

Two-year study of amphibians in Oaks Bottom Wildlife Refuge



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Introduction

Oaks Bottom Wildlife Refuge is a 141 acre refuge in southeast Portland, Oregon. Historically, it was largely wetland habitat, but much of the area has been used as a landfill for household and construction waste, and much of the wetland has disappeared—the north end of the park has been raised almost 2m by fill. After the City of Portland acquired it in 1959, the area was allowed to regrow into wildlife habitat, but the amount of wetland habitat was still greatly reduced from before it was used as a landfill. Wetland habitats are important for many species, and one taxon that often depends on them is amphibians. The first question of this study is: What amphibian species are using Oaks Bottom Wildlife Refuge?

In the early 2000's it was observed here that many native pond-breeding amphibians were breeding in ponds that dried up too soon to allow metamorphosis, or in ponds that were too deep for desirable aquatic vegetation and allowed predators such as fish and invasive bullfrogs. There was a general lack of breeding ponds of the ideal size and depth for native amphibian breeding. In 2005, two new amphibian breeding ponds were constructed in Oaks Bottom in hopes of creating better native habitat. The second question of this study is: How are the newly-constructed ponds affecting amphibian populations?

Amphibians in the Pacific Northwest have a life-history that is heavily influenced by seasonal changes. Amphibians generally need to stay moist and are at constant risk of desiccation. Therefore, they must generally spend the hot, dry summers taking refuge in relatively moist forested areas. Many species use ponds for breeding, and therefore they are influenced by the hydroperiod of the water in which they breed. Soil moisture content and pond depth certainly vary with the seasons, but there are many additional factors that may or may not change throughout the year, and may affect amphibians. The third question of this study is: How do amphibians and their habitat characteristics change throughout the year?

Methods

To answer these questions, another researcher or I visited Oaks Bottom once per week for two full breeding seasons and monitored both amphibians and their habitat characteristics during each visit.

Sampling of terrestrially-breeding amphibians

Each week we conducted a 30-minute search for terrestrially-breeding salamanders. When we discovered a salamander we recorded its species, the type of object under which we found it, and the GPS coordinates. Time spent recording data was not included in total search time.

Sampling of terrestrial habitat

The only terrestrial habitat factor that we sampled was precipitation. We obtained daily precipitation values for southeast Portland through the United States Geological Survey website and ran a regression analysis of the number of salamanders that we found on a given survey by the amount of precipitation in the previous two days.

Sampling of pond-breeding amphibians

Each week that water was present in ponds we sampled for pond-breeding amphibians. The type of sampling depended on the life-history stage of the amphibians. From when the ponds filled in to the time that the last egg hatched we surveyed for eggs, and from the time that the first egg hatched to the time that the ponds dried up we surveyed for tadpoles. We sampled each of four ponds as shown in Figure 1.

Egg Surveys

Our egg surveys were time-constrained searches of randomized transects in and across each pond. We started each search at a randomized location on the north/south axis of the pond; we determined this location using a random number table where 0 is the far north end and 9 is the far south. We used a coin toss to determine whether to start at the east side and

move west or to start at the west side and move east. Once we crossed the pond we moved 1m south and continued in the opposite direction; if we reached the south end of a pond we continued at the north end of the pond. Figure 2 shows our transect method.

We searched each pond for 20 minutes, looking for egg masses on the water surface, on the pond bottom, and attached to vegetation. For each egg mass we recorded the species, the approximate number of eggs, the developmental stage of the eggs, and the type of object to which the mass was attached. If there were fewer than ten eggs in a mass, we counted each egg individually. If there were between ten and 100 eggs we estimated to the nearest 5, and if there were more than 100 we estimated to the nearest 50.

Tadpole Surveys

We walked the perimeter of each pond 1m in from the edge. Every three steps we dipped an aquarium net (opening is approximately 600cm²) into the water. The net entered the water at a full arm's length at a 45° angle to my direction of movement (halfway between my front and my side facing the center of the pond). I pulled the net straight towards my body at a depth of ~0.5m. We identified every amphibian that we encountered to the species level, as well as identifying other organisms that we found in the pond to a coarse level. We recorded how many times I dipped the net in each pond to obtain a measure of amphibian density.

Sampling of pond characteristics

Each week that there was water in a pond we sampled each of ten factors: Collecting a water sample—we collected an integrated water sample from the deepest point of the pond, or from a point 1.5m deep if the pond was deeper than 1.5m. To collect an integrated water sample we inverted an empty 25mL vial and submerged it in the pond to the bottom. Then we slowly turned it upright as we brought the vial towards the surface to obtain a sample of water that is representative of all depths.

pH—We dipped a colorpHast[®] pH-indicator strip in the water sample for two seconds and read the pH after 2 minutes.

Nitrates and nitrites—We dipped an Industrial Test Systems' nitrogen test strip in the water sample for two seconds and read the results after 60 seconds.

Dissolved oxygen—We snapped a CHEMets[®] dissolved oxygen vacuole in the water sample and read the results after 10 minutes.

Temperature—We held a glass thermometer at a depth of ~20cm at of the deepest point of the pond (or at a location that was 1.5m deep if the pond was deeper than 1.5m) for 30 seconds.

Depth—We recorded the depth of each pond at the deepest point for ponds <1.5m deep.

Clarity—We measured the clarity of each pond on a scale of '1'-'5' (with '1' being cloudy and '5' being clear). To do this, we stuck a ruler into the water until we could no longer see the tip. We scored a '1' if this distance was <5cm, a '2' if it was between 5 and 10cm, a '3' if it was between 10 and 15cm, a '4' if it was between 15 and 20cm, and a '5' if it was >20cm.

Percent aquatic vegetation—We measured the percent of aquatic vegetation present in the pond by visually dividing the pond into 25 equal segments, and counting how many of these segments were dominated by aquatic vegetation.

Percent refugia—We measured the percent refugia in the pond using the same method described above in percent aquatic vegetation. Refugia include branches, sticks, and plants with areas for tadpole and larvae to hide.

Surrounding vegetative cover—We surveyed the 10m surrounding the pond and classified the area on a scale of '1'-'5' with a '1' indicating that the ground is almost completely exposed at a height of 1m or below (0-20 percent covered) and a '5' indicating that the ground is almost completely covered at a height of 1m or below (80-100 percent covered).

Results

Terrestrially-breeding amphibians

We found two species of terrestrially-breeding salamanders in Oaks Bottom (Figure 3): Oregon salamander *Desmognathus eschscholtzii*, and Western red-backed salamander *Plethodon vehiculum*. During my surveys, we also encountered many long-toed salamanders (a pond-breeding species) utilizing the same habitats as the terrestrially-breeding species. Figure 4

shows how occurrence of each of these species changed throughout the year. I found a much higher total number of red-backed salamanders (78) than Oregon salamanders (9).

We found that precipitation in the two days prior to a survey was positively correlated with the number of salamanders that I found during a survey. There are more salamanders above ground when it has been raining more.

Pond-breeding amphibians

We found three species of pond-breeding amphibians during surveys—Pacific chorus frog *Pseudacris regilla*, red-legged frog *Rana aurora*, and long-toed salamander *Ambystoma macrodactylum*. Figures 5 and 6 show how the eggs and tadpoles, respectively, changed through the year. In general, long-toed salamanders seemed to breed earlier than chorus frogs and red-legged frogs. Long-toed salamanders also seemed to have a second peak of breeding, likely because most of the eggs from the first breeding episode froze.

Figure 7 shows how each of the factors that I monitored changed through time. Most of the factors do not show a clear pattern through time. Depth of each pond wavers through the wet season and eventually decreases as each pond dries up in the summer, and temperature rises fairly steadily in each pond.

The total amount of native amphibian breeding greatly increased from 2008-2009 (Figure 8), even though the established pond in which there was the most breeding in 2008 (Salamander Slough) saw a decrease in breeding of all native species in 2009. This is because there was greatly increased breeding in the two newly-constructed ponds as the amphibians discover and colonize them. I did not begin sampling the channel area until 2009, and I therefore cannot compare breeding between the two years.

Discussion

Terrestrially-breeding amphibians

Oaks Bottom seems to be a good habitat for two species of terrestrially-breeding salamanders: Oregon salamander, and the Western red-backed salamander. This habitat also

provides upland habitat for the pond-breeding long-toed salamander. A previous study by Reed College students showed that these species have stable populations over the past seven years. We found that although all three species were found under a variety of cover objects, the species seemed to prefer different objects. Red-backed salamanders were most often found under chunks of cement, while Oregon and long salamanders were most often found under logs.

The population of red-backed salamanders seems to be relatively large and healthy, but the population of Oregon salamanders does not. I am worried about the Oregon salamanders in this area because I found such low numbers of them. In a study looking at terrestrially-breeding salamanders and their habitat all over the city, I discovered that Oregon salamanders prefer logs over other types of cover, so it is possible that adding logs to Oaks Bottom will increase the Oregon salamander population.

The two-terrestrially-breed salamanders seem to be present throughout the winter and spring, and drop in occurrence in May. They are likely moving underground to stay moist. The pond-breeding long-toed salamander appears to be more present in the spring and early summer, presumably as it is moving away from ponds after breeding and into the forest to spend the summer.

As expected, that found terrestrial salamander presence to be positively correlated with precipitation because, as they breathe through their skin, they need to stay moist at all times.

Pond-breeding amphibians

The two newly-constructed ponds in this area have very healthy populations of chorus frogs and long-toed salamanders. Addition of refugia in the form of branches to Aurora Lake greatly increased tadpole survival (in the summer of 2008 no tadpoles survived to metamorphosis, whereas hundreds did in the summer of 2009 after addition of refuge). To make these ponds attractive to red-legged frogs I simply suggest waiting. The plants that are colonizing the ponds are favorable for red-legged frogs and I believe that they simply need time to mature. In addition, I recommend monitoring these ponds for invasive plants as I have discovered purple loosestrife and mint beginning to invade Tadpole Pond. Also, Aurora Lake has

little surrounding vegetative cover. Amphibians benefit from cover surrounding ponds so that they can safely move to and from the ponds. I recommend adding trees, shrubs, and ferns to the area surrounding this pond.

These two new ponds have been very quickly colonized by native amphibians, and breeding in these ponds quickly passed that in the existing pond. This shows that there were existing populations of native amphibians that simply did not have enough suitable breeding habitat, and these new ponds have provided additional habitat, and we are still seeing increasing native amphibian breeding in the two new ponds every year. The addition of these ponds has increased the amount of native amphibian breeding in Oaks Bottom by about 4-fold.

Also, I encountered one rough-skinned newt in this area, not during any of my surveys. It was an adult swimming in Tadpole Pond in February. The Reed College study never found any adult rough-skinned newts in Oaks Bottom, and I have not found anyone else who has ever seen one here. Because I found it in one of the newly-constructed ponds during breeding season, it is possible that this area did not previously provide this species with suitable breeding habitat, and now that these ponds are present this species will be able to colonize the area.

We did not see a pattern in any of the chemical parameters of the ponds through time. We had noticed that tadpoles develop at different rates in different pond, and we hypothesized that changes in chemical concentrations might influence the rate of tadpole development, but this study does not support this hypothesis. It does support the hypothesis that temperature is acting as a signal for tadpole development—as the temperature of a pond increases tadpoles develop more quickly, presumably because they need to make it out of the water before it completely dries up.

Salamander Slough is experiencing very low numbers of chorus frogs, red-legged frogs, and long-toed salamanders. This pond could benefit from more aquatic vegetation. *Eleocharis* is present in the pond, but it does not start growing until the pond is already dried up in the late summer. It is possible that the pond is too deep to support much aquatic vegetation, but I recommend attempting to plant more native species.

The deep, channeled area near the bluff trail is an important area for red-legged frogs with high densities of egg masses and many adults spotted. This area also seems to be a high-

traffic area for people. I recommend continuing the split-rail fence along the path in this area, because the current fence is only diverting people a few feet as I see trails developing from its ends. I also recommend adding branches to this pond. Although there is aquatic vegetation, all plant species except for reed-canary grass do not grow until the pond is almost dry in the summer and therefore do not provide egg mass attachment substrate. Almost all of the red-legged frog egg masses that I found here were attached to one large branch of a tree that had fallen into the water. I believe that the water is too deep and the sides are too steep for many plants to take hold, but branches can provide adequate egg attachment substrate.

In Wapato Lake I found few chorus frog egg masses or tadpoles even though I heard hundreds calling. I believe this is because the recently-invaded purple loosestrife is not ideal habitat for native pond-breeding amphibians. I therefore recommend continuation of the efforts to eradicate purple loosestrife in this pond.

There is also a small, rocky pond at the very southern end of this area near the bike path. This pond had a high density of chorus frog eggs and tadpoles. I recommend planting native plants in this pond as it completely lacks any aquatic vegetation.

Another potential threat to the amphibians in Oaks Bottom is the fungus-induced disease chytridiomycosis. This disease has been found all over the world and is devastating amphibian populations around the world. Work by Chauncey Anderson from the United States Geological Survey showed that this fungus that causes this disease is present in ponds in Oaks Bottom. This disease does not seem to have much of an effect on terrestrial salamanders or chorus frogs, but it is possible that it is contributing to the low number of red-legged frogs and long-toed salamander larvae.



Figure 1 Map of the north end of Oaks Bottom Wildlife Refuge showing my four study ponds. Aurora Lake and Tadpole Pond are the newly-constructed ponds.

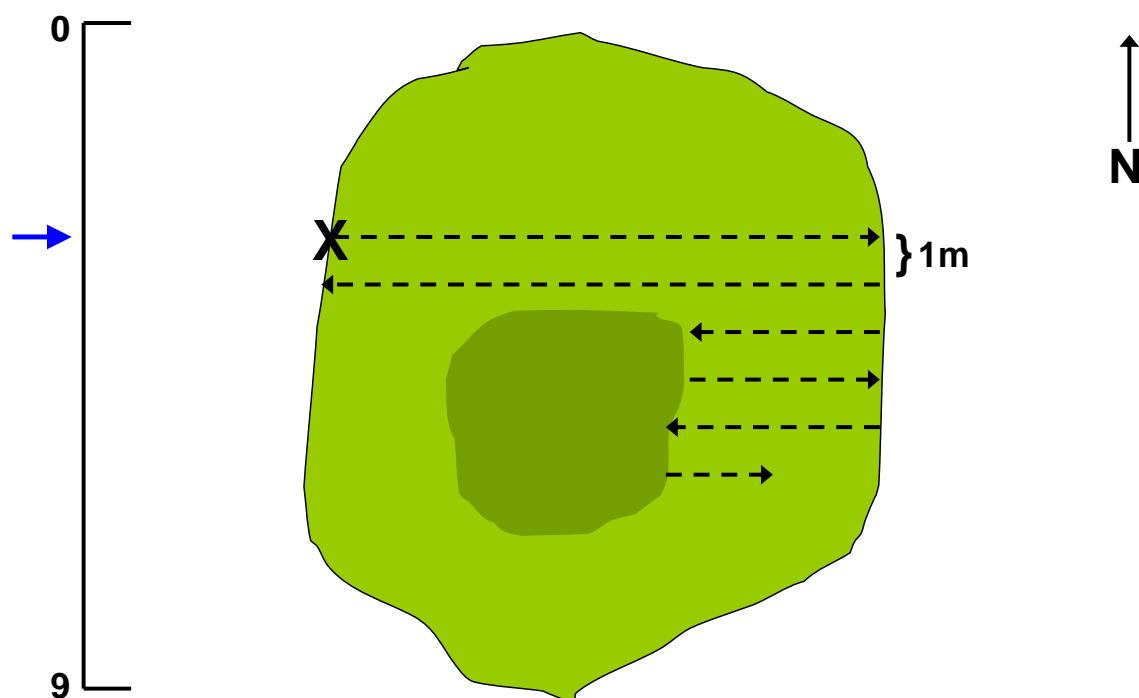


Figure 2 Sampling method for egg mass surveys. The entire green area represents a pond; the lighter green is water <1m deep, and the darker green is water >1m deep. I constrained searches to 20 minutes. I began the search by selecting a random single digit number from a random number table and correlated it to the distance from the north end of the pond (from 0 to 9); in this case it was 3 (indicated by the blue arrow, X denotes where I began the survey). I determined whether to start at the east end and go west or start at the west end and go east by flipping a coin. When I reached the east or west end of the pond (or water that was deeper than 1m) I turned around, moved 1m south, and continued. In this example I conducted two full pond, and three and a half partial pond, transects before the end of the 20 minute interval.



Oregon salamander—
Ensatina eschscholtzii



Western red-backed salamander—
Plethodon vehiculum



Long-toed salamander—
Ambystoma macrodactylum

Figure 3 Salamanders that I encountered during my terrestrial survey. The Oregon and red-backed salamanders are terrestrially-breeding, while the long-toed salamander is pond-breeding.

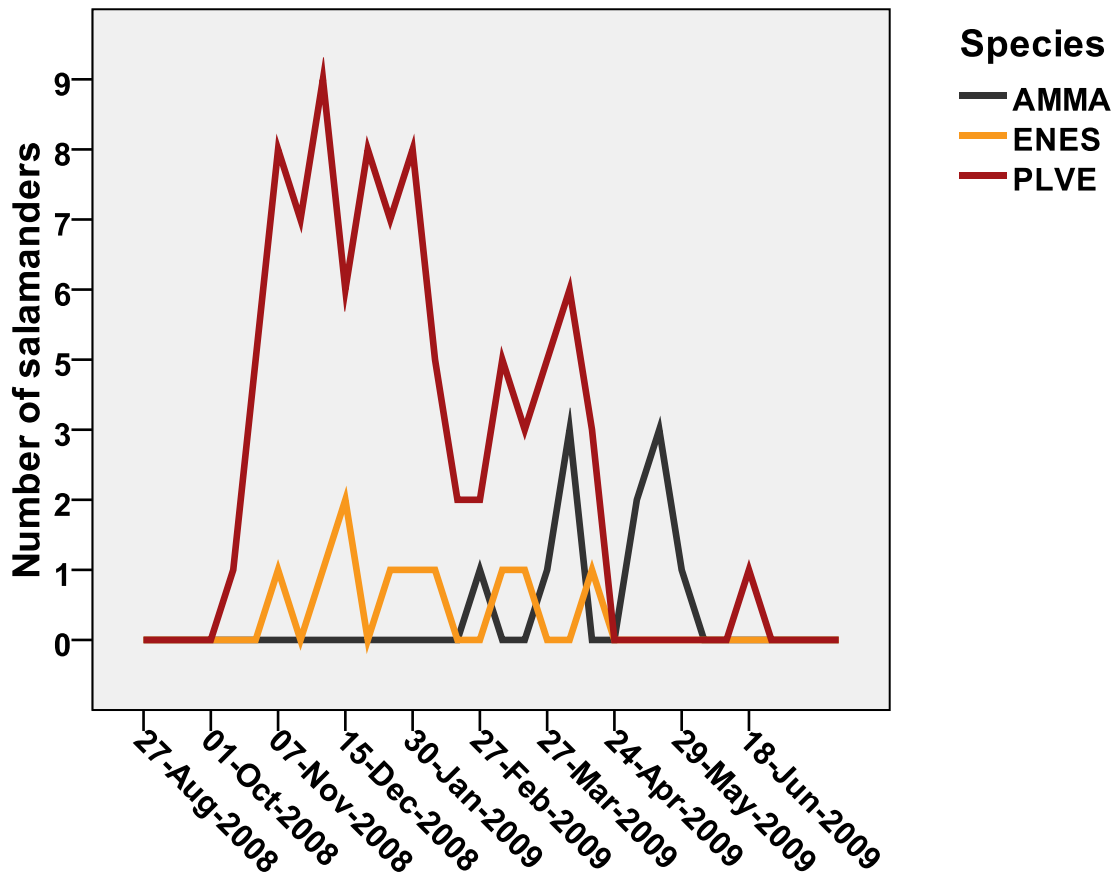


Figure 4 Salamander occurrence throughout the year. Species are as follows: AMMA—long-toed salamander, ENES—Oregon salamander, and PLVE—red-backed salamander. The two terrestrially-breeding salamanders seemed to be more present during the wet season, and the long-toed salamander was more present after breeding in the spring.

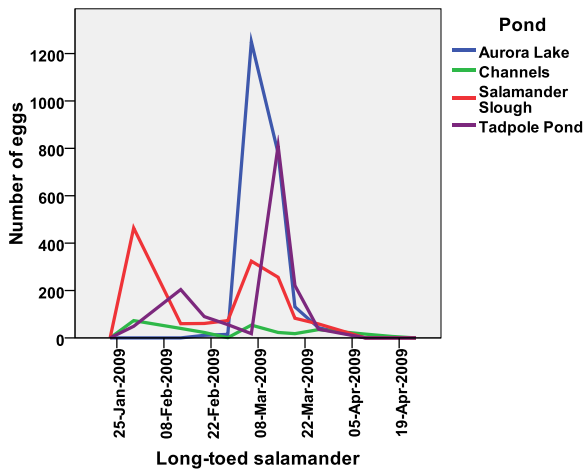
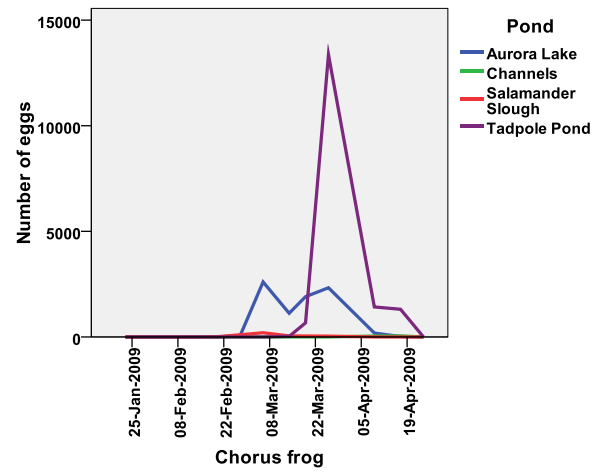
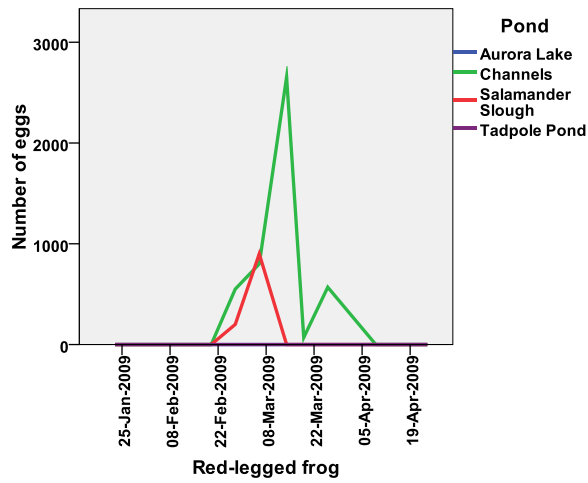


Figure 5 Timing of amphibian breeding in ponds. The y-axis is the number of eggs found during a 20-minute survey in each pond on each date. Red-legged frogs had the highest density of breeding in the channels, chorus frogs did in the newly-constructed Tadpole Pond, and long-toed salamanders did in both of the newly-constructed ponds.

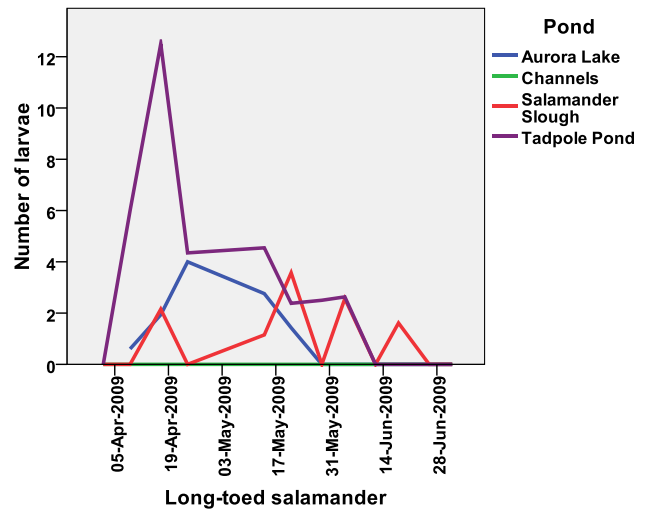
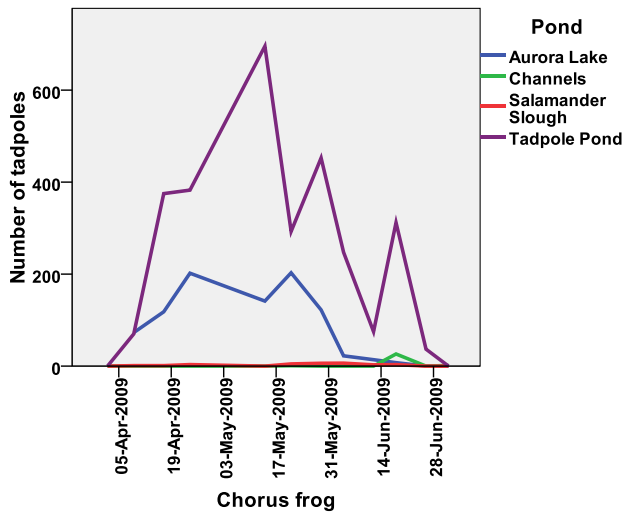


Figure 6 Timing of amphibian tadpoles and larvae in ponds. The y-axis is the number of tadpoles or larvae found per 100 met dups in each pond on each date. I found so few red-legged frogs that I could not compare them. Chorus frogs had the highest density in the newly-constructed Tadpole Pond, followed by the newly-constructed Aurora Lake. Long-toed had the highest density in Tadpole Pond as well, but were also present in moderate levels in Aurora Lake and Salamander Slough.

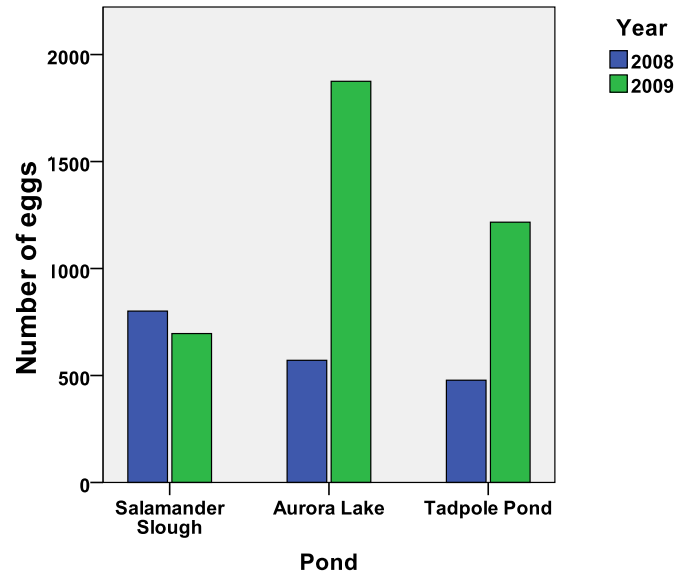
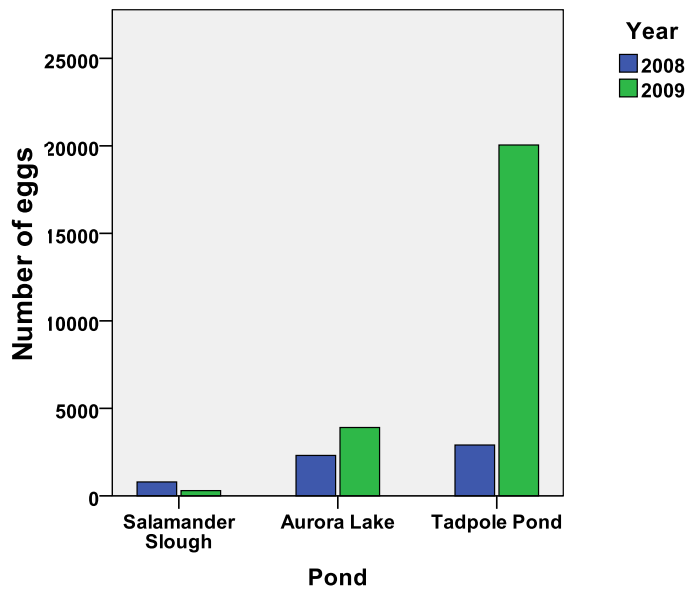


Figure 7 Comparison of breeding in ponds between 2008 and 2009. Chorus frogs are shown on the left, and long-toed salamanders are shown on the right. For both species, there was a decreased breeding in the established pond in 2009 than in 2008, but increased breeding in the newly-constructed ponds. This shows that these species are colonizing the new ponds and choosing them over the established pond. The total native amphibian breeding increased in Oaks Bottom by about four-fold after the addition of the two new ponds.