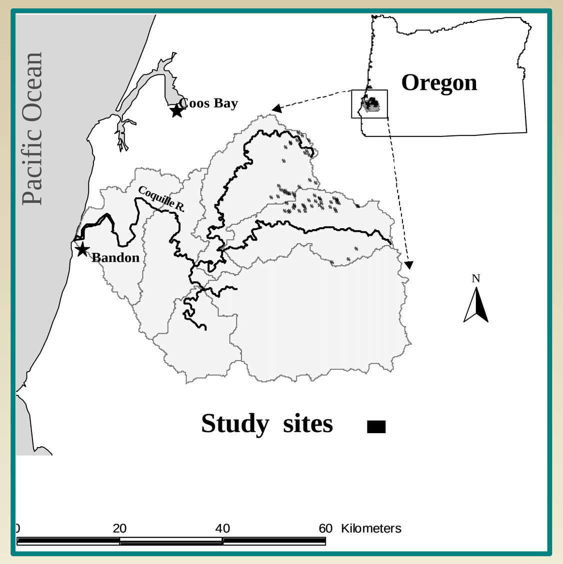

Figure 2. Study area and study sites.

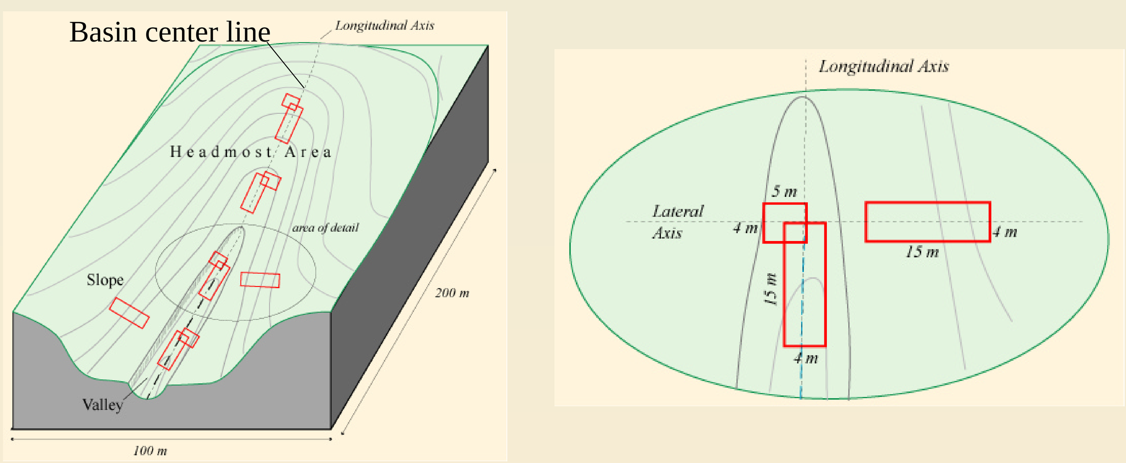

Figure 3. Zero-order basin geomorphology and amphibian transect set-up.

I made **between-species** comparisons of **proximity to ridgeline** (shortest distance from ridgeline to capture) and maximum **distance from basin center** using general linear models.

For each species, I compared differences in captures between 3 **geomorphic surface zones** (valley, headmost, slope) and 3 **lateral zones** (0-2 m, 2-5 m, >5 m from center) using log linear models.

I used **indicator species analysis** (Dufrene and Legendre 1997) to quantify the degree of association between amphibian species and geomorphic and lateral zones. I developed **species assemblages** associated with each zone in each typology, considering only species whose **maximum indicator values** were significant (p≤0.05).

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Results

Amphibians with over 30 captures included 2 sensitive species (southern torrent and clouded salamanders), one riparian indicator (Dunn's salamander), one aquatic species (Pacific giant salamander) and two generalist/ upland species (western red-backed salamander and ensatina).

Five of 15 between-species comparisons for proximity to ridgeline were significant (**Table 1**). "Wet" species (Pacific giant, southern torrent, and Dunn's salamanders) were captured 1.0 to 3.6 times further from ridgeline than "dry" species (clouded salamander and ensatina). Nine of 15 comparisons for maximum distance from basin center were significant (**Table 1**). Maximum distances from center of captures for wet species were less than half that of dry species.

Table 1. **Between-species** comparisons of **spatial patterns** in zero-order basins, including ratios of median proximities to ridgeline (95% CI), and (median) maximum distance from center (95% CI). Only significant comparisons (ratios **not** including 1.0) are depicted. Comparisons made using general linear models with Tukey-Kramer adjustments. N=63.

Wet species	Dry species	Ratios: Proximity to ridgeline	Ratios: Distance from center
Pacific giant[1]	**Ensatina**	1.92 (1.02, 3.63)	0.17 (0.06, 0.42)
Pacific giant[1]	**Clouded**	ns	0.17 (0.07, 0.43)
Pacific giant[1]	**W. red-backed**	ns	0.1 (0.04, 0.23)
S. torrent	**Ensatina**	1.75 (1.14, 2.7)	0.22 (0.11, 0.43)
S. torrent	**Clouded**	1.59 (1.05, 2.38)	0.23 (0.12, 0.43)
S. torrent	**W. red-backed**	ns	0.13 (0.07, 0.23)
Dunn's	**Ensatina**	1.72 (1.15, 2.63)	0.36 (0.19, 0.68)
Dunn's	**Clouded**	1.56 (1.06, 2.33)	0.37 (0.20, 0.68)
Dunn's	**W. red-backed**	ns	0.21 (0.12, 0.36)

[1] aquatic life forms (larval and neotenic).

Torrent and Dunn's salamander (wet species) median captures were significantly higher in valleys than in headmost areas, and higher in headmost areas than in slopes (**Table 2**, **Figure 4**). Clouded salamander and ensatina captures were significantly lower in valley areas than in headmost areas.

Wet species captures were highest in areas within 5 m of center (**Table 2**, **Figure 4**). Western red-backed and clouded salamander captures were highest in the 2-5 m zone. There were no differences in captures between the three geomorphic zones for western red-backed salamander, and between lateral zones for ensatina.

Table 2. Ratios of species captures for geomorphic surface and lateral zones (95% CI), made with contrasts from log linear models. **Bold** indicates significant contrasts (p<0.05). "Model fit" statistic is deviance divided by degrees of freedom. N= 189.

Species	Geomorphic surface zone contrasts: Model fit Dev/df	Geomorphic: Ratios Valley / Headmost	Geomorphic: Ratios Headmost / Slope	Lateral zone contrasts: Model fit Dev/df	Lateral: Ratios 0-2 m/ 2-5 m	Lateral: Ratios 2-5 m / > 5 m
S. torrent[1]	1.80	**4.95 (2.20, 11.13)**	**11.65 (2.36, 57.55)**	1.36	**6.08 (2.58, 14.34)**	**13.77 (1.63, 116.27)**
Dunn's	1.25	**3.10 (1.75, 5.49)**	**6.12 (2.12, 17.03)**	1.07	1.52 (0.92, 2.53)	**9.09 (3.26, 25.36)**
W. red-backed[2]	1.69	0.78 (0.54, 1.13)	0.96 (0.70, 1.32)	1.56	**0.49 (0.37, 0.65)**	**1.55 (1.10, 2.17)**
Clouded	1.38	**0.38 (0.26, 0.55)**	1.60 (0.95, 2.72)	1.44	**0.53 (0.27, 0.85)**	**2.10 (1.02, 3.45)**
Ensatina	1.02	**0.10 (0.03 – 0.30)**	1.16 (0.71, 1.90)	1.06	1.19 (0.30, 1.45)	1.53 (0.39, 1.79)

[1]Lateral model included year as a covariate. Geomorphic model included day number as a covariate.
[2]Lateral model included day number as a covariate.

Indicator species analysis suggested that amphibians, especially terrestrial-breeders, assort more along geomorphic than lateral gradients (**Table 3**). Clouded and ensatina salamanders were significant indicators for headmost zones. Western red-backed salamander was a marginally significant indicator for slope zones. Other species were strong indicators for fluvial conditions in the 0-2 m lateral zone within valley zones.

Table 3. Amphibian assemblages associated with geomorphic surface zones and lateral zones, developed using indicator species analysis. "Maximum Indicator Value" represents the percentage of perfect indication of a species for the zone with which it was most strongly associated. Only species with values significantly higher than random expectation are shown. N=176 for geomorphic surface zones, 166 for lateral zones.

Geomorphic surface zones	Maximum Indicator Value (%)	p<
Valley		
Dunn's	56.7	0.001
S. torrent	52.7	0.001
Pacific giant (aq.)	19.4	0.001
Pacific giant (terr.)	11.3	0.004
Headmost		
Clouded	29.8	0.002
Ensatina	24.4	0.003
Slope		
W. red-backed	31.4	0.055

Lateral zones	Maximum Indicator Value (%)	p<
0-2 m		
S. torrent	57.3	0.001
Dunn's	49.4	0.001
Pacific giant (aq.)	15.3	0.005
Tailed frog	7.1	0.035
2-5 m		
No significant species		
> 5 m		
No significant species		

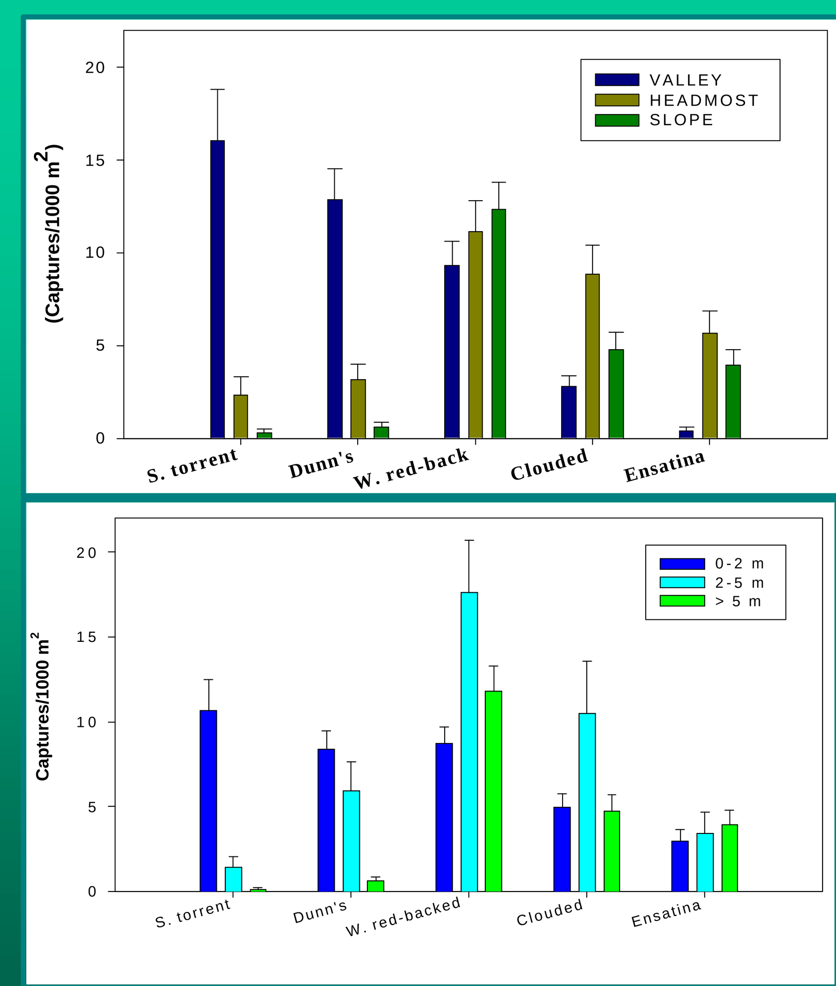

Figure 4. Amphibian capture densities (captures/ 1000 m^2) for **geomorphic** (upper) and **lateral** (lower) zones.

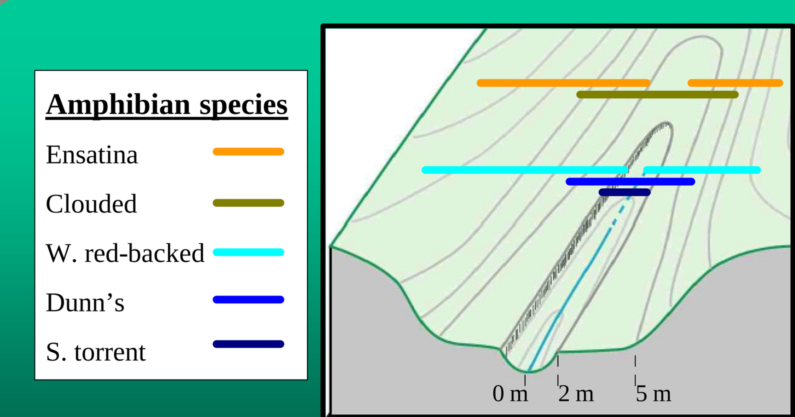

Figure 5. Schematic representation of amphibian assemblages in zero-order basins.

Conclusions

- **Riparian** and **terrestrial** amphibians **partitioned spatial habitats** in zero-order basins.
- Amphibian **diversity** was highest **within 5 m** of basin center, supporting the **importance** of **inner gorges** (Olson et al. 2000), and suggesting **spatial compression** of **fluvial** and **hillslope** habitats.
- Zero-order basins supported distinct amphibian **assemblages** (**Figure 5**) including:
  - A **valley** assemblage (S. torrent and Dunn's salamanders) associated with fluvial processes (e.g. saturation, scour), 0-2 m from center.
  - A **headmost** assemblage (ensatina and clouded salamander) associated with **intermediate** overstory structure and fluvial processes.
  - A **slope** assemblage (western red-backed salamander), in stable areas 2-5 m from center.
- **Management** should consider the role of zero-order basins (and **geomorphic surfaces** within them) in support of **distinct amphibian assemblages** in steep, forested landscapes.

Citations

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Olson et al. 2000. Characterizing stream, riparian, uplsope habitats and species in Oregon managed headwater forests. Pages 83-88 ***in*** J. Wiggington and R. Beschta, editors. Riparian Ecology and Management in Multi-Land Use Watersheds. International conference of the American Water Resources Association, Portland, OR.

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