Amphibian & Reptile Monitoring

2000-2016

on the Lester and Monique Anderson Lands

in Lincoln, Vermont

Prepared for the

Colby Hill
Ecological Project

Prepared by

Jim Andrews and Erin Talmage
Vermont Reptile and Amphibian Atlas Project
642 Smead Road
Salisbury, Vermont
05769

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Introduction

In the spring of 1999 Lester Anderson expressed an interest in establishing herpetological monitoring at selected sites on his property. Three types of monitoring were discussed: egg-mass counts of spring breeding amphibians, cover-board monitoring of woodland salamanders, and snake monitoring using artificial cover (slate). All these methods provide indices of different segments of the local herpetofaunal population. During the 1999 field season four ponds were selected for egg-mass monitoring and counts began. During the 2000 field season both the cover-board transects for salamanders and the snake-covers were put in place. Counts began along the cover-board transects in 2000. However, many of the snake-covers broke over the late fall and winter and needed to be replaced with thicker slates during the early fall of 2001 before counts began. The thicker slates have held up well with only two or three needing replacement each year since.

Beginning with the 2008 field season, egg-mass counts and salamander cover-board surveys were scheduled to alternate annually to reduce costs. Data updates are now produced every other year as well. During the 2008 season, cover-boards were not checked, egg-mass surveys took place, and a report was written. Despite our plans, due to funding limitations, only the snake-covers were checked during the 2009 field season and no report was written. In 2010 egg-masses were surveyed, salamander cover-boards were checked, and an update was written. In 2011, 2013, and 2015 we monitored only the snake-covers to keep them on an alternating-year-schedule. In 2012, 2014, and 2016 we monitored egg-masses and salamander cover-boards. This report and the snake monitoring during the fall of 2017 will both be on the 2017 budget. The 2018 budget will fund amphibian monitoring (egg-masses and salamander cover-boards) only. This alternation between amphibian monitoring and snake monitoring with a report is an effort to help minimize costs and keep the budget fairly stable from year to year. A day or two of maintenance is needed every year to replace rotten and broken covers, repaint marks, and trim vegetation. Our goal is to keep all artificial covers in use even on years when we are not checking them. Although annual monitoring would be ideal, we have fit our monitoring schedule to budget realities. Long-term monitoring is both rare and valuable.

Methods

Egg-mass counts

Egg-mass counts take place at four ponds: Upper Fred Pierce (UFP), Lower Fred Pierce (LFP), Wells (WP), and Guthrie (GP). Upper Fred Pierce Pond is immediately across Colby Hill Road (east) from the Anderson residence. Lower Fred Pierce is roughly 100 m south of the residence across Colby Hill Road. Both of these ponds are found on the Fred Pierce tract. Guthrie Pond is immediately inside the gate off Guthrie Road on the Guthrie-Bancroft tract. Wells Pond is in a field roughly 50 m northwest of the Wells homestead on the Wells tract. Exact locations for these ponds are shown in the 2001 & 2002 reports.

Egg-mass counts at this site are designed to monitor egg-masses of two spring breeding species with very large and easily identified egg-masses: *Lithobates sylvaticus* (Wood Frog) and *Ambystoma maculatum* (Spotted Salamander). The annual high count of egg-masses for each species is the index that over time can be used to show the relative size of the female breeding population at these sites (Corn and Livo, 1989). It is not intended to provide an estimate of the total population of either of these species only a convenient index of the number of breeding females. This is a variation of the breeding site survey recommended by Heyer et al. (1994). Adults and young of these and other species may be found during these counts and their presence and numbers are noted but these numbers are not intended to provide meaningful indices to those populations.

Since the egg-masses are visible for a few weeks after laying, the high count will be very close to the total count in most years. These counts are not cumulative nor do they have to be from the same day for different species. All surveys are performed under conditions that allow the viewer to see easily into the pond (limited wind, no rain, and adequate light from a high angle). Polarized glasses are sometimes helpful, and worn when necessary. The counts are designed to take place in habitats where Wood Frog and Spotted Salamander have been previously located and during or shortly after their breeding period. Egg-mass counts begin soon after the snow and ice melt and continue at weekly intervals until egg-laying activity ends or the total number of egg-masses is declining.

The winter of 2015-2016 had record warm temperatures and below average snowfall. Burlington, Vermont received 34.3 inches of snow, considerably lower than the mean of 72.2 inches. (http://www.weather.gov/btv/historicalSnow accessed Jan. 20, 2017). It was the warmest winter in 121 years in all New England states. This was in strong contrast to the winter of 2014-2015, which was considered one of the harshest winters on record. (https://www.washingtonpost.com/news/capital-weather-gang/wp/2016/03/08/americas-year-without-a-winter-the-2015-2016-season-was-the-warmest-on-record/?utm_term=.d39012d33f59 accessed Jan. 20, 2017). The warm winter in 2015-2016 appears to have resulted in the early amphibian movement seen in the spring of 2016. Movement was seen in the Champlain Valley as early as March 10. We found active Wood Frogs and egg masses in Guthrie, Wells, and Lower Fred Pierce on March 31. This was more than two weeks earlier than in 2014 when the first egg masses were seen on April 16th, and there was still six inches of snow still on the ground in 2014. After the harsh winter of 2014-2015 we did not collect egg mass data, nor did we in 2013, a year when there was movement in the Champlain Valley as early as March 12. These large annual variations are not visible in our tables due to our every-other-year monitoring schedule; however, long-term changes will still show over time.

Cover-boards for salamanders

Three sets of cover-boards were constructed and put in place along the old wood road connecting the Guthrie-Bancroft fields with Rte. 17. This road starts near the Lincoln/Bristol border and continues into Bristol as you head northwest toward Route 17. It appears that all of the cover-boards; however, are within the town of Bristol. The first two sets each contain 15 pairs of cover-boards. Although it was our intention to have three sets of 15 pairs, it was discovered in 2001 that the third set of cover-boards actually contained 16 pairs rather than the 15 that were intended. The extra set was left in place and the data are included. Exact locations of the three sets with UTM coordinates are shown in the 2001 report. These cover-boards were spaced based on North American Amphibian Monitoring Program (NAAMP) protocols with Canadian design covers (Craig et al., 1999) that have been shown to be highly successful in attracting salamanders. The structures (salamander condos) are built of four rough-cut white-oak boards that measure 305 mm x 152 mm (12" x 6") and two spacers. White oak was selected on the basis of its resistance to rot while in ground contact, however both boards and spacers have needed to be replaced at the rate of five or six per year as they gradually become saturated and rotten. Each condo consists of two boards side by side on the ground with a slight gap (~10 mm) left between them, so that they almost form a square 305 mm by 315 mm. The remaining two boards are placed on top of them and at right angles to them. In between the two layers of boards, along the outside edges, are two spacers (8 mm x 22 mm x 260 mm long), which are used to lift the outside edge of the upper two boards 8 mm and create a small gap of varying height for the salamanders. The pairs of structures were placed a minimum distance of 0.5 m apart based on NAAMP recommendations and each pair of condos was located a minimum distance of 6 m from the nearest pair. The three 15-pair transects are separated by distances of between 100 and 200 m. All organic matter was removed from under the condos so that they rested on the mineral layer. Herbaceous growth was removed from between the pairs and for a distance of ~50 cm in all directions and is kept free from the area. Forest litter is removed from the top of the condos but left between and around them. All condos are numbered with latex exterior paint (white). These numbers fade over the course of a year and are remarked as needed. The first set of 15 pairs consists of condos marked 1A and 1B through 15A and 15B. The second set consists of condos 16 A & B through 30 A & B, and the last set consists of condos 31 A & B through 46 A & B.

Records are kept on the specific condo in which amphibians are found. In addition, all amphibians found under the cover-boards are measured to provide information on age-class structure of the population using the boards. We measure both the snout to vent length (SVL) and the total body length (TBL) of the salamanders. However, the small salamander species that are being monitored using this method, sometimes lose all or a portion of their tails to predatory birds and small mammals. Consequently, the most reliable measure of size is their snout to vent length (SVL). Starting in 2006, in addition to taking length measurements we began measuring the mass of most of the salamanders as well. Kate Kelly was part of the data collection team in the fall of 2016. With her assistance we were able to look for the presence of eggs in a few of the salamanders.

We also keep records on where within the salamander condos the amphibians are found. It is of interest to us in order to more effectively design future condos. Four locations have been noted: board (between boards), ground (between board and ground), crack (in the space between the boards) and adjacent (along side the cover-boards). Salamanders found adjacent to the cover boards are not counted in our monitoring totals.

These counts are currently scheduled for every other year. Since the cover-boards have been very successful at attracting salamanders, we can obtain enough data and save time and money by only checking ½ of them during a given year. As described above, the covers are placed in pairs and both are labeled with the same numbers but different letters. During 2016 we checked only the A covers and left the B covers undisturbed.

Snake-covers

The snake-covers were initially an experiment but they are working well. I am not aware of any other efforts to monitor snake populations using covers, though they are used as an inventory tool at other locations. I chose to use slate as a result of its ability to absorb the sun's rays and retain its heat as well as slate's permanence in ground contact. Through experience and informal communications with other herpetologists I have come to believe that the larger the piece of cover the better, but practical and aesthetic considerations led me to initially try old roofing slate. The largest used roofing slate that I could locate was 610 mm x 360 mm and 5 mm thick. With two of these slates I formed a sandwich with a small wooden spacer (~18 mm x ~22 mm x ~260 m) placed approximately ¼ of the way in from the outside edge to create a small space of varying height between the slates. I placed forty of these slate sandwiches along the upper margins of the Guthrie-Bancroft fields at a distance of roughly 2 m from the trees (see earlier reports for photos). I chose the upper margins of the fields to maximize the exposure to southern and western sun. The snake-covers were placed on the cut grass that already was in place. No additional cutting or clearing was done. During the late fall and winter of 2000-2001 most of the original snake-covers were broken. During the early fall of 2001, they were all replaced with thicker slate slabs that measured 560 x 360 mm and were 20-25 mm thick. Each year a few of these thicker covers are found to be broken and they are replaced, even if it is a year when monitoring does not occur. In addition, a few slates need to be remarked each year. We use white exterior latex paint for the numbers. Some of the new slates are slightly longer (610 mm x 360 x 20-25 mm thick) but otherwise identical. Five new sets of covers were added to the transect during the summer of 2008. These covers continue the transect on the north side of the stonewall and hedge row into the adjacent field to the north. This is an effort to determine if distance from the stonewall has an impact on the use of individual artificial covers. Data from the new covers (41-45) are not used for year-to-year monitoring comparisons.

Snakes often disperse widely during their foraging season; consequently it was unknown whether forty pairs of artificial cover would attract enough snakes to provide useful data, however they seem to be working well. Conditions under the covers have changed from the first couple years as underlying vegetation dies, invertebrates colonize them, and small mammals begin to tunnel under them. In some places the woods began creeping into the field and/or branches reaching out and shading the covers. Initially the covers were approximately two meters from the woods. In 2007 we began an annual opening up of the cover array, including clearing brush that has moved into the field and cutting low branches that have shaded the covers. Sometimes ants completely fill the spaces between the covers with their nests. When this occurs, the spaces between the covers are cleaned out but the nests under the covers are left in place. If the ants persist in filling in the space between the covers, the pair of covers is moved slightly to one side of the ant nest.

We chose to monitor the slates in late summer, as it is after the young of the year have been produced and snake numbers are at their annual maximum. In addition, the cooler air temperatures of late summer/early fall should make the relative warmth of the slate more attractive at this time of the year. The snake-covers are checked once a week until the snake's den for the winter.

After a few years of monitoring we became aware that during the annual maintenance of the snake covers in July, gravid female snakes (mostly Red-bellied Snakes) were using the covers. We believe they are using the covers for incubation sites to help raise their body temperatures and speed development of their embryos. As a result, we have

started to gather data while doing the summer maintenance. This provides data on clutch sizes, since the number of embryos within their bodies can be determined by palpation.

When a snake is found, we measure the snout to vent distance as well as the total body length. We record any unusual physical markings or injuries, and when we find Milksnakes (*Lampropeltis triangulum*) we record their patterns to allow us to distinguish individual snakes. In 2006 and 2007, in addition to length measurements we massed the majority of the snakes we found. We also keep records on where within the snake-cover the reptiles are found. Two locations are noted: between (between slate) and surface (between slate and ground).

We monitored the snake-covers during the fall of 2015, and we will monitor them again in the fall of 2017. We continue to follow our schedule such that in years when we monitor the snake-covers, the amphibians are not monitored. These are good years (to keep budgets even) to write summaries of our findings. The way the pattern has developed, the reports are written in the late winter/early spring of the year prior to the monitoring of the snake-covers in the fall.

Basic species information

Two spring-breeding amphibians that deposit large easily identified **egg-masses** are using the breeding ponds: *Ambystoma maculatum* (Spotted Salamander) and *Lithobates sylvaticus* (Wood Frog). The Spotted Salamander is a large (190 mm) heavy-bodied salamander that is widespread in Vermont in areas where mature hardwoods or mixed hardwoods and suitable breeding ponds occur and migration is not obstructed. It is black with yellow spots and is largely fossorial (lives underground). It emerges from its woodland over-wintering sites during the first warm rains of spring to migrate to its breeding pond. Within a few short weeks it returns to its summer foraging territory. The egg-masses that it deposits are the most obvious evidence of its occurrence in an area.

The Wood Frog is a medium sized (60 mm) frog that is almost entirely terrestrial. It is easily recognized by its white upper lip and black mask on a solid brown background. It forages and over winters in the woodlands and only enters ponds in the spring to breed. It too is widespread in Vermont as long as healthy woodlands and breeding ponds can be found and travel between the two is largely unobstructed. It also deposits large and easily identified egg-masses in early spring. Within two weeks it has usually returned to nearby woodlands.

Only one species of salamander is found often enough under the **cover-boards** to be monitored: *Plethodon cinereus* (Eastern Red-backed Salamander). However, we have also found limited numbers of *Desmognathus fuscus* (Northern Dusky Salamander), *Ambystoma maculatum* (Spotted Salamander), *Eurycea bislineata*, Northern Two-lined Salamander, and *Notophthalmus viridescens* (Eastern Newts).

The Eastern Red-backed Salamander is a slender and small (40 mm) salamander that is our (Vermont's) only fully terrestrial species of amphibian. Its most common color morph has a dark reddish-brown back with black sides and a salt and pepper (gray and white speckled) belly. Occasionally it is missing the red stripe on its back and the entire salamander is a dark gray/brown color, this is referred to as a *lead* morph. Very occasionally the entire salamander is orange-red, this is called the *erythristic* morph. This species undergoes its larval stage and metamorphosis inside the egg. Eggs are laid in moist conditions inside a rotten log or in cavities in the soil as long as there is some solid object to suspend the egg-mass from. Consequently, it does not require open water at any life-stage and is dispersed widely in medium to mature hardwoods or mixed hardwoods regardless of the distance to the nearest water body. It is sensitive to soil pH, soil moisture, depth of leaf litter, and the structure and age of the woodlands in which it breeds. As a result, it is a good species to monitor as an indicator of forest health.

When the **snake-covers** were placed, it was unknown which species of snake would be most attracted to them. During the fall of 2001 only *Storeria occipitomaculata* (Red-bellied Snake) used the snake-covers. The Red-bellied Snake is a small, secretive, viviparous (giving live birth) snake of woodlands and woodland openings. Using data gathered in Vermont through 2006, an adult Red-bellied Snake has a median SVL of 195 mm and a median TBL of 240 mm (n=79). A neonate Red-bellied Snake in Vermont has a median SVL of 88 mm and a median TBL of 110.5 mm (n= 62) (Andrews, 2006). Using data gathered in Vermont through February 2013, the longest reported Red-bellied

Snake was 330.2 mm (Andrews 2013). They are found throughout the state in small openings within forested areas (Andrews, 2013). They have a state rank of S5 and are the third most frequently reported species in the state. They have a brown, gray, or black dorsum (back) and a bright red venter (belly). Three light spots can be seen on the neck: one in the middle and one on each side. They are harmless to humans and quite docile. They feed primarily on slugs but will also eat other invertebrates (Mitchell, 1994). We have one record of a female Red-bellied Snake collected (legally) in Bridport, VT and brought into captivity. She then gave birth to 14 young on July 29. Determining the sexes of snakes can be difficult as there are no definitive external characteristics. Generally the males have a longer tail relative to their total body length although there is often some overlap. Male Red-bellied Snakes generally have a tail length of 21-25% of their TBL while females generally have a tail length of 17-22% of their TBL (Ernst and Barbour 1989). The amount of taper in the tail in the first 8 caudal scale rows posterior to the vent is often a good indicator of gender with the female having a definite taper and males having almost no taper. However, even this indicator is not always clear. As we continue to collect more data and improve our techniques we may be able to draw some conclusions regarding the sexual make up of the snakes using the snake-covers.

Since 2001, two additional species have been located under the snake-covers: *Thamnophis sirtalis* (Common Gartersnake) and *Lampropeltis triangulum* (Milksnake). As of 2016, Common Gartersnakes were the most frequently encountered snake (366) using the covers with Red-bellied Snake second (299) and Milksnake a distant third (40). However, relative numbers of each species vary from year to year.

The Common Gartersnake is known to reach a total body length of up to 1000 mm (39 inches) in Vermont, though most adults are closer to 600 (~24 inches). The largest Common Gartersnake recorded in Vermont was found in Marshfield Vermont in 2009, the snake measured 1041 mm (41 inches). They are the most common snake in the state (Andrews, 2013) and are widespread at all elevations and in a wide variety of habitats but are most abundant near a combination of water, small open areas, and exposed rock. Their primary food item is amphibians but worms, insects, spiders, and other small invertebrates are also eaten. Male Common Gartersnakes mature in one to two years at an SVL of 360 mm – 390 mm, females usually mature in two to three years at an SVL of 420 mm to 550 mm. Litter sizes average 27 with a range from 1 to 101. Young Common Gartersnakes are born from mid-June to early November with most appearing in August and September. Neonates average 178 TBL (120mm – 278mm), and have a tendency to aggregate together (Ernst and Ernst, 2003). We have two records of gravid Common Gartersnakes run over and found dead on the road. Ten babies (also run over) were found near the body of an adult female in 2005, and 15 young were found near the body of the second in 2014 (Andrews, 2015). In 2014, two gravid Common Gartersnakes were found, and 9 and 17 embryos were detected through palpation (Andrews 2015). Based on our records through 2006 for adult and juvenile Common Gartersnakes found in Vermont, the average SVL is 336 mm and TBL is 412 mm and the median SVL is 350 and the TBL is 438 (Andrews, 2006). Male Common Gartersnakes generally have a tail length that is 21-30% of their TBL and females have a tail length that is 17-22% of TBL (Ernst and Barbour, 1989).

The Milksnake is the second most frequently reported snake in Vermont, though this may in part be the result of its large size and its tendency to live near overgrown human dwellings, foundations, and barns. Average length adults are generally longer than Common Gartersnakes. The largest Vermont Milksnake measured 1187 mm (46.75 inches). It was found in Middlebury in 2015 (Andrews 2017). Milksnakes are oviparous (egg laying), smooth scaled, and eat a wide variety of prey including small mammals, birds, other snakes, and invertebrates. They often will shake their tails when irritated and are frequently confused with rattlesnakes as a result of this behavior. The sex of the Milksnake is not possible to determine based on tail length because there is too much overlap between males and females (Ernst and Barbour 1989).

Results and Discussion

Egg-mass Counts

In 2016, egg-mass counts were performed on eight dates at the four ponds that were selected for monitoring in 1999 (March 31, April 7, April 14, April 21, April 27, May 4, May 11, and May 20). All four ponds are man-made and

fish-free with well-defined shorelines and within easy migration distance of hardwoods. Since all of these ponds are permanent or semi-permanent they almost always hold some water even through dry years.

The results of this year's counts are shown in Tables 1-5 and Figures 1-6. The winter of 2015-2016 was the warmest in 121 years with close to half the normal amount of snowfall. This is in contrast to the last time we collected egg mass data (2013-2014). That winter was the coldest in over 25 years; it averaged 4 degrees below average temperatures between November 1, 2013 and March 31, 2014. Annual vacillation in winter conditions is not new at this site but we are seeing new extremes.

In 2016 the dates for the high counts of Wood Frogs were April 14 (for Upper and Lower Fred Pierce, and Wells) and April 21 for Guthrie, with the first activity and masses seen on March 31 in every pond but Upper Fred Pierce. This was the earliest date that we have recorded egg masses at this site. In 2014 (record cold winter) the date for high counts of Wood Frog eggs was April 23 in all four ponds, and the earliest date any tadpoles were seen was April 30.

Table 1. Maximum counts of egg-masses in the Lower Fred Pierce Pond on the Lester and Monique Anderson lands in Lincoln from 1999 to 2016.

Lower Fred Pierce Pond	*Ambystoma maculatum*	*Lithobates sylvaticus*	Notes
1999 count dates: 5/5, 5/18	134	1	Early masses missed.
2000 count dates: 4/17, 4/29, 5/14	122	155	Timed well, early eggs of *L. sylvaticus* nonviable.
2001 count dates: 5/1, 5/7, 5/14, 5/21	178	101	Timed well, very dry spring.
2002 count dates: 4/23, 5/1, 5/10, 5/20	270	170	Timed well, irregular spring with late snow.
2003 count dates: 4/17, 4/25, 5/3, 5/9, 5/20	260	210	Timed well, cool spring, April drier than normal.
2004 count dates: 4/9, 4/15, 4/22, 4/29, 5/6, 5/12	166	228	Timed well.
2005 count dates: 4/13, 4/20, 4/26, 5/4, 5/11, 5/25	137	365	Timed well, went slightly later than normal.
2006 count dates: 4/14, 4/20, 4/27, 5/4, 5/11, 5/25	158	454	Timed well, went slightly later than normal.
2007 count dates: 4/4, 4/18, 4/25, 5/2, 5/17, 5/23, 5/30	181	554	Timed well – spring started late but went quickly.
2008 count dates: 4/9, 4/18, 4/23, 4/30, 5/7, 5/14, 5/21	251	392	Timed well.
2010 count date: 4/2, 4/8, 4/15, 4/23, 4/30	216	237	Timed well – spring started early.
2012 count date: 4/3,4/13, 4/18, 4/25, 5/2, 5/16	210	159	Two separate springs separated by a cold and dry spell.
2014 count date: 4/9, 4/16, 4/23, 4/30, 5/7, 5/14	153	278	Timed well.
2016 count date: 3/31, 4/7 4/14, 4/21, 4/27, 5/4, 5/11, 5/20	108	258	Longer than normal season.

Table 2. Maximum counts of egg-masses in the Upper Fred Pierce Pond on the Lester and Monique Anderson lands in Lincoln from 1999 to 2016.

Upper Fred Pierce Pond	*Ambystoma maculatum*	*Lithobates sylvaticus*	Notes
1999 count dates: 5/5, 5/18	63	20	Early masses missed.
2000 count dates: 4/17, 4/29, 5/14	54	62	Timed well, early eggs of *L. sylvaticus* nonviable.
2001 count dates: 5/1, 5/7, 5/14, 5/21	72	66	Timed well, very dry spring.
2002 count dates: 4/23, 5/1, 5/10, 5/20	137	95	Timed well, cool spring, April drier than normal.
2003 count dates: 4/17, 4/25, 5/3, 5/9, 5/20	80	144	Timed well, cool spring, April drier than normal.
2004 count dates: 4/9, 4/15, 4/22, 4/29, 5/6, 5/12	92	71	Timed well.
2005 count dates: 4/13, 4/20, 4/26, 5/4, 5/11, 5/25	113	60	Timed well, went slightly later than normal.
2006 count dates: 4/14, 4/20, 4/27, 5/4, 5/11, 5/25	125	102	Timed well, went slightly later than normal.
2007 count dates: 4/4, 4/18, 4/25, 5/2, 5/17, 5/23, 5/30	115	107	Timed well – spring started late but went quickly.
2008 count dates: 4/9, 4/18, 4/23, 4/30, 5/7, 5/14, 5/21	77	63	Timed well.
2010 count date: 4/2, 4/8, 4/15, 4/23, 4/30	66	80	Timed well – spring started early.
2012 count date: 4/2, 4/8, 4/15, 4/23, 4/30	52	91	Two separate springs separated by a cold and dry spell.
2014 count date: 4/9, 4/16, 4/23, 4/30, 5/7, 5/14	75	114	Timed well.
2016 count date: 3/31, 4/7 4/14, 4/21, 4/27, 5/4, 5/11, 5/20	60	61	Longer than normal season. *A. maculatum* high count May 20.

Table 3. Maximum counts of egg-masses at Guthrie Pond on the Lester and Monique Anderson lands in Lincoln from 1999 to 2016.

Guthrie Pond	*Ambystoma maculatum*	*Lithobates sylvaticus*	Notes
1999 count dates: 5/5, 5/18	50	5	Early masses missed.
2000 count dates: 4/17, 4/29, 5/14	138	538	Timed well, early eggs of *L. sylvaticus* nonviable.
2001 count dates: 5/1, 5/7, 5/14, 5/21	183	340	Timed well, very dry spring.
2002 count dates: 4/23, 5/1, 5/10, 5/20	121	133	Timed ok, may have missed high count for *L. sylvaticus* irregular spring late snow.
2003 count dates: 4/17, 4/25, 5/3, 5/9, 5/20	230	330	Timed well, cool spring, April drier than normal.
2004 count dates: 4/9, 4/15, 4/22, 4/29, 5/6, 5/12	96	450	Timed well.
2005 count dates: 4/13, 4/20, 4/26, 5/4, 5/11, 5/25	83	280	Timed well, went slightly later than normal.
2006 count dates: 4/14, 4/20, 4/27, 5/4, 5/11, 5/25	111	328	Timed well, went slightly later than normal.
2007 count dates: 4/4, 4/18, 4/25, 5/2, 5/17, 5/23, 5/30	118	427	Timed well – spring started late but went quickly.
2008 count dates: 4/9, 4/18, 4/23, 4/30, 5/7, 5/14, 5/21	128	221	Timed well.
2010 count date: 4/2, 4/8, 4/15, 4/23, 4/30	225	270	Timed well – spring started early
2012 count date: 4/2, 4/13, 4/18, 4/25, 5/2, 5/16	107	262	Two separate springs separated by a cold and dry spell.
2014 count date: 4/9,4/16, 4/23, 4/30, 5/7, 5/14	220	625	Timed well, productive year.
2016 count date: 3/31, 4/7 4/14, 4/21, 4/27, 5/4, 5/11, 5/20	149	465	Longer than normal season. *A. maculatum* high count May 20.

Table 4. Maximum counts of egg-masses in the Wells Pond on the Lester and Monique Anderson lands in Lincoln from 1999 to 2016.

Wells Pond	*Ambystoma maculatum*	*Lithobates sylvaticus*	Notes
1999 count dates: 5/5, 5/18	66	50	Early masses missed.
2000 count dates: 4/17, 4/29, 5/14	96	91	Timed well, early eggs of *L. sylvaticus* nonviable.
2001 count dates: 5/1, 5/7, 5/14, 5/21	111	80	Timed well, very dry spring.
2002 count dates: 4/23, 5/1, 5/10, 5/20	126	62	Timed well, irregular spring with late snow.
2003 count dates: 4/17, 4/25, 5/3, 5/9, 5/20	110	71	Timed well, cool spring, April drier than normal.
2004 count dates: 4/9, 4/15, 4/22, 4/29, 5/6, 5/12	110	59	Timed well.
2005 count dates: 4/13, 4/20, 4/26, 5/4, 5/11, 5/25	106	74	Timed well, went slightly later than normal.
2006 count dates: 4/14, 4/20, 4/27, 5/4, 5/11, 5/25	97	63	Timed well, went slightly later than normal.
2007 count dates: 4/4, 4/18, 4/25, 5/2, 5/17, 5/23, 5/30	120	53	Timed well – spring started late but went quickly.
2008 count dates: 4/9, 4/18, 4/23, 4/30, 5/7, 5/14, 5/21	114	36	Timed well.
2010 count date: 4/2, 4/8, 4/15, 4/23, 4/30	153	76	Timed well – spring started early.
2012 count date: 4/3, 4/13, 4/18, 4/25, 5/2, 5/16	101	61	Two separate springs separated by a cold and dry spell
2014 count date: 4/9, 4/16, 4/23, 4/30, 5/7, 5/14	126	171	Timed well. Productive year.
2016 count date: 3/31, 4/7 4/14, 4/21, 4/27, 5/4, 5/11, 5/20	172	100	Longer than normal season. *A. maculatum* high count May 20.

Table 5: Combined high counts of *Ambystoma maculatum* and *Lithobates sylvaticus* egg-masses for all ponds monitored on Lester Anderson lands in Lincoln, Vermont.

Lester Anderson Lands year and count dates	*Ambystoma maculatum* (combined)	*Ambystoma maculatum* (average)	*Lithobates sylvaticus* (combined)	*Lithobates sylvaticus* (average)
1999: 5/5, 5/18	313	78.3	Early masses	missed
2000: 4/17, 4/29, 5/14	410	102.5	846	211.5
2001: 5/1, 5/7, 5/14, 5/21	544	136.0	587	146.8
2002: 4/23, 5/1, 5/10, 5/20	654	163.5	460	115.0
2003: 4/17, 4/25, 5/3, 5/9, 5/20	680	170	755	188.8
2004: 4/9, 4/15, 4/22, 4/29, 5/6, 5/12	464	116.0	808	202.0
2005: 4/13, 4/20, 4/26, 5/4, 5/11, 5/25	439	109.8	779	194.8
2006: 4/14, 4/20, 4/25, 5/4, 5/11, 5/25	491	122.8	947	236.8
2007: 4/4, 4/18, 4/25, 5/2, 5/17, 5/23, 5/30	534	133.5	1141	285.3
2008: 4/9, 4/18, 4/23, 4/30, 5/7, 5/14, 5/21	570	142.5	723	180.8
2010: 4/2, 4/8, 4/15, 4/23, 4/30	660	165	663	165.8
2012: 4/3, 4/13, 4/18, 4/25, 5/2, 5/16	470	117.5	575	143.8
2014: 4/9, 4/16, 4/23, 4/30, 5/7, 5/14	574	143.5	1188	297
2016: 3/31, 4/7 4/14, 4/21, 4/27, 5/4, 5/11, 5/20	489	122.3	884	221
Average for all years	**520.9**	**130.2**	**739.7**	**184.9**

Figure 1. Egg-mass data from Lower Fred Pierce Pond on Lester Anderson lands in Lincoln, Vermont (2000-2016). In 2012, the Wood Frog egg-mass total was a combination of the high counts of both peaks (159).

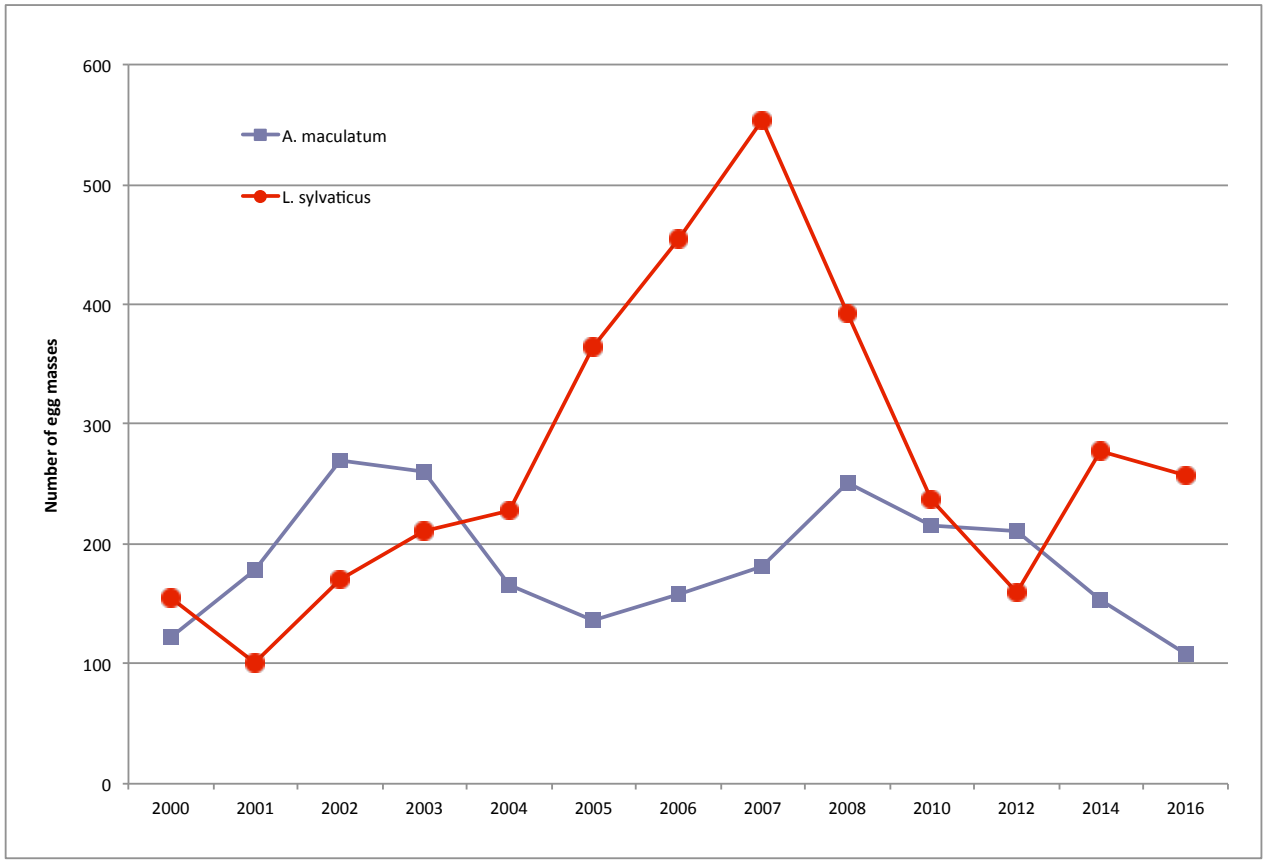


Figure 2. Egg-mass data from Upper Fred Pierce Pond on Lester Anderson lands in Lincoln, Vermont (2000-2016).

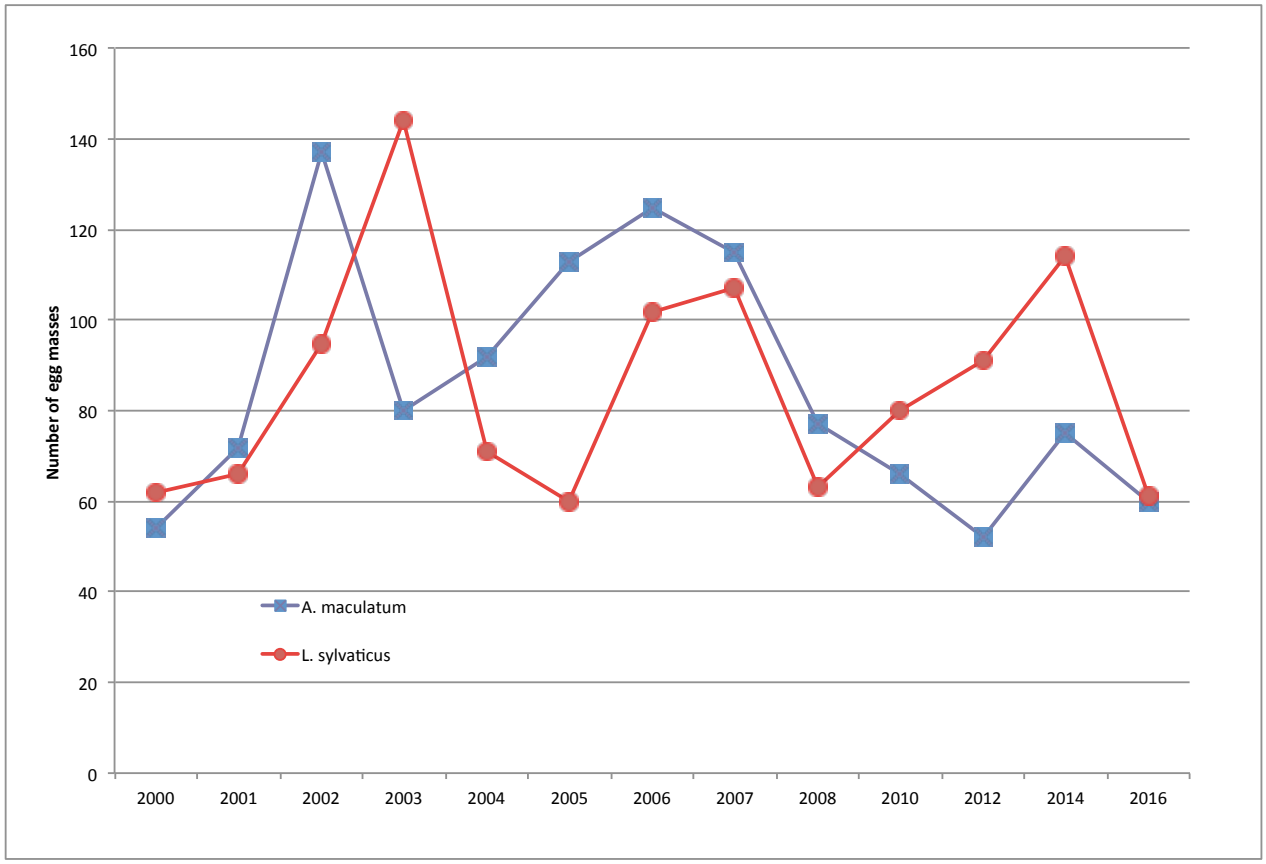


Figure 3. Egg-mass data from Guthrie Pond on Lester Anderson lands in Lincoln, Vermont (2000-2016). In 2012, the Wood Frog egg-mass total was a combination of the high counts of both peaks (262).

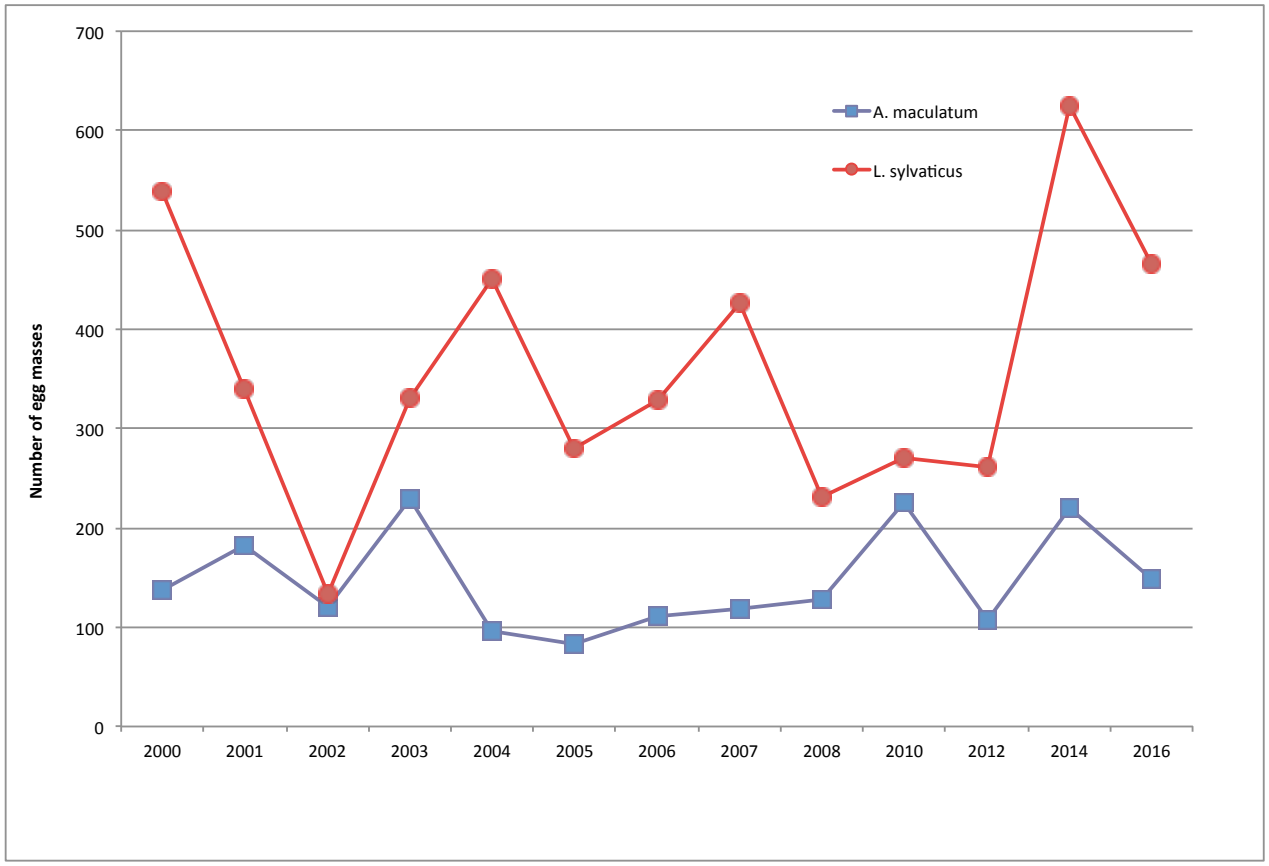


Figure 4. Egg-mass data from Wells Pond on Lester Anderson lands in Lincoln, Vermont (2000-2016). In 2012, the Wood Frog egg-mass total was a combination of the high counts of both peaks (63).

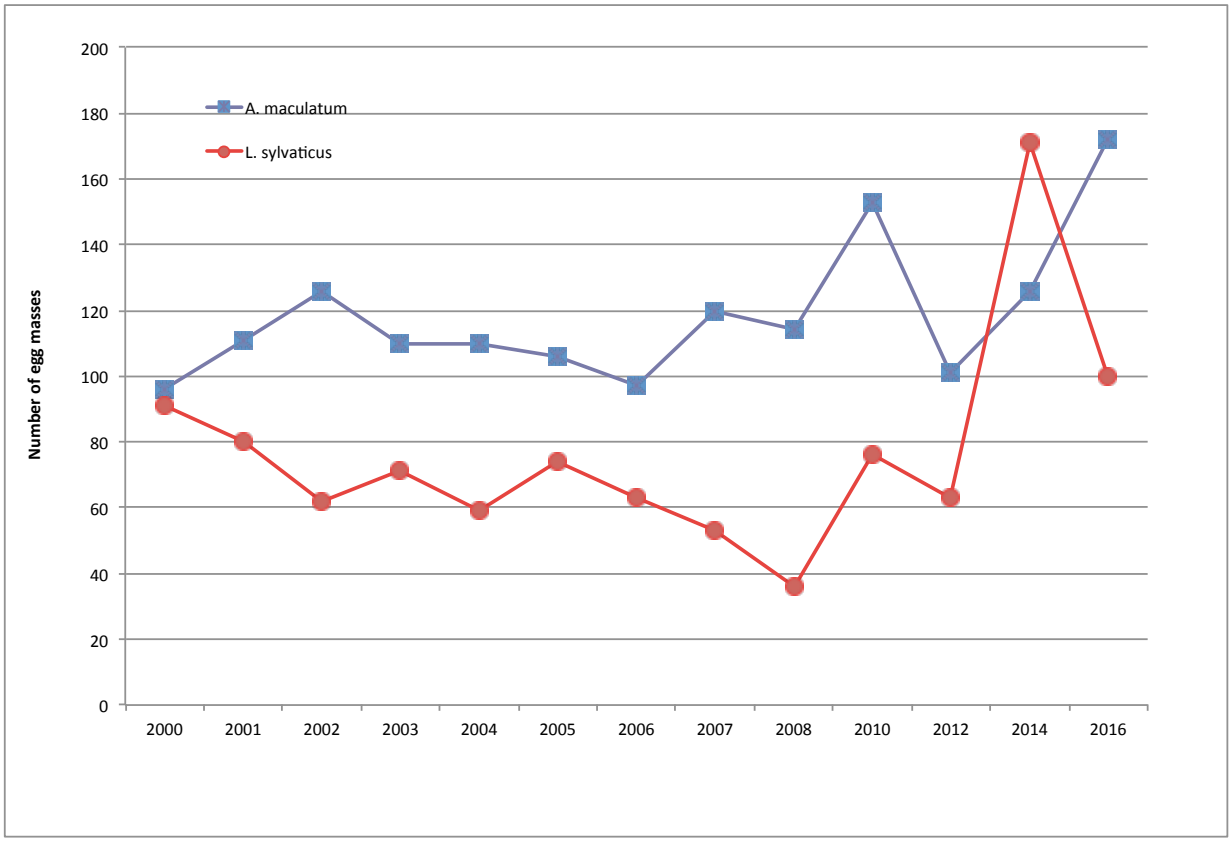
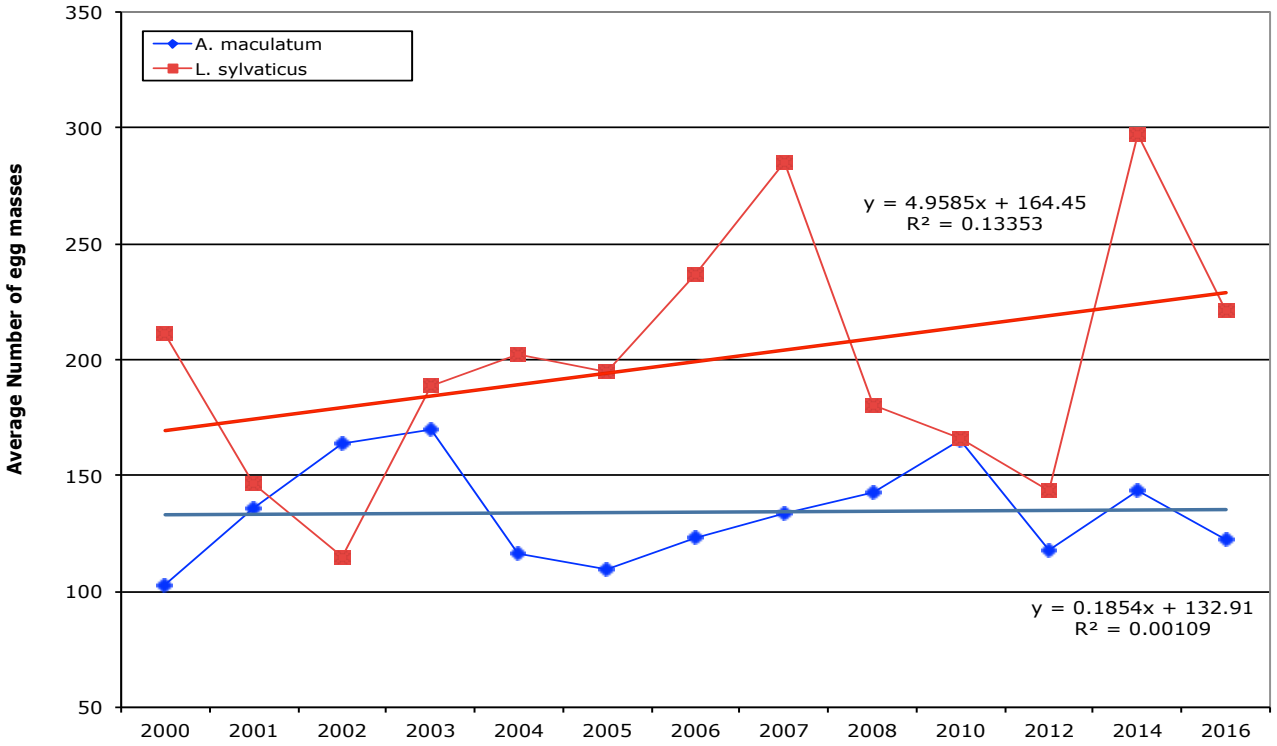


Figure 5: Average High Counts and trend lines for *A. maculatum* and *L. sylvaticus* egg-masses on Lester Anderson Lands, Lincoln, Vermont (2000-2016).



As we have now collected 13 years of data over a 17-year period we are able to look at long-term trends in timing for this site (Figures 6 and 7). These figures show the dates of first egg-mass counts for both species is getting earlier in the year and the date of peak egg-masses for Wood Frog is also trending to an earlier date too.

The date of first egg masses for Wood Frogs appears approximately 17 days earlier than when we started this study in 2000. On average the date of the appearance of the first egg-masses of this species has been changing at the rate of about 1 day earlier per year. It is possible that we missed some early egg masses due to the timing of our site visits. If we assume that to be the case, the peak egg mass data are the safer and more conservative data. Those data show at least a 9-day change over the last 17 years. Since Wood Frogs move en mass to breeding sites as soon as appropriate conditions occur in the spring, whereas Spotted Salamanders arrival at ponds and deposition of eggs is much more gradual, Wood Frogs reflect the earlier spring thaws much more clearly.

Figure 6: First egg-masses detected and peak egg-masses (with trend lines) for *L. sylvaticus* across all four ponds on Lester Anderson Lands, Lincoln, Vermont (2000-2016).

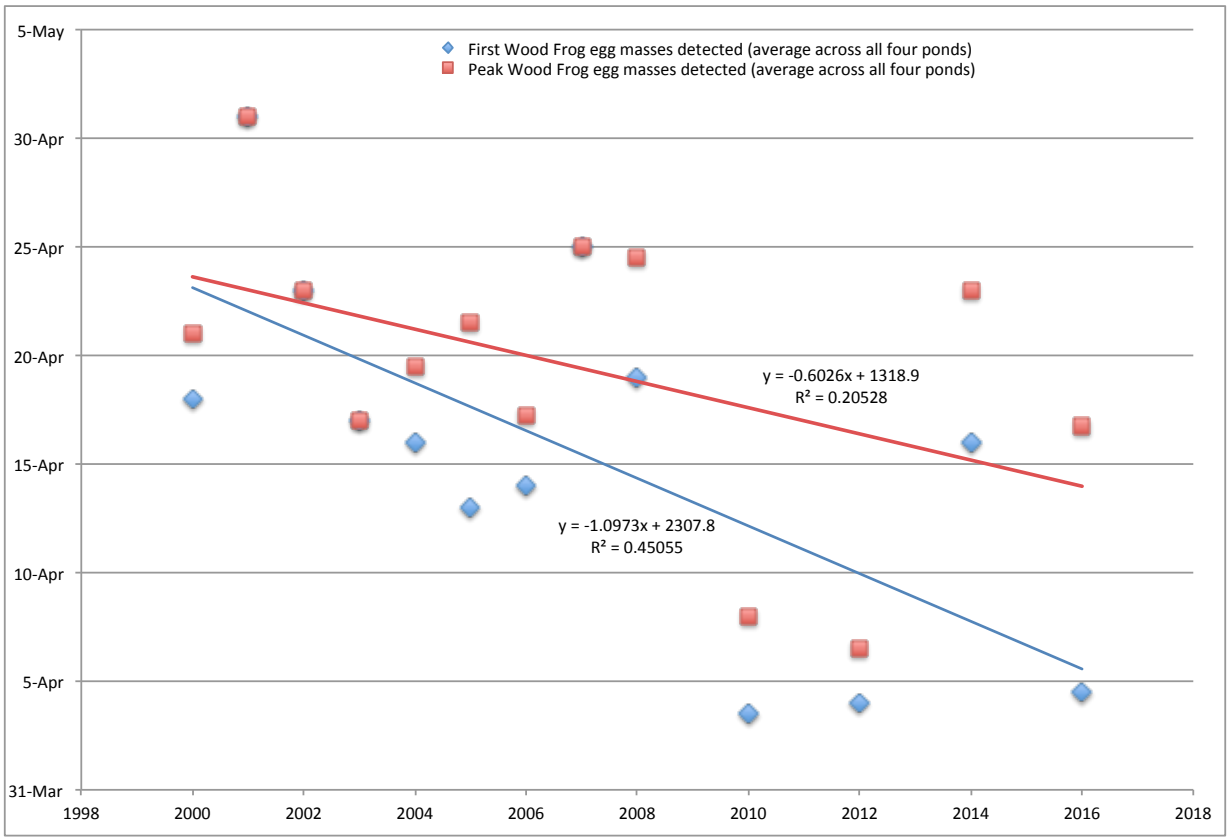
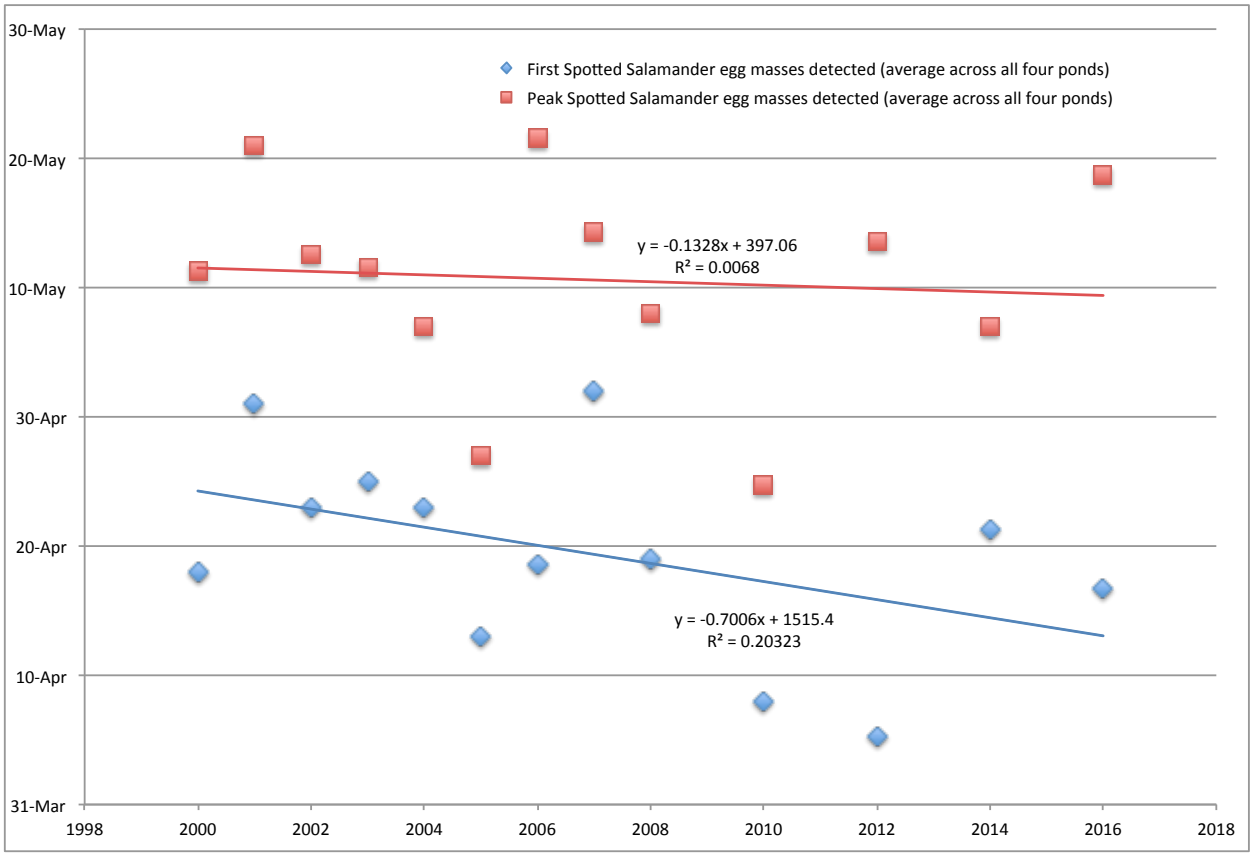


Figure 7: First egg-masses detected and peak egg-masses (with trend lines) for *A. maculatum* across all four ponds on Lester Anderson Lands, Lincoln, Vermont (2000-2016).



Spotted Salamander

During the 2016 season the first egg-masses were seen at Guthrie on April 14 and at Wells, Upper Fred Pierce, and Lower Fred Pierce on April 21 (Appendix Tables 1-4). The high counts for Spotted Salamander egg-masses were on May 11th for Lower Fred Pierce, and May 20th for the remaining three ponds. The trend for first Spotted Salamanders egg masses over all is approximately 10 days earlier; although the peak egg masses has shown little change (Figure 7).

At Guthrie we saw an increase in egg-masses between 2005 and 2010. In 2012 we saw a decrease from 225 to 107 egg-masses. Numbers of masses detected have gone up and down in recent years, with 149 detected in 2016 (Figure 3 and Table 3). At Lower Fred Pierce the number of egg-masses has fluctuated each year with a low detected in 2000 (122) and the high in 2002 with 270. (Figure 1 and Table 1). At Upper Fred Pierce the numbers of egg-masses had been declining since 2006 to a low of 52 egg-masses found in 2012, the numbers remained fairly low in 2016 when 60 were detected (Table 2, Figure 2, and Appendix Table 2. There was roadwork above the pond in early 2016 and David Brynn told us a fair amount of sediment went into the pond. On April 14 we cut a branch and put it into the pond. We saw some masses attached to the branch on later dates. There were a record number of Spotted Salamander egg-masses seen at Wells in 2016, when 172 masses were counted (Table 4 and Figure 4). The combined high count and the average high count for all ponds can be seen in Table 5.

Annual variation in these numbers is to be expected, and can be seen in Figures 1-7. Although there is year-to-year variation, it is not consistent from pond to pond. In Figure 5 egg-mass numbers for all ponds are combined and averaged. Throughout the entire duration of the study the number of egg-masses appears to cycle, increasing then decreasing every few years. Over all, the population of breeding females appears to show little long-term variation.

We will be watching to see if the numbers cycle on a regular multi-year pattern. On average, Lower Fred Pierce Pond continues to be the most productive breeding location and Upper Fred Pierce the least productive.

According to Bishop (1941) breeding adult females lay from 2-4 egg-masses during their brief egg-laying period. Using an average of 3 masses per adult and the combined egg-mass numbers from Table 5, this suggests that in 1999 approximately 104 female Spotted Salamanders laid eggs in these ponds. These numbers increased to 227 females in 2003, dropped, then rose to approximately 220 in 2010 and now have dropped back to 163 females. It is possible that adult females do not lay eggs every year but rather build up energy reserves for a year or more between egg-laying events. Consequently the group of females laying in any given year may well be entirely different from those laying the previous year. Unusual winter temperatures, droughts, predation, food availability, the number of foraging opportunities, energy storage, water levels, road work, and adjacent woodlot management are a few of the factors that either combined or individually could influence the number of females breeding in a given year.

Wood Frogs

As mentioned above, the 2015-2016 was the warmest winter in 121 years, dramatic when compared to our previous count in 2014 following the coldest winter in over 25 years, or compared to the prior count that followed another record warm winter (2011-2012). It is no surprise we are seeing annual fluctuations in the date we first see egg masses. Still, as mentioned above, the long-term trends in timing are clear. Egg masses are being deposited more than two weeks earlier (Figure 6).

The combined number of Wood Frog egg-masses from all ponds in 2007 was at a high of 1,141. During subsequent years, it dropped, with the lowest count of 573 in 2012. In 2014 the numbers rebounded and we ended up with our highest count number since monitoring began (1,188). We were slightly above average in 2016 with 884. As we have seen in the past, numbers of egg-masses/year fluctuate and therefore can potentially rebound or crash in a matter of just a couple years. The greatest numbers of Wood Frog egg-masses in 2016 were found in Guthrie with 465 masses detected (Table 3 and Figure 3). We also recorded 100 egg-masses at Wells, which was the second highest number ever counted in that pond. Trend lines for Wood Frog egg-masses show a slight increase for combined totals for all four ponds (Figure 5). We find Wood Frog egg masses at Upper Fred Pierce each year, but we rarely find many tadpoles. It is likely that Eastern Newts eat the tadpoles, or that Green Frog break up the eggs but we do not know exactly what is happening.

We found a thin layer of ice over and around the Wood Frog eggs on April 7, and both Upper Fred Pierce and Wells were totally frozen over. Pictures were taken. At Guthrie a few weeks later (April 21), we were able to see that 1000's of the eggs had died on the surface.

During egg-mass counts we also found Eastern Newts (*Notophthalmus viridescens*) and Green Frogs at all of the breeding ponds. Both of these common species spend their adult lives in or near permanent still water. Eastern Newts lay individual eggs attached to vegetation and Green Frogs lay egg-masses (surface films) during the summer, consequently they are not suitable for spring egg-mass monitoring. The Eastern Newts are voracious predators on the Wood Frog eggs and even the Green Frog larvae scrape the algae off the Wood Frog eggs until the masses fall apart.

Canada Geese were seen at Guthrie on May 4. They appeared to show some resistance to leaving the area on that day suggesting that they might be nesting there, but we did not see them on subsequent visits. Other birds seen or heard in the vicinity of the ponds during the 2016 egg-mass counts included; American Crow, American Robin, American Woodcock, Baltimore Oriole, Barred Owl (feather), Black-capped Chickadee, Black-throated Blue warbler, Black-throated Green warbler, Blue-headed Vireo, Blue Jay, Bobolink, Broad-winged Hawk, Brown Creeper, Chestnut-sided warbler, Chipping Sparrow, Common Grackle, Common Yellowthroat, Downy Woodpecker, Eastern Phoebe, Gray Catbird, Great Blue Heron (tracks), Killdeer, Least Flycatcher, Mourning Dove, Northern Flicker, Ovenbird, Purple Finch, Red-breasted Nuthatch, Red-winged Blackbird, Rose-breasted Grosbeak, Pine Warbler (not confirmed, found near Chipping Sparrow), Ruby-crowned Kinglet, Song Sparrow, White-breasted Nuthatch, White-throated Sparrow, Yellow-bellied Sapsucker, and Yellow-rumped Warbler. Since we only

occasionally recorded bird species we saw or heard near our survey sites, this is not a complete list of the birds on the property.

Fairy Shrimp were also seen at Guthrie on April 14. This was the first time we saw and/or recorded their presence at any of the survey ponds.

Summary Egg-mass Counts

Our egg-mass indices taken from all sites combined suggest a slightly increasing number of female Wood Frogs over the course of our monitoring period; however, annual variation is great and the trend could be reversed easily with a couple poor breeding years. Breeding female Spotted Salamander numbers appear fairly stable over the long term.

There are clear changes in the dates of first egg-masses deposited and average dates of high counts of egg-masses for both species. These show the earlier dates of spring arrival over the 17-year study period. Since the Wood Frog responds most quickly to the arrival of spring breeding conditions, its response to the earlier spring conditions is most dramatic with the date of first-observed egg-masses a full 17 days earlier and the dates of peak counts nine days earlier. The Spotted Salamander timing reflects the same dramatic trend for the appearance of the first egg-masses. They are appearing 10 days earlier then back at the turn of the century. Their peak egg-mass dates are trending in the same direction but much more subtly (3 days).

Snake-covers

In 2015 snake-covers were checked nine times at weekly intervals starting on Sept. 2 with subsequent checks on Sept. 9, 16, 23, and 30, Oct. 7, 14, 21, and 28 (Tables 6, 7, and 8). It is safe to assume that we have multiple captures of the same snakes over the course of the monitoring period. To evaluate population changes over time we generate an index of the annual population size for each species from a subset of our data. The index that we are using in Figures 8 and 9 is simply the average number of snakes of each species seen on their three highest counts. If there were multiple days with the same number of captures the earlier dates were used. No new species of snake were seen during the 2015 season.

In 2015 this index for Common Gartersnakes was 10.67 (the same as in 2009). This was the third highest average since the study's inception. In 2011 this index was 3.67 and in 2013 it was 2.67. Clearly, there is a great deal of fluctuation from year to year.

Red-bellied Snake had an index of 5.33 in 2009; by 2015 it had dropped to 0.66, the lowest, with 2.33 and 3.0 in the intervening years (2011 and 2013). This may be part of a multi-year cycle, as they have recovered from previous lows in the past; although we have never found as few as we did in 2015. Anecdotally, we tend to see the high counts for Red-bellied Snakes later in the fall, late September and October. This may be because some overwinter in the ant colonies established below the covers and/or the result of an increased need for the heat provided by the slate as the temperature cools.

The most unusual results for 2015 were the relatively high number of Milksnakes detected (Table 8). The index calculated was 1.67, higher than Red-bellied for the first time in this study's history. This represented a total of seven detections, and based on our descriptions and measurements they were all individual snakes, five were considered young-of-the year (SV length were no more than 260 mm)..

Relatively few snakes were captured in 2011 and 2013 when compared to previous years. Both Red-bellied Snakes and Common Gartersnakes had been declining since 2008 at our study site at Guthrie; although Common Gartersnakes rebounded in 2015. Prior to 2008 Common Gartersnakes were increasing steadily in population where Red-bellied Snakes showed large annual variation. However, neither of these two species shows a clear long-term population trend.

We check our snake-covers in the fall so that we will be able to include the young of the year in our data. However, we have now discovered that young of the year numbers are the primary influence on our snake indices. Most of these young snakes will not survive their first year.

Fluctuations in snake numbers may be related to the amount or quality of incubating substrate (hay, compost, exposed rock), incubation temperatures, food availability, predators, overwintering mortality, disease or other factors. There may also be interactions between the species that we have not yet determined. Milksnakes have been known to eat both Red-bellied Snakes and gartersnakes (Ernst and Ernst 2003).

Two Red-bellied Snakes, four Common Gartersnakes, and three Milksnakes were found using the covers during our maintenance visit on July 17, 2015. An additional two Milksnakes and one (dead) Red-bellied Snake were found in the stone foundation. Snakes were measured and palpated. One Red-bellied Snake was found with 11-12 embryos. No eggs or embryos were detected in any of the Milksnakes.

During maintenance on August 2, 2016 only one snake (a Milksnake) was found under the cover boards, and two Common Gartersnakes were found in the stone foundation. No Red-bellied Snakes were seen. This is unusual considering it is often during our maintenance that we find gravid female Red-Bellied Snakes using the covers. Just a few years prior, we found 12 gravid Red-bellied snakes on July 31, 2013.

Both Red-bellied Snakes and Common Gartersnakes give live birth and gravid females would be carrying young in July. Milksnakes lay eggs. Our data is very limited for ovipositing and hatching dates in Vermont. According to the literature, Milksnakes lay eggs from May to mid-July, and young hatch late July to late September (Ernst and Ernst 2003). Milksnake eggs have been found in Vermont on May 10 and August 2 (Andrews Herp Atlas 2016).

It appears that the snake covers are good thermal refugia for the Red-bellied Snakes in which the females can raise their body temperatures to optimal levels for internal incubation. If so, the lack of gravid females in July could be a predictor for fewer captures in the fall.

Some of the snake covers have small mammal tunnels under them. In addition, many invertebrates were found using the snake-covers. These are rarely identified to species and this is not a comprehensive list. However, in 2015 we noted ants, centipedes, crickets, and Small Milkweed Bugs (*Lygaeus kalmia*).

On October 14, 2015 while looking through the foundation we found an Eastern Small-footed bat (*Myotis leibii*). This is a threatened species in Vermont with a state heritage rank of 1 (the rarest). They are known to spend the day under rocks, but we have only found them a couple times despite our decades of rock turning looking for snakes.

We also detected multi-flora rose between cover boards 1 - 2, an invasive species like Buckthorn. Both European buckthorn and multi-flora rose should be carefully monitored and removed as resources allow.

Table 6. Fall 2015 snake-cover results from the Lester Anderson lands on the Bristol/Lincoln border in Vermont for the Common Gartersnake (*T. sirtalis*).

Date	*Species*	S-V length in mm	Total length in mm	Location Cover # - Cover Area	Physical Info
Sept. 2	*T. sirtalis*	145	185	#2 between	
Sept. 2	*T. sirtalis*	150	193	#4 between	
Sept. 2	*T. sirtalis*	150	195	#14 between	
Sept. 2	*T. sirtalis*	150	195	#31 surface	
Sept. 2	*T. sirtalis*	155	195	#11 surface	
Sept. 2	*T. sirtalis*	155	205	#14 surface	
Sept. 2	*T. sirtalis*	160	205	#4 surface	
Sept. 2	*T. sirtalis*	165	215	#4 surface	
Sept. 2	*T. sirtalis*	175	225	#4 surface	
Sept. 2	*T. sirtalis*	180	225	#24, on top of cover	
Sept. 2	*T. sirtalis*	348	458	#6 surface	
Sept. 2	*T. sirtalis*	360	380	#19 between	Most of tail missing
Sept. 2	*T. sirtalis*			#4, surface	Three escaped
Sept. 16	*T. sirtalis*	155	205	#4 between	
Sept. 16	*T. sirtalis*	160	195	#4 between	
Sept. 16	*T. sirtalis*	175	220	#1 surface	
Sept. 16	*T. sirtalis*	180	225	#5 surface	
Sept. 23	*T. sirtalis*	180	225	#1 surface	
Sept. 23	*T. sirtalis*	180	230	#6, between	
Sept. 23	*T. sirtalis*	180	230	#31 surface	
Sept. 23	*T. sirtalis*	180	225	#31 surface	
Sept. 23	*T. sirtalis*	184	229	#1 surface	
Sept. 23	*T. sirtalis*	185	233	#23 surface	
Sept. 23	*T. sirtalis*	189	244	#16 surface	
Sept. 23	*T. sirtalis*	190	245	#3 surface	
Sept. 23	*T. sirtalis*	194	259	#23 surface	
Sept. 30	*T. sirtalis*	190	245	#31 surface	
Sept. 30	*T. sirtalis*	190	240	#39 surface	
Sept. 30	*T. sirtalis*	190	245	#40 between	
Sept. 30	*T. sirtalis*	210	280	#14 surface	
Sept. 30	*T. sirtalis*			#5 surface	Shed skin
Oct. 7	*T. sirtalis*	172	218	#1 surface	
Oct. 7	*T. sirtalis*	175	225	#1 surface	
Oct. 7	*T. sirtalis*	185	240	#4 surface	
Oct. 7	*T. sirtalis*	185	230	#23 surface	
Oct. 7	*T. sirtalis*	190	240	#2 between	
Oct. 7	*T. sirtalis*	190	245	#31 surface	
Oct. 7	*T. sirtalis*	205	270	#2 between	
Oct. 7	*T. sirtalis*	300	375	#23 between	
Oct. 14	*T. sirtalis*	155	205	#2 between	
Oct. 14	*T. sirtalis*	180	230	#27 surface	
Oct. 14	*T. sirtalis*	200	260	#23 surface	
Oct. 14	*T. sirtalis*	220	290	#35 surface	

Figure 8. Average *T. sirtalis* total captures and average *T. sirtalis* adult captures per highest three counts under snake-covers 1-40 over entire season (2002-2015).

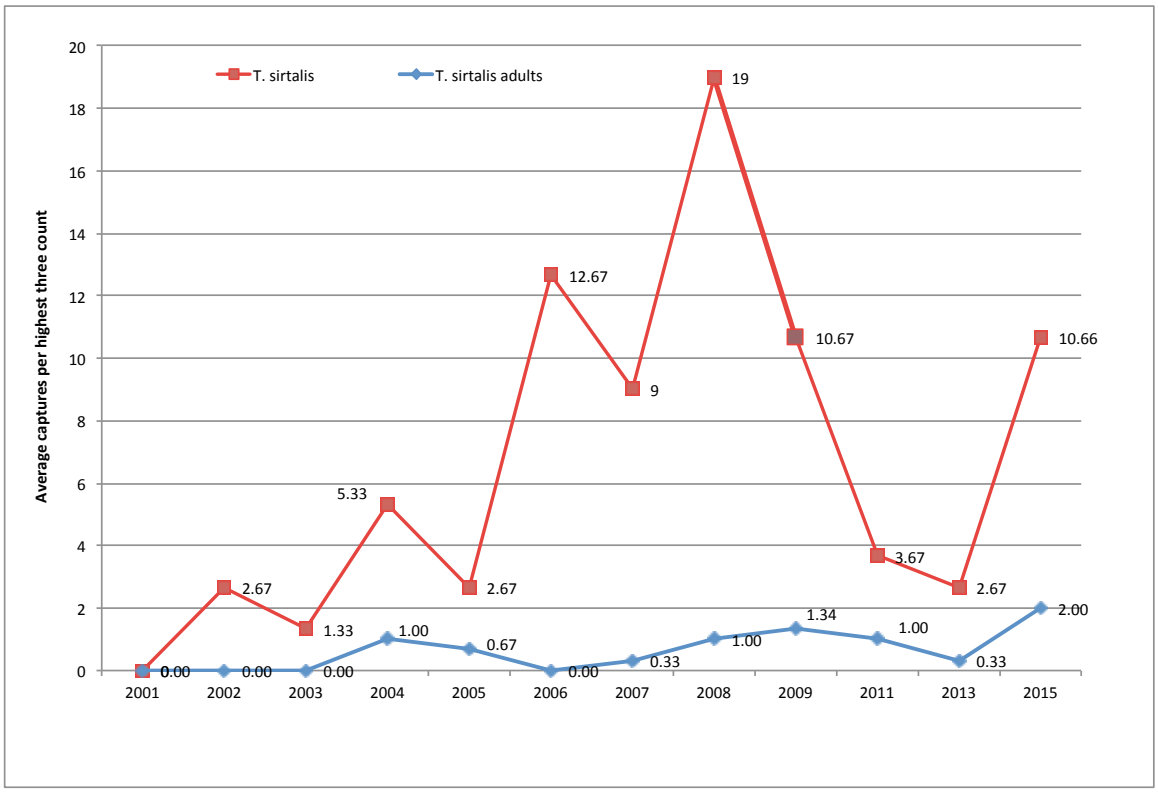


Table 7. Fall 2015 snake-cover results from the Lester Anderson lands on the Bristol/Lincoln border in Vermont for the Red-bellied Snake (*S. occipitomaculata*).

Date	Species	S-V length in mm	Total length in mm	Location Cover # - Cover Area	Mass and Physical Info
Oct. 21	*S. occipitomaculata*	140	175	#33 surface	
Oct. 21	*S. occipitomaculata*	190	230	#35 surface	

Figure 9. Average *S. occipitomaculata* total captures and average *S. occipitomaculata* adult captures per highest three counts under snake-covers 1-40 over entire season (2001-2015).

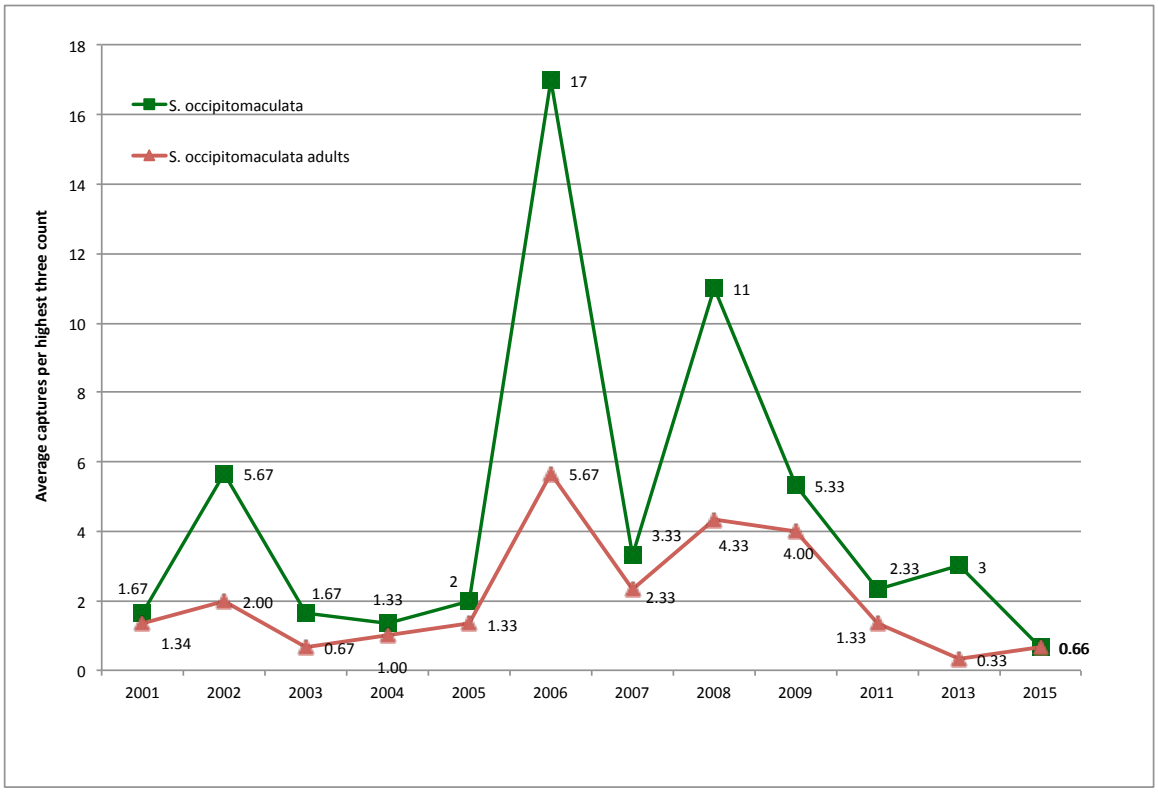


Table 8. Fall 2015 snake-cover results from the Lester Anderson lands on the Bristol/Lincoln border in Vermont for Milksnakes (*L. triangulum*).

Date	Species	S-V length in mm	Total length in mm	Location Cover # - Cover Area	Mass and Physical Info
Sept. 9	*L. triangulum*	305	405	#27 surface	The Y is not enclosed and opens to front, #4 is connected left, 30 in connected left, 39 is vent, 49 in total
Sept. 16	*L. triangulum*	210	243	#13 between	Young of year clean Y, 9 Y left, 25 Y right, 29 has spot on left, 38 Y left, 40 is vent, 51
Sept. 16	*L. triangulum*	210	245	#14 between	Young of year close to all, 6 spot right, 13 spot right, 25 Y left, 31 spot left, 35 Y left, 40 vent, 48 total
Sept. 23	*L. triangulum*	210	250	#23 surface	Y with a dot enclosed, 32 Y right, 38 Y left, 40 vent, 46 Y right, 50 total
Sept. 23	*L. triangulum*	330	380	#23 surface	Y with a dot between 13 and 14 - 2 dots, 36 vent, between 38 and 39 - dot right, 47 total
Sept. 30	*L. triangulum*	210	245	#23 surface	Y connects (not enclosed) little dot in front of Y, #2 off to right, #5 on left, #17 on right, #27 y left, #29 Y right, #37 Y left, 39 vent, 42 left, 53 - tip
Oct. 7	*L. triangulum*	210	235	#11 between	Looks like it just ate Y with dot, base of Y connected on right, 9 - Y left, 36 - vent, 41 spot on right, 47 - total

Figure 10. Average *L. triangulum* total captures and average *L. triangulum* adult captures per highest three counts under snake-covers 1-40 over entire season (2001-2015).

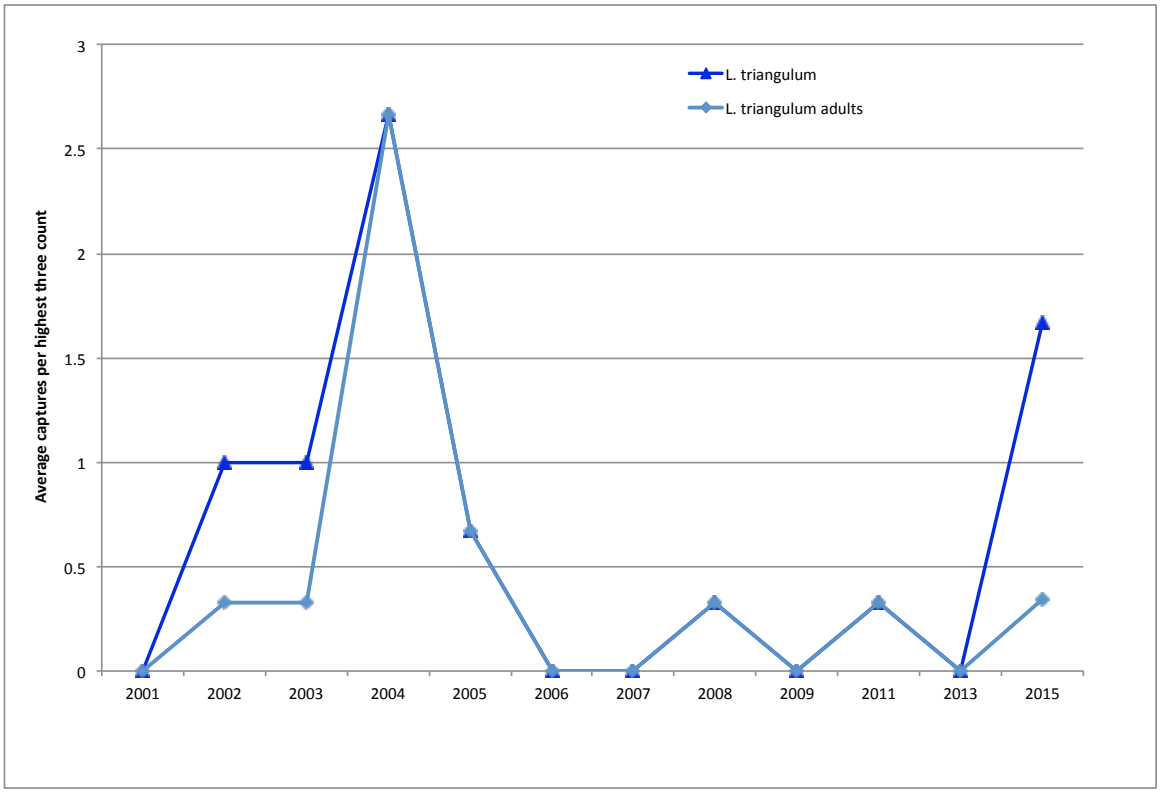


Table 9a. Accidental and unidentified snakes captured during the 2015 summer and fall in and around the snake-cover from the Lester Anderson lands on the Bristol/Lincoln border in Vermont.

Date	Species	S-V length in mm	Total length in mm	Location Cover # - Cover Area	Mass and Physical Info
July 17	*L. triangulum*	490	576	Foundation	Food in belly, no eggs detected in belly, unknown sex. White belly below head, Y broken, 6 Y right, 12 Y left, blotches 32 vent, 34 Y left, 35 Y right, 41 total blotches
July 17	*L. triangulum*	730	830	Foundation	No eggs, unknown sex, necrosis @ vent. (Photograph taken) Complete Y totally enclosed, 35 Y to rt., 36 vent 44 total blotches
July 17	*L. triangulum*	285	327	#19 between	Enclosed Y, 2 on right, 11 Y right, 16 Y left, 28 Y left, 29 H, 34 vent, 37 left, 42 left, 45 to tip. Food in belly.
July 17	*L. triangulum*	260	300	#31 surface	Complete Y 38 vent, 46 total, between 39 and 40 two side blotches.
July 17	*L. triangulum*	220	247	#39 between	Complete Y, 9 Y both ways (left and right), 15 Y left and right, 19 Y right, 21 Y right, 23 W facing 26 vent, 33 spot on right 34 total blotches.
July 17	*S. occipitomaculata*	225	253	#14 between	11-12 embryos
July 17	*S. occipitomaculata*			#10	Found after cleaning
July 17	*S. occipitomaculata*	730	830	Foundation	Dead on top of rock wall
July 17	*T. sirtalis*	292	384	#14 between	
July 17	*T. sirtalis*	265	337	#14 surface	Male
July 17	*T. sirtalis*			#13	Found after cleaning
July 17	*T. sirtalis*			#14	Found after cleaning
Sept. 9	*L. triangulum*			In rock wall, 3 feet down from surface	Shed skin
Sept. 9	unidentified			#4 surface	Shed skin
Sept. 9	unidentified			#5 surface	Shed skin

Table 9b. Accidental and unidentified snakes captured during the 2016 summer and fall in and around the snake-cover from the Lester Anderson lands on the Bristol/Lincoln border in Vermont.

Date	Species	S-V length in mm	Total length in mm	Location Cover # - Cover Area	Mass and Physical Info
Aug 2	*L. triangulum*	420	485	#23 between	Between Y is not enclosed, 24 Y left, 36 Y left between 40 and 41 spots, 42 vent, 44 - 45 spot left, 51 total.
Aug 2	*T. sirtalis*			Low on foundation	Two found

Summary-Snake-covers

We have twelve solid years of data from the snake-covers and we can begin to look at population trends for all three species. Red-bellied Snakes have been declining since 2008 at our study site at Guthrie. Only two were detected during our survey in 2015, and none were seen during cleaning in the summer of 2016 (Figure 9A and 9B). The numbers of young Common Gartersnakes had been increasing dramatically and steadily through 2008, although the numbers of surviving adults only showed very slight changes during the same time period (Figure 8). However, from 2008 through 2013 they went through a period of steady decline. Then in 2015, a greater than average number of gartersnakes were captured, reversing the trend. Both species show large annual variation. However, neither shows a clear long-term population trend. Milksnakes continue to be very rare at the transect site at Guthrie; although more were found in 2015 than in the previous decade. Our snake indices are primarily influenced by young of the year numbers. Highly productive years result in very small increases in adult numbers. Most of these young snakes do not appear to survive their first year.

Cover-boards (Salamander)

The cover-boards were not monitored during 2011, 2013, and the 2015 field seasons, but were checked in 2012, 2014, and 2016. Cover-boards are checked annually for maintenance purposes. At those times, the boards are renumbered and/or replaced as needed. In addition, brush and downed trees are cleared from around the cover-boards and along the access trail. In 2015, during the two days of maintenance of the cover-boards on August 7 and August 27, a combined total of 88 Eastern Red-backed Salamanders and 3 Northern Dusky Salamander (*Desmognathus fuscus*) were found. During the 2 days of maintenance in the summer of 2016 on August 2 and August 3, 74 Eastern Red-backed Salamanders were seen, along with 3 Eastern Newts and one Northern Dusky Salamander. It is worth noting that during cleaning in the summer of 2014 and 2013, 158 and 121 salamanders were detected.

In 2016 the cover-boards were checked on eight dates: Sept. 6, 13, 21, and 27, Oct. 5, 11, 19, and 26 (Table 10). This year we again stopped the counts in the fall once we determined the number of salamanders seen each week was consistently decreasing. As we have done previously, we only counted salamanders under one of each pair of cover-boards (the A cover-boards in 2016). This is the method we intend to stick with in the future since it produces plenty of salamanders for our purposes, saves both time and money, and reduces the stress on the animals.

The species found under the cover-boards are almost exclusively the Eastern Red-backed Salamander. However, Northern Dusky Salamanders were part of our count on three occasions in 2016: September 6 (#12A), September 27 (#10A), and October 19 (#10A). Two Northern Dusky Salamanders were also found during maintenance. One at #12A and one at 10A.

A Northern Dusky Salamander was found in 2014 on September 3 (#12A), and on September 15 (#11A). Over all, Northern Dusky Salamanders have been found under the cover-boards ten times during the regular monitoring, and have been found six times while performing maintenance. They were found on cover-board #10 (8 times), cover-board #11 (2 times), cover-board #12 (5 times), and cover-board #16 (one time). This section of cover-boards is in a particularly wet area and that is the habitat preferred by this species. In addition, they are not known to travel more than a couple meters from their preferred habitat and that certainly appears to be shown here. Of course, individual Northern Dusky Salamanders may have been seen and counted on repeated visits.

In 2016 the high count for numbers of Eastern Red-backed Salamanders on one day was 32 (Sept. 6, Table 10). In 2014 the high count for numbers of Eastern Red-backed Salamanders on one day was 50 (Sept. 3). In 2012 the high count for numbers of Eastern Red-backed Salamanders on one day was 60 (Sept. 12), and in 2010 the high count was 63. To adjust for day-to-day variation caused by weather and seasonal differences we have developed an index to compare high counts from year to year. We have taken the highest three counts and averaged them. Results are shown in Figure 11. The high counts are often the first three counts in September, but occasionally include a count taken in October. In 2016, the high counts were Sept 6, 13, and 21. The high count of 32 in 2016 is considerably lower than any other year of this study.

The highest count has been the first count in the fall on over 50% of the survey years. We had previously thought that since there is no obvious weather change of significance that corresponds with the drop in numbers after the first check, the quick decline was possibly a result of disturbance. To check this, in 2003 and 2004 we checked all cover-boards on the first check, but only one half of the cover-boards on the following check, and every other subsequent check. Interestingly, the rate of decline was almost identical for those covers checked every two weeks and those checked every week. Apparently, checking at one or two week intervals did not have any impact on board use as a result of disturbance (Andrews and Talmage 2005). This is in accordance with the results published by Marsh and Goicochea (2003). They also found no difference between covers checked every week and covers checked every three weeks. It should be mentioned that although temperatures clearly drop as the fall progresses and these ectotherms need to descend to greater soil depths (or move to other locations) to keep from freezing, the decline in numbers under the boards begins before the decline in temperatures. Their original movement must be triggered by day length or some other factor other than temperature.

We have seen fall migrations of Eastern Red-backed Salamanders at other sites and this phenomenon was recently reported by Woolbright and Martin (2014). It appears this movement is from wetter substrates to upslope over wintering locations that are better drained. The better-drained locations probably allow the salamanders to descend below the depth of freeze without hitting the water table. This seasonal migration to more appropriate wintering locations may be part of the reason we see fewer salamanders as the fall progresses. Some of this movement may be almost entirely vertical as well, if the location already is sufficiently drained. Another possible explanation for declining numbers through the fall may be the result of the fact that Eastern Red-backed Salamanders start mating in the autumn and continue through the spring. One study found a population in NY started mating in the second week in October. Females have the ability to keep sperm in their cloacae through late April (Petranka 1998). Perhaps the high early-fall numbers are related to salamanders moving for mating purposes before disappearing underground for over wintering.

Based on Vermont data, juvenile Eastern Red-backed Salamanders are most often found from late July through November (Andrews 2007). This suggested to us, that the peak population size under the cover-boards should also be in the fall as opposed to the summer. In 2005 we tested this by doing additional counts in the summer. Counts were made on June 28 and August 3. As we had hypothesized, the high counts were in the early fall (Andrews and Talmage 2006). This may be something to look at again in the future as the numbers do appear to be consistently high when the cleaning is being done in the summer, and in 2014 and 2016 totals were higher than our high count (even when doubled) in the fall. It also would be interesting to do a count in mid-August when eggs, if in the vicinity, may have hatched. We did find four recently hatched young with an adult on September 3, 2014.

Eastern Red-backed Salamander Population Indices

In 2014, although below average number of salamanders were detected, our index still showed an increasing population. As shown in Figure 11, that no longer appears true when the 2016 data were incorporated into the chart. Conditions do not appear to be improving for this species in the immediate monitoring area. Whether this is due to local forest management, other local factors, or is part of a larger regional trend due to weather or other conditions is not known. We would expect conditions to improve as hardwood forests age and produce increasing amounts of coarse woody debris. This debris provides moisture refugia, cover from predators, and egg-laying sites. The presence of the cover-boards themselves might bring about a temporary increase in population, but this would have to level off once the boards had been colonized. The record warm and dry winter of 2015-2016, followed by an extremely dry summer (about 10 inches below the mean precipitation) may have influenced the population. The drought may have influenced the population by reducing breeding opportunities, causing animals to move to wetter areas, or causing animals to move farther underground than our cover boards. Our most recent analysis of Eastern Red-backed Salamander numbers (through 2014) at our Mt. Mansfield monitoring site show that their population had also been increasing at that site, but we do not have any 2015 data and we have not yet processed the 2016 data. Monitoring at multiple sites allows us to make these comparisons. Long-term monitoring allows us to see if these changes are sustained or if multi-year cycles exist.

It is important to note that individuals are not marked, and the total number of salamanders caught is not known. The same individuals may well have been counted on more than one date. However, for purposes of comparison from year to year we do not need to know the number of individuals. We can compare averages, high counts, and size-class information from the high-count days (Figures 11 and 12, and Tables 10, 11, and 12). As mentioned in earlier reports, Caitlin Corey's results suggest that there is an upper limit to the number of adults that we can theoretically find under the boards, since adults using the cover-boards may exclude same-sex adults (Corey, 2002). Although we see annual variation, the average for the top three counts has shown variation since it peaked in 2006 (Figure 11), perhaps we have reached this upper limit. Corey's results also suggest that there is possible predation upon younger juveniles; therefore, the age-class data generated by the cover-boards may not be representative of those in the larger populations. It is still important data to collect. In theory, once we reach the upper limit, the age class distribution under the cover-boards would remain relatively stable. We are now able to begin to look at this question (Tables 10 and 11 and Figure 12). It does not appear that the age class structure is stable at the present time, but it may be approaching stability, as the lines appear to be leveling off (Figure 12). At the same time there may be other factors we have yet to discover that influence the age classes of the salamanders found under the cover-boards. As this study continues it will be interesting to see if Corey's hypotheses are correct.

As we continue to gather data we are able to learn more about the Eastern Red-backed Salamander's population on this portion of the Anderson Lands and also its general natural history, including but not limited to, size and mass information (Figure 13 and 14). In 2016 Kate Kelly joined us in the field. She has experience determining the sex of salamanders and we were able to learn the technique and sex a couple of the animals. We also were able to detect the existence of eggs. Due to the time involved, we did not sex all of the animals, but it is a piece of data we may want to consider collecting in the future.

Table 10. Fall 2016 cover-board results from the Lester Anderson lands on the Bristol/Lincoln border in Vermont. The species being monitored is Eastern Red-backed Salamander (*Plethodon cinereus*). Only the B cover-boards of each pair were checked. (241 were counted in 2014)

Snout to Vent Length							
Date	1-20 mm	21-30 mm	31-40 mm	41-50 mm	51-60 mm	Unk.[1]	Total
Sept. 6	1	7	13	9	0	2	32
Sept. 13	0	3	13	10	0	0	26
Sept. 21	0	1	14	7	0	1	23
Sept. 27	0	4	8	2	0	0	14
Oct 5	2	0	9	6	0	0	17
Oct. 11	0	3	8	3	0	0	14
Oct. 19	0	0	1	1	0	0	2
Oct 26	0	1	3	2	0	0	6
Total	**3**[2]	**19**[2]	**69**[2]	**40**[2]	**0**[2]	**3**[2]	**134**[2]

[1] Salamanders escaped before measurements were taken.
[2] Salamanders may have been caught on more than one occasion throughout the field season.

Figure 11. Average number of Eastern Red-backed Salamanders (*Plethodon cinereus*) captured during the three highest counts[1] during cover-board monitoring on the Lester Anderson lands on the Bristol/Lincoln border in Vermont (2001-2016).

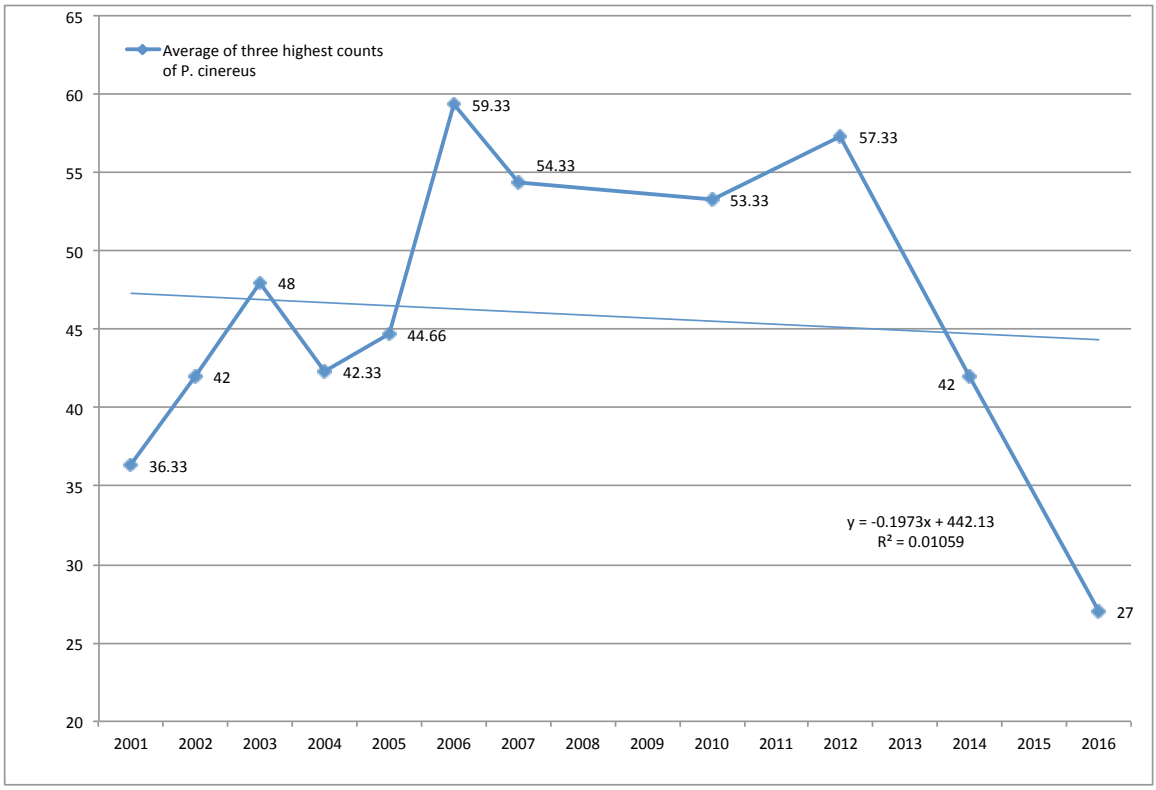


Table 11. Totals[2] for each cohort of Eastern Red-backed Salamanders (*Plethodon cinereus*) found on the three highest count days during cover-board monitoring on the Lester Anderson lands on the Bristol/Lincoln border in Vermont (2001-2016).

Snout to Vent Length						
Date	1-20 mm	21-30 mm	31-40 mm	41-50 mm	51-60 mm	Unk.[1]
2001	0	5	71	22	1	0
2002	0	7	91	25	0	0
2003	2	24	94	23	0	0
2004	2	40	64	19	0	0
2005	1	35	78	18	0	1
2006	10	40	93	34	0	0
2007	3	43	87	32	0	1
2010	0	15	98	46	0	1
2012	0	18	93	60	0	1
2014	6	16	67	44	2	0
2016	1	11	40	26	0	3
Average/Year	**2.3**	**23.1**	**79.6**	**31.7**	**0.6**	**0.4**

[1]Salamanders escaped before measurements were taken.
[2]Half of cover-boards checked (or data used), for each year. Cover-boards A in 2001, 2003, 2006, 2010, 2014, 2016. Cover-boards B in 2002, 2005, 2007, 2012, and odd numbered cover-boards in 2004.

Table 12. Percentage of totals for each cohort of Eastern Red-backed Salamanders (*Plethodon cinereus*) found on the three highest count days during cover-board monitoring on the Lester Anderson lands on the Bristol/Lincoln border in Vermont (2001-2016).

Snout to Vent Length			
Date	1-20 mm	21-40 mm	41-60 mm
2001	0.00%	76.77%	23.23%
2002	0.00%	79.67%	20.33%
2003	1.40%	82.51%	16.08%
2004	1.60%	83.20%	15.20%
2005	0.75%	85.17%	13.53%
2006	5.65%	75.14%	19.21%
2007	1.81%	78.31%	19.28%
2010	0.00%	70.63%	28.75%
2012	0.00%	64.54%	34.88%
2014	4.44%	61.48%	34.07%
2016	1.23%	62.96%	35.08%
Average/Year	**1.53%**	**74.58%**	**23.60%**

[1]Salamanders escaped before measurements were taken.

Figure 12: Percentage of totals for each cohort of Eastern Red-backed Salamanders (*Plethodon cinereus*) found on the three highest count days during cover-board monitoring on the Lester Anderson lands on the Bristol/Lincoln border in Vermont (2001-2016).

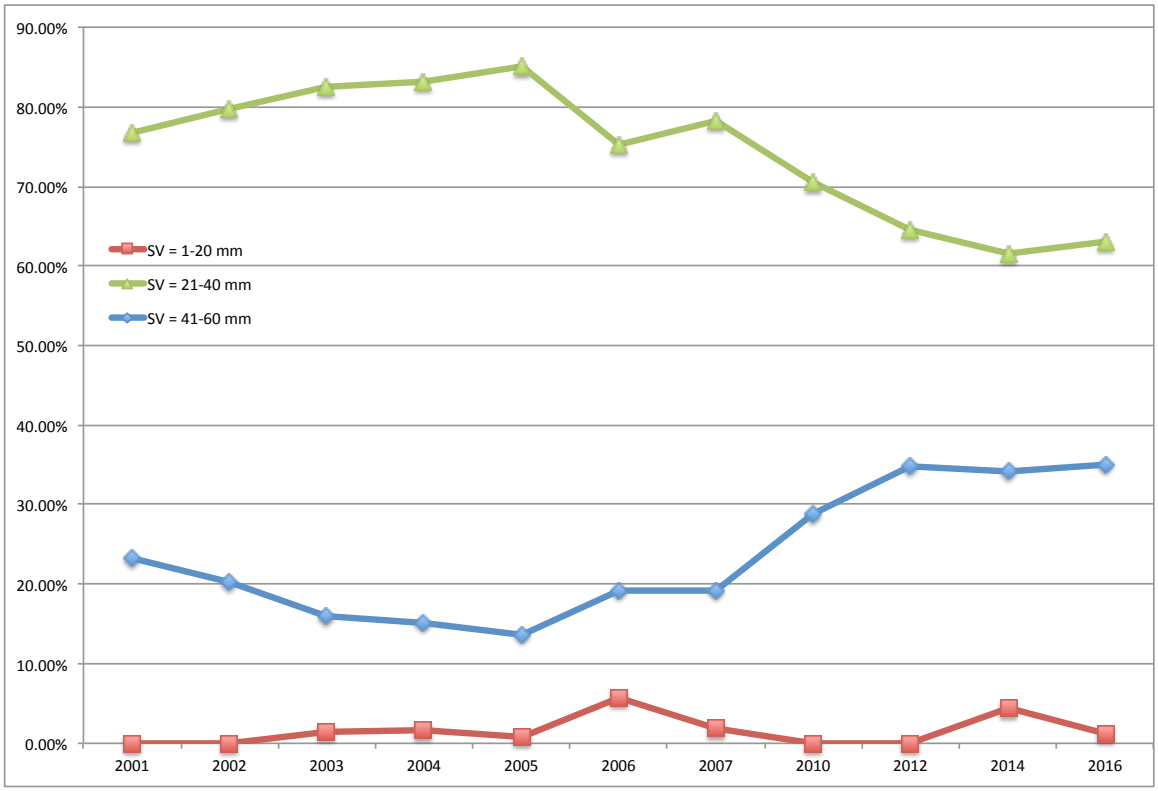


Figure 13: SV lengths for all *P. cinereus* found during cover-board monitoring on the Lester Anderson lands on the Bristol/Lincoln border in Vermont (2001-2016) n = 4180 captures.

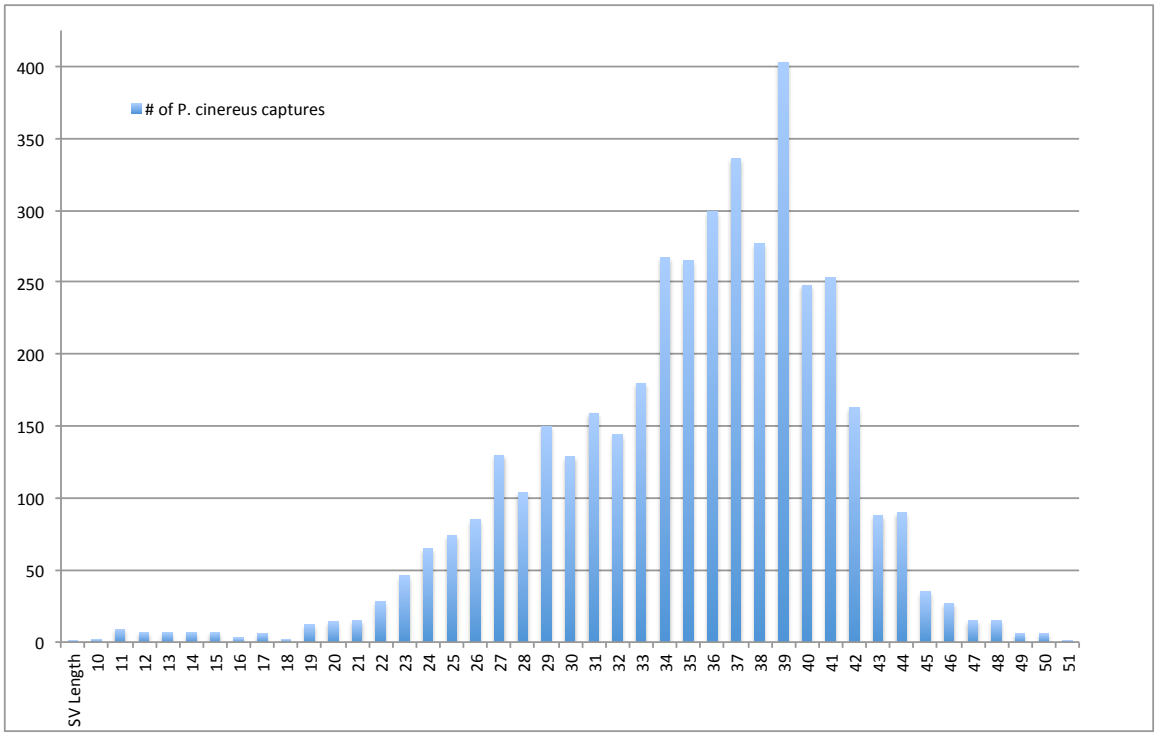
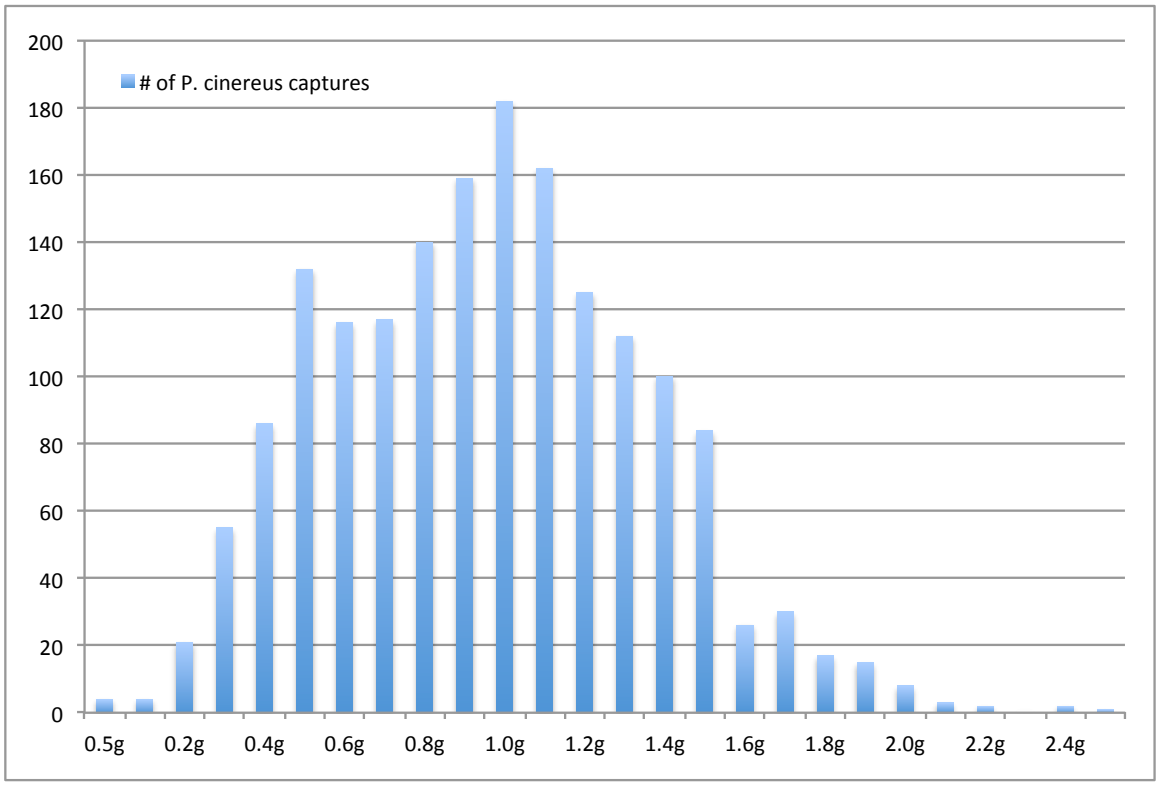


Figure 14: Mass in grams for all *P. cinereus* (for which mass was measured) found during cover-board monitoring on the Lester Anderson lands on the Bristol/Lincoln border in Vermont (2006-2016) n = 1703 captures.



Summary Salamander Cover Boards

Red-backed Salamander numbers increased for a period of five years at the beginning of the study. They then plateaued for the next six years and have been declining precipitously for that last four years. For the last ten years there seems to be a shift occurring from the middle size-class to the larger size class with little change in the percentage of the small size class.

Other Species

Many invertebrates were found using the cover-boards. In 2016 we noted slugs and slug eggs, Camel Crickets, leaf cutting moth larvae, ground beetles, spiders, a night crawler, and the millipede *Sigmoria trimaculata*. This millipede is common in this area. It is part of a group of millipedes (polydesmids) that release cyanide as a defense. We heard and recorded a White-breasted Nuthatch and Tufted Titmouse (both common species). We also found Spring Peepers and American Toads along the trail, along with Northern Dusky and Eastern Two-lined Salamanders in the tributary stream by the pull off on Route 17. In addition Cindy Sprague pointed out numerous mushroom species as we walked. A list of what we identified could be assembled if desired.

Future Study

Our current schedule is as follows: we schedule an annual maintenance day in late July each year and take advantage of this day to check snake covers. This provides data on gravid females and might turn up the rarer (at this site) Milksnakes. Data on gravid females are otherwise not available during fall checks. In spring 2015 we wrote a full report and monitored the snake covers in the fall. In 2016, we monitored egg-masses and one-half the cover boards but did not write a report. In early 2017 we wrote this report and plan to monitor the snake covers in the fall. In 2018

we plan to monitor the egg-masses in spring and one-half the cover-boards (the Bs) in the fall. We might want to consider focusing on only one type of monitoring in each report. For example, one year it would be on snakes, two years later it would cover egg-mass counts, and two years later it would cover salamanders. This would leave a gap of six years (three data sets) between reports on any one monitoring protocol. However, it would allow for more in-depth reporting on each type of monitoring.

Thanks

Opportunities for long-term monitoring are both exceptionally rare and very valuable. Most funding for this type of project is short-term. This greatly limits the type of data that can be gathered and the reliability of the data. We continue to appreciate the opportunity that has been created for us through the Colby Hill Ecological Project. Data such as these are not being gathered anywhere else that I am aware of.

Acknowledgments

Jim Andrews, Kate Kelly, Cindy Sprague, and Erin Talmage helped gather data with some regularity. Levi Smith, Morgan Barnes, Sara Smith, and Amy Alfieri also helped at least once with data collection. Cindy Sprague, Kate Kelly and Caroline Greenberg helped with maintenance. Erin Talmage helped prepare this report.

Appendix

Appendix Table 1. Spring 2016 egg-mass data from Lower Fred Pierce Pond on Lester Anderson lands in Lincoln, Vermont.

Date	*Ambystoma maculatum* egg-masses	*Lithobates sylvaticus* egg-masses	Notes
March 31	0	4 Very fresh	Early spring following significantly warm winter with cold snaps in between warm days. Some movement, as early as March 10th, in valley has occurred.
April 7	0	117 Two dried up, one on land	Visibility okay to poor, dark, but no ice. Early spring, then very cold for the last few days.
April 14	0 No eggs or spermatophores	258 Some are pretty fresh	Cold nights, cool days, some rain.
April 21	17 One is opaque	165 A few pretty fresh, no algae yet, some green with dead eggs (older). Big group is green with dead eggs but we counted them again. A few have hatched.	Visibility good, a little cloudy and slight film on top polarizing glasses used. Sunny, warmer, and dry the past few days.
April 27	57	149 A few (7) look new since last week, big group is green, with tadpoles and dead eggs (marginally countable), entire top edge is dead >500 tadpoles.	Visibility excellent. Snowed yesterday (~3"), frost overnight.
May 4	71 One mass, with all dead eggs, seen floating. A few masses look sort of fresh.	18 Most eggs in pieces and dead eggs on bottom. Greater than1500 tadpoles scattered around, surprisingly few.	Cool in the 40's (F), last few days with light rain. Visibility okay to poor, cannot see in the middle, cloudy, polarizing glasses worn all day.
May 11	108 Some pretty fresh, new from last week.	0 Greater than 1400 tadpoles seen.	Cold nighttime temps, seasonal during day. Visibility excellent, polarizing glasses worn.
May 20	102	0 Greater than1500 tadpoles spread out, below surface.	Chilly with light frost a few days ago, yesterday was sunny. Visibility excellent to good, film on water and silt mats, some on bottom hard to see, polarizing glasses used all day.

Appendix Table 2. Spring 2016 egg-mass data from Upper Fred Pierce Pond on Lester Anderson lands in Lincoln, Vermont.

Date	*Ambystoma maculatum* egg-masses	*Lithobates sylvaticus* egg-masses	Notes
March 31	0	0	Visibility okay, breezy, water clear. Visibility on cattails side limited. Cattails, along with other emergent vegetation growing into pond. Can see the new culvert that has brought road gravel into yard, and some road water probably went to pond. Early spring following significantly warm winter with cold snaps in between warm days. Some movement, as early as March 10th, in valley has occurred.
April 7	0	0	Visibility below poor - totally iced over, ice about 1/2" (photo) some scattered duck weed on edge with cattails, duck tracks in ice. Early spring, then very cold for the last few days.
April 14	0	61 Some pretty fresh	Visibility excellent, one branch cut and put in pond, polarizing glasses worn. Cold nights, cool days, some rain big tadpoles swimming within *L. sylvaticus* egg masses.
April 21	5	31	Visibility excellent, polarizing glasses used. Sunny, warmer, and dry this last few days. Last week we put a few sticks in Upper Fred Pierce, a few *A. maculatum* egg masses on them today. David joined us and told us this pond got a large amount of sediment this year from roadwork.
April 27	50 Using sticks we threw in pond two weeks ago. Can see clumps of spermatophores.	6	Visibility excellent -excellent, Jim saw ice on pond when drove by earlier, ice is gone now. Snowed yesterday (~3"), frost overnight.
May 4	43 At least one is very fresh	0	Cool, 40's (F) last few days, with light rain. Visibility okay to poor, cloudy slight breeze, a little pollen
May 11	54	0 Very few tadpoles seen (~3)	Cold nightly, seasonal days.
May 20	60	0	Chilly with light frost a few days ago. Yesterday was sunny Visibility excellent, polarizing glasses used all day.

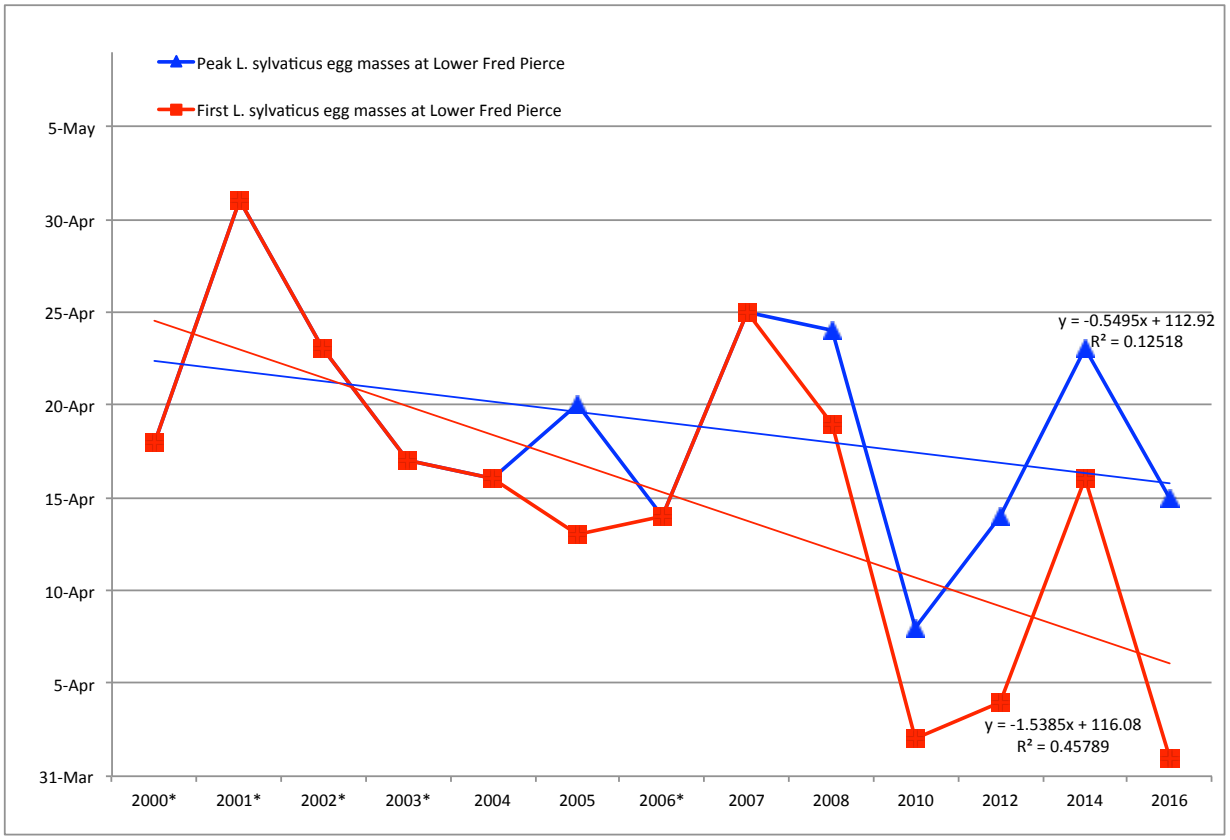
Appendix Table 3. Spring 2016 egg-mass data from Guthrie Pond on Lester Anderson lands in Lincoln, Vermont.

Date	*Ambystoma maculatum* egg-masses	*Lithobates sylvaticus* egg-masses	**Notes**
March 31	0	1 Very fresh.	Visibility okay, water clear but slight breeze Early spring following significantly warm winter with cold snaps in between warm days. Some movement, as early as March 10th, in valley has occurred.
April 7	1	331 We took pictures and then broke up ice. It was ~1/4 inch thick. We then counted an additional 43 masses. Many showing white as it eggs already dead.	Visibility cloudy, breezy, could not see anything deep. Weather History: Early spring then very cold for the last few days.
April 14	4 16 clumps of fresh spermatophores.	415 Egg masses on edge have thin layer of ice on top. (Saw fairy shrimp – not recorded at this before).	Visibility good to excellent polarizing glasses used, water level up, thin layer of ice on edge Weather History: Cold nights, cool days, some rain.
April 21	30 At least one clump of spermatophores 2 very fresh, one looked like a cigar; one size of a quarter).	465 Big group of masses on roadside: the masses are full of algae. Some have hatched out, hard to differentiate individual masses. Lots of dead eggs (1000's) on surface, no new masses). A few of the first ones we saw are on verge of hatching, some relatively fresh.	Visibility excellent, water high, big rock totally submerged - glasses worn. Weather History: Sunny, warmer, and dry this last few days.
April 27	54 Some pretty fresh (a few days old), ~10 with no viable eggs, some of the egg masses with non-viable have a high % of non-viable eggs.	79 Greater than1,000 tadpoles. Some signs of dead eggs on surface. Lot and lots of dead eggs, although some tadpoles are alive, not counting any broken and shapeless masses, did count individuals and ones that were still masses.	Visibility good to excellent, dead cattails on water surface along edge, could be hiding some masses. Weather History: Snowed yesterday (~3"), frost overnight.
May 4	74 a few pretty fresh, some opaque, some dead ones, some of the masses have a high percentage of non viable eggs.	41 Tadpoles ~ 0.75", lots and lots collected together where eggs had been, >17000.	Weather History: cool, 40's last few days with light rain. Visibility poor, cloudy, pollen on surface, polarizing glasses worn.
May 11	134	0 Greater than 9000 tadpoles.	Weather History: cold nightly, seasonal days. Visibility excellent, polarizing glasses worn, water level still very high.
May 20	149	0 Lots of tadpoles swimming in counter clockwise direction, >11,500.	Weather History: chilly with light frost a few days ago. Yesterday was sunny Visibility excellent, trees provided shade on one side.

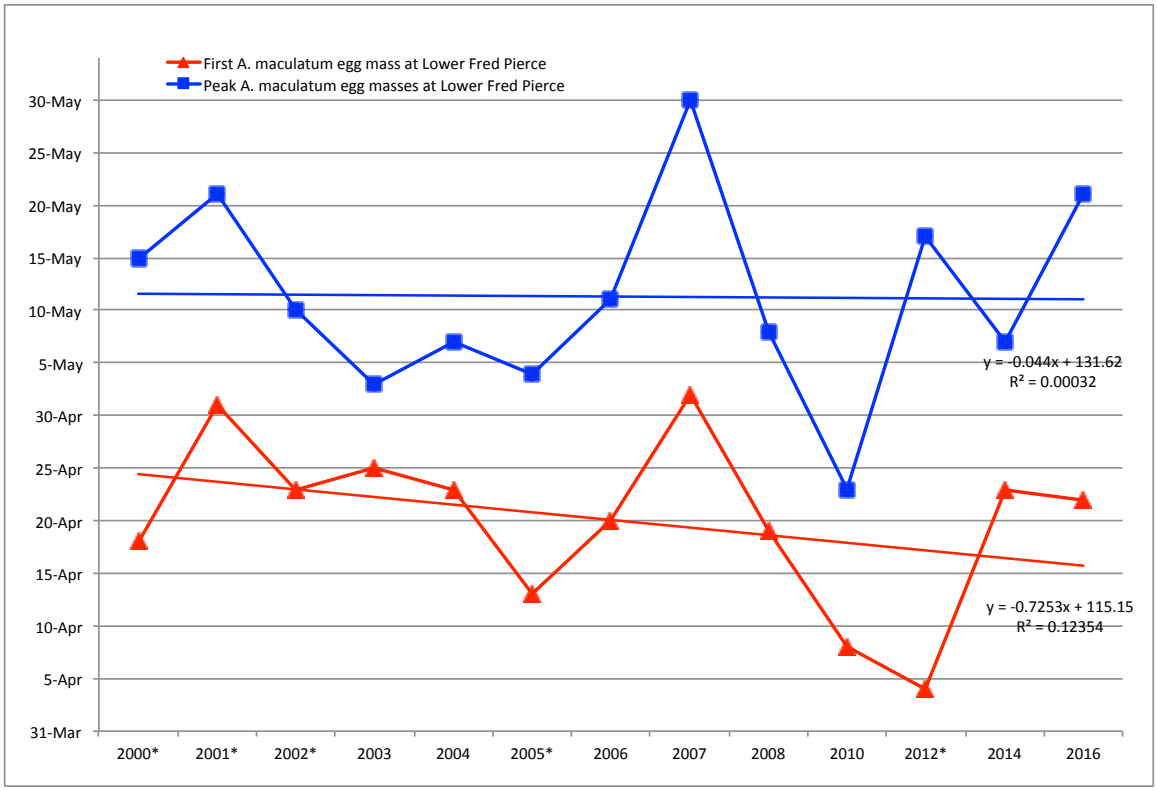
Appendix Table 4. Spring 2016 egg-mass data from Wells Pond on Lester Anderson lands in Lincoln, Vermont.

Date	*Ambystoma maculatum* egg-masses	*Lithobates sylvaticus* egg-masses	Notes
March 31	0	4	Visibility okay, water clear but slight breeze Early spring following significantly warm winter with cold snaps in between warm days. Some movement, as early as March 10th, in valley has occurred.
April 7	0	0	Visibility below poor - totally iced over (photo) ice on edge ~1/4", out a little further where we saw masses last week ~1/2" of ice Weather History: Early spring then very cold for the last few days.
April 14	4 Seven clumps of spermatophores.	100	Visibility below poor - totally iced over (photo) ice on edge ~1/4", out a little further where we saw masses last week ~1/2" of ice Weather History: Early spring then very cold for the last few days.
April 21	74 Some very fresh, size of quarter, 3 opaque, 5 clumps of spermataphores.	88	Visibility excellent, polarizing glasses used submerged Weather History: Sunny, warmer, and dry this last few days.
April 27	134 A few pretty fresh.	60 Some green, some eggs matching, little tadpoles on masses, some eggs dead on surface.	Visibility excellent - polarizing glasses worn, can see to bottom, Weather History: Snowed yesterday (~3"), frost overnight.
May 4	145 One mass pulled up and inspected, all eggs were dead, 3 others with non-viable eggs.	55 Most are old but still have shape, green, dead cells tadpoles on top of eggs, some still in eggs, not so far along as Guthrie	Weather History: cool, 40's last few days with light rain. Visibility good.
May 11	154 A few still bluish, pretty fresh.	14 Egg masses full of dead eggs, and mostly hatched. Tadpoles dispersed but no big clouds,~ 200	Weather History: cold nightly, seasonal days. Visibility excellent, polarizing glasses worn.
May 20	172	0 Did not notice any tadpoles	History: chilly with light frost a few days ago. Yesterday was sunny Visibility excellent.

Appendix Figure 1: First egg-masses detected and peak egg-masses (with trend lines) for *L. sylvaticus* at Lower Fred Pierce on Lester Anderson Lands, Lincoln, Vermont (2000-2016).



Appendix Figure 2: First egg-masses detected and peak egg-masses (with trend lines) for *A. maculatum* at Lower Fred Pierce on Lester Anderson Lands, Lincoln, Vermont (2000-2016). Move to appendix



Appendix Figure 3: Wood Frog egg-masses killed by freezing. Shown immediately after the freeze (left) and twenty days later (right).

Appendix Figure 4: Small ground nesting wasp nest of unknown species.

Appendix Figure 5: Polydesmid (*Sigmoria trimaculatam* left) and slug eggs (right).

Appendix notes Precipitation data from http://w2.weather.gov/climate/xmacis.php?wfo=btv, accessed Feb 6, 2017

Precipitation data from South Lincoln were missing 3 months of data. The 9 months with precipitation data totaled 33.51 inches. (Similar or close towns (Hanksville, Waitsfield, & Salisbury) were also missing data.) To get an estimate of total precipitation, I looked at Burlington International Airport which gets an annual total of 38.39 inches, and added in the months of missing data to South Lincoln's total (Jan, March, and April 1.19, 2.26, and 1.8) bringing the total to an estimated 38.8 inches of precipitation in 2016; although, it would likely be a little higher as Lincoln on average gets more precipitation. For comparison, the average annual precipitation for South Lincoln was 47.98 inches (ttp://w2.weather.gov/climate/xmacis.php?wfo=btv, access Mar 17, 2017.