Stormwater Ponds as Surrogate Wetlands for Assessing Amphibians as Bioindicators

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ABSTRACT

Amphibians are utilized as bioindicators of wetland health. However, in many cases our information on amphibian biology and wetland ecology is inadequate to establish cause and effect relationships between human alterations of the landscape, wetland characteristics and amphibian usage, survival and health. Stormwater ponds may provide an unprecedented opportunity to study this linkage because these ponds can function as models for small, simple wetlands. Moreover, many wetlands in urbanizing environments are deliberately converted to stormwater ponds or are unintentionally functioning as such. Stormwater ponds are also relatively abundant, accessible and easy to study, and therefore may provide readily obtainable amphibian data from a large sample size of ponds over a short period of time. Consequently, the use and condition of amphibians in stormwater ponds can help detect both the causes and levels of risk to biological integrity at natural wetlands.

We surveyed 52 stormwater ponds in King County to determine the extent of use by amphibian species, whether mortality occurred prior to larvae metamorphosis due to pond drying, and if landscape and in-pond factors correlate with amphibian use. Preliminary results indicate that 96% of ponds were used for breeding by at least one of six species of amphibians: 3 salamanders (Northwestern salamander - Ambystoma gracile, long-toed salamander - A. macrodactylum, rough-skinned newt -Taricha granulosa) and three frogs (red-legged frog - Rana aurora, bullfrog - R. catesbeiana, Pacific treefrog - Hyla regilla).

The most widely distributed and most abundant in stormwater ponds is the Pacific treefrog. The introduced bullfrog is present in 52% of ponds surveyed, and does not appear to exclude native amphibians. In fact, abundance of all but the Pacific treefrog is apparently higher in ponds with bullfrogs. Rough-skinned newts were the least common of the six species observed. The Oregon spotted frog (Rana pretiosa) and Western toad (Bufo boreas) were not observed.

Preliminary analysis shows that long-toed salamanders, Pacific treefrogs and red-legged frogs are more abundant in ponds with a higher ratio of percent cover of thin-stemmed emergent vegetation to open water. They may be using such emergent cover for hiding from predators. Percent forest cover within 200 meters of ponds is positively correlated with abundance of Northwestern salamander and red-legged frog breeding ($p < .10$). Future work will examine the extent of egg stranding and correlations between multiple pond and landscape variables (including water level fluctuation) and species diversity and abundance.

INTRODUCTION

Why amphibians as bioindicators?

Advantageous Ecological Characteristics:

- **Wide geographic distributions**
- **Localized home ranges and limited mobility**
- **Integral organisms to many wetlands**

Advantageous Biological Characteristics:

- **Spend all or critical parts of their life in wetlands**
- **Thin permeable skin**
- **Unshelled eggs**
- **Long life span**

Advantageous Physiological Characteristics:

One or More Life Stages are Associated with Free Water or Wet Environments

- **Aquatic eggs and larvae may be particularly sensitive to habitat disturbance**
- **e.g., desiccation, pollution, ultraviolet B, pH**
- **Anthropogenic stressors appear as diseases and deformities**

Stormwater ponds

Stormwater ponds are important to amphibian communities in developing areas for several reasons:

- **required by King County & other local governments**
- **designed to capture stormwater runoff from impervious surfaces and reduce intensity and duration of floods in wetlands and streams**
- **prolific**
- **rapid water level fluctuation and other features may have beneficial or detrimental impacts on amphibians**

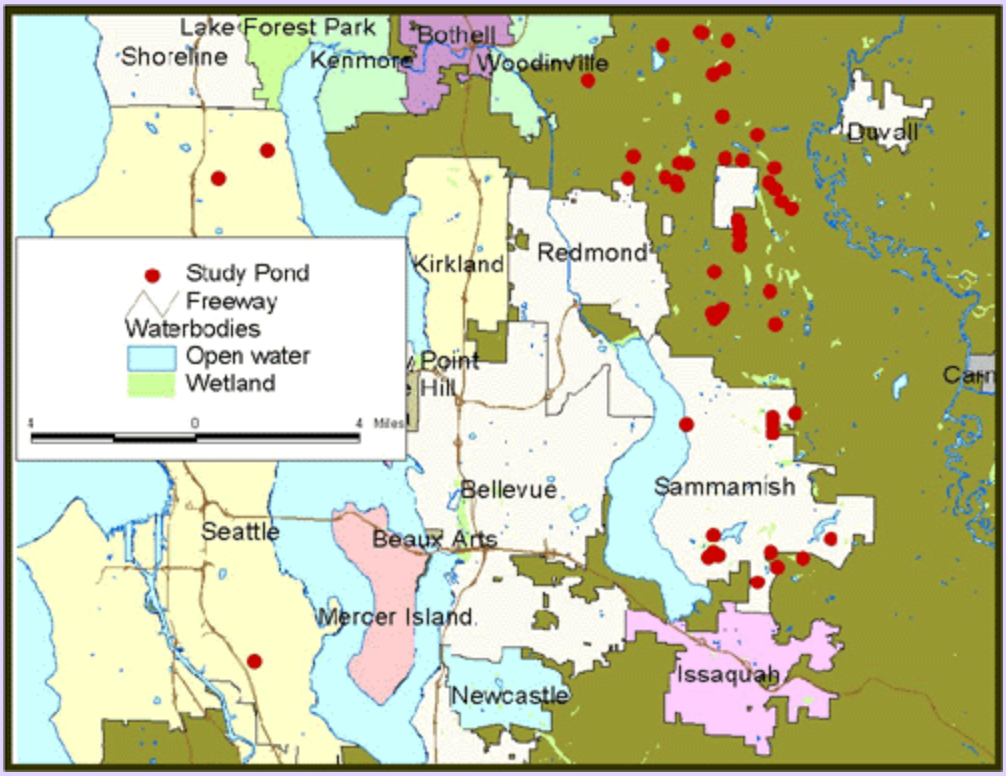
Do stormwater control ponds contribute to amphibian declines, or do they augment populations?

OBJECTIVES

- **Determine extent of stormwater pond usage**
- **Examine correlations between pond characteristics and amphibian diversity, abundance and survival**
- **Investigate relationships between landscape features and amphibian communities at stormwater ponds**
- **If stormwater ponds are found to contribute significantly to amphibian declines, provide recommendations for pond design and management**

METHODS

Study Sites
52 residential stormwater control ponds were surveyed: 49 in eastern King County, north and east of Lake Sammamish, and 3 in the Seattle city limits.



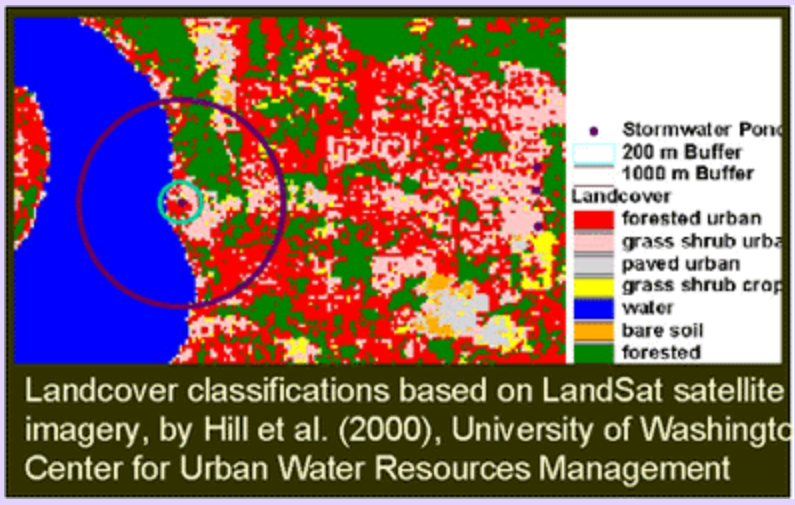
Determine Distribution and Abundance of Amphibians
- Egg census
- Aquatic larvae trapping
- Dipnetting
- Bullfrog count

Classify Stormwater Ponds
- Water permanence
- Pond age

- Max springtime water depth
- Percent cover of thin-stemmed emergent vegetation
- Percent open water
- 5 other variables

Characterize Adjoining Landscapes

- Percent forest cover and urban land within 200 m and 1000 m radius of each pond
- Distance to nearest forest & natural wetland
- Road type separating pond from forest/wetland

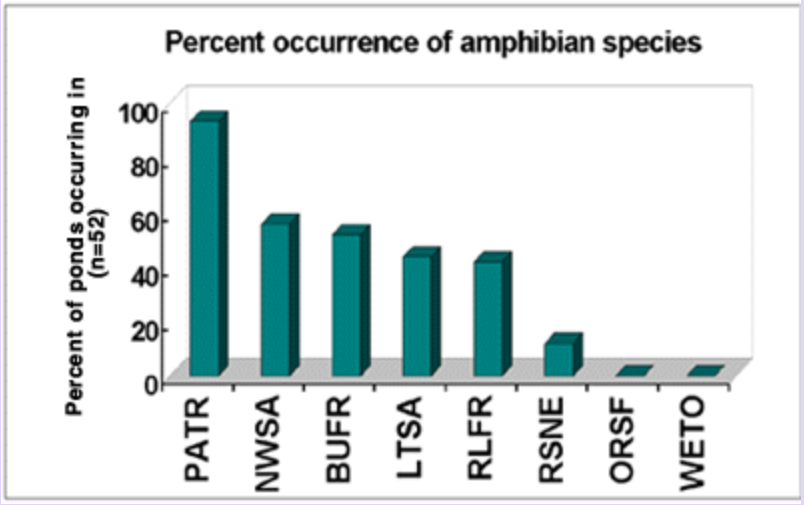


Landcover classifications based on LandSat satellite imagery, by Hill et al. (2000), University of Washingto Center for Urban Water Resources Management

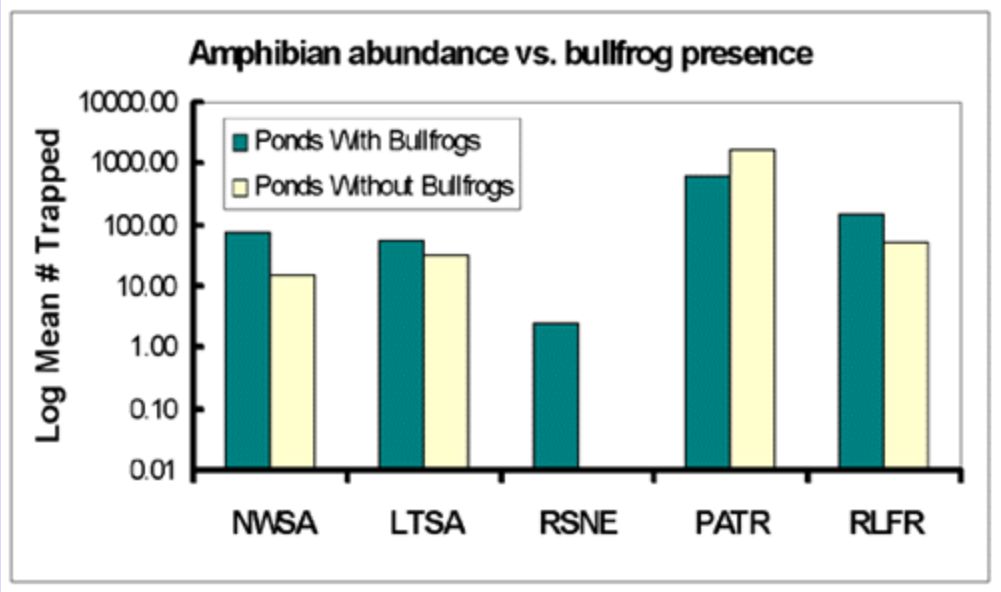
RESULTS

Preliminary results indicate that 6 amphibian species are found in the 52 residential stormwater ponds in this study:

Presented in order of percent of the 52 ponds each species occurs in, Pacific treefrogs are by far the most common. Bullfrogs are found in over half of the ponds, indicating that they are using stormwater ponds for dispersal. Red-legged frogs are present in just under half of the ponds, which is encouraging, given their low abundance in Oregon wetlands. The Oregon spotted frog and western toad are not observed in this study.

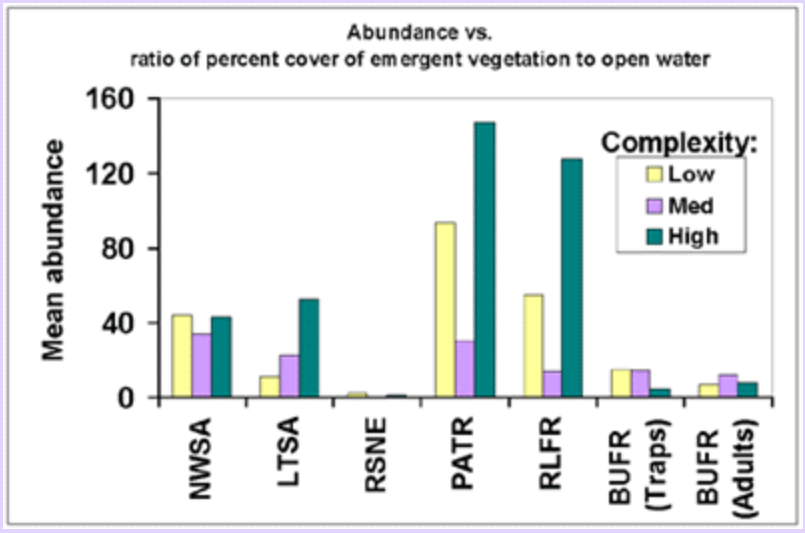


NATIVES COEXIST WITH BULLFROGS
Bullfrogs, introduced predators of native amphibians, are often blamed for amphibian declines, and red-legged frogs very seldom co-occur with bullfrogs in ponds in Oregon and California. In our study, most native species are slightly more abundant in ponds WITH bullfrogs, with the exception of the Pacific treefrog.



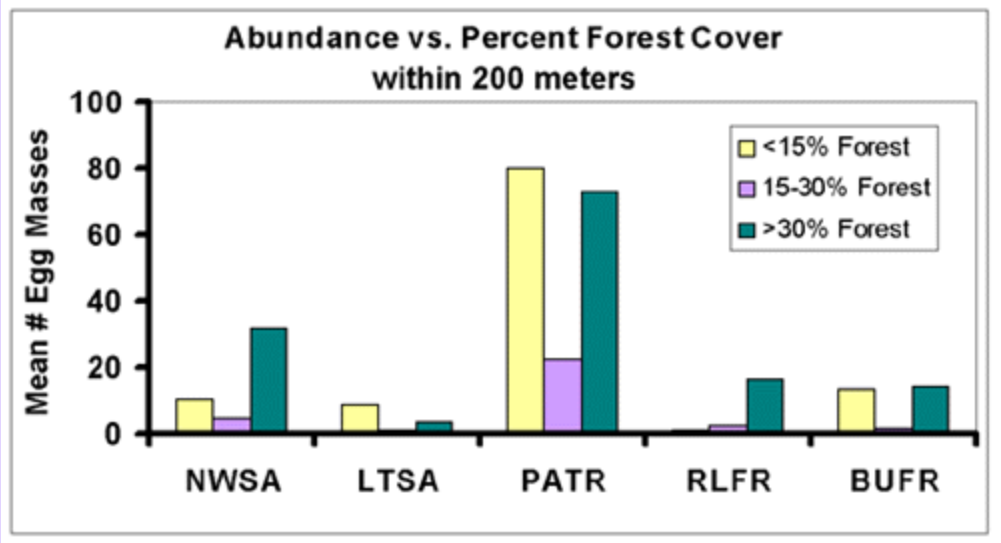
IN-POND HABITAT COMPLEXITY

A preliminary look at mean abundance vs. an index of in-pond habitat complexity: species that are more likely to be eaten by other amphibians (LTSA, PATR and RLFR) are more abundant when there is more emergent vegetation. The emergent vegetation may provide both food and cover.



FOREST COVER

A simple linear regression of percent forest cover within 200 meters of each pond compared to egg abundance indicates that Northwestern salamanders and red-legged frogs are significantly more abundant when forest cover is greater (p<.10).



CONCLUSIONS

Amphibians use stormwater ponds widely, so studies of these ponds show promise in helping to detect both the causes and levels of risk to biological integrity at natural wetlands. Preliminary analysis indicates that community composition appears to be dependent on a number of factors, including (but not limited to) percent cover of emergent vegetation, degree of forest cover in surrounding landscape, and other factors. Larvae abundance does not appear to be limited by the presence of bullfrogs.

FUTURE WORK

- **Water level fluctuation measurement through May 2001**
- **Multivariate analysis, search for correlations and threshold values for abundance vs. predators, landscape measurements, & pond variables**

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