City of Portland

Pond-breeding Amphibian Long-term Monitoring Project

~ Findings and Recommendations From the 2010 Field Season ~

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INTRODUCTION

It is a widely known fact that amphibian populations are declining and becoming extinct across the globe. Factors such as habitat fragmentation, introduced species, global climate change, disease outbreaks, and pesticide contamination are contributing to a forty-three percent decline in amphibian populations worldwide (Stuart *et al* 2004). Amphibians have moist, permeable skin that can rapidly absorb toxic substances in the environment and because of this they can be considered excellent indicators of environmental health (Marks 2006). Habitat requirements for many species of amphibians include a variety of both wetland and forested areas. For populations to be successful, these habitats must be both individually suitable for amphibians and connected to each other (Bowne & Bowers 2004).

Here in the Pacific Northwest urban sprawl and development are increasing at an alarming rate and natural habitats and fragile wetland areas are disappearing. In the Willamette Valley alone, 40-87% of original wetland areas have been lost to urbanization, agriculture, silviculture, and flood-control projects (Gabriel 1993, Oregon Biodiversity Project 1998). Therefore, it is imperative that we strive to get a more complete understanding of the effects of development on amphibians populations so that better management decisions can be implemented in an effort to prevent further displacement of species from their native ranges (Paton and Egan 2001; Mitchell and Brown 2008).

In the city of Portland, however, environmental awareness, stewardship, and conservation appear to be on the rise. In an effort to learn more about our natural areas and their role in amphibian conservation, the City of Portland, Parks and Recreation (PP&R) and Bureau of Environmental Services (BES), allocated funding for an amphibian monitoring project in the spring of 2008. In this initial assessment of amphibian occurrence in the city of Portland, nine species were found to be breeding in aquatic or terrestrial habitats (Holzer 2009). Of these nine breeding species, six were documented in ponds and wetlands in a variety of habitats throughout the city during the 2008 & 2009 breeding seasons.

In the 2010 breeding season, the amphibian monitoring project continued with the following goals:

1. To collect a 3rd year of consecutive abundance/density data on pond-breeding amphibian populations at selected sites in the city of Portland

2. To determine environmental and chemical factors influencing amphibian presence and to make recommendations for specific sites accordingly

3. To design and implement amphibian monitoring training sessions for both city of Portland employees and volunteer citizen scientists

The focus of this report is to summarize the findings of the 2010 field season for pond-breeding amphibians and to introduce long-term ecological monitoring goals for the amphibian monitoring project in the city of Portland.

METHODS

Sampling sites

A total of sixty-four sites within five watersheds were surveyed in Portland, Oregon, from January 2010 through June 2010. These sites were selected for monitoring in the 2010 field season by a committee of BES and PP& R ecologists based on the needs and interests of individual watershed teams. In Table 1 (below), sites are organized by watershed and listed in order of their priority for monitoring. Almost every site was visited twice during the winter (egg mass) season and three times during the spring (tadpole/larvae) season. Detailed descriptions of individual sites and survey findings can be found in the "discussions" section of this report.

Table 1. 2010 Study Sites organized by watershed and priority needs for monitoring.
(Numbers in parenthesis denote number of pond/wetland sites that were surveyed within each area.)

	Columbia Slough	**Johnson Creek**
Priorities for Monitoring	Four Corners Complex: Winmar & Mason Flats (5) Alice Springs (2)	Circle Ave Sites (2)
		Pumpelly Pond (1)
		Powell Butte stock pond (1)
	Whitaker Ponds (4)	Zenger Farms (3)
	Schlessinger/Zen (2) 138th stormwater facility	Leach Botanical Gardens (1)
		Brookside Ponds (7)
Priorities for Site Visits	Swales in Big 4 North: Bernard's Pond (1) WMS Pond (2)	Brownwood/Schweitzer (8)
		Alsop Wetland (1)
		Hillside Properties (1)
	Johnson Lake (1)	Powell Butte (2)
	Blue Heron Wetland (1)	Errol Heights (3)
		Crystal Springs (1)
		Tideman-Johnson (2)
		Kelly Creek (3)
		Beggar's Tick Marsh (1)
	Mainstem Willammette	**Tryon & Fanno Creek**
Priotities for Monitoring	Oaks Bottom Wildlife Refuge (4)	April Hill (1)
	Sellwood Riverfront Park (1)	
	Water pollution C.Lab Test Swale (1)	
	Audubon Society Pond (1)	
Priorities for Site Visits	None	Tryon Creek Headwaters (3)
		Maricara Park (1)

Species

The Pacific Northwest provides aquatic breeding grounds for over twenty species of native frogs, toads, and salamanders (Corkran 2006). In the Portland area, six species of pond-breeding amphibians occur; five are native to the northwest and one, the American Bullfrog (*Lithobates catesbeianus)* is a non-native, introduced species from the eastern United States that arrived in the 1920s or 1930s to meet the demands of the restaurant industry with their big, meaty legs (Corkran 2006). In this study, four of the native pond-breeding species will be targeted for occurrence during field surveys (Table 2).

Table 2: Pond-breeding amphibians in Portland, OR.

Common Name	Latin name	Species Code
Pacific Treefrog*	*Pseudacris regilla*	PSRE
Red-legged Frog*	*Rana aurora*	RAAU
Long-toed Salamander*	*Ambystoma macrodactylum*	AMMA
Northwestern Salamander*	*Ambystoma gracile*	AMGR
Rough-skinned Newt	*Taricha granulose*	TAGR
American Bullfrog**	*Lithobates catesbeianus*	LICA

* Four target native species in 2010 study, ** Non-native species

Rough-skinned Newt (*Taricha granulosa)* is omitted from the list this season due to the difficulty in both finding egg masses and in identifying species at the larval stage. However, when observed in the field (whether in egg mass form or adult), *T. granulosa* was recorded and is noted in the site discussions section of this report. Additionally, American Bullfrog (*Lithobates catesbeianus)* was included in the data set when observed in the field, typically in adult form, due to their indistinct and late breeding season.

Egg mass surveys

The survey protocol used in this study (in both the 2009 & 2010 breeding seasons) was originally adapted from the Metro Regional Parks and Greenspaces, "Amphibian Egg Mass Monitoring Protocol", in which visual encounter surveys are conducted in a *time-constrained* matter (Metro 2006). Time-constrained surveys assess relative amphibian abundance by catch per person-hour of sampling, where times recorded are search and capture times and do not include time spent recording and identifying species (Thoms *et al* 1997). For sampling sites in the 2010 field season

that were too large to be completely surveyed in one visit (complex wetland sites), time constrained surveys were used.

An additional method of sampling, called an *area-constrained survey*, calculates relative amphibian abundance by determining number of egg masses surveyed per square meter sampled. Area-constrained surveys were the preferred method for 2010 sampling sites for which the entire area of the site could be surveyed and dimensions of the habitat easily obtained.

Both time-constrained and area-constrained surveys are recommended subsampling monitoring methods in lentic habitats that can be repeated over time at a site to assess changes in species presence or relative abundance (Thoms *et al* 1997). During the 2010 breeding season, from late January through late March, sites were surveyed for egg masses using whichever method of surveying was most appropriate for each site, depending on site characteristics, sampling resources, and number of surveyors.

For each egg mass survey, the surveyor starts at one end of the pond and walks along a transect and scans visually an area approx 1m wide until the other end of the site is reached. The direction is then reversed as the surveyor walks another transect, parallel to the last and approximately 1m apart. This method is continued until the chosen area of the site has been completely surveyed. For sites with no established perimeter, such as wetland areas with forested corridors, a portion of the area was marked off to create a visually recognizable perimeter, and the new site dimensions were recorded.

Upon spotting an egg mass the surveyor stops and records: species, approximate number of eggs, developmental stage of the eggs, and type of attachment vegetation. In sites where egg masses were in high density, the number of eggs in each mass was omitted and tallies of egg masses were recorded instead. Approximate percentage of site surveyed and total survey time were also recorded. An example datasheet used during the 2010 egg mass season is included in Appendix 2.

Tadpole/larvae surveys

During the spring season, from March to late June 2010, the perimeter of each pond was surveyed for tadpoles and salamander larvae. For this method, the surveyor stands in the pond, approximately 1m from the edge, and dips a net into the pond (about one arm's length) pulling the net towards the shore (from deep to shallow) every three steps of the perimeter. Individual numbers of species from each scoop were recorded. Additional information was gathered on snout-to-vent lengths (SVL), for approximately ten individuals at each site to determine the range of developmental

stages per species. Appendix 3 contains examples of two datasheets used during the 2010 tadpole/larvae season.

In an on-going effort to refine study results, new methodology was considered and tested in the field during the spring season. For one week in June 2010, a different type of dip-net survey was introduced as an alternative and potentially superior method for spring surveys in this study. The dip-net survey, instead of being isolated to the perimeter of the pond, is dispersed throughout the site. The site is divided into ten sections, and for each chosen dip-net location, the surveyor submerges the net under water and walks for ten seconds while scooping with momentum. Catch species and numbers are recorded.

In addition, during the spring and summer field season, all larval salamanders were recorded as "Caudata", (the order of salamanders) to prevent misidentification of species. As both of the target salamander species in this study share the same genus, their identification at larval stage is challenging in the field.

Sampling of site conditions

In addition to the egg mass and tadpole/larvae surveys, a variety of supplemental data was collected regarding water quality and site characteristic at each site. Tables 3-4 summarize the methods used for each of these procedures during the 2010 field season.

Table 3. Sampling factors collected for water quality analysis and methods used.

Water Quality Data	Method
water temperature	Measurement (° C) was taken 12" below surface when possible.
dissolved oxygen	CHEMets ® vacuoles were snapped into water sample and recorded as "ppm" after waiting ten minutes for accurate reading.
pH	Measurement was recorded using pHydrion ® "Brilliant Dip Stik 0-13", 0-6, and 6.5-13 and averages of all three were recorded.
nitrates & nitrites	"5 in 1" Test Strips from Eco-Check™ were dipped into water sample and measurement was recorded after 60 seconds.
subsurface visibility	Clarity of pond was recorded as poor (visibility less than 1ft down), fair (less than 2ft down), or excellent (greater than 2ft down).

Table 4. Pond characteristics and other site factors collected and methods used for each.

Pond Characteristics	Method
Depth	Measurement was recorded at deepest point of site (cm).
Area of site	Dimensions of site estimated at Ordinary High Water Mark.
surrounding vegetative cover	An area of 10m surrounding the pond was surveyed and classified on a scale of 1-5, with "1" indicating exposed ground at height of 1m or below (0-20% cover) and "5" indicating complete ground cover at height of 1m or below (80-100% cover).
surrounding cover objects	This is a measurement of protective cover objects (such as rocks and logs) around the edge and within a 10m buffer around the site. A "1" was scored for 0-2 cover objects, a "2" for 3-4 objects, a "3" for 4-5 objects, a "4" for 6-7 objects, and "5" for 8 or more objects.
% aquatic vegetation	Pond was visually divided into 25 segments and estimates of aquatic vegetation dominating each segment were recorded (spring season).
% perimeter vegetation	This was calculated by recording the % of vegetation around the edge and within a 1m buffer around the site.
% refugia	This is a measurement of how much of the site (above & below the water) is covered by objects like sticks, logs, rocks, and vegetation.
% shading from above	An ocular estimate was made of percent of shade provided from above by trees, shrubs, herbaceous plants, or other.
% shading from surface	An ocular estimate was made of the percent of shading provided from floating vegetation on the water surface.
Other site factors	*seasonal or permanent, man-made or natural, distance to forest, distance to running water, distance to another pond*

Trainings

One of the goals of the amphibian long-term monitoring project is to promote outreach and education. In an effort to involve concerned citizens and city of Portland employees in the amphibian monitoring project, two trainings were held this year in February of 2010. Employees of both BES and PP&R received an in-class training session on survey protocol and amphibian identification methods for both pond and terrestrially breeding species. Interested parties then

had the opportunity to attend a field-based training session to further their amphibian identification skills and to help assist with the 2010 monitoring efforts.

A formal information session on the amphibian monitoring program was also organized for approximately fifteen volunteers with PP&R. Each of these volunteers also had the opportunity to attend a follow-up field training. Depending on availability and level of training, some volunteers assisted with surveys throughout the egg mass season at specific sites.

RESULTS

Target species presence

Results for the 2010 sampling season indicate the presence of all four target species in varying abundances and densities over the Portland area. Out of 54 sites surveyed during egg mass season, Pacific Treefrog egg masses were found at 32 sites (59%), Long-toed Salamander and Red-legged Frog egg masses were found at 26 sites (48%) and 23 sites (43%) respectively, and Northwestern Salamander egg masses were found at 12 sites (22%). Ten of the remaining sites in this study were either reported as "dry" (insufficient amount of water for breeding purposes) or received only a tadpole/larvae survey in 2010. Table 5 lists the presence of species for each watershed in the 2010 breeding season and Figure 1 shows the location of these species within each watershed of Portland.

In terms of species richness, 4 sites (7%) contained all four native species breeding together and 16 sites (30%) contained three native species breeding together (typically Pacific Treefrog, Red-legged Frog, and Long-toed Salamander). Ten sites (19%) had only two native species and six sites (11%) had only one native species. Sites with two or fewer species, had an unspecific assemblage of native species. Two sites in this study, for example, contained solely Northwestern Salamander..

Species densities also varied across watersheds and can be seen in Figure 2. The top ten sites for Pacific Treefrog egg mass & tadpole densities occurred throughout the Johnson Creek Watershed and in one site in the Mainstem Willamette Watershed. High densities of Red-legged Frogs were consistently found within the Johnson Creek Watershed, with over 80% of the top ten densest locations represented by both east and west Johnson Creek sites. Based on the egg mass season alone, Long-toed Salamander densities were scattered across sites within four separate watershed and Northwestern Salamander densities occurred in the Columbia Slough Watershed (40% of top ten densest sites) and in the Johnson Creek Watershed (60% of top ten densest sites).

Non target species

Rough-skinned Newt was identified at two sites: April Hill, Fanno Creek watershed (in egg mass form) and Audubon Society Pond, Willamette Watershed (in adult form). Known locations of this species in other sites, based on the 2009 findings, are included in the species presence map in Figure 1. American Bullfrog were visually observed (in adult or tadpole form) at 12 of the 17 sites (71%) surveyed in the Columbia Slough watershed, 2 of the 32 sites (6%) surveyed in the Johnson Creek Watershed, and in one site surveyed in the Mainstem Willamette Watershed.

Introduced Methodology

At 26 sites in June 2010, two different tadpole/larvae survey techniques were compared: sampling of the perimeter of the site vs. sampling with the area of the site with introduced dip-netting methodology. The perimeter sampling method, as was used in 2008 & 2009, was found to produce a higher number of organisms caught per scoop. This was true for 75% of Pacific Treefrog catches, 82% of Red-legged Frog catches, and 65% of salamander (Caudata spp.) catches.

Influential factors and comparison of years (2008-2010)

To compare influential factors across the years (2 egg mass seasons & 3 tadpole/larvae seasons), a multiple linear regression analysis was performed by Katie Holzer (former Amphibian Researcher with PP&R) using the statistical program, SPSS. The results of these analyses are illustrated in Figures 7- 11, and are summarized in Table 5 (below) and are further explained in Appendix 5. In comparing amphibian densities across seasons (Figure 12), Pacific Treefrog egg mass densities in 2009 were found to be a good predictor of tadpole densities in 2009 but not of the 2010 egg mass densities.

Table 5. Summary of findings in 2010 based on multiple linear regression analyses (preformed by K. Holzer).

Factor	Significance
Natural vs. man-made	Native species did not prefer natural ponds over man-made ones
pH	Relationship between lower pH of sites and RAAU density
Bullfrog presence	No effect on native amphibian densities
Pond clarity	No effect on amphibian densities
% refugia	Positive correlation of PSRE density in ponds with higher % refugia

DISCUSSION

Species presence

Based on the sampling results from the 2010 pond-breeding amphibian season, Pacific Treefrogs were found to be the most common native species in Portland, OR. Long-toed Salamanders were found as frequently as Red-legged Frogs, and Northwestern Salamanders were found to be the least abundant. These results are largely consistent with findings in 2009, with the exception that Long-toed Salamanders were found in fewer sites and in lower densities during 2010. One possible explanation for these declines is that Long-toed Salamanders are the earliest of pond-breeding species, laying eggs as early as December. This year was a particularly early breeding year for all native species and because sampling did not begin until late January, it is possible that a large number of egg masses were missed during mid-winter egg-mass surveys. Furthermore, Long-toed Salamander egg masses can be mistakenly identified as Pacific Treefrog by the untrained eye. Because a number of new surveyors were trained this year, it is possible that this confusion occurred. To collect the most accurate data on species richness, it is recommended that surveys begin earlier in the 2011 field season, when Long-toed Salamanders first begin to enter the ponds (which may also prevent misidentification of later-breeding Pacific Treefrogs).

Both Pacific Treefrogs and Long-toed Salamanders have a large range of habitat preferences, which is one possible reason for their relative abundance compared to other amphibians in the city. Both of these species are relatively tolerant to habitat disturbances and alterations, although this does not imply they can be found in highly developed areas (Leonard et al., 1993). Red-legged Frogs and Northwestern Salamanders, however, have more constrained habitat requirements. They are more sensitive to habitat changes, especially when neighboring upland habitat is destroyed or disconnected from sites in which they breed (Nussbaum et al., 1983, Oregon Conservation Strategy, 2006.)

Despite the fact that Red-legged Frogs have declined by nearly 70% in the Willamette Valley (Kiesecker *et al* 2001), this species has been found for the third consecutive year in specific sites in the Portland area. When looking at an enlarged map of each watershed, it is obvious that Red-legged Frogs are breeding (or attempting to breed) in sites that share a significant amount of upland habitat. When moving to and from breeding grounds, adult frogs can migrate from 300m to 1km, and occasionally up to 5km (Hayes 2008). During these migrations, Red-legged Frogs typically move through forested upland habitat, and their preferred upland habitat vegetation has been documented to

be Sword Fern (Hayes 2008). Therefore, it is not surprising that in this study, Red-legged frogs were found in highest densities in sites with neighboring forest habitat, specifically in the Johnson Creek Watershed (Figure 4 & Figure 5). In both the egg mass season & tadpole season, the top eight densest sites for Red-legged frogs were found amongst the sites represented in both the east and west site locations of the watershed (Figure 2). The inclusion this year of sites within the "Brownwood-Schweitzer" complex & the Alsop wetland area, southeast of Powell Butte, further supports this assessment, in so far as they share connected habitat and Red-legged Frog presence.

Although low numbers of Northwestern salamanders were recorded in both the 2009 and 2010 breeding seasons, this species appears to have found a niche at certain sites in the Columbia Slough Watershed. Over half of the documented egg masses of Northwestern salamanders in the city (54%) were found in the "Four Corners" wetland complex in the northeastern region of the city (Figure 3). Sites here are very deep and dominated by tall wetland grass-like plants such as Reed Canarygrass (*Phalaris arundinacacea)* and rushes (*Juncus* spp.). Two sites in the Johnson Creek watershed, Zenger Farms wetland and the neighboring "Triangle" site (north of the springwater trail), also contained high densities of Northwestern salamanders. It is interesting to note that each of these sites had a similar habitat composition to that of the Columbia Slough sites (though *P. arundinacacea* was more prevalent than *Juncus* spp.). Although an invasive species, *P. arundinacacea* is a commonly chosen species for Northwestern salamander egg mass attachment (as documented in the 2009 and 2010 study), and removing this plant from the ecosystem (without providing replacement vegetation of similar structure) may prove detrimental to established populations of Northwestern salamanders.

Based on these observations, it is recommended that Red-legged frogs and Northwestern salamanders be continuously monitored in the city of Portland. In areas of known species presence, improving habitat connectivity and establishing wildlife corridors may greatly improve populations and increase breeding capabilities of both species. In addition, collecting vegetation data on additional attributes at each site could be used to conduct simple analyses in an attempt to link Red-legged Frogs (and Northwestern Salamanders) to specific habitat requirements. This project is already being undertaken in the city of Gresham (Guderyahn, 2010) and by GIS specialists hoping to show these relationships using various mapping programs with the National Wetland Index (Faber-Hammond, 2010).

Influential factors

The analyses summarized in Table 4 were conducted by Katie Holzer and are explanations of possible correlations over the course of the study. To determine potential trends, further study is necessary. It is worth nothing, however, that the multiple linear regression analysis found very few trends throughout the seasons for a single species.

Of the analyses conducted, one trend that appears to be particularly obvious is the apparent preference of non-natural, man-made sites by native species in Portland. One possible explanation for the occurrence of higher densities of pond-breeding amphibians in man-made ponds over natural sites is that most pond-breeding amphibians in Portland (perhaps with the exception of Northwestern salamanders) breed successfully in smaller, more densely vegetated ponds rather than larger, more permanent, less densely vegetated ponds. As people settled in Portland over the past 150 years, small, temporary ponds were drained and filled to create houses and arable farmland. Of the remaining natural ponds, most are large, permanent bodies of water that have little vegetation cover and consequently are not ideal breeding habitats for most of our native amphibians. More recently constructed man-made ponds, however, are typically small and vegetated (such as stormwater ponds, golf course ponds, and backyard ponds) and are potentially more suitable for native amphibians.

Another interesting finding in this study is the possible trend between Red-legged frog presence and sites with lower pH values. Although this trend could be explained by acidity in upland habitat soils dominated by conifers (sheltering adult Red-legged Frogs), it is possible that the actual pH numbers in this study may be inaccurate. During the 2009 field season, pH was determined and recorded in the field by a single researcher. This year, however, a variety of volunteers took water quality data at a handful of sites, some of which contained Red-legged frogs. Regardless of this potential error, if a real pattern exists between pH and Red-legged frogs, additional water quality data needs to be collected from successive survey years to clearly establish this relationship.

Despite possible conjecture, neither water clarity levels in ponds nor bullfrog presence were found to be good predictors of native amphibian abundance or density. The majority of Bullfrogs in the Portland area have established themselves in sites that have been severely altered or disturbed by humans. Because of the favorable habitat conditions at these sites (and most likely highly unfavorable to natives), bullfrogs have become a “problem” due to their highly successful breeding. There is, however, no scientific evidence to suggest that bullfrogs displace native species, such as Northern Red-legged frogs, in habitats that are structurally complex (Hayes and Jennings 2005, Pearl et al. 2005, Curry 2007).

Perhaps in such sites, where Red-legged frogs are coexisting with Bullfrogs, increasing the structural complexity of the pond would improve Red-legged frog populations. A complex vegetative structure, with at least a 50:50 ratio of open water to vegetation, provides refuge, food, calling locations, and oviposition braces for egg-mass attachment for Red-legged frogs (Curry, 2008).

When analyzing correlations of amphibian densities across multiple seasons, it is worth noting that populations of all species, especially frogs, can vary wildly from one year to the next. A high number of egg masses in one season is not necessarily indicative of a high population of that species in that location, year to year. For example, Red-legged Frogs were found in very high densities throughout the Johnson Creek Watershed this year, specifically in the seven constructed ponds at Brookside. Long-term monitoring of these sites (and all sites in the neighboring areas) will afford a better understanding of population numbers.

Methodology

For the past three spring seasons, "perimeter surveys" have been used to show densities of species at each site and to inform the researcher of survivorship from egg mass to tadpole/larvae stage and finally to metamorphosis. The inclusion this year of the dip-net sampling method was a valuable alternative to a perimeter search in sites with no established perimeter (Alsop Wetland and April Hill). These surveys also produced presence of species that were not found during the perimeter sampling (for example, Red-legged frog at Zenger Farms).

Both methods of tadpole/larvae surveying, however, produce a wide range of results. Not only are tadpoles & larvae easily flushed by the surveyor's presence (whether on the perimeter or in the center), but they preferentially congregate in warmer areas of the pond. This can be in shallow water with emergent vegetation or in deep areas at the bottom of a site where water temperatures are warmer than the surface (Thoms, *et al* 1997). During the field season, Red-legged Frog tadpoles were observed hanging out in deeper water, and it is therefore possible that perimeter sampling will likely underestimate their actual numbers.

Regardless of chosen survey technique, spring visits to ponds can be used to determine approximate times of year when each species is undergoing metamorphosis, and based on the hydro-period, be used to determine the viability of each breeding site.

Future recommendations and monitoring goals

Over the last two and a half years, the city of Portland pond-breeding amphibian monitoring project has addressed species presence and abundance at selected sites in five watersheds. This study has documented *what* is breeding here, and *where*, while determining possible environmental factors that may be influencing amphibian populations. In successive years of this study, future goals could attempt to address *why* certain species assemblages occur at known amphibian breeding sites. For example, asking questions such as: How are diseases and other environmental factors, such as "Chyrid" fungus (*Batrachochytrium dendrobatidis*) affecting amphibian populations? Are Bullfrogs contributing to native species declines? Which sites warrant further investigation to address these questions while prioritizing monitoring efforts?

To address both the issue of *B. dendrobatidis* and Bullfrogs in the ecosystem, areas that should be targeted for priority monitoring include sites that are unique, with high diversity of native species in dry *and* permanent water bodies AND sites that occur with *and* without Bullfrogs. For example, permanent water sites in the Columbia slough with all 4 or 5 native pond-breeding amphibians *and* Bullfrogs include Winmar Flats & WMS Ponds. Seasonal sites in the Johnson Creek Watershed where all 4 or 5 natives are thriving *without* Bullfrogs include Pumpully's Pond and Powell Butte stock pond. Long-term monitoring of these sites could attempt to address changes in native species densities across sites and determine prevalence of *B. dendrobatidis* in sites that do or do not dry up.

Because of their sensitivity to pollutants and disturbances, pond-breeding amphibian species are good indicators of ecosystem health and should therefore be continuously monitored. In terms of prioritizing areas of future monitoring, Red-legged frogs could serve as an umbrella species for other amphibians by becoming the focus of management efforts to increase habitat protection (Curry 2008). In addition to protecting habitat, the city of Portland could focus on creating habitat corridors and constructing more ponds in documented red-legged frog habitats within each watershed. Perhaps incentives could be introduced to private property owners that border Red-legged Frog habitat. The "Pumpully Pond", in the Circle Avenue area, is an example of a structurally complex site that could be used as an excellent model for attracting pond-breeding species in high abundances both on private and public landscapes.

Involvement of the public could become the necessary link to improving the future of amphibian species. For example, volunteer based citizen scientist programs could be implemented to conduct long-term ecological monitoring studies of pond-breeding amphibians in Portland. Other

jurisdictions in the region have already begun these types of programs (Clark Co., Gresham, Metro), some having been in existence for over five years. Amphibian data sets could be shared regionally, with an established methodology and a minimum criteria of baseline data. Creating this kind of network of amphibian monitoring programs would increase public awareness and better inform the city of the status of amphibian populations, thus improving the health of our shared ecosystems natural resources as a whole.

Recommended future monitoring goals include:

1. Determining areas of connected habitat between amphibian breeding grounds, and monitoring Red-legged Frog populations in adjacent sites.

2. Continued monitoring of specific factors and their effects on amphibian densities, such as weather, depth of pond, and pH.

3. Establishing a protocol for amphibian surveys in pre and post construction sites.

4. Developing a Citizen Science Amphibian Monitoring Program with established methodology (from 2010 field season).

INDIVIDUAL SITE COMMENTS & RECOMMENDATIONS

The following sites are listed exactly as they appeared on the "2010 Pond-breeding Amphibian Monitoring Priority List" created on 12/10/2009 by Claire Puchy, BES. For a chart of specific recommendations for each site, see Appendix 5.

Columbia Slough Watershed

Winmar Flats

This site was divided into four quadrants (NW, NE, SW, SE) to better record species findings in the large wetland area (although all of these sites are connected during periods of high water and/or via beaver channels). The "Big 4" wetland complex, and the entirety of the slough, has very low to zero populations of Pacific Treefrog and Long-toed Salamander (two common species) in every quadrant/pond surveyed. The moderate density of Red-legged Frog egg masses recorded were found only in the northwest pond, and the highest density of Northwestern Salamander in the entire city was found only in the south ponds: a record 44 egg masses were recorded in a single day.

The high density of Bullfrogs breeding here (mainly observed in the north ponds) are an unknown factor on native amphibians. Site characteristics in certain sections of Winmar Flats, such as a thick, quick-sand like pond floor, make for difficult surveys of tadpoles & salamander larvae and very low numbers of each species were recorded.

The preferred attachment vegetation for Red-legged Frog in the northwest pond was *Juncus spp.*, and for Northwestern Salamander in the south ponds it was an even mix of both *Juncus spp*. and Reed Canarygrass (*Phalaris arundinacea).* During future surveys of the wetland complex, it is recommended that data continues to be recorded for each quadrant separately.

Mason Flats

The north & south channels surrounding this area were incredibly difficult to survey for egg masses (one Pacific Treefrog egg mass was found) due to the sink-hole like substrate and tadpole/larvae surveys were not attempted in the channels. This difficult terrain is also found throughout the "Bart's Hollow" area, where a tadpole/larvae survey produced no results. Although there were no egg mass surveys conducted at "Bart's Hollow", it is suspected that most amphibians in the area are preferentially choosing the neighboring site of Alice Springs, just to the north.

Alice Springs

The west pond of Alice Springs has moderate populations of Pacific Treefrog & Long-toed Salamander while the east pond (formerly "long-toed pond") has moderate populations of Red-legged Frog and a high density of Long-toed Salamander (consistent with 2009 findings). The amount of garbage that is dumped in each of these ponds is disconcerting and dangerous, and removal of this trash is recommended from August through January, as to not disturb breeding and metamorphosing amphibians. Continued monitoring of this site is recommended, especially with the recent plantings in 2009, and because the significant amount of upland habitat surrounding Alice Springs is likely to support migrating populations of Red-legged Frogs.

Whitaker Ponds

There are no native amphibians breeding in each of the large ponds (west & east) or the small pond at the base of the gazebo (consistent with 2008 & 2009 findings). However, this year, during an unofficial survey, approximately 100 Pacific Treefrog tadpoles were observed in one of the small storm water ponds in late June, suggesting that this site is supporting populations of breeding treefrogs. It is recommended that water levels are monitored in this site and the hydro-period increased if Pacific Treefrog are desired here. One of the other adjacent storm water ponds is typically dried out each season (and dominated by *Juncus spp*.) and deepening this pond, or increasing the hydroperiod, may afford an additional breeding opportunity for Pacific Treefrogs.

There is also a very high density of Bullfrogs throughout the site, with a high concentration in the east pond. Bullfrog removal efforts at this site *may* increase native amphibian presence, but because the habitat is so favorable for them, it is likely that they would readily return (Holzer 2009). Small scale "Bullfrog round-ups" have been conducted, as an educational outreach event by PP& R, and over the past three years a total of 90 frogs were harvested.

Schlesinger (Zen)—138th Storm Water facility

This area has healthy populations of both Pacific Treefrogs and Long-toed Salamanders that are likely attracted to the diverse amount of plant cover and the longer hydroperiod of the site. The relatively high density of *P. arundinacea* at the site does not appear to be deterring native amphibians and I would recommend that IF spraying is necessary *in the pond*, it does not occur until late in the season, when all amphibians have left the water (July/August through early December). In late June,

2010, a survey was conducted at the site after a recent spraying of *P. arundinacea*. The water on site was contaminated and salamanders were found floating dead on the surface.

Big 4 North Swale: Bernard's Pond

This site is dominated by Yellow Flag Iris and Bullfrogs, although it appears to support a moderate population of both Pacific Treefrog and Long-toed Salamander.

Big 4 North Swale: WMS Pond

The large area (consisting of the round pond along the east site and the channel area along the west) has all four native species breeding here along with Bullfrogs. There is excellent aquatic vegetation to serve as attachment species for Red-legged Frogs and *P. arundinacea* dominates the perimeter of the site, providing attachment species for Northwestern Salamanders.

Johnson Lake/92nd Ave WQF

This site was reported DRY on April 1, 2010 and no return trips were made.

Blue Heron Wetland

This site is located near NE 13th, across from the Columbia Edgewater Golf Course. It was not surveyed during egg mass season but was visited in the late summer when the west half of the site had dried up and the east half remained with approx. 2-3ft of water. Bullfrogs were visually observed throughout the entire site, effectively using the east half for breeding. I suspect that this site may support a substantial amount of native amphibians, including Red-legged Frog and Northwestern Salamander, and it is recommended that a survey be conducted here during the egg-mass season of 2011.

Johnson Creek Watershed

Circle Avenue Area: Pumpelly constructed pond

This is a privately owned and maintained pond at the base of the east side of Powell Butte. Consistent with findings in 2009, this site has very healthy populations of all 4 native pond-breeding amphibians, and Rough-skinned Newts have been identified in previous years. There are no Bullfrogs on site, even though the pond retains water year-round, possibly because they are removed

by Mr. Pumpelly. This pond is an excellent example of a man-made site that successfully attracts amphibians in high abundances and future monitoring of this site is recommended. Pumpully's pond is an excellent, healthy pond that could continue to serve as an ideal training site for those involved in the amphibian monitoring program.

Circle Avenue Area: Water Bureau Site (aka "horse pasture pond")

This large wetland area has a large population of three native species (Pacific Treefrog, Long-toed Salamander, and Red-legged Frog) and a high density of Bullfrogs (that may or may not be breeding on site). All of the Red-legged Frog egg masses were found in the north part of the site, where fallen branches and aquatic vegetation. provide ideal attachment objects. This is consistent with the 2009 findings and it is recommended that more branches be placed in the pond to attract Red-legged Frogs and Northwestern Salamanders (Holzer, 2009). Yellow Flag Iris is also found throughout the site.

Circle Avenue Area: Brunkow Pond (aka Deep vernal pond)

This is an interesting "pit" that has become a "pond" that is attracting low densities of Pacific Treefrog, Long-toed Salamander, and Red-legged Frog (consistent with 2009 findings). The dominant vegetation is *Nuphar luteum* although there is a diverse amount of perimeter vegetation around the pond. Although this site is not ideal, it does appear to be providing suitable breeding habitat, and there are no current recommendations for altering it.

Powell Butte: Stock pond

This small, vernal pond at the top of Powell Butte, aptly named "stock pond", has some of the highest densities of all four native amphibians in the entire city. In a single day, with only 40% of the site covered, a record number of egg masses were recorded for Pacific Treefrog (586), Long-toed Salamander (509), and Red-legged Frog (112). No Bullfrogs are present, and Northwestern Salamanders were recorded in lower densities this year (as compared to 2009). There is excellent aquatic vegetation (*Juncus spp*., *Eleocharis spp.*, *Carex spp*.) and an ideal, long hydroperiod. The only recommendation for this site is to continue protecting it from the public and to encourage less frequent visitation by researchers, ecologists and volunteers. Because of the large amount of upland habitat around Powell Butte, the construction of additional vernal ponds is strongly encouraged (consistent with 2009 recommendations).

Zenger Farm Wetland & Triangle Site

In the wetland at Zenger Farms (including the "Tire Pond" at the base of the hill), all four native amphibians can be found, although three out of the four are far less dense than at other neighboring sites (consistent with 2009 findings). There is, however, a very high density of Northwestern Salamanders, with the second highest recorded number of egg masses (42) in the city, recorded during a single survey. Each of these egg masses was attached to *P. arundinacea*, as that is the dominant plant on site, and removal of this plant is not recommend (as it is the only plant suitable for Northwestern Salamander egg mass attachment). A relatively high density of Northwestern Salamanders was also found in the neighboring area of "Triangle" (which has very similar habitat characteristics to the Zenger wetland).

Leach Botanical Gardens Pond

This tiny little pond supports a healthy population of Pacific Treefrog (with the second highest density recorded in the city), Long-toed Salamander, and a small population of Red-legged Frog. This year was the first year where Red-legged Frog tadpoles were recorded in addition to their egg masses, suggesting that perhaps there is sufficient aquatic vegetation for their survival.

Brookside (7 constructed ponds)

Native amphibians are establishing well to these seven small ponds that are providing excellent habitat, including Pacific Treefrog, Long-toed Salamander, and Red-legged Frog. (Although Bullfrogs are present, they appear to only be breeding in the large, exposed, main pond at Brookside.) For two years in a row now, RAAU have been found in 6 of the 7 constructed ponds, with densities (in 4 of the 7 ponds) second only to Powell Butte & Pumpelly sites. In addition, the tadpole/larvae surveys in these ponds produced very high densities of Red-legged Frogs and Pacific Treefrogs. It is recommended that these ponds are surveyed in successive years as they are a hot spot of native amphibian activity and that Purple Loosestrife be removed whenever found. (When this plant takes over a site, it is unfavorable for amphibians.)

Brownwood-Schweitzer & Kelly Creek

This huge area is located on the SE side of Powell Butte with established populations of native amphibians. Each of the sites surveyed is not really a *pond* and more of a channel, with

fluctuating water levels. In three sections of the site (Schweitzer North BW 4, "JC KC North BW", abandoned JC channel) a very low density of Red-legged Frogs was recorded. The only Bullfrogs observed on site are breeding in the abandoned JC channel as well as in the Kelly Creek meander. This entire area of Brownwood-Schweitzer has very high breeding potential, and excellent upland habitat throughout, though it is difficult to know which areas of the site are most suitable for pond-breeding amphibians. It is recommended that a complete survey of this area is conducted in the 2011 breeding season to determine which sites are being used by native species.

Alsop Wetland

Within this large wetland area, three native species are breeding in a very small section of the site, approximately 15m x 20m, bordering the private property at the south end of the site. This part of the site has excellent aquatic vegetation and an ideal depth for Pacific Treefrog, Long-toed Salamander, and Red-legged Frog.

Hillside Properties: north of Springwater Trail at base of the bluff

This site was visited in the winter and was mostly DRY, with the exception of a few inches of moist substrate in parts of the site. This site is probably not a realistic breeding site, unless in years of heavy rain.

Powell Butte : Private property on north side

The location of this site, at SE 141st & Mall, places it right along the west side of Powell Butte. This amount of water in this site probably varies seasonally but I do not believe that it a suitable breeding ground for amphibians. The site is also very exposed, sandwiched between two lawns and a neighborhood street. No amphibians were found during a tadpole/larvae survey in the spring.

Powell Butte: Three Firs Ridge Wetland (bog) site

When visited in the spring, no pond was found at this site. Instead, a very moist, bog-like area was holding about an inch of water in one area. Based on the contours of the slope where this bog is located, it is not suspected that believe that this area will ever retain amounts of water sufficient for amphibian breeding. I recommend a different location for potentially creating a second pond on Powell Butte.

Errol Hts.—the ponds constructed in 2007

Each of these three ponds was surveyed during the egg mass season and no amphibians were found. Although the ponds have an adequate depth and decent amount of aquatic vegetation (that is sure to increase in following years), I am not surprised with the lack of amphibians. In both 2008 & 2009, no pond-breeding amphibians were recorded in the other ponds at Errol Heights. It is possible that the ground water is significantly cooler here than other sites (delaying normal egg mass laying time frame) and/or that the elevated levels of nitrates are negatively affecting amphibians (Holzer, 2009).

Crystal Springs (coordinate with Dr. Kaplan at Reed College)

Despite several attempts to coordinate with Dr. Kaplan, contact was never made and thus, no surveys of Crystal Springs or Reed Canyon were conducted in 2010. It is suspected that the Crystal Springs pond has a high population of Bullfrogs and possibly other native pond-breeding amphibians. A survey in 2011 is recommended here, especially because the area near the East Moreland Golf Course was predicted to be suitable Red-legged Frog habitat (Josh Faborhammond, 2010).

***Tideman-Johnso*n**

The pond by the boardwalk has a relatively small population of Pacific Treefrog and Long-toed Salamander attempting to breed here (as egg masses for both species were recorded). In 2009, the only amphibian found here was Rough-skinned Newt. This pond is shallower than most ponds surveyed in this study, and the recommendation to deepen it was suggested by Katie Holzer in 2009. The other site surveyed in this area was across the creek, on the south side by Associated Chemicals, and it was reported as "dry" when visited in the late winter. Although it is possible that this site may seasonally fill with water, it is not suspected to be a suitable breeding habitat.

Beggar's Tick Marsh

Thanks to trained PP& R volunteers, approximately 30% of this enormous wetland/pond site was surveyed during the egg mass season and moderate numbers of Pacific Treefrog and Long-toed Salamander were recorded (consistent with 2009 findings). In addition, a small number of RAAU egg masses were also recorded for the first time at this site. The center of this pond is ideal habitat for this species, so it is not surprising that they are breeding here (and were not surveyed in this part

of the site in 2009). Although no tadpoles were found during a perimeter tadpole survey, one Red-legged Frog "metamorph" was observed in July, 2010, when the site had dried.

Mainstem Willamette Watershed

Oaks Bottom Wildlife Refuge:

Both Aurora Lake and Tadpole Pond (the two constructed ponds in the north part of Oaks Bottom) are attracting large numbers of breeding amphibians, specifically Pacific Treefrog & Long-toed Salamander. The second highest number of Pacific Treefrog egg masses found in one visit occurred in Tadpole pond where 300 were recorded. Long-toed salamanders appear to prefer the deeper water in Aurora Lake. In both sites, the planted aquatic vegetation is establishing very well and the placed branches in Aurora Lake are providing egg mass attachment for Long-toed salamanders as well as providing an immense amount of refuge & shelter for amphibians in Tadpole Pond. The invasive species of mint may need to be monitored, in addition to Purple Loosestrife at each site.

The pond at the base of the north parking lot, which is called "ancient pond" (and sometimes "salamander slough") supports a small population of Red-legged Frogs, in addition to Pacific Treefrogs & Long-toed Salamanders. This year the aquatic vegetation at this site seemed to have improved from previous years, as *Eleocharis spp.* was found in over 50% of the pond.

The "channels" area of Oaks Bottom, near the bluff trail and adjacent to the springwater corridor trail, also hosts moderate populations of Pacific Treefrogs, Long-toed Salamanders, and Red-legged Frogs. This year the aquatic vegetation in this site had improved and Red-legged Frog egg masses were found throughout the site, attached to plants such as *Polygonum spp.* (unlike in 2009, when egg masses were found only attached to branches of a fallen tree). The survivorship of this species in this area, however, may have been affected by the late spring rains which flooded the entirety of the low-lying wetland area north of Wapato Lake. Large numbers of Willamette River fish were observed within feet of the bluff trail. It is recommended that this site is continually monitored for Red-legged frogs that appear to be colonizing this area of Oaks Bottom. Continued monitoring for transient camps is also recommended, as they have become quite popular in the area.

One final site, located south of Wapato Lake, in the open meadow area across from Oaks Park, was surveyed in late spring. This is a small pond with very turbid water and no aquatic vegetation, and somehow a very high number of Pacific Treefrog tadpoles appear to be thriving here.

Sellwood Riverfront Park Pond

This pond was surveyed for the first time in 2010 and a healthy population of Pacific Treefrogs, Red-legged Frogs and Long-toed Salamanders were found breeding here. Because of the vulnerability of Red-legged Frog egg masses in such an exposed site, it is recommended that dogs (from the off-leash dog area) be leashed upon entering the pond (or prohibited from entering altogether).

Water Pollution Control Lab and Test Swale

For the second year in a row, this small test swale appears to be supporting a healthy, though small, population of Pacific Treefrogs. This is a beautiful site, abundant with birds and a diverse amount of vegetation and lots of potential to continue to provide suitable breeding habitat for Pacific Treefrog. During tadpole/larvae surveys, however, large amounts of cigarette butts and Styrofoam pieces were repeatedly scooped up and therefore it is recommended that signs to be placed around the pond informing people to not dump their trash (and of the amphibian presence in the pond).

Willamette Watershed

Portland Audubon Society: Sanctuary Pond

No amphibian egg masses were recorded here in the winter, and the only amphibian species observed during a tadpole/larvae survey was Rough-skinned Newt. In previous years, all five native pond-breeding amphibians have been found here by Tierra Curry in 2006. It is recommended that Tom Costello, the site director, be contacted and informed of the amphibian breeding season such that scheduled plantings in the pond do not overlap with critical amphibian breeding time from December through April.

Tryon Creek Watershed

Tryon Creek Headwaters

The newly constructed ponds at Tryon Creek Headwaters did not attract breeding amphibians in the 2010 season, but it is possible that Pacific Treefrog will colonize this site in the next couple of years. The only recommendation for these ponds is to continue monitoring.

Maricara Park

The area of this park that was visited does not appear to hold water long enough to be a suitable breeding pond for amphibians. Pacific Treefrogs are common in the area (perhaps breeding somewhere near-by) and it is therefore recommended that parts of the wetland area are deepened, according to 2009 recommendations, by 24-36" and monitored for colonization (Holzer 2009).

Fanno Creek Watershed

April Hill:

This site is another small wetland that supports populations of Pacific Treefrogs, Long-toed Salamanders, and Rough-skinned Newts. It is relatively shallow, compared to most ponds that were surveyed in this study, although it is possible that a small percentage of amphibians are successfully breeding here. A very high density of Long-toed Salamander larvae were recorded here in early spring, several months prior to the pond drying. It is recommended that water levels be monitored in 2011 and that amphibian surveys continue to inform us of species presence in the Fanno Creek Watershed. Once the deepest area of the wetland is determined, a small area of the wetland could be deepened (approximately 10mx10m). A longer hydroperiod and a larger area for amphibians to disperse would allow for a greater percentage of successfully breeding species.

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Table 6. Species presence for all sites surveyed in 2010 (based on egg-mass data).
Species codes: PSRE: *Pseudacris regilla* (Pacific Treefrog), RAAU: *Rana aurora* (Red-legged frog), AMMA: *Ambystoma macrodactylum* (Long-toed Salamander), AMGR: *Ambystoma gracile* (Northwestern Salamander), LICA: *Lithobaties catesbeiana* (American Bullfrog). "N/a" is marked for sites that did not receive an egg mass survey in 2010 and "*" indicates sites for which species information was generated from tadpole/larvae surveys.

Water-shed	Site Name	PSRE	RAAU	AMMA	AMGR	LICA
CS	Winmar Flats: SW Pond				x	x
CS	Winmar Flats: NW Pond	x	x	x	x	x
CS	Winmar Flats: NE Ponds	x	x		x	x
CS	Winmar Flats: SE Ponds	x			x	x
CS	Mason Flats: Bart's Hollow*					
CS	Alice Springs: West Pond	x		x		
CS	Alice Springs: East Pond (Long-toed pond)		x	x		
CS	Whitaker: West Pond					x
CS	Whitaker: East Pond					x
CS	Whitaker: bullfrog gazebo pond					x
CS	Whitaker: small storm water pond*	x				
CS	"Schlessinger (Zen)"/138th Storm Water Facility	x		x		x
CS	Big 4 North: Bernard's Pond	x			x	x
CS	Big 4 North: WMS Pond	x	x		x	x
CS	Big 4 North: WMS Pond- "east, small pond"	x	x	x	x	x
CS	Johnson Lake/ "92nd Ave WQF"					
CS	Blue Heron Wetland*	n/a	n/a	n/a	n/a	x
JC	Circle Ave: Pumpelly Pond	x	x	x	x	
JC	Circle Ave: Water Bureau Site	x	x	x		x
JC	Circle Ave: Brunkow Pond	x	x	x		
JC	Powell Butte: Stock Pond	x	x	x	x	
JC	Zenger: Tire Pond	x	x	x		
JC	Zenger: Wetland	x	x	x	x	
JC	Triangle Site (North of Springwater)			x	x	
JC	Leach Botanical Gardens Pond	x	x	x		
JC	Brookside Ponds 1-7	x	x	x		
JC	Brookside Pond 2	x	x	x		
JC	Brookside Pond 3	x	x	x		
JC	Brookside Pond 4	x		x		
JC	Brookside Pond 5	x	x	x		
JC	Brookside Pond 6	x	x	x		
JC	Brookside Pond 7	x				
JC	Schweitzer North BW 1				x	
JC	Schweitzer North BW 2,3					
JC	Schweitzer North BW 4	x	x			
JC	Abandoned JC Channel*		x	x		x
JC	JC KC North BW	x	x			
JC	Schweitzer South BW 1,2,3,4					
JC	Alsop Wetland	x	x	x		
JC	Hillside Properties					
JC	Powell Butte: Private Prop. North side					
JC	Powell Butte: Three Firs Ridge Wetland (bog) site					
JC	Erroll Heights (three new 2007 ponds)					
JC	Crystal Springs (coordinate w. Dr. Kaplan REED)	n/a	n/a	n/a	n/a	n/a
JC	Tideman Johnson: across creek					
JC	Tideman Johnson: boardwalk pond	x		x		
JC	Kelly Creek meander					x
JC	Beggar's Tick	x	x	x		
WM	OB: Aurora Lake	x		x		
WM	OB: Ancient Pond	x	x	x		x
WM	OB: Channels	x	x	x		
WM	OB: Tadpole Pond	x		x		
WM	Sellwood Riverfront Pond	x	x	x		
WM	Water Pollution Control Lab & Test Swale	x				
WM	Audubon Society Pond					
TC	Tryon Creek Headwaters					
TC	Maricara Park	n/a	n/a	n/a	n/a	n/a
FC	April Hill	x		x		

Watershed codes: CS- Columbia Slough, JC- Johnson Creek, WM- Willamette, TC- Tryon Creek, FC- Fanno Creek

Table 7. Species assemblage comparison between years for sites surveyed in 2008, 2009 and 2010.
Species codes: PSRE: Pacific Treefrog (*Pseudacris regilla)*, RAAU: Northern Red-legged Frog (*Rana aurora)*, AMMA: Long-toed Salamander (*Amybstoma macrodactylum)*, AMGR: Northwestern Salamander (*Ambystoma gracile)*, TAGR: Rough-skinned Newt (*Taricha granulose)*, LICA: American Bullfrog (*Lithobaties catesbeiana)*. ("N/A" is placed in the column if a site did not receive a survey in a given year.)

Water-shed	Site	PSRE			RAAU			AMMA			AMGR			TAGR			LICA		
		2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010
CS	Ramsey			n/a			n/a			n/a			n/a			n/a	x	x	n/a
CS	Whitaker			x													x	x	x
CS	Schlessinger/ 138th WQF	x	x	x				x	x	x	x						x	x	x
CS	Winmar Flats	x	x	x		x	x	x	x	x	x	x	x		x		x	x	x
CS	Alice Springs	x	x	x		x	x	x	x	x							x		
CS	Big 4 N. swales	n/a	x	x	n/a	x	x	n/a	x	x	n/a		x	n/a			n/a		x
JC	Circle Ave Sites	x	x	x	x	x	x		x	x	x	x					x		x
JC	Pumpully Pond	x	x	x		x	x		x	x		x	x	x	x				
JC	Powell Butte Stock Pond	x	x	x	x	x	x		x	x	x	x	x	x	x				
JC	Zenger Farms	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
JC	Leach Botanical Gardens	n/a	x	x	n/a	x	x	n/a		x	n/a			n/a			n/a		
JC	Brookside	x	x	x	x	x	x	x	x	x	x			x			x	x	
JC	Beggar's Tick	x	x	x			x	x	x	x									
JC	Erroll Heights																		
JC	Tideman Johnson	n/a		x	n/a			n/a		x	n/a			n/a	x		n/a		
JC	Kelly Creek				x	x											x	x	x
JC	Schweitzer/ Alsop	n/a	n/a	x	n/a	n/a	x	n/a	n/a	x	n/a	n/a		n/a	n/a		n/a	n/a	x
WM	Oaks Bottom	x	x	x	x	x	x	x	x	x					x		x	x	x
WM	Water Poll. Control Lab	n/a	x	x	n/a			n/a			n/a			n/a			n/a		
WM	Sellwood Riverfront Pond	n/a	n/a	x	n/a	n/a	x	n/a	n/a	x	n/a	n/a		n/a	n/a		n/a	n/a	
WMM	Audubon Society Pond	n/a	n/a		n/a	n/a		n/a	n/a		n/a	n/a		n/a	n/a	x	n/a	n/a	
TC	Tryon Creek Headwaters																		
TC	Maricara																		
FC	April Hill	n/a	x	x	n/a			n/a	x	x	n/a			n/a			n/a		

Watershed codes: CS- Columbia Slough, JC- Johnson Creek, WM(M)- Mainstem Willamette (& Willamette), TC- Tryon Creek, FC- Fanno Creek

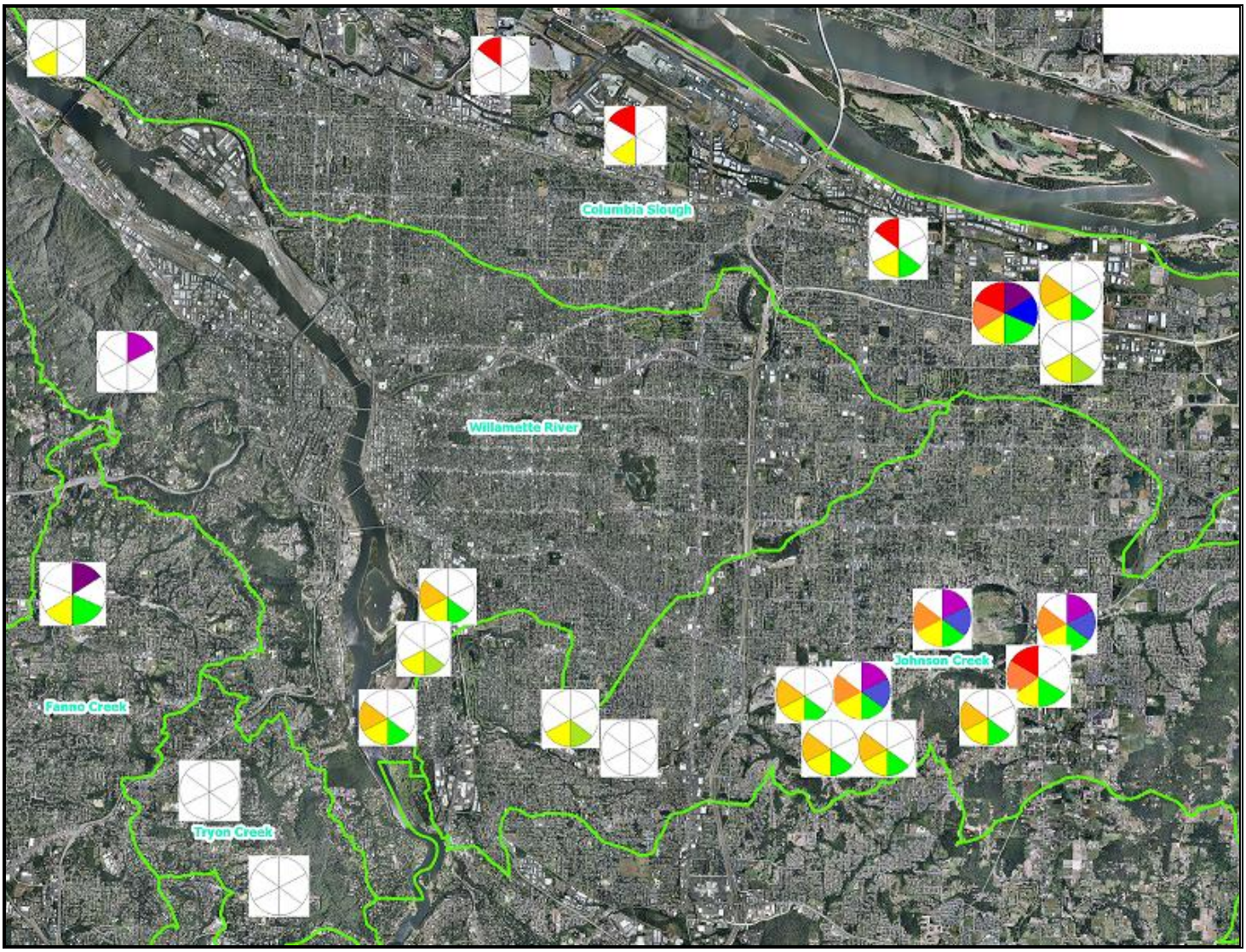


Figure 1: **Presence of pond-breeding amphibians in 2010 breeding season**.
(Locations for Rough-skinned Newts included from 2009 field season.) Watershed outlines in green.

American Bullfrog	Long-toed Salamander	Northwestern Salamander
Pacific Treefrog	Red-legged Frog	Rough-skinned Newt

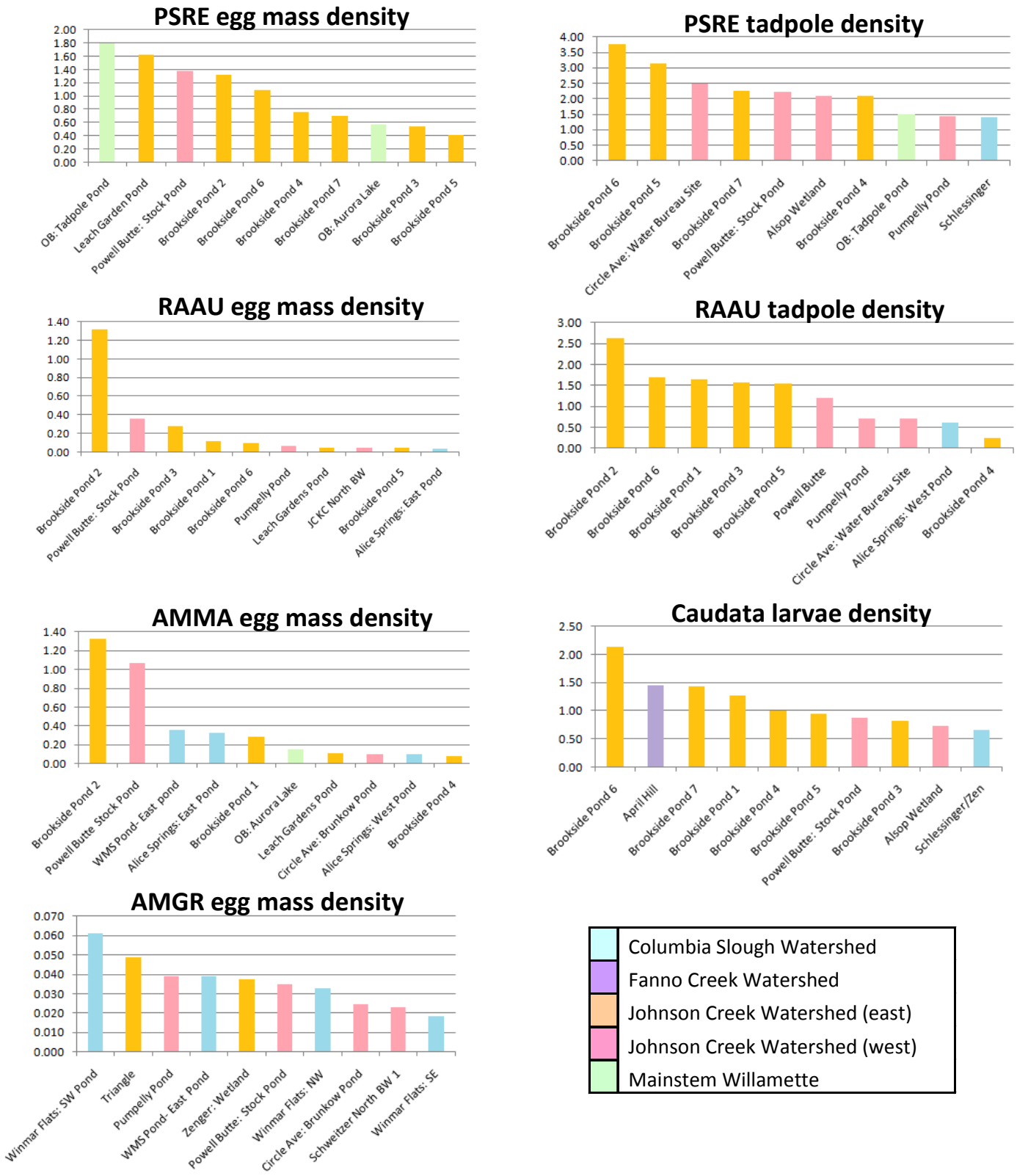


Figure 2. Ten ponds with highest densities for each species for each stage surveyed. Each graph shows the amphibian densities for the ten ponds with the highest densities for a given species for a given stage in 2010. All densities are the natural logarithm of the number found per unit time or distance. Species codes are as follows: PSRE-*Pseudacris regilla*, Pacific tree frog; RAAU-*Rana aurora*, Northern Red-legged frog; AMMA-*Ambystoma macrodactylum*, Long-toed salamander; AMGR-*Ambystoma gracile*, Northwestern Salamander; Caudata-all salamanders (difficult to distinguish at larval stage). The colors of the bars correspond to the watershed in which the ponds are located (see legend).

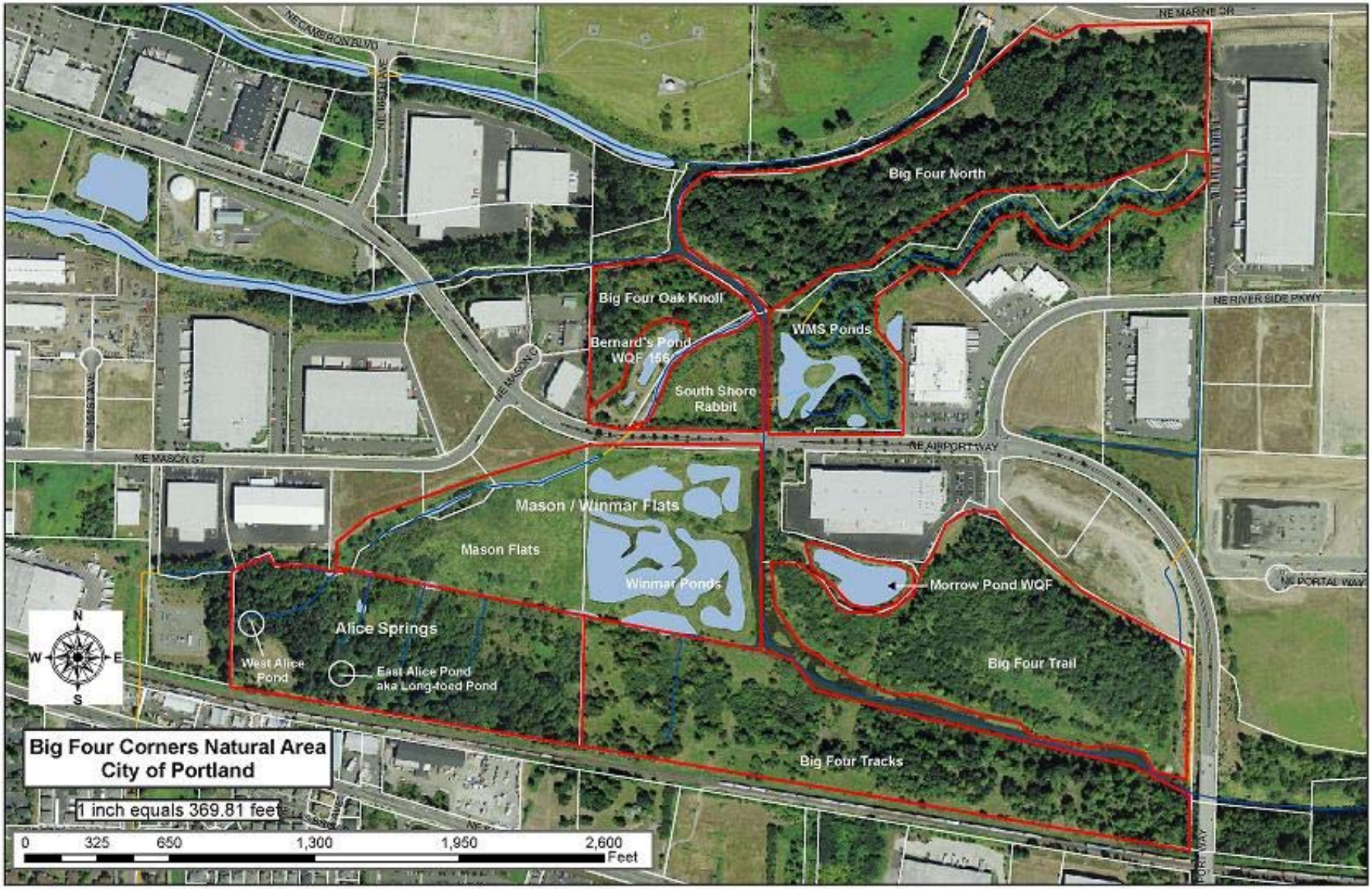


Figure 3. "Four Corners" Wetland Complex, Columbia Slough Watershed.
This map shows habitat connectivity between sites in "Big 4" where all four target native species are breeding. (ArcMap created by BES Columbia Slough Watershed Team 2010)

Figure 4: Shared upland habitat amongst sites in "east" Johnson Creek Watershed. Sampling sites in the majority of this area contained high densities of Red-legged Frogs in both egg-mass and tadpole seasons. Sites south of "Brunkow Pond" (including the Brownwood/Schweitzer area, abandoned Johnson Creek Channel, Kelly Creek restoration areas, and Alsop Wetland) received preliminary site visits to assess presence/absence of species.

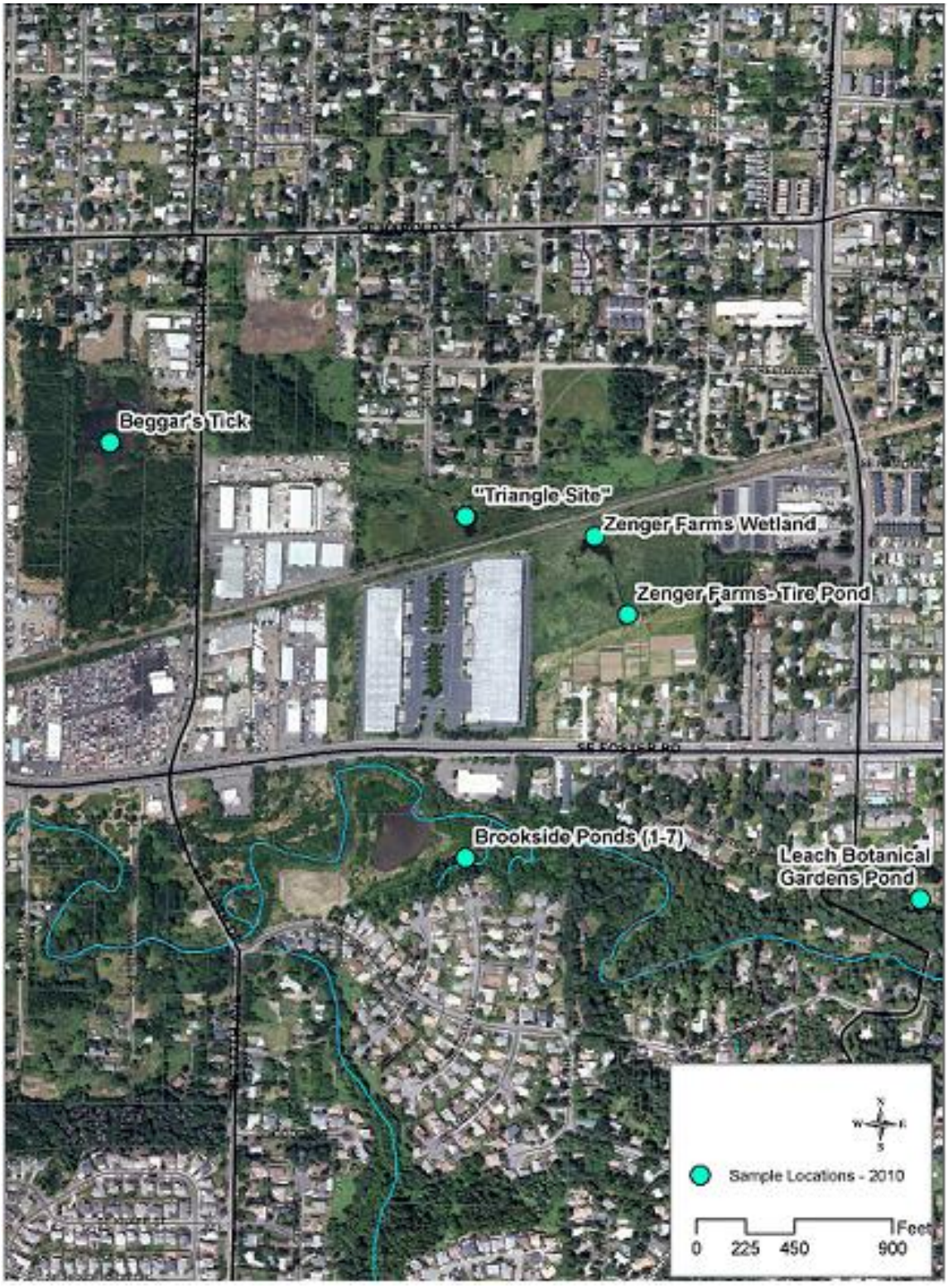


Figure 5: Sites with high densities of Red-legged Frogs in "west" Johnson Creek Watershed. This map also shows upland habitat connectivity between all seven Brookside Ponds and the forested areas surrounding Leach Gardens. Sites of high density for Northwestern Salamanders include Zenger Farms and neighboring Triangle site.

Figure 6: Shared habitat amongst sites in Oaks Bottom Wildlife Refuge and Sellwood.
This map illustrates the shared habitat connecting sites throughout north and south Oaks Bottom Wildlife Refuge. Although the center of the reservoir is labeled, it was not surveyed in 2010. Red-legged Frogs were found in three sites on this map, with their presence being documented for the first time in Sellwood Riverfront Park.

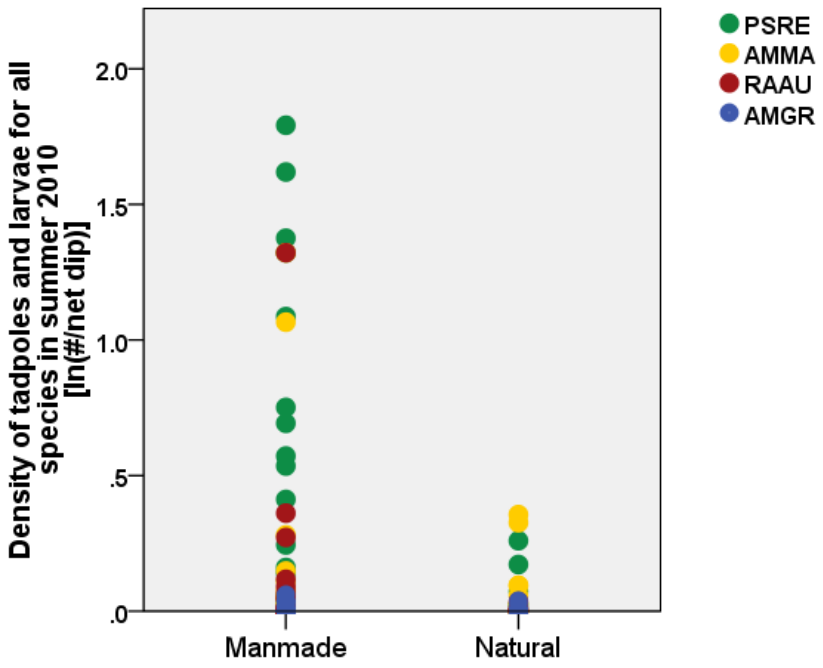


Figure 7: Density of amphibians in manmade vs. natural ponds. This graph shows the density of tadpoles and larvae of all native pond-breeding amphibian species in summer 2010. Each point represents one pond. This is an example of the trend found in analysis that no species had higher density in natural ponds than manmade ponds in any season surveyed. Many species in many seasons even had higher densities in manmade ponds than in natural ponds, and this difference was significant for chorus frogs.

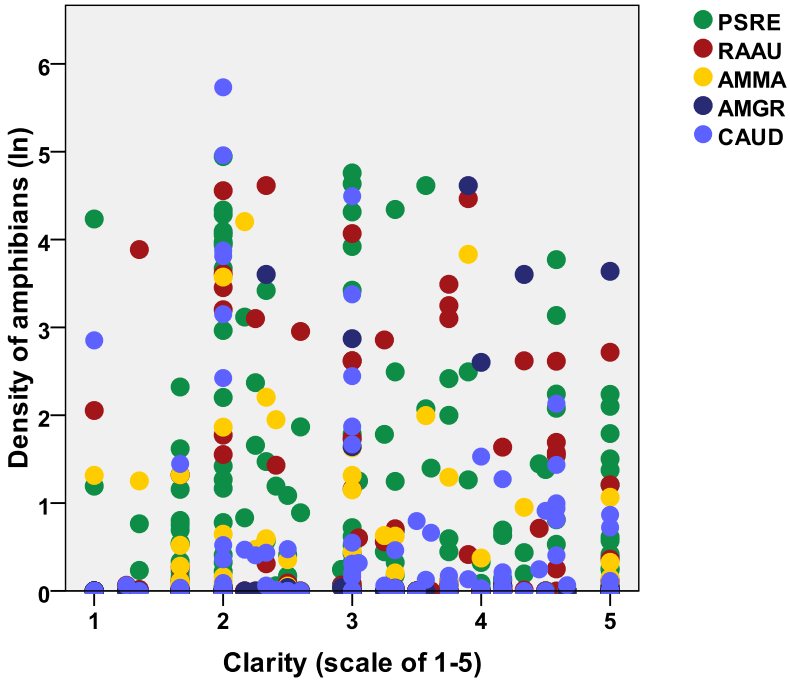


Figure 8: Relationship between amphibian density and pond clarity. This graph shows the relationship between densities (eggs and tadpoles/larvae) of all native pond-breeding amphibian species and the clarity of the pond on a scale of 1-5. Each point represents one pond in one season. A clarity score of "1" is a very turbid pond whereas a clarity score of "5" is a very clear pond. Species are as follows: PSRE: Pacific Treefrog, RAAU-red-legged frog, AMMA-long-toed salamander (eggs), AMGR-Northwestern salamander (eggs), CAUD-Caudata larvae (all salamander species). In general, there was no relationship between pond clarity and amphibian density.

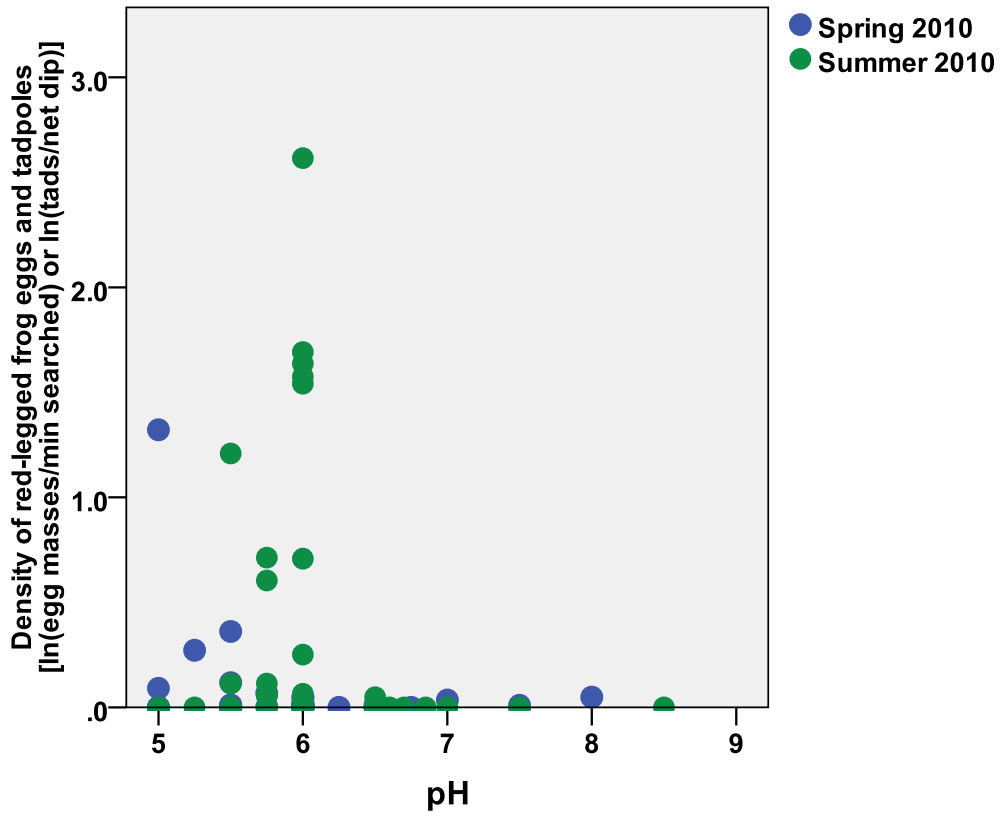


Figure 9: Relationship between Red-legged frog density and pH of a pond. This graph shows the relationship between Red-legged frog density (eggs and tadpoles) and pH during 2010. Each point represents one pond. This negative relationship was identified as important in the analysis in four out of the five survey seasons.

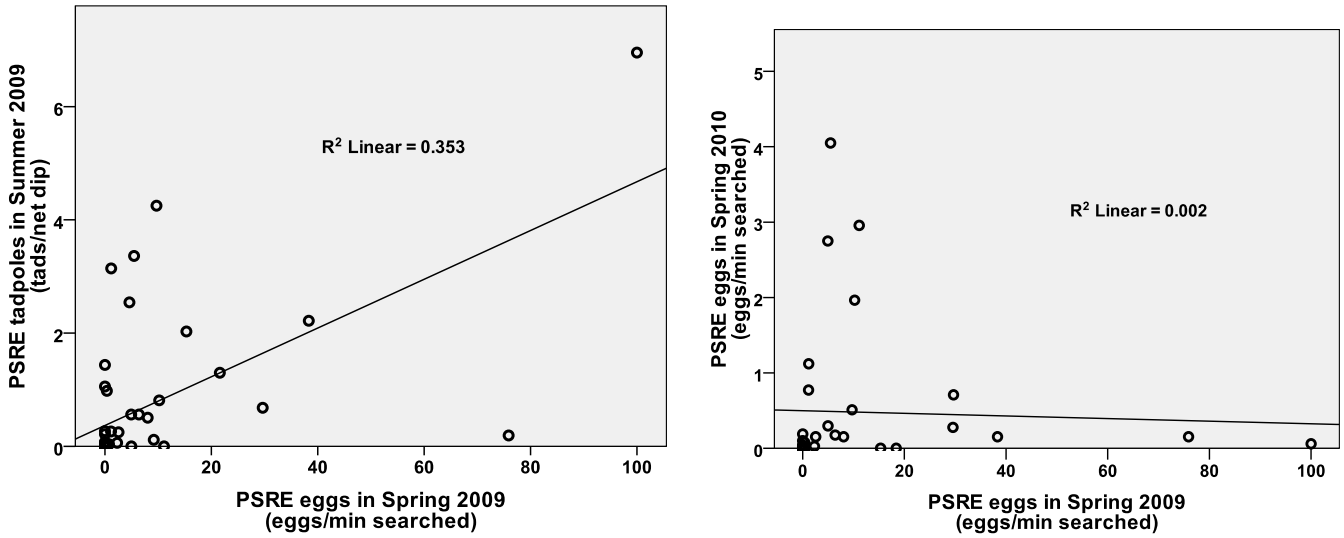


Figure 10: Correlations of amphibian densities among years. On the left is an example of a positive relationship of amphibian density among seasons. Each point is a pond that was surveyed for Pacific Treefrog (PSRE) in spring and summer 2009. The R^2 value indicates that ~35% of the variation in chorus frog tadpole density in 2009 is explained by its regression on PSRE egg density in 2009. On the right is an example of a lack of relationship of amphibian density among seasons. It shows that <1% of the variation in PSRE egg density in 2010 is explained by its regression on PSRE density in 2009.

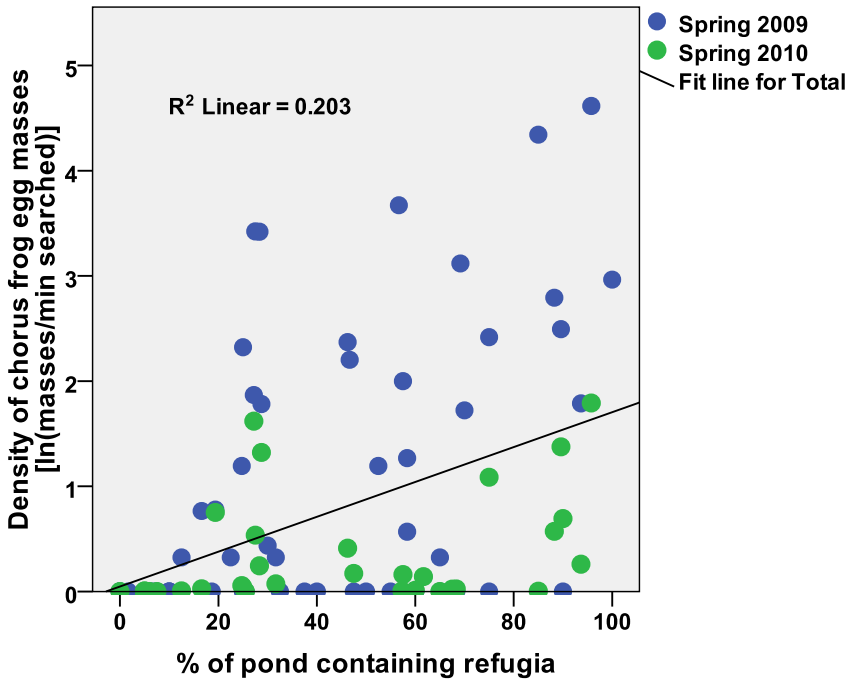


Figure 11: Relationship between Pacific Tree frogs and amount of refugia in ponds. This graph shows an example of the relationship between Pacific Treefrog and how much refuge (hiding places such as plant or sticks) is in a pond. Each point represents one pond. Refuge was identified as an important factor in three out of the five seasons for Treefrog. This relationship is positive, with higher densities of Treefrogs in ponds with more refuge.

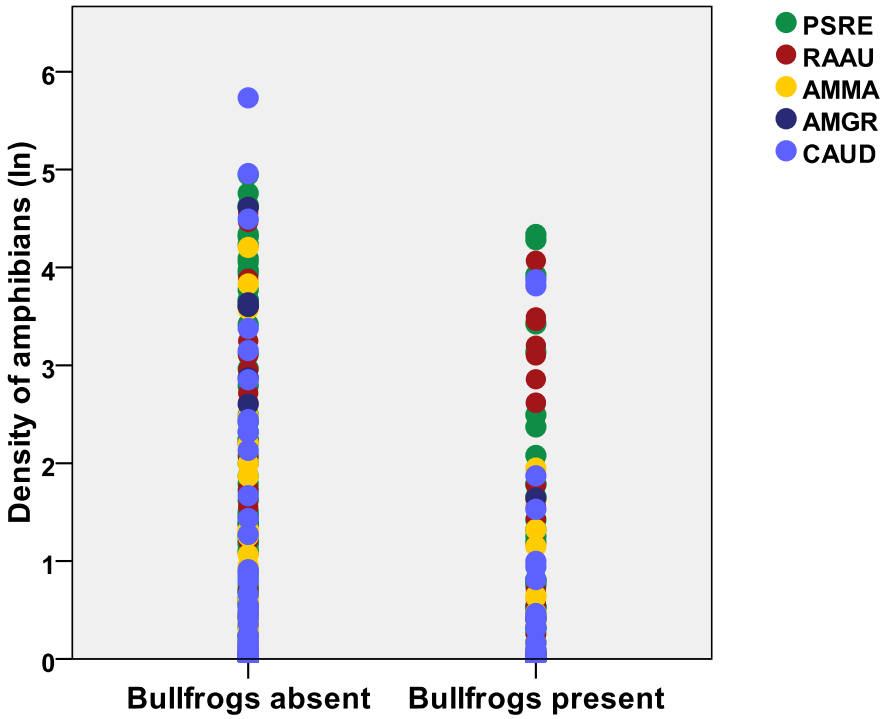


Figure 12: Comparing densities of amphibians in ponds with and without Bullfrogs. This graph shows the densities (eggs and tadpoles/larvae) of all species of pond-breeding amphibians in all seasons surveyed. Each point represents one pond in one season. Species are as follows: PSRE: Pacific Treefrog, RAAU: Red-legged frog, AMMA: Long-toed salamander (eggs), AMGR: Northwestern salamander (eggs), CAUD-Caudata larvae (all salamander species). In general, Bullfrog presence was not a good predictor of native amphibian density.

APPENDICES

Appendix 1: List of plant species observed in 2010 field season and their use as attachment vegetation for amphibian egg masses.

Scientific Name	Common Name	Use in egg mass attachment
Alisma plantago	Water Plantain	no
Carex obnupta	Slough Sedge	yes
Ceratophyllum demersum	Coontail	no
Cornus stolonifera	Red-Osier Dogwood	yes
Eleocharis spp.	Spike Rushes	yes
Equisetum spp.	Horsetail species	no
Iris pseudacorus	Yellow Flag Iris	no
Juncus effusus	Soft Rush	yes
Ludwigia palustris	Water Purslane	no
Lysichiton americanum	Skunk Cabbage	no
Nuphar luteum	Yellow Pond-lily	no
Oenanthe sarmentosa	Water Parsley	no
Phalaris arundinacea	Reed Canarygrass	yes
Polygonum amphibium	Water Ladysthumb	yes
Polygonum hydropiperoides	Waterpepper	yes
Potamogeton natans	Floating-leaved Pondweed	yes
Scirpus microcarpus	Small-fruited Bullrush	yes
Scirpus tabernaemontani	Soft stem Bullrush	yes
Sparganium emersum	Narrowleaf Burreed	no
Typha latifolia	Cattail	no
Veronica anagallis-aquatica	Water Speedwell	no
Veronica scutellata	Marsh Speedwell	no

Appendix 2. Sample datasheet used for egg mass surveys in the 2010 field season.

Egg Mass Survey
Data Sheet

DATE:

SITE NAME:

Sheet ___ of ___

OBSERVERS (name, e-mail, phone)

_____

_____

START TIME

END TIME

% AREA VISITED:

CONDITIONS:

Weather: clear / p. cloudy / cloudy / overcast / windy / high rain / low rain / mist

Air Temp: _____ °C Water depth: _____ ft

Water Temp [top, bottom]: _____ °C , _____ °C

Subsurface Visibility*: poor / fair / excellent

Water pH: _____ D.O. _____ Nitrates: _____ Nitrites: _____

FIELD NOTES: (presence of adult frogs, other wildlife, disturbances to site):

Time on Stop Watch	Species**	Stage***	# eggs in mass	Attachment Vegetation**** (and attachment species?)	Field Notes (GPS location for RAAU & AMGR)

*Visibility: Poor = less than 1ft down
Fair = less than 2ft,
Excellent = greater than 2ft

***Stage: R = round, fresh embryo K= kidney shaped
T = pre-hatch embryo with tail H = hatched

**Species: Pacific Treefrog (*Pseudacris regilla)* = PSRE
Long-toed Salamander (*Ambystoma macrodactylum)* = AMMA
Northern Red-legged Frog (*Rana aurora)* = RAAU
Northwestern Salamander (*Ambystoma gracile)* = AMGR
Rough-skinned Newt (*Taricha granulosa)* = TAGR

****Attachment Vegetation:
N = none (egg mass is floating)
G = grass or grass-like plant (living)
W = woody plant (stick, branch, non-living)
O = other

Appendix 3: Page one of sample datasheet used for "perimeter sampling" during Tadpole/Larvae Surveys in the 2010 field season.

Tadpole/Larvae Perimeter Sampling **Data Form**	**SITE:**		**Sheet ______ of ______**
DATE:	OBSERVERS:	START TIME:	END TIME:
FIELD NOTES:		SITE NOTES:	

Scoop #	**Species**	**Tally**	**Field Notes**

Species

Pacific Treefrog (*Pseudacris Regilla*) = PSRE	Long-toed Salamander (*Ambystoma macrodactylum*) = AMMA
Northern Red-legged Frog (*Rana aurora*) = RAAU	Northwestern Salamander (*Ambystoma gracile*)= AMGR
Bullfrog (*Lithobates catesbeiana*) = LICA	Rough-skinned Newt (*Taricha granulose*) = TAGR

Appendix 3. Page two of sample datasheet used for "dip-net sampling" during Tadpole/Larvae surveys in the 2010 field season.

Tadpole/Larvae Dip Net Survey **SITE NAME:** **Sheet _____ of _____**

Data Form

DATE: | OBSERVERS: | SITE: | Site Width (m): _____

GPS North: _____ | Site Length (m): _____

START TIME: | END TIME: | CONDITIONS: | Weather: clear / part.cloudy / cloudy / raining / windy

FIELD NOTES: | Air Temp (°C): _____

Location # (1-5)	Species**	SVL(mm)***	Hindlimb (Y/N)	Forelimb (Y/N)	Abnormal?	Field Notes

* Visibility: Poor = less than 1ft down, Fair = less than 2ft, Excellent = greater than 2ft

**Species:

Northern Red-legged Frog (*Rana aurora*) = RAAU

Pacific Treefrog (*Pseudacris regilla*) = HYRE

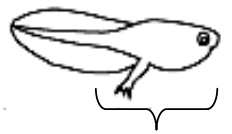
Bullfrog (*Lithobates catesbeiana*) = LICA

Northwestern Salamander (*Ambystoma gracile*) = AMGR

Long-toed Salamander (*Ambystoma macrodactylum*) = AMMA

Rough-skinned Newt (*Taricha granulose*) = TAGR

***Snout-vent Length (SVL) -->



tip of snout to end of vent

Appendix 4. Results of 2010 multiple linear regressions for each species for each season surveyed (compiled and written by Katie Holzer).

A multiple linear regression with stepwise selection was run for each species in each season surveyed. In each analysis, the response variable was the density of that species that season, and the predictor variables were each of the 23 factors (column headings below). Each table shows the variables that were found to be significant at the p=0.10 level for that species in that season (depth, temp (º C), ln(DisRun)). If a + is shown in a cell, it indicates that the model found that factor to be significantly positively correlated with density of that species for that season. If a – is shown, a significant negative correlation between the factor and the species density for that season was found. If the cell is empty, the model did not find that factor to be important in predicting the density of that species in that season.

Abbreviations of factors are as follows: depth=depth of deepest part of pond at mean high water; temp=average temperature of the pond 10cm below the surface; nitrate=concentration of nitrates; nitrite=concentration of nitrites; pH=pH; DO=dissolved oxygen; clarity=the amount of suspended solids; refugia=amount of refuge in pond such as plants and branches; dry?=does the pond dry during the summer?; natural=is the pond natural (vs. man-made)?; fish?=are fish present in the pond?; bullfrogs?=are bullfrogs present in the pond?; % aq veg=percent of the pond covered in aquatic vegetation; % aq RCG=percent of the aquatic vegetation that is reed canary grass; # aq plnt=number of species of aquatic plants; % pr veg=percent of the perimeter of the pond that is covered in vegetation; % pr RCG=percent of the perimeter vegetation that is reed canary grass; # pr plnt=number of plant species on the perimeter; Cov obj=amount of cover objects (i.e. rocks and logs) in the 10m surrounding the pond; ln(Area)=natural log of the area of the pond at mean high water; ln(DisFor)=natural log of the distance to the nearest substantial forested patch; ln(DisOth)=natural log of the distance to the nearest other amphibian breeding pond; ln(DisRun)=natural log of the distance to the nearest running water.

Salamander (*Caudata*) larvae from three summers

	depth	*temp*	*nitrate*	*nitrite*	*pH*	*DO*	*clarity*	*refugia*	*dry?*	*Natural?*	*Fish?*	*Bullfrogs?*
Sum 08					-				+			
Sum 09			-									
Sum 10							+		+			

(cont'd)	*% aq veg*	*% aq RCG*	*# aq plnt*	*% pr veg*	*% pr RCG*	*# pr plnt*	*Cov obj*	*ln(Area)*	*ln(DisFor)*	*ln(DisOth)*	*ln(DisRun)*
Sum 08	+										
Sum 09				+		+		-			
Sum 10	+							-		-	

Long-toed salamander (*Ambystoma macrodactylum)* from two egg mass seasons (springs)

	depth	*temp*	*nitrate*	*nitrite*	*pH*	*DO*	*clarity*	*refugia*	*dry?*	*Natural?*	*Fish?*	*Bullfrogs?*
Spr 09												
Spr 10												

(cont'd)	*% aq veg*	*% aq RCG*	*# aq plnt*	*% pr veg*	*% pr RCG*	*# pr plnt*	*Cov obj*	*ln(Area)*	*ln(DisFor)*	*ln(DisOth)*	*ln(DisRun)*
Spr 09			+		-			-			
Spr 10	+			-		-		-			

Northwestern salamander (*Ambystoma gracile)* from two egg mass seasons (springs)

	depth	*temp*	*nitrate*	*nitrite*	*pH*	*DO*	*clarity*	*refugia*	*dry?*	*Natural?*	*Fish?*	*Bullfrogs?*
Spr 09					-				-			-
Spr 10												

(cont'd)	*% aq veg*	*% aq RCG*	*# aq plnt*	*% pr veg*	*% pr RCG*	*# pr plnt*	*Cov obj*	*ln(Area)*	*ln(DisFor)*	*ln(DisOth)*	*ln(DisRun)*
Spr 09										+	
Spr 10				+					+		

Pacific tree frog (*Pseudacris regilla)* from two egg mass seasons (springs) and three tadpole seasons (summers):

	depth	*temp*	*nitrate*	*nitrite*	*pH*	*DO*	*clarity*	*refugia*	*dry?*	*Natural?*	*Fish?*	*Bullfrogs?*
Sum 08						-		+	+			
Spr 09	-		-					+		-		
Sum 09								+		-		
Spr 10									+			
Sum 10										-		

(cont'd)	*% aq veg*	*% aq RCG*	*# aq plnt*	*% pr veg*	*% pr RCG*	*# pr plnt*	*Cov obj*	*ln(Area)*	*ln(DisFor)*	*ln(DisOth)*	*ln(DisRun)*
Sum 08					+					-	
Spr 09											
Sum 09											
Spr 10			+					-	+		
Sum 10	+					+					

Northern red-legged frog (*Rana aurora)* from two egg mass seasons (springs) and three tadpole seasons (summers)

	depth	*temp*	*nitrate*	*nitrite*	*pH*	*DO*	*clarity*	*refugia*	*dry?*	*Natural?*	*Fish?*	*Bullfrogs?*
Sum 08		-			-				+			
Spr 09	+			-	-						+	
Sum 09					-							
Spr 10												
Sum 10					-							

(cont'd)	*% aq veg*	*% aq RCG*	*# aq plnt*	*% pr veg*	*% pr RCG*	*# pr plnt*	*Cov obj*	*ln(Area)*	*ln(DisFor)*	*ln(DisOth)*	*ln(DisRun)*
Sum 08											
Spr 09	+			+				-		+	
Sum 09											
Spr 10						-		-			
Sum 10		+									

Appendix 5. Page one of recommendations for sites surveyed during 2010 amphibian monitoring season.
Watershed codes: CS- Columbia Slough, JC- Johnson Creek, WM- Willamette Watershed, TC- Tryon Creek, FC- Fanno Creek

Recommendations for 2010 Amphibian Monitoring Sites in Portland, OR

PSRE- Pacific Treefrog, **RAAU**- Red-legged Frog, **AMMA**- Long-toed Salamander, **AMGR**- Northwestern Salamander, **TAGR**- Rough-skinned Newt, **LICA**- Bullfrog

Water-shed	Site Name	Site owner, info	Pond-breeding Species Presence	Site Recommendations
CS	Winmar & Mason Flats	BES	PSRE, RAAU, AMMA, AMGR, LICA	Continue monitoring (for populations of RAAU, AMGR). Reed Canarygrass is dominant, increase *Juncus spp.* throughout ponds if possible (consistent with 2009 recommendations).
CS	Alice Springs	BES	PSRE, RAAU, AMMA	Continue monitoring. Remove garbage throughout site (possible stewardship activity) and continue planting native plants.
CS	Whitaker Ponds	Parks & Rec	PSRE, LICA	Determine maintence schedule of south stormwater pond (PRF 1), to increase hydroperiod (where PSRE tadpoles were found). Deepen other stormwater ponds by 18" to encourage PRSE breeding. Continue invasive species (Bullfrog) removal efforts (as stewardship activity).
CS	"Schlessinger"/Zen Ponds	BES, 138th Stormwater Facility	PSRE, AMMA, LICA	Monitor invasivs (Bullfrog, Reed Canarygrass) but avoid site spraying IN the pond during amphibian metamorphosis (from Dec/January through July/August).
CS	Big 4 North Swales	BES	PSRE, RAAU, AMMA, AMGR	Bernard's Pond & WMS ponds: continue monitoring (for AMGR & RAAU).
CS	Johnson Lake	BES, 92nd Ave WQF	unknown	Site visit recommended in 2011 to determine hydroperiod of site and native species presence.
CS	Blue Heron Wetland	BES	LICA*	Complete survey of entire site during egg mass season (in 2011) to include full list of native species presence. *Data from summer survey only.
JC	Circle Ave: Pumpelly Pond	Private	PSRE, RAAU, AMMA, AMGR, TAGR*	Continue monitoring for native species and continue Bullfrog removal efforts (Pumpully). Use site as location for future trainings. *Identified in 2009.
JC	Circle Ave: Water Bureau Site	Water Bureau	PSRE, RAAU, AMMA, AMGR*	Continue monitoring native species and monitor invasives (Bullfrog, Iris). *Found in 2009
JC	Circle Ave: Brunkow Pond	Parks & Rec	PSRE, RAAU, AMMA	No recommendations- site is unique. Continue monitoring for RAAU if possible.
JC	Powell Butte: Stock Pond	Parks & Rec	PSRE, RAAU, AMMA, AMGR, TAGR*	Continue monitoring- highest densities of native species found 2008-2010. Site is possibly "at capacity". Additional breeding pond locations T.B.D. Monitor for invasives (Reed Canarygrass discovered in 2010). Continue protecting from public, possibly with increased shrubbery or fence.
JC	Zenger Farms & "Triangle"	BES	PSRE, RAAU, AMMA, AMGR	Continue monitoring- high densities of AMGR found in 2010. Watch nitrate levels. Reed Canarygrass is dominant, increase plantings of *Juncus spp.* if possible.
JC	Leach Botanical Gardens	Private	PSRE, AMMA, RAAU	Increase numbers of planted plants (not potted) and deepen pond if possible.
JC	Brookside Constructed Ponds 1-7	Parks & Rec	PSRE, RAAU, AMMA, LICA*	Continue monitoring- RAAU are thriving here. Watch for invasives (Reed Canarygrass, Purple Loosestrife) and protect sites from public disturbances. *Not breeding in constructed ponds.

Appendix 5. Page two of recommendations for sites surveyed during 2010 amphibian monitoring season.
Watershed codes: CS- Columbia Slough, JC- Johnson Creek, WM- Willamette Watershed, TC- Tryon Creek, FC- Fanno Creek

Water-shed	Site Name	Site owner, info	Pond-breeding Species Presence	Site Recommendations
PSRE- Pacific Treefrog, **RAAU**- Red-legged Frog, **AMMA**- Long-toed Salamander, **AMGR**- Northwestern Salamander, **TAGR**- Rough-skinned Newt, **LICA**- Bullfrog				
JC	Brownwood/ Schweitzer	BES	PSRE, RAAU, LICA	Continue monitoring in 2011 to complete survey of entire site (with increased effort). This area has potential for native species to breed successfully in selected areas.
JC	Alsop Wetland	BES	PSRE, RAAU, AMMA	Continue monitoring- only one year of data has been collected. Site is located in hot spot of native amphibian activity in East Portland.
JC	Hillside Properties	Parks & Rec	unknown	Unlikely to hold sufficient water levels to attract breeding amphibians. Mid-winter site visit in 2011 is recommended if possible.
JC	Powell Butte: Private-North side	Private	unknown	Site visit recommended in 2011 to monitor for possible breeding species. Possible Iris removal.
JC	Powell Butte: 3 Firs Ridge Wetland	Parks & Rec	unknown	No recommendations- not suitable for amphibian breeding.
JC	Errol Heights	Parks & Rec	none	Absence of amphibians is intriguing here- continue monitoring throughout site in 2011 (new & existing ponds). Continue to monitor nitrate levels & water surface temperatures.
JC	Crystal Springs	Private	unknown	Consultation with Reed College necessary for future monitoring. Crystal Springs was not surveyed in 2010; A complete survey during egg-mass season in 2011 is recommended.
JC	Tideman Johnson	Parks & Rec	PSRE, AMMA	Continue monitoring to determine presence or absence of PSRE & AMMA especially if desired future conditions include deepening pond for greater amphibian survivorship.
JC	Kelly Creek meander	BES	LICA	Monitor invasives (Bullfrogs). No other recommendations.
JC	Beggar's Tick	Parks & Rec	PSRE, RAAU, AMMA	Continue monitoring, especially for RAAU. Remove trash throughout site (possible stewardship activity) and increase native plant species around perimeter of site if possible.
WM	Oaks Bottom	Parks & Rec	PSRE, AMMA, RAAU, LICA*	Continue monitoring throughout site, especially for RAAU in scrub/shrub wetland. *Observed as adults in north end of site, possibly not breeding (dependent on weather and water levels).
WM	Sellwood Riverfront Pond	Parks & Rec	PSRE, AMMA, RAAU	Continue monitoring, especially for RAAU and monitor for invasives (Bullfrog, plants). Limit, and ideally prohibit, off leash dog activity!
WM	Water Pollution Control Lab & Test Swale	BES	PSRE	Remove trash from pond (possible stewardship activity) or create educational signs around pond.
WM	Audubon Society Pond	Private	TAGR*	Continue monitoring for other natives- and AVOID winter plantings during egg mass season (from December through March). *Observed as adults.
TC	Tryon Creek Headwaters	Parks & Rec	unknown	Continue monitoring to determine when and if PSRE will colonize new ponds.
TC	Maricara Park	Parks & Rec	unknown	Unlikely to hold sufficient water levels to attract breeding amphibians. Mid-winter site visit in 2011 is recommended, if possible.
FC	April Hill	Parks & Rec	PSRE, AMMA, TAGR	Monitor water levels in 2011 and continue monitoring for native species. Determine deepest area of wetland and increase hydroperiod by deepening small area of site (approx. 10mx10m).