Amphibians in the City:
Presence, Influential Factors, and Recommendations in Portland, OR

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Background

We are currently in the midst of the largest extinction of species on Earth in 65 million years (Myers & Knoll 2001, Baillie et al. 2004). Although this crisis is affecting nearly all taxa, amphibians are being hit particularly strongly, as one in three amphibian species are described as being threatened with extinction (Pounds et al. 2006). There are some unique amphibian characteristics that are likely contributing to their rapid decline including: moist, permeable skin; necessity of multiple habitats (e.g. ponds for breeding and forest for the summer); site fidelity; and the fungus-caused disease chytridiomycosis (Smith & Moran 1930, Bowne & Bowers 2004, Stumpel & Voet, Retallick et al. 2004). The loss of amphibians is sure to have profound effects on many ecosystems including disruption of food chains and nutrient cycling. Also, because amphibians are often affected by habitat degradation before other taxa, they act as indicators to future trends of other species. Amphibians are declining rapidly, and it is likely that other taxa will follow. Amphibians are present in the city of Portland, OR, but there is little data about which species are where and in what numbers. The species present and the factors that affect them are the focus of this study. The study is divided into terrestrially-breeding amphibians and pond-breeding amphibians.

Goals

This study has three goals:
1. Determine what amphibians are present in Portland and in what densities.
2. Determine what factors are influential for amphibians in Portland.
3. Make recommendations for habitat conservation and restoration that benefit amphibians.

Methods

Study Sites
I sampled at the following sites:

Columbia Slough Watershed:
- Ramsey Wetlands
- Schlesinger Wetlands
- Whitaker Ponds
- Four Corners
- Winmar Flats
- Alice Springs

Tryon Creek Watershed
- Maricara
- Fullebomber
- Headwaters
- Marshal Park

Johnson Creek Watershed
- Pompelly Property
- Powell Butte
- Kelly Creek
- Zenger Farms
- Brookside
- Beggar's Tick
- Circle Avenue
- Flavel Ridge
- Errol Heights

Willamette Watershed
- Oaks Bottom Wildlife Refuge
- Hoyt Arboretum
- Forest Park
- Water Quality Test Center

Sampling of Terrestrially-breeding Amphibians

At each site I conducted a 30-minute search for terrestrially-breeding amphibians after it had been raining for at least 36 hours.

Sampling of Pond-breeding Amphibians

I sampled for amphibians by walking the perimeter of each pond 1m in from the edge, dipping an aquarium net every three steps, and identifying every amphibian in my net to the species level. From this sampling I obtained an estimation of both the abundance and density of each amphibian species in each pond. I only sampled the tadpole (frog) and larvae (salamander) stage of the amphibian life cycle. I sampled each pond for amphibians eight times between June 2008 and August 2009.

Sampling of Terrestrial Factors

At each site I conducted ten 50m by 2m transects. In each transect I recorded the number of rocks, the number of logs, the amount of ground cover, and the type of ground cover. Every 1.5m I search for amphibians, and when I encountered one I recorded how far I was from the path.

Sampling of Pond Factors

I sampled each pond for the following factors three times during the late spring and summer of 2008: pH, nitrates, nitrites, dissolved oxygen, bottom temperature, surface temperature, depth, area of pond, clarity, percent aquatic vegetation, percent refugia, percent shading from above, percent shading from surface, surrounding vegetative cover, and surrounding cover objects. I also collected the following data for each pond: distance to nearest forested habitat, distance to nearest running water, shortest distance to another pond, whether or not the pond dried up, the age of the pond, and whether the pond was man-made or natural.

Analyses

I tested for correlations or associations of each amphibian species and each factor. I used Chi-squared analyses for discrete factors and linear regression analyses for continuous factors.

Results

Terrestrially-breeding amphibian presence

I found three species of terrestrially-breeding amphibians: Oregon salamander (*Ensatina eschscholtzii*), western red-backed salamander (*Plethodon vehiculum*), and Dunn's salamander (*Pl. dunni*). The sites at which I found these species are shown in Figure 1.

Pond-breeding amphibian presence

I found six species of pond-breeding amphibians: long-toed salamanders (*Ambystoma macrodactylum*), northwestern salamanders (*A. gracile*), rough-skinned newts (*Taricha granulosa*), Pacific chorus frogs (*Pseudacris regilla*), red-legged frogs (*Rana aurora*), and American bullfrogs (*R. catesbeiana*). I found red-legged frogs only in low number, and northwestern salamanders in even lower numbers. The American bullfrog is also of particular concern because it is not native to the Pacific Northwest and it is potentially competing with natives and predating upon them. The sites at which I found these species are shown in Figure 2.

Terrestrial Factors

Terrestrially-breeding salamanders were positively correlated with the amount of ground cover, the number of cover objects, and sites where ground cover was predominantly leaves, needles, or ivy. They were negatively correlated with site dominated by grass. There was no pattern in where I found these salamanders in relation to the path.

Pond Factors

I found that amphibians were not associated with native or man-made ponds. Chorus frogs and long-toed salamanders were associated with ponds that dry up and bullfrogs were associated with ponds that did not dry up.

The following are the continuous factors that best correlated with amphibian abundance and density. All natives were positively correlated with the percent of aquatic vegetation and the percent of aquatic refugia (places to hide). Many natives were also positively correlated with the percent of surrounding vegetative cover. Natives were generally negatively correlated with the clarity of the pond water. Tadpoles and larvae were negatively associated with nitrate level. Red-legged frogs and northwestern salamanders were negatively associated with the pH of the pond.

Conclusions

Amphibian presence in Portland

We have populations of three native terrestrially-breeding and five native pond-breeding amphibian species in Portland. Most of these populations are in small patches that are largely isolated from each other. We also have non-native American bullfrogs in many of these areas. In addition, I found one species of stream-breeding amphibian in Portland—the pacific giant salamander (*Dicamptodon tenebrosis*). As I only found this area at one site (Forest Park), I did not do further analytical comparisons with this species.

Influential factors

Terrestrially-breeding amphibians do better in areas that have a lot of ground cover and cover objects. My main suggestion to benefit these species is to not clear away cover, including downed woody material. Also, because they were so negatively correlated with the amount of grass, I recommend replacing grass0dominated areas with debris and native plantings if terrestrially-breeding amphibians are desired.

I was just as likely to find pond-breeding amphibians in man-made ponds as in natural ponds. This indicates that constructing new ponds is promising for amphibian restoration. The native amphibians in Portland can develop to metamorphosis in one season, so they can breed in ponds that dry up at some point during the summer. Bullfrogs take two years to develop to metamorphosis in this area, and therefore need to breed in ponds that retain water year-round. Because of this, building ponds that dry up in the summer will likely encourage native breeding and discourage bullfrog breeding. However, there were also many ponds that had native tadpoles and larvae that dried up before these amphibians could metamorphose, so these ponds need to not dry up too soon. The ideal time for drying is August. However, northwestern salamanders often take two years to develop, and the only pond in which I found them that dried up was the pond on Powell Butte.

All native amphibians were more abundant and were present in higher densities in ponds that had more aquatic vegetation and more aquatic refugia. These are important for egg-laying substrate and as refuge from predators. Plants and refugia can be added to make the ponds better for amphibians. Plants can also be planted around the ponds to provide cover for amphibians moving to and from the ponds, as I also found this to be an important factor.

The negative correlation of amphibians with water clarity that I found has many possible explanations among which this study cannot distinguish. Regardless of the cause, it is important to know that amphibians do not require crystal clear water, and that they often reside in cloudy water.

As tadpoles and larvae where negatively correlated with nitrate levels, I recommend monitoring and attempting to reduce these levels where possible. Nitrates seemed to have a negative effect starting at only 1ppm.

I did not find red-legged frogs or northwestern salamanders breeding in ponds that had a pH higher than 7.2. Increased fertilizer input into ponds can cause an elevated pH, and I therefore recommend maintaining a low level of fertilizer input.

I did not find a negative association between the presence of bullfrogs and the presence of any native species. This suggests that bullfrogs do not have a strong negative impact on natives. Also, I believe that bullfrog removal is not effective because if the habitat continues to be desirable for them, they will return.

Pond-breeding amphibians use very similar upland habitat as terrestrially-breeding amphibians, and therefore my terrestrial recommendations will also benefit pond-breeding amphibians.

Major Recommendations

1) Leave debris and downed woody material on-site
2) Maintain a low amount of open, grassy, upland habitat
3) Construct new ponds where possible
4) Make ponds a depth that dries in the summer after July (30-100cm)
5) Plant plants in the pond
6) Put refuge in the pond (sticks, branches, etc.)
7) Plant plants around the pond
8) Maintain low nitrate and fertilizer levels in ponds

Literature Sited

Baillie, J. E. M., C. Hilton-Taylor and S. N. Stuart. 2004. IUCN Red List of Threatened Species. A Global Species Assessment. IUCN Gland, Switzerland and Cambridge, UK.

Browne, D. R. and M. A. Bowers. 2004. Interpatch movements in spatially structured populations: a literature review. *Landscape Ecology* **19(1)**: 1-20.

Myers, N. and A. H. Knoll. 2001. The biotic crisis and the future of evolution. *Proceedings of the National Academy of Science* **98 (10)**: 5389-5392.

Pounds, J. A., M. R. Bustamante, L. A. Coloma, J. A. Consuegra, M. P. Fogden, P. M. Foster, E. La Marca, K. L. Masters, A. Merino-Viteri, R. Puschendorf, S. R. Ron, G. A. Sanchez-Azofeifa, C. J. Still and B. R. Young. 2006. Widespread amphibian extinctions from epidemic disease driven by global warming. *Nature* **439**: 161-167.

Retallick, R. W. R., H. McCallum and R. Speare. Endemic infetion of the amphibian chytrid fungus in a frog community post-decline. PLoS Biology 2(11): e351.

Smith, E.C. and T. Moran. 1930. The formation of lactic acid in desiccated amphibian muscles. *Proceedings of the Royal Society of London*. Series B, Containing Papers of a Biological Character **106(742)**: 122-131.

Stumpel, A. H. and H. Voet. 1998. Characterizing the suitability of new ponds for amphibians. *Amphibia-reptilia* **19(2)**: 125-142.

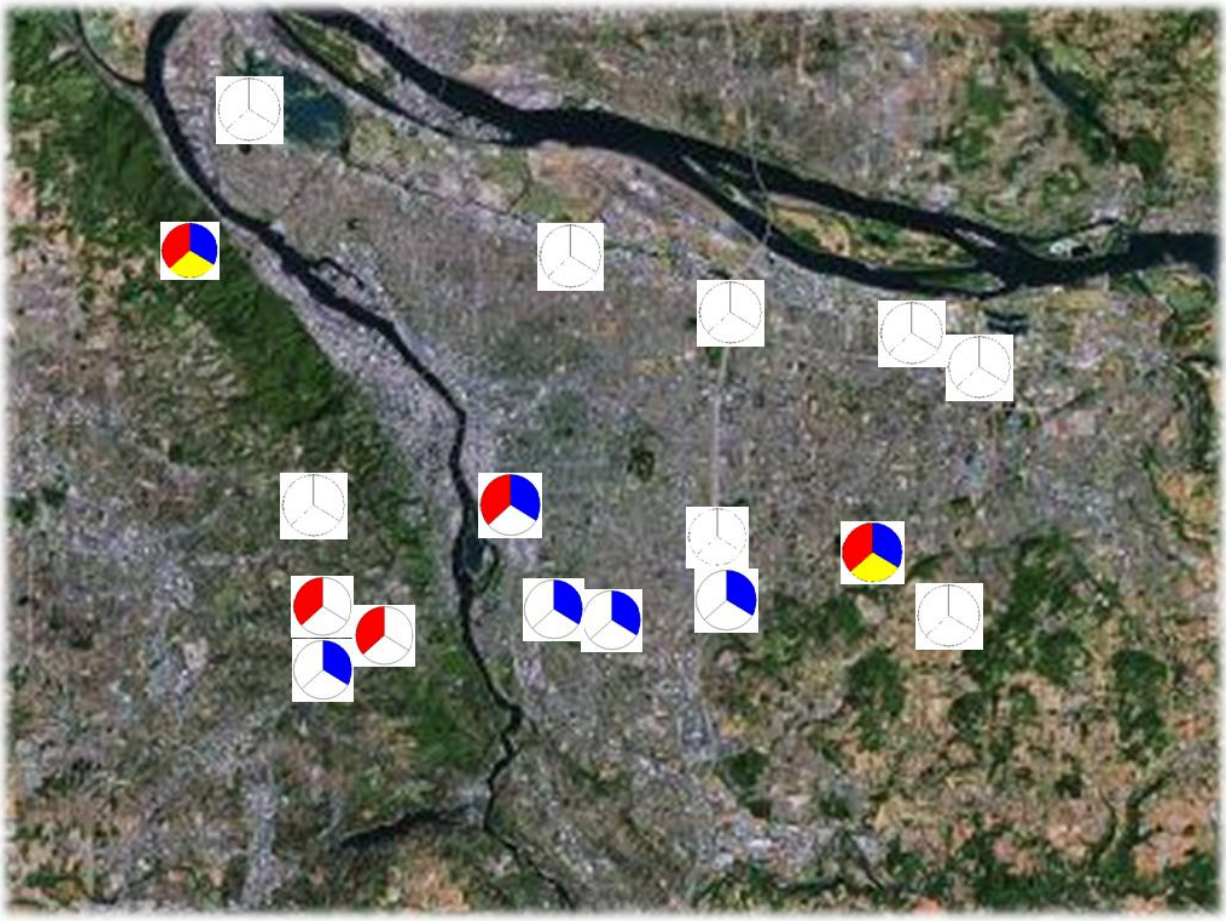

Figure 1 Map of Portland showing where I found each terrestrially-breeding salamander. Blue—Oregon salamander, red—red-backed salamander, yellow—Dunn's salamander.

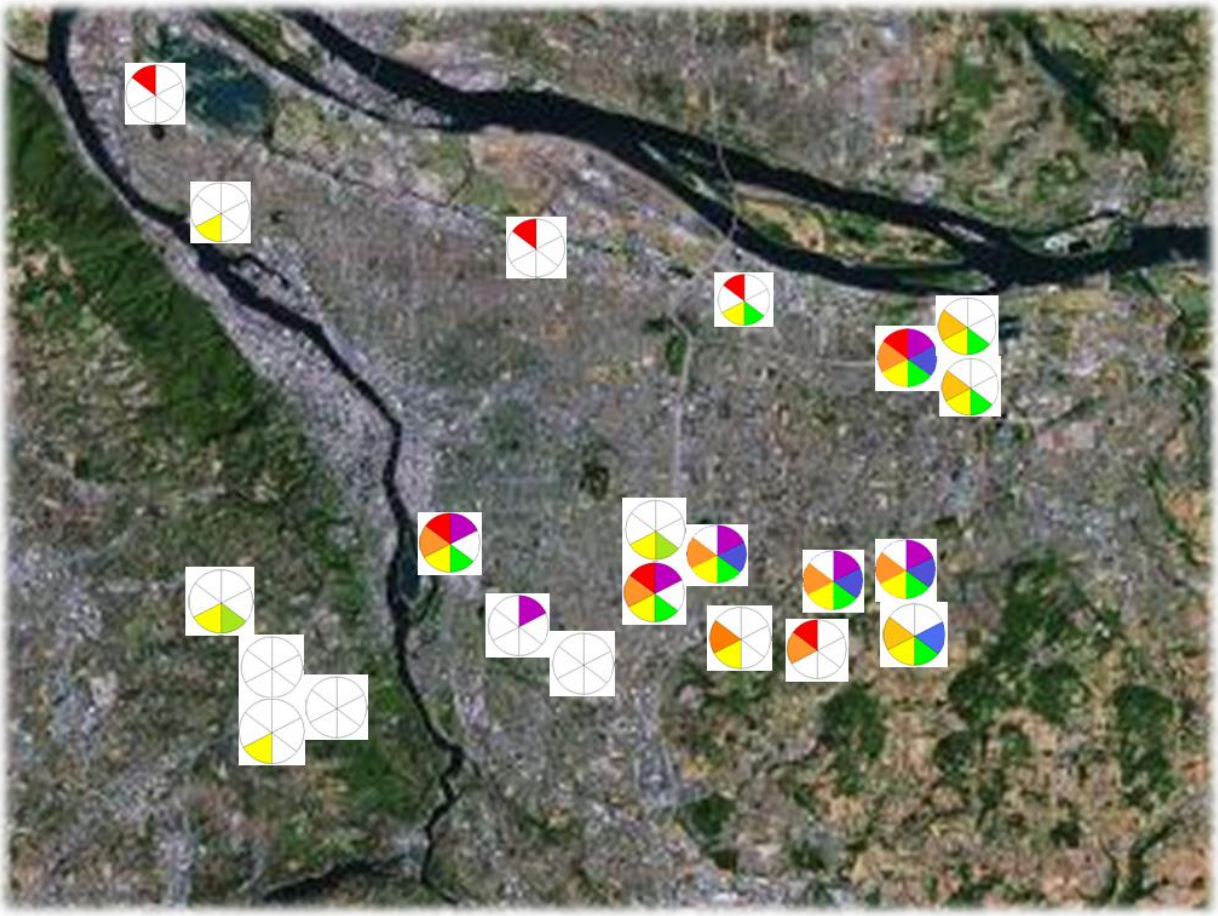

Figure 2 Map of Portland showing where I found each pond-breeding species. Red—bullfrog, orange—red-legged frog, yellow—chorus frog, green—long-toed salamander, blue—Northwestern salamander, purple—rough-skinned newt.