Amphibian & Reptile Monitoring

2000-2018

on the Lester and Monique Anderson Lands

in Lincoln, Vermont

Prepared for the

Colby Hill
Ecological Project

Prepared by

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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 subsequent odd years we monitored only the snake-covers to keep them on an alternating-year-schedule. In even years, including 2018, we monitored egg-masses and salamander cover-boards. This report and the snake monitoring during the fall of 2019 will both be on the 2019 budget. The 2020 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 numbers, 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 extremely valuable, and we are grateful for the opportunity.

For 2019, we proposed additional monitoring for stream salamanders on the new CHEP parcel (Abe's Knees). We planned to place 20 slate covers along a small stream and seepage area to monitor for two common saturated-soil salamanders: Northern Dusky Salamander (*Desmognathus fuscus*) and Northern Two-lined Salamander (*Eurycea bislineata*). We would have checked the covers three times during the year. The first year would have been to see if our covers and cover-placement worked well as a monitoring method, and to make any minor modifications in location of the covers, the timing of the checks, and/or other aspects of the techniques that might have needed to be improved. David Brynn and Marc Lapin expressed an interest in having us monitor stream flow as well. We put together a preliminary budget, but it was decided that for budgetary reasons it would be better not to start this pilot program in 2019.

Egg-mass counts: Methods

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 former Anderson residence. Lower Fred Pierce is roughly 100 m south of the former 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: Wood Frogs (*Lithobates sylvaticus)* and Spotted Salamanders (*Ambystoma maculatum)*. 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 is 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 we wear them during most counts. The counts were designed to take place in habitats where Wood Frog and Spotted Salamander had been previously located, and during or shortly after their breeding period. They 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.

Egg-mass Counts: Basic species information

Two spring-breeding amphibians that deposit large easily identified **egg-masses** are using the breeding ponds: Spotted Salamander and Wood Frog. The Spotted Salamander is a large (~190 mm total length) 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 overwintering sites during the first warm rains of spring to migrate to its breeding pond. An adult female usually deposits from 2-4 egg masses within a few days and returns to its summer foraging territory. Larvae spend most of the summer in their natal ponds and usually metamorphose, leave their ponds, and return to the woods in the late summer. Spotted Salamander is a long-lived species with adults reaching over 20 years of age. Since the adults spend most of their lives underground, egg-masses 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 mostly-solid brown background. It forages in the woodlands and only enters ponds in early spring to breed. Like Spotted Salamanders, Wood Frogs also deposit large and easily identified egg-masses. It is referred to as an explosive breeder, in that most Wood Frogs using a given pond breed and lay eggs within the span of two weeks and then return to nearby woodlands. Tadpoles metamorphose and become terrestrial frogs by mid-to late summer in the same year they were laid. In contrast to the Spotted Salamander, Wood Frogs have a life expectancy of only 3-5 years. They are one of Vermont's freeze-tolerant anurans and overwinter in the leaf litter. A continuous layer of snow cover adds insulation and helps keep temperatures above the limits of its cellular antifreeze. It is widespread in Vermont as long as healthy woodlands and breeding ponds can be found and travel between the two is largely unobstructed.

Egg-mass Counts: Results and Discussion

In 2018, egg-mass counts were performed on seven dates at the four ponds that were selected for monitoring in 1999 (April 11, April 17, April 24, May 2, May 10, May 16, and May 24). 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 1-7, additional details and photographs are in the Appendix. In 2018 the date for the high count of Wood Frogs was May 2 in all four ponds, with the first activity and first masses seen on April 17 (Lower Fred Pierce), April 24 (Upper Fred Pierce, and Guthrie), and May 2 (Wells).

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 2018.

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 dates: 4/2, 4/8, 4/15, 4/23, 4/30	216	237	Timed well – spring started early.
2012 count dates: 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 dates: 4/9, 4/16, 4/23, 4/30, 5/7, 5/14	153	278	Timed well.
2016 count dates: 3/31, 4/7 4/14, 4/21, 4/27, 5/4, 5/11, 5/20	108	258	Longer than normal season.
2018 count dates: 4/11, 4/17, 4/24, 5/2, 5/10, 5/16, 5/24	176	286	Timed well.

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 2018.

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 dates: 4/2, 4/8, 4/15, 4/23, 4/30	52	91	Two separate springs separated by a cold and dry spell.
2014 count dates: 4/9, 4/16, 4/23, 4/30, 5/7, 5/14	75	114	Timed well.
2016 count dates: 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.
2018 count dates: 4/11, 4/17, 4/24, 5/2, 5/10, 5/16, 5/24	56	42	Timed well.

Table 3. Maximum counts of egg-masses at Guthrie Pond on the Lester and Monique Anderson lands in Lincoln from 1999 to 2018.

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 dates: 4/2, 4/8, 4/15, 4/23, 4/30	225	270	Timed well – spring started early
2012 count dates: 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 dates: 4/9,4/16, 4/23, 4/30, 5/7, 5/14	220	625	Timed well, productive year.
2016 count dates: 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.
2018 count dates: 4/11, 4/17, 4/24, 5/2, 5/10, 5/16, 5/24	264	465	Timed well.

Table 4. Maximum counts of egg-masses in the Wells Pond on the Lester and Monique Anderson lands in Lincoln from 1999 to 2018.

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 dates: 4/2, 4/8, 4/15, 4/23, 4/30	153	76	Timed well – spring started early.
2012 count dates: 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 dates: 4/9, 4/16, 4/23, 4/30, 5/7, 5/14	126	171	Timed well. Productive year.
2016 count dates: 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.
2018 count dates: 4/11, 4/17, 4/24, 5/2, 5/10, 5/16, 5/24	125	165	Timed well.

Table 5: Combined high counts of Spotted Salamander (*Ambystoma maculatum*) and Wood Frog (*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	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
2018: 4/11, 4/17, 4/24, 5/2, 5/10, 5/16, 5/24	702	175.5	958	239.5
Average for all years	**532.9**	**133.2**	**754.3**	**186.6**

Figure 1. Egg-mass data from Lower Fred Pierce Pond on Lester Anderson lands in Lincoln, Vermont (2000-2018). In 2012, the Wood Frog egg-mass total was a combination of the high counts of both peaks (159).

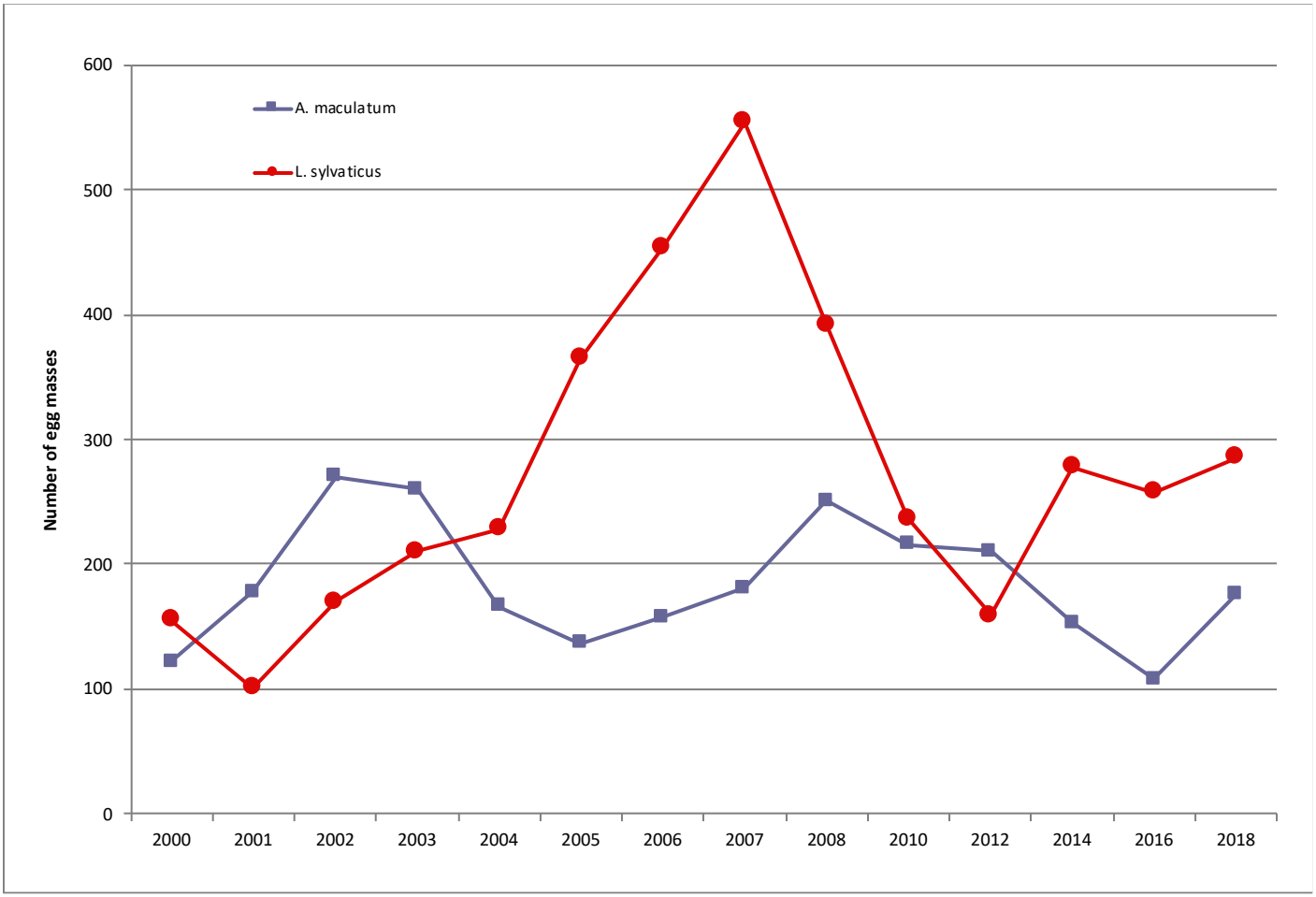


Figure 2. Egg-mass data from Upper Fred Pierce Pond on Lester Anderson lands in Lincoln, Vermont (2000-2018).

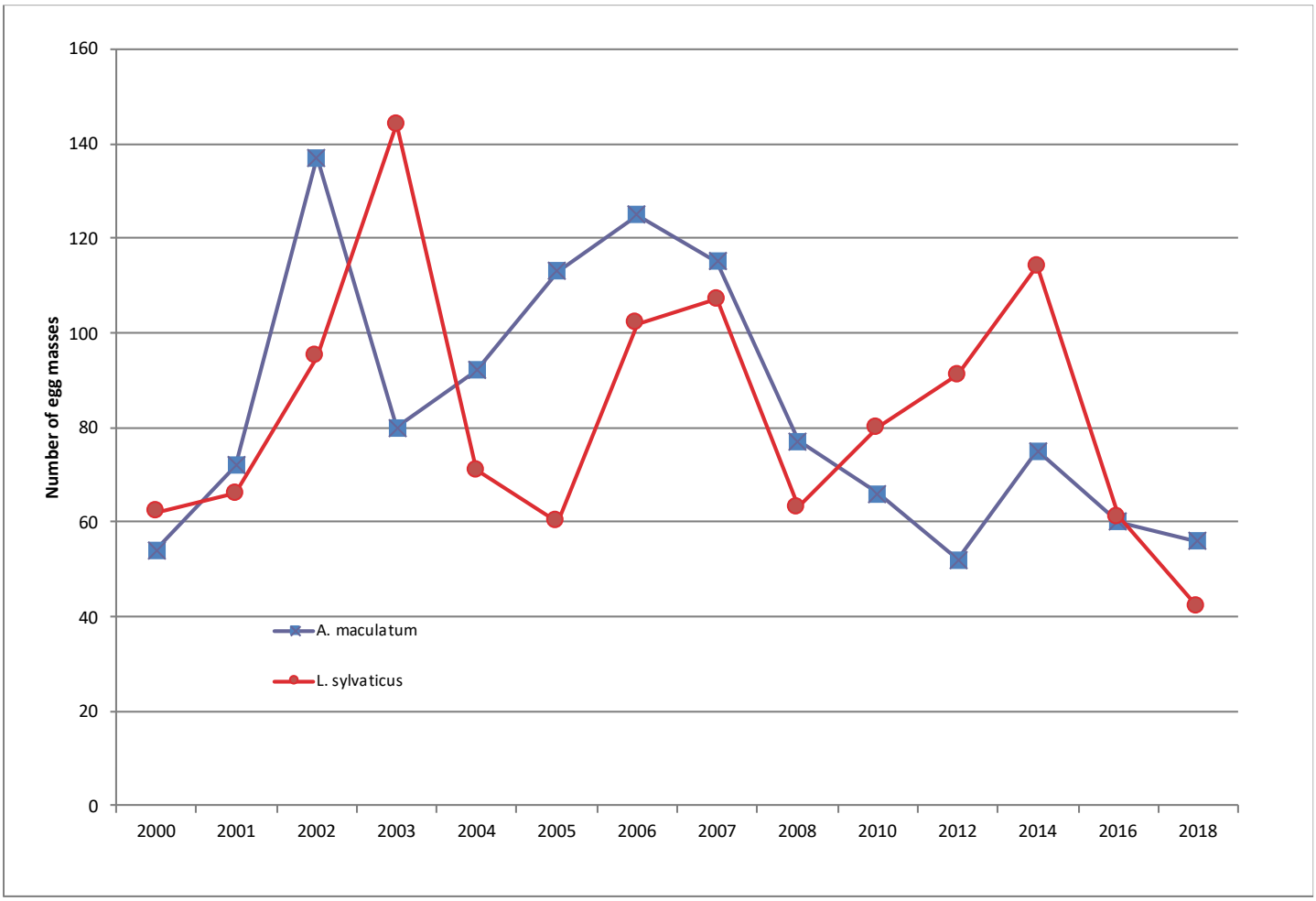


Figure 3. Egg-mass data from Guthrie Pond on Lester Anderson lands in Lincoln, Vermont (2000-2018). In 2012, the Wood Frog egg-mass total was a combination of the high counts of both peaks (262).

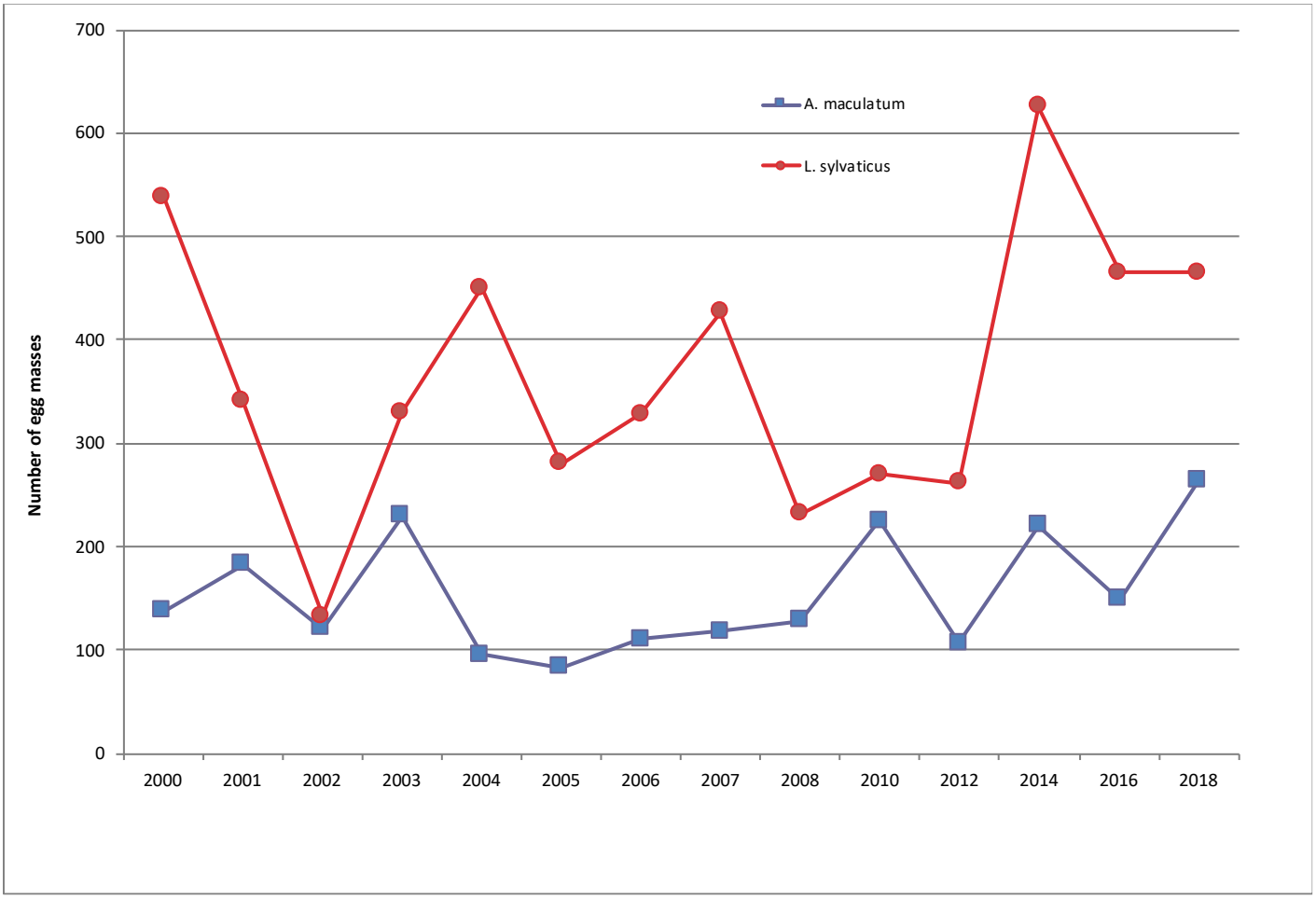


Figure 4. Egg-mass data from Wells Pond on Lester Anderson lands in Lincoln, Vermont (2000-2018). In 2012, the Wood Frog egg-mass total was a combination of the high counts of both peaks (63).

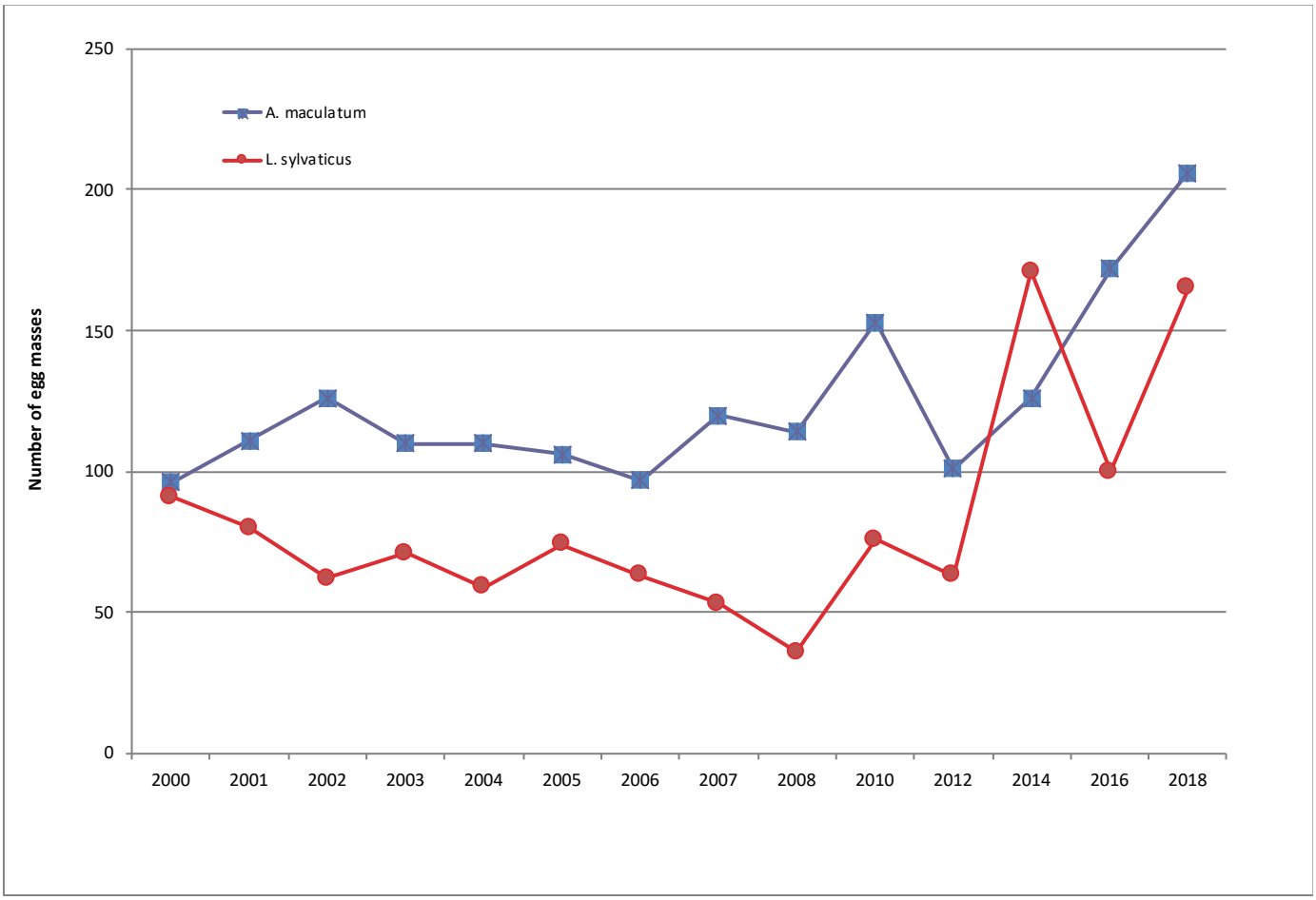
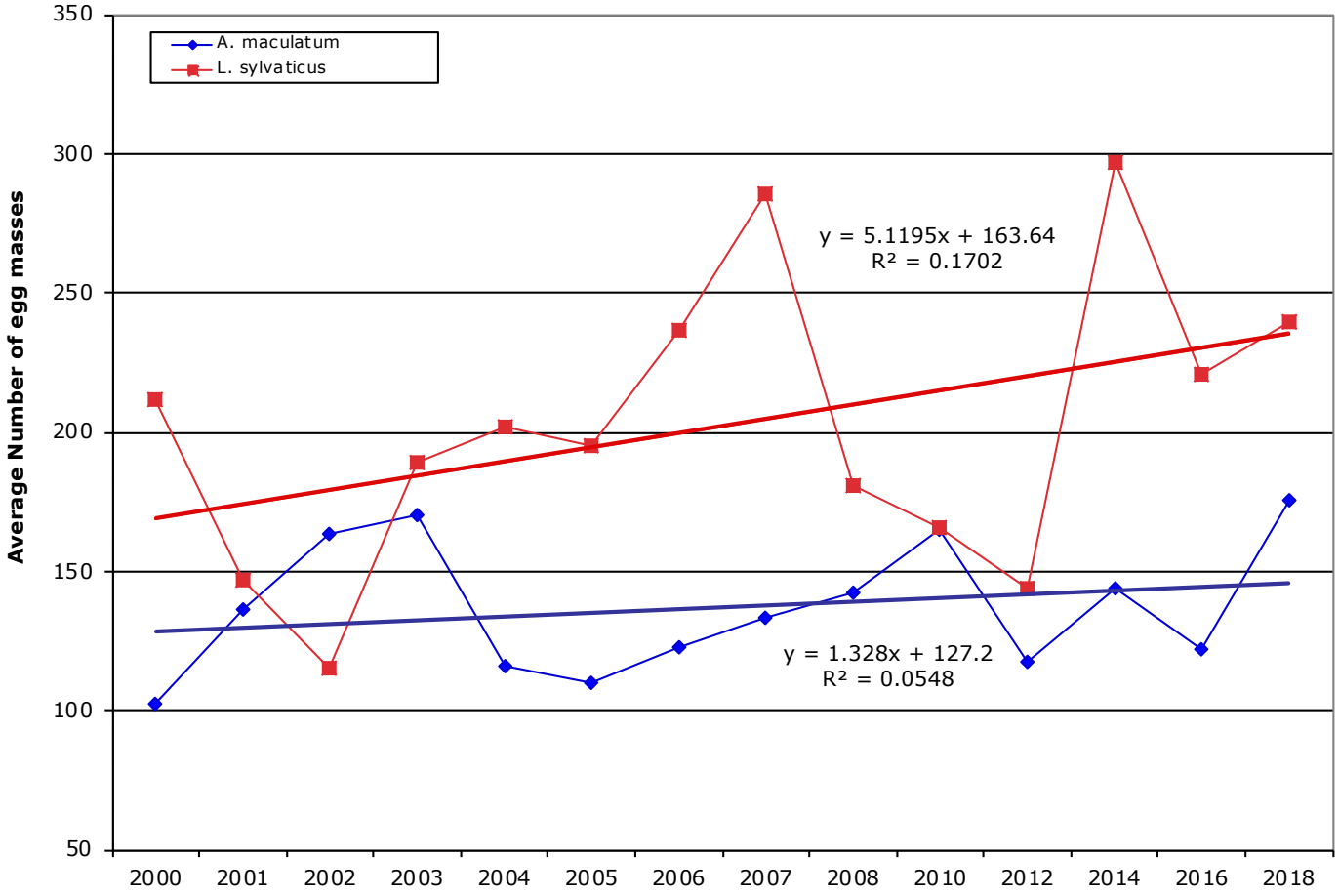


Figure 5: Average High Counts and trend lines for Spotted Salamander (*A. maculatum)* and Wood Frog (*L. sylvaticus*) egg-masses on Lester Anderson Lands, Lincoln, Vermont (2000-2018).



Spotted Salamander

The combined number of Spotted Salamander egg-masses from all ponds was 702 egg-masses, the highest number we have recorded from any one year (Table 5). 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, Table 1, and Appendix 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 and dropped even more in 2018 when 42 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 during that time. We did notice at times in 2018 that the water was murky with a fair amount of debris. It was necessary to use a stick to move vegetation, to see farther into the water. 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 and 264 (a record high) in 2018 (Figure 3, Table 3, and Appendix 3). There were a record number of Spotted Salamander egg-masses seen at Wells in 2016, when 172 masses were counted but fewer were seen in 2018 when 125 were detected (Table 4, Figure 4, and Appendix 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 1-5. 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 a gradual increase (Figure 5). 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 breeding in in 2003, dropped to a low of 146 in 2005 fluctuated each year, but have risen to a record high of 234 breeding females in 2018. Studies have shown that a small number of females breed every year, but most skip one or more years (Petranka 1998). 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, 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

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 since monitoring began (1,188). We were slightly above average in 2018 with 958. 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 number of Wood Frog egg-masses in 2016 were found in Guthrie with 465 masses detected. Exactly the same number was detected in 2018 (Figure 3, Table 3, and Appendix 3). We also recorded 165 egg-masses at Wells, which was the second highest number ever counted in that pond. Trend lines for Wood Frog egg-masses show an increase for combined totals for all four ponds (Figure 5). In the past we have found Wood Frog egg masses at Upper Fred Pierce each year, but we rarely found many tadpoles. In 2018 we found more than 6500 tadpoles. We had been suspicious that the Eastern Newts (*Notophthalmus viridescens*) were eating the tadpoles or the eggs, and/or that the Green Frogs (*Lithobates clamitans*) were breaking up the egg-masses. In 2018, many fewer Green Frog tadpoles were detected than in recent years which could help explain the larger number of Wood Frog tadpoles. On average, Guthrie is the most productive breeding location and Upper Fred Pierce and Wells are the least productive.

Weather and Climate

As we have now collected 15 years of data over an 18-year period we are able to look at long-term trends in timing for this site (Figures 6 and 7).

In 2014 *The Vermont Climate Assessment: Considering Vermont's Future in a Changing Climate* was published (Galford et al., 2014). Some of their key messages include: the state's average temperature has increased by 1.6 F since 1960; and, 45% of that change has been since 1990. Annual precipitation has increased by 5.9 inches since 1960. This increase is not uniform, and mountainous regions are receiving relatively more precipitation. The freeze thaw cycles are shifting, and the freeze period is decreasing by 3.9 days per decade. Freeze period is the total number of freeze days per year (days with a minimum temperature at or below 28 F). These changes could impact amphibian breeding cycles, overwintering sites, and food supplies.

The results we have seen in the four ponds on the Anderson Lands are not surprising based on the climate changes we are seeing on state and national levels. In the past 18 years, although the weather has varied from winter to winter (including two of the warmest winters and one of the coldest with large variations in snowfall) the overall effect of the changing climate appears when we look at the trends over multiple years and decades.

During the 2018 season the first Wood Frog egg-masses were seen on April 17 (Lower Fred Pierce), April 24 (Upper Fred Pierce and Guthrie), and May 2 (Wells) (Appendix Tables 1-4). The high counts for Wood Frog egg-masses were on May 2nd for all four ponds. The first Wood Frog egg-masses are appearing approximately 10-11 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 1/2 day earlier per year. It is possible that we missed some early egg-masses due to the timing of those first 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 three-day change over the last 17 years.

During the 2018 season the first Spotted Salamander egg-masses were seen on April 24 at all four ponds (Appendix Tables 1-4). The high counts for Spotted Salamander egg-masses were on May 2 for Lower and Upper Fred Pierce, May

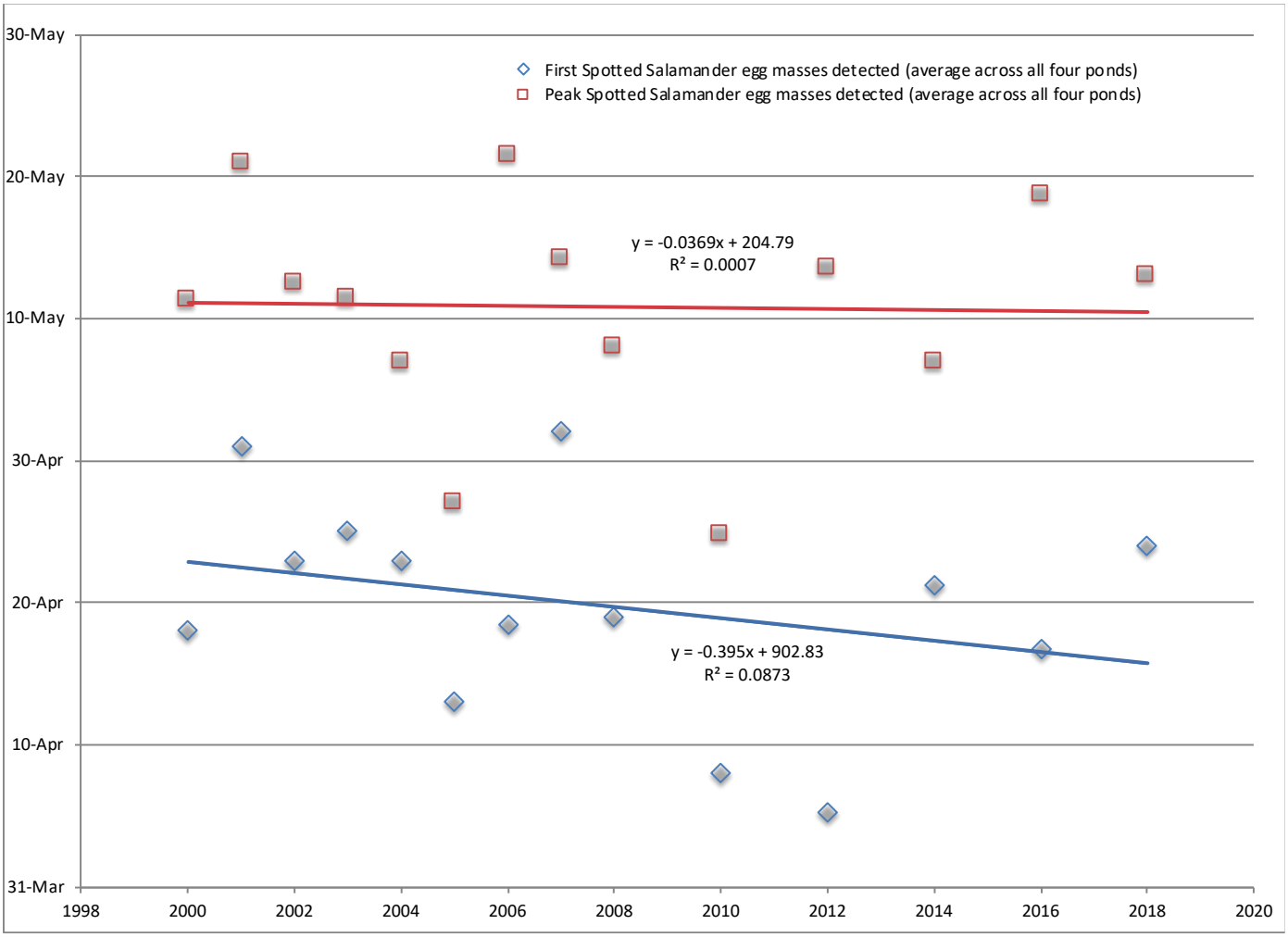
10 at Wells, and May 16 at Guthrie. The first Spotted Salamanders egg-masses are seen approximately 7-8 days earlier than when we began gathering data in 2000; although the peak number of egg masses has shown little change (Figure 7).

Since Wood Frogs move en masse 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.

These results are some of the first showing how climate change may be directly affecting Vermont's amphibians.

Figure 6: First egg-masses detected and peak egg-masses (with trend lines) for Wood Frog (*L. sylvaticus)* across all four ponds on Lester Anderson Lands, Lincoln, Vermont (2000-2018).

Figure 7: First egg-masses detected and peak egg-masses (with trend lines) for Spotted Salamander (*A. maculatum)* across all four ponds on Lester Anderson Lands, Lincoln, Vermont (2000-2018).



Egg-mass Counts: Summary

Although numbers of breeding females of both species appear to be declining in Upper Fred Pierce and increasing in Wells, 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 these trends could be reversed easily with a couple poor-breeding years. Breeding female Spotted Salamander numbers appear fairly stable over the long term, but may be increasing slightly.

Trends since 2000, show the dates of first egg-mass counts and peak egg-mass counts for both species are coming earlier in the spring.

Notes on Other Species

During egg-mass counts we also found Eastern Newts 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.

We found an unusually patterned female adult Green Frog at Guthrie on May 24 (see Appendix Figure 3a). We also heard a Spring Peeper (*Pseudacris crucifer*) calling at both Guthrie and Lower Fred Pierce.

A Mallard was seen on Guthrie on April 11 when Kate Kelly arrived, but was not seen on subsequent visits. Other birds seen or heard in the vicinity of the ponds during the 2018 egg-mass counts included; American Robin, American Crow, American Goldfinch, American Woodcock, Baltimore Oriole, Barred Owl, Black and White Warbler, Black-capped Chickadee, Blue-headed Vireo, Blue Jay, Broad-winged Hawk, Brown Creeper, Canada Goose, Chipping Sparrow, Common Raven, Common Yellowthroat, Dark-eyed Junco, Eastern Bluebird, Eastern Phoebe, Gray Catbird, Hermit Thrush, House Wren, Least Flycatcher, Mourning Dove, Northern Flicker, Ovenbird, Pileated Woodpecker, Purple Finch, Red-breasted Nuthatch, Red-eyed Vireo, Red-winged Blackbird, Rose-breasted Grosbeak, Ruby-crowned Kinglet, Song Sparrow, Tufted Titmouse, White-throated Sparrow, Warbling Vireo, Wild Turkey (could have been a hunter calling), Wood Thrush, 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. We also found Red-winged Blackbird nests with eggs at Guthrie (nest with four eggs) and at Wells (three eggs) (see Appendix Figure 3a).

Other species recorded were colonial bryozoans (see Appendix Figure 3a), leeches (*Macrobdella decora*), and diving beetles (Dytiscidae family). We noted that black flies had hatched on May 24. During at least one of the weeks of our survey period we found blooming Marsh Marigold, Trillium, and Trout Lily.

We noticed fairy shrimp on April 14, 2016 at Guthrie (This was the first time we saw and/or recorded their presence at any of the survey ponds. We did not notice them in 2018, (nor did we focus a great deal of attention on looking for them).

Snake-covers: Methods

The snake-covers were initially an experiment in snake-monitoring methods, but they are working well. We were not aware of any other efforts to monitor snake populations using covers, though they are used as an inventory tool at other locations. We 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 we have come to believe that the larger the piece of cover the better, but practical and aesthetic considerations led us to initially try old roofing slate. The largest used roofing slate that we could locate was 610 mm x 360 mm and 5 mm thick. With two of these slates we 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. We 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). We 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, *Storeria occipitomaculata*) 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 Eastern 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 2017, and we will monitor them again in the fall of 2019. 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 and the monitoring of the snake-covers takes place in the fall of the same calendar year.

Snake-covers: Basic species information

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 Red-bellied Snakes used the snake-covers. The Red-bellied Snake is a small, secretive, viviparous (giving live birth) snake of woodlands and woodland openings. 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). 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. 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: Common Gartersnake (*Thamnophis sirtalis*) and Eastern Milksnake. As of 2018, Common Gartersnakes were the most frequently encountered snake (461) using the covers with Red-bellied Snake second (304) and Eastern Milksnake a distant third (62). However, relative numbers of each species vary from year to year.

The Common Gartersnake is the most common snake in the state (Andrews, 2019). They 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).

The Eastern 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. Eastern 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 Eastern Milksnake is not possible to determine based on tail length because there is too much overlap between males and females (Ernst and Barbour 1989).

Snake-covers: Results and Discussion

In 2017 snake-covers were checked nine times at weekly intervals starting on Sept. 6 with subsequent checks on Sept. 13, 20, and 27, Oct. 3, 11, 18, and 24, and Nov 1 (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, 9, and 10 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 numbers of total captures and young of the year were averaged. No new species of snake were seen during the 2017 season.

In 2017 this index for Common Gartersnakes was 12.34, compared to 2015 when it was 10.66. We have not detected over 12 since 2006. 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 during the span of this study, but rebounded slightly to 2.34 in 2017. 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.

Similar to 2015 when we detected seven distinct Eastern Milksnakes, in 2017 we again detected a relatively high number of Eastern Milksnakes (Table 8). The index calculated was 3.67. This is higher than the index for Red-bellied Snakes for only the second time in this study's history. This represented a total of 15 detections and based on our descriptions and measurements we found one snake twice, but all other findings were distinct individuals, eight were considered young-of-the year (SV lengths were no more than 260 mm).

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. Eastern Milksnakes have been known to eat both Red-bellied Snakes and gartersnakes (Ernst and Ernst 2003).

One Common Gartersnake, and four Eastern Milksnakes (one dead) were found using the covers during our 2017 maintenance visits on July 11 and 19. An additional four Eastern Milksnakes and two Common Gartersnakes were found in the stone foundation. Snakes were measured and palpated. No Red-bellied Snakes were found on those two days.

One Common Gartersnake, and two Eastern Milksnakes were found using the covers during our 2018 maintenance visits on July 18, 2018. Snakes were measured and palpated. No Red-bellied Snakes were found at that time. On September 10 and five times during October and early November we randomly checked a few snake covers, while walking towards the salamander covers. During those incidental checkings we found seven Common Gartersnakes, one Eastern Milksnake, and nine Red-bellied Snakes, including six young of the year (five were found together on October 22 (see Appendix Figure 3b).

Both Red-bellied Snakes and Common Gartersnakes give live birth and gravid females would be carrying young in July. Eastern Milksnakes lay eggs. Our data is very limited for ovipositing and hatching dates in Vermont. According to the literature, Eastern Milksnakes lay eggs from May to mid-July, and young hatch late July to late September (Ernst and Ernst 2003). Eastern Milksnake eggs have been found in Vermont on May 10 and August 2 (Andrews 2019).

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.

Notes on Other Species

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 2017 we noted ants, sow bugs, ground beetles, slugs, springtails (probable), Isabella Tiger Moth caterpillars, isopodes, black and camel crickets, and a harvestman. We also found cocoons attached to the slate. We did see earthworms including night crawlers but did not notice any invasive snake worms.

Additional invertebrates noted (not under the cover-boards) were a cyanide millipede in the wooded area and a blister beetle in the grass. We poked around the milkweed patches when returning to the cars and found Monarch caterpillars on Sept. 6 and Sept. 13, one of which showed signs of being predated on by a fly species in the Tachinidae (McFarland, K. pers. Communication). We saw adult Monarchs on Sept. 27 and Oct. 3. We also saw Painted Ladies (Sept 27) and a Sulphur Butterfly (Oct. 18). We noted the following birds: eight Wild Turkeys, Common Raven, American Goldfinch, Canada Geese, Red-tailed Hawk, Black-capped Chickadee, White-breasted Nuthatch, Blue Jay, and on October 3 we saw a small flock of six Red Crossbills.

We found a few additional amphibians and reptiles while checking the snake-covers in 2017 including a Green Frog (heard Sept. 6), Wood Frog YOY (Sept.), Pickerel Frog (*Lithobates Palustris)* (Sept. 13), Common Gartersnake (*S*ept. 20), Gray Treefrog (*Hyla versicolor*, heard Sept. 20), Spring Peeper (heard Sept. 20). A dead snake was found that had been apparently killed by the mower (Sept. 20).

On occasion we found amphibians using the cover-boards. In 2017 we found Eastern Red-backed Salamander (*Plethodon cinereus* (4 times), American Toad (*Anaxyrus* americanus), possibly preparing to overwinter – was on the surface of #8, but not detected in later weeks).

In 2015, we detected multi-flora rose between cover boards #1 and #2. We did not notice it in 2017, but if it is detected again it should be removed as resources allow.

Table 6. Fall 2017 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. 6	*T. sirtalis*	140	180	#2 between	
Sept. 6	*T. sirtalis*	155	210	#2 between	
Sept. 6	*T. sirtalis*	140	180	#2 between	
Sept. 6	*T. sirtalis*	130	160	#2 between	
Sept. 6	*T. sirtalis*	145	185	#6 ground	
Sept. 6	*T. sirtalis*	135	170	#6 ground	
Sept. 6	*T. sirtalis*	155	200	#6 ground	
Sept. 6	*T. sirtalis*	145	182	#6 ground	
Sept. 6	*T. sirtalis*	360	465	#32 between	About to shed
Sept. 6	*T. sirtalis*	285	370	#32 ground	
Sept. 6	*T. sirtalis*			#36 between	Shed skin
Sept. 6	*T. sirtalis*	140	179	#43 ground	
Sept. 6	*T. sirtalis*	310	395	#43 ground	
Sept. 6	*T. sirtalis*	310	415	#43 ground	
Sept. 13	*T. sirtalis*	135	165	# 2 between	
Sept. 13	*T. sirtalis*	145	185	# 2 between	
Sept. 13	*T. sirtalis*	120	150	# 2 between	
Sept. 13	*T. sirtalis*	145	185	# 2 between	
Sept. 13	*T. sirtalis*	145	185	#1 between	
Sept. 13	*T. sirtalis*	135	170	#1 between	
Sept. 13	*T. sirtalis*	145	185	#5 between	
Sept. 13	*T. sirtalis*	160	205	#5 between	
Sept. 13	*T. sirtalis*	135	165	#5 ground	
Sept. 13	*T. sirtalis*	130	165	#5 ground	
Sept. 13	*T. sirtalis*	140	180	#6 between	
Sept. 13	*T. sirtalis*	145	190	#6 between	
Sept. 13	*T. sirtalis*	145	190	#11 between	
Sept. 13	*T. sirtalis*	400	510	#11 between	
Sept. 13	*T. sirtalis*	130	165	#12 between	
Sept. 13	*T. sirtalis*	140	180	#12 between	
Sept. 13	*T. sirtalis*	310	400	#32 between	
Sept. 13	*T. sirtalis*	135	170	#43 ground	
Sept. 13	*T. sirtalis*	145	190	#43 ground	
Sept. 20	*T. sirtalis*	140	177	#43 ground	
Sept. 20	*T. sirtalis*	140	180	#43 ground	
Sept. 20	*T. sirtalis*	180	230	#43 ground	
Sept. 20	*T. sirtalis*	155	195	#43 ground	
Sept. 20	*T. sirtalis*	150	190	#43 ground	
Sept. 20	*T. sirtalis*	160	205	#42 between	
Sept. 20	*T. sirtalis*	170	220	#42 between	
Sept. 20	*T. sirtalis*	160	200	#42 between	

Sept. 20	*T. sirtalis*	165	215	#42 between	
Sept. 20	*T. sirtalis*	340	440	#32 between	
Sept. 20	*T. sirtalis*	360	460	#32 ground	
Sept. 20	*T. sirtalis*	315	425	#32 ground	
Sept. 20	*T. sirtalis*	180	225	#32 ground	
Sept. 20	*T. sirtalis*	170	220	#32 ground	
Sept. 20	*T. sirtalis*	340	425	#21 between	
Sept. 27	*T. sirtalis*			#43 between	Dead-young of the year
Sept. 27	*T. sirtalis*	170	220	#23 surface	
Sept. 27	*T. sirtalis*	154	199	#12 surface	
Sept. 27	*T. sirtalis*	145	185	#5 between	
Sept. 27	*T. sirtalis*	165	205	#5 between	
Sept. 27	*T. sirtalis*	165	210	#2 between	
Sept. 27	*T. sirtalis*	182	232	#44 between	
Oct. 3	*T. sirtalis*	180	230	#2 between	
Oct. 3	*T. sirtalis*	130	165	#5 surface	
Oct. 3	*T. sirtalis*	155	200	#5 surface	
Oct. 3	*T. sirtalis*	340	440	#12 between	
Oct. 3	*T. sirtalis*	160	205	#13 surface	
Oct. 3	*T. sirtalis*	140	180	#21 between	
Oct. 3	*T. sirtalis*	145	185	#23 surface	
Oct. 3	*T. sirtalis*	180	240	# 23surface	
Oct. 3	*T. sirtalis*	190	235	#38 between	
Oct. 3	*T. sirtalis*	165	210	#42 between	
Oct. 3	*T. sirtalis*	185	240	#42 surface	
Oct. 3	*T. sirtalis*	170	215	#44 surface	
Oct. 3	*T. sirtalis*	145	185	#44 surface	
Oct. 3	*T. sirtalis*	170	214	#44 surface	
Oct. 3	*T. sirtalis*	180	235	#44 surface	
Oct. 3	*T. sirtalis*	140	180	#44 surface	
Oct.11	*T. sirtalis*	150	190	#5 surface	
Oct.11	*T. sirtalis*	160	205	#5 surface	
Oct.11	*T. sirtalis*	150	190	#6 between	
Oct.11	*T. sirtalis*	165	210	#6 between	
Oct.11	*T. sirtalis*	195	240	#22 surface	
Oct.11	*T. sirtalis*	165	210	#23 between	
Oct.11	*T. sirtalis*	190	240	#23 surface	
Oct.11	*T. sirtalis*	200	255	#23 surface	
Oct.11	*T. sirtalis*	150	195	#23 surface	
Oct.11	*T. sirtalis*	145	193	#23 surface	
Oct.11	*T. sirtalis*	155	200	#44 surface	
Oct.18	*T. sirtalis*	160	205	#5 surface	
Oct.18	*T. sirtalis*	163	203	#23 surface	
Oct.18	*T. sirtalis*	160	200	#27 surface	
Oct.18	*T. sirtalis*	160	205	#4 surface	

Figure 8. Average Common Gartersnake (*T. sirtalis)* total captures and average Common Gartersnake adult captures per highest three counts under snake-covers 1-40 over entire season (2002-2017).

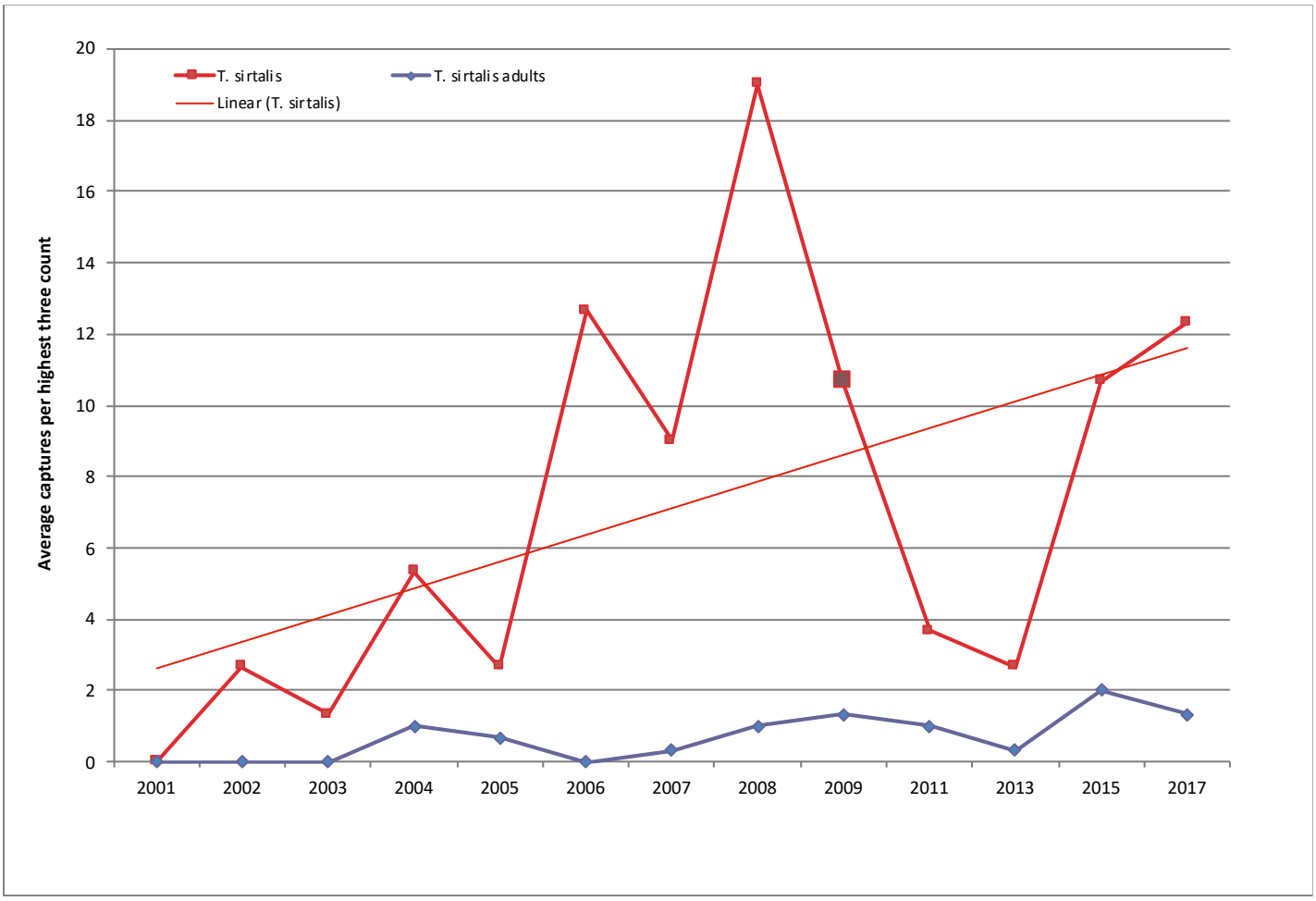


Table 7. Fall 2017 snake-cover results from the Lester Anderson lands on the Bristol/Lincoln border in Vermont for the Red-bellied Snake (*S. occipitomaculata*). (Two were found in 2015).

Date	Species	S-V length in mm	Total length in mm	Location Cover # - Cover Area	Mass and Physical Info
Oct. 3	*S. occipitomaculata*	70	90	#15 between	
Oct. 3	*S. occipitomaculata*	240	290	#42 between	
Oct. 3	*S. occipitomaculata*	150	195	#42 between	
Oct. 11	*S. occipitomaculata*	75	95	#23 surface	
Oct. 18	*S. occipitomaculata*	155	200	#5 surface	
Oct. 18	*S. occipitomaculata*	75	95	#6 surface	Nice red colored belly
Oct. 18	*S. occipitomaculata*	195	230	#23 surface	
Oct. 18	*S. occipitomaculata*	149	194	#25 surface	
Oct. 18	*S. occipitomaculata*	70	87	#27 surface	
Oct. 24	*S. occipitomaculata*	85	110	#27 between	
Nov. 1	*S. occipitomaculata*	160	195	#5 surface	

Figure 9. Average Red-bellied Snake (*S. occipitomaculata)* total captures and average Red-bellied Snake adult captures per highest three counts under snake-covers 1-40 over entire season (2001-2017).

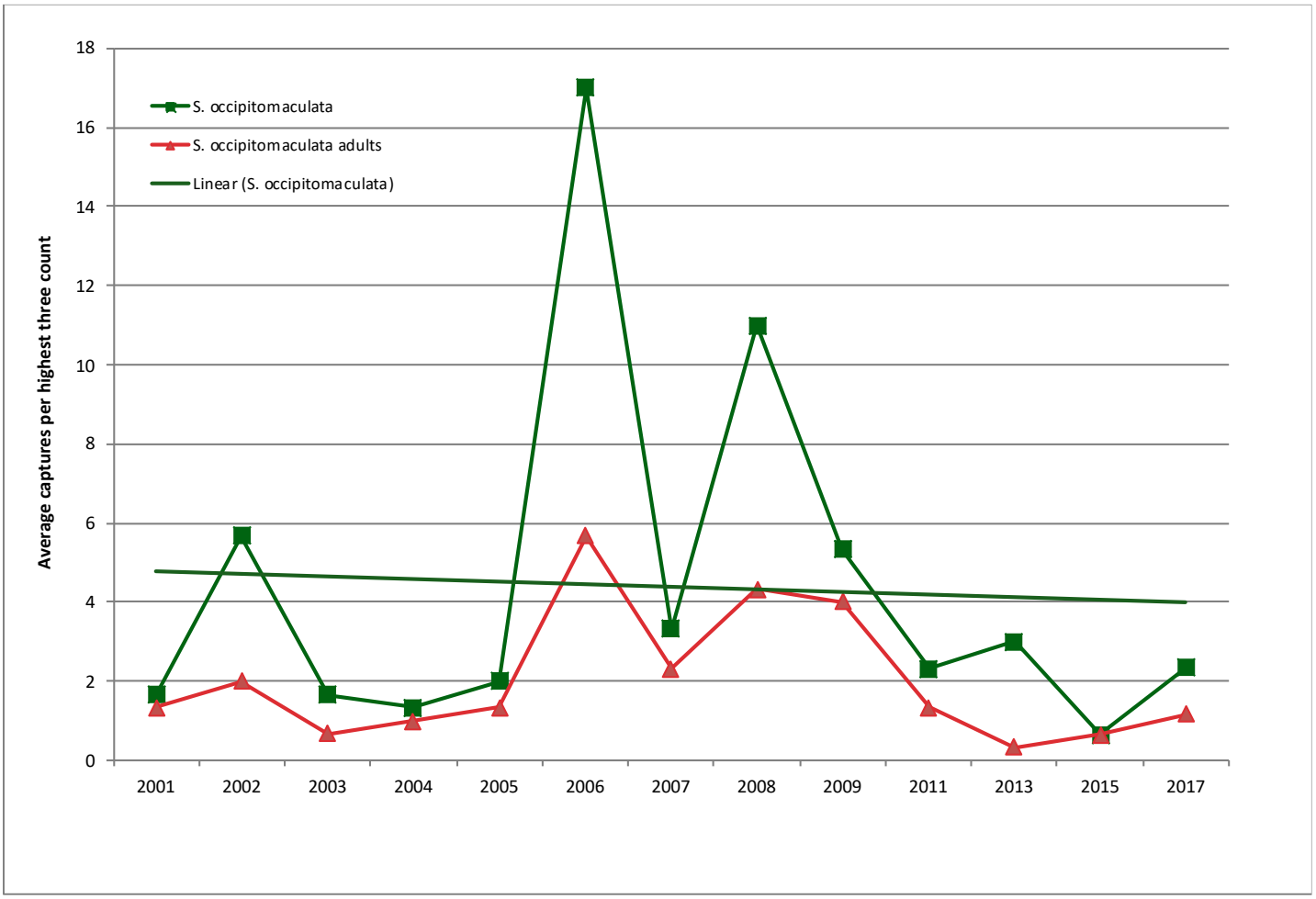


Table 8. Fall 2017 snake-cover results from the Lester Anderson lands on the Bristol/Lincoln border in Vermont for Eastern Milksnakes (*L. triangulum*).

Date	*Species*	S-V length in mm	Total length in mm	Location Cover # - Cover Area	Physical Info
Sept. 6	*L. triangulum*	260	300	#21 between	Nice white Y totally enclosed, #6 is spot right, #13 spot right, #25 spot is split, #30 spot left, #39 spot left and vent, #47 total
Sept. 6	*L. triangulum*	290	330	#27 between	Top of Y open and connects on left, #8 spot left, #18 spot left, #25 spot right, #36 spot right, #39 vent, 50 total. Shaking tail.
Sept. 6	*L. triangulum*	440	520	#32 ground	Y is open at top like "a river" bottom of Y extends down 1/2" #2 extends forward on left, #7 spot left, #28 spot left, #32 spot right, #39 spot right, #50 vent, #54 spot left, #63 total.
Sept. 6	*L. triangulum*	510	585	#22 ground	Top of Y open and connects to edge on both sides, #5 Y to left, #16 Y to left #28 Y left, #39 is vent, #48 spot left
Sept. 13	*L. triangulum*	280	320	#21 between	Y in enclosed, #6 spot left, #10 spot left, #13 spot right, 25 broken in middle, #30 spot on left, #38 is vent, 47 total *"We think it just ate something."*
Sept. 13	*L. triangulum*	430	500	#34 between	Y is connected on left, #6 spot right, #16 is a weak Y right, #40 is vent, 51 total. Saw hemipenes (male)
Sept. 13	*L. triangulum*	450	530	# 39 between	Y connects on both sides. Y is 3/4" with small bulge near top of Y then it splits and extends on both sides, #2 is zig zag to left, #7 spot left, #21 spot left, 41 vent, 46 spot left, 55 total
Sept.20	*L. triangulum*	510	590	#23 between	Tips of Y are open and both sides more like a V, #6 Y left, #10 spot right, #29 Y left, #37 Y left, #41 vent, 50 total.
Sept. 27	*L. triangulum*	192	217	#8 surface	Y totally enclosed, #13 Y right, #18 Y right, #22 Y left, #37 vent, #40 spot right, 46 total.
Sept. 27	*L. triangulum*	195	225	#38 between	Y has no tips, #5 spot right, #9 spot right, #11 Y right, #13 Y right, #20 spot left, #32 vent, #36 spot right, 41 total
Sept. 27	*L. triangulum*	210	240	#28 ground	Y is nice and enclosed both tips have little dots, #2 Y left, #11 Y left, #15 Y right, #8 Y right, #21 Y left, #23 Y right, #35 vent, 45 total
Sept. 27	*L. triangulum*	220	250	#27 between	Y looks like a steer head the top are very pointy, #20 Y right, #27 Y right,# 37 vent, #40 Y right, 48 total
Oct. 3	*L. triangulum*	200	235	#6 surface	Dot with two little dots instead of a Y, #13 Y right, #29 Y left, #31 vent, 40 total
Oct. 3	*L. triangulum*	205	235	#28 surface	U instead of a Y, #5 is weird; it is L right, #35 vent, 40 spot right, 46 total.
Oct. 3	*L. triangulum*	220	255	#28 surface	Y is a U with a dot in center, #13 dot right, #21 Y right, #33 Y right, #36 vent, #38 Y left, #39 Y right, 44 total.

Figure 10. Average Eastern Milksnakes (*L. Triangulum)* total captures and average Eastern Milksnake adult captures per highest three counts under snake-covers 1-40 over entire season (2001-2017).

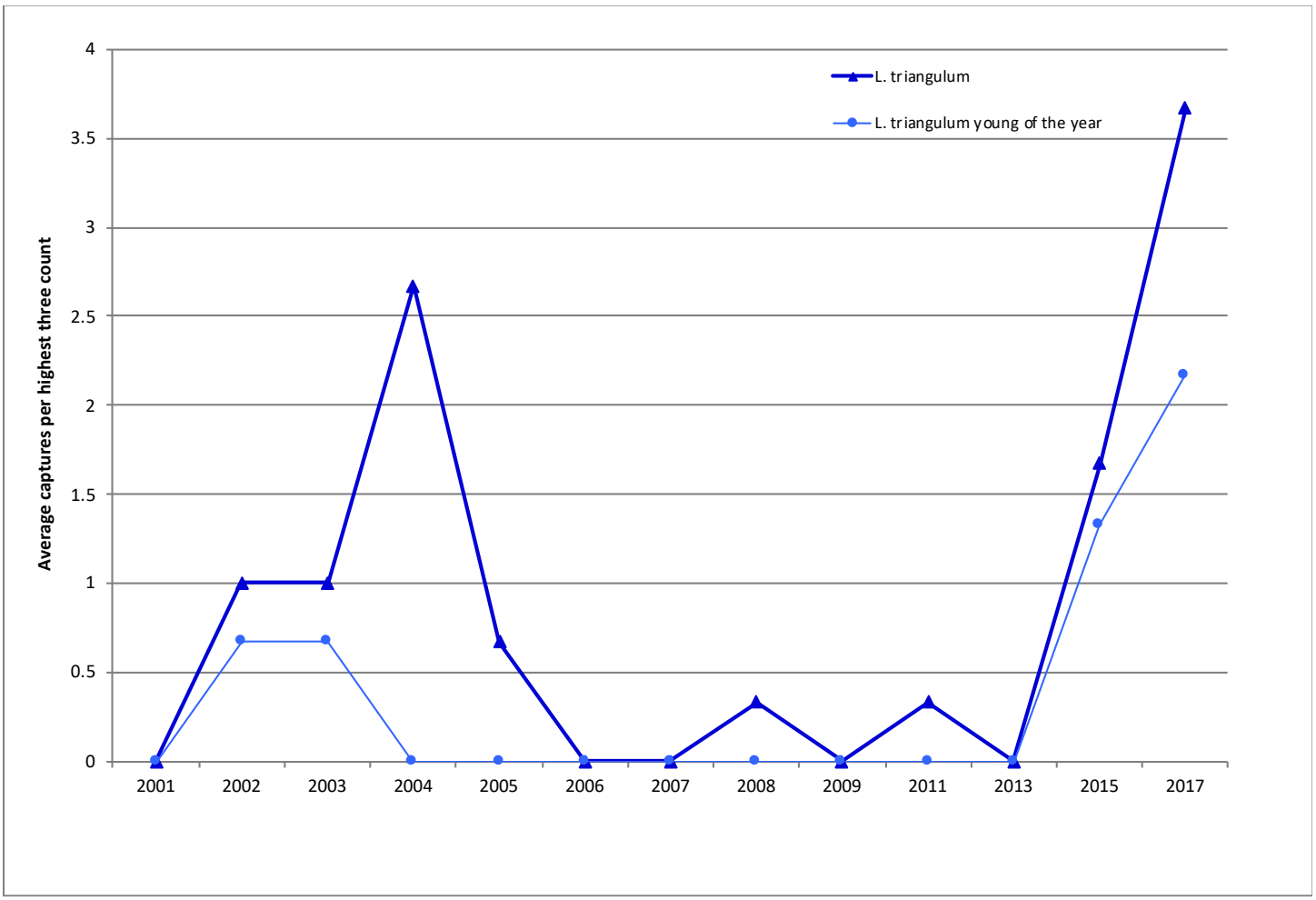


Table 9a. Accidental and unidentified snakes captured during the 2017 summer and fall in and around the snake-cover from the Lester Anderson lands on the Bristol/Lincoln border in Vermont.

Date	Species	S-V length in mm	Total length in mm	Location Cover # - Cover Area	Mass and Physical Info
July 11	*L. triangulum*	295	340	#36 surface	Skin was between and under boards. Dead (crushed head). Possibly killed when bear (?) lifted them, dropped bottom cover on it.
July 11	*L. triangulum*	812	935	Foundation	Y complete, #1 giant H, #12 spot R, #15 spot R, #18 mostly R, #19 mostly L, #21 mostly L, #22 mostly R, #24 mostly L, #26 mostly R, #32 mostly L, #35 vent, #39 mostly L, 45 total, likely male (no eggs, minimal tail taper) , about to shed.
July 11	*L. triangulum*	485	565	Foundation	Top and bottom pieces of Y visible, scar in the middle, #28 mostly L, #32, #33, #34 mostly R, #37 mostly L, #38 vent, 48 total, likely male
July 11	*T. sirtalis*			Foundation	2 of them
July 19	*L. triangulum*	490	550	#23 between	Y open on both side, #5 Y left,# 9 spot left, #21 1st scar, #28 Y left, #36 Y left, #40 vent, #48 Y left, 49 total. Between 46 - 47 is 2nd scar
July 19	*L. triangulum*			#28 between	
July 19	*L. triangulum*			#29 surface	
July 19	*T. sirtalis*	280	375	#23 between	
July 19	*L. triangulum*	450	515	Foundation	Y open on bottom and just a dot on the right, #3 Y left, #4 Y right, #30 Y left, #40 spot right, #42 vent, #47 Y right, 50 total
July 19	*T. sirtalis*			Foundation	
July 19	*T. sirtalis*	280	375	#23 between	
Sept. 6	*T. sirtalis*		~483	Foundation	Measure is an estimate
Sept. 6	*T. sirtalis*				Shed skin
Sept. 13	*L. triangulum*	768	888	Foundation	Y broken on left side but enclosed, #25 right,# 30 Y right,# 38 is vent, #43 Y right, 47 total.
Sept 13.	*L. triangulum*			Foundation	Shed skin, feels fresh
Sept 20	L. triangulum			Foundation	In rocks, could not catch
Sept. 20	T. sirtalis				In rocks, could not catch
Sept. 20	T. sirtalis	165	210	Foundation	
Sept. 20	Unidentified snake			Mowed fields	Dead (had been mowed over)
Sept 20	T. sirtalis	165	210	In debris slate pile	
Dec 8	S. occipitomaculata			#27 surface	Responded to touch but very slowly. Young of year, 70-80 mm (total length). A few light snows and frosts with one night of warm rain Dec 5, ground not frozen.

Table 9b. Accidental and unidentified snakes captured during the 2018 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 18	*L. triangulum*	235	275	#20 between	
July 18	*L. triangulum*	230	267	#21 between	
July 18	*T. sirtalis*	435	555	#32 between	Male?
Sept. 10	*T. sirtalis*	190	250	#2 between	Male?
Sept. 10	*T. sirtalis*	195	245	#2 ground	
Sept. 10	*T. sirtalis*			#2 between	2 shed skins
Sept. 10	*T. sirtalis*	210	275	#6	
Sept. 10	*T. sirtalis*	340	340	#29 ground	
Sept. 10	*L. triangulum*	310	355	#29 ground	Enclosed Y, #4 spot right, #17 spot right, #22 spot left, #27 spot left, #37 split, #41 vent, #43 Y left, 53 total. Two hemipenes partially everted. (see photo)
Sept. 10	*unknown*				Pieces of shed skin
Oct. 15	*S. occipitomaculata*			#19 between	
Oct. 15	*S. occipitomaculata*			#20 between	
Oct. 15	*T. sirtalis*			#21	Found on top of coverboard, partially eaten
Oct. 15	*S. occipitomaculata*			#22 ground	
Oct. 22	*S. occipitomaculata*			#20 ground	5 YOY all together (photo)
Oct. 22	*T. sirtalis*			#26 ground	
Oct. 29	*Nothing found*			#20	Looked underneath to see if YOY were still there
Nov. 5	*S. occipitomaculata*			#20 ground	1 YOY

There are some cover-boards along the transect that seemed to predictably have snakes, and others where we seem to rarely find snakes. To determine if this was indeed true, we plotted snakes by cover-boards in two ways. Figure 11 is raw data of all snakes found by cover-board. Figure 12 is all snakes by years that the cover-board has been part of transect and surveyed.

Figure 11: Total Snakes detected per cover-board for all covers (2001-2017). Cover-boards 1-40 have been checked 13 times starting in 2001. Cover-boards 41-45 have been checked 6 times starting in 2008.

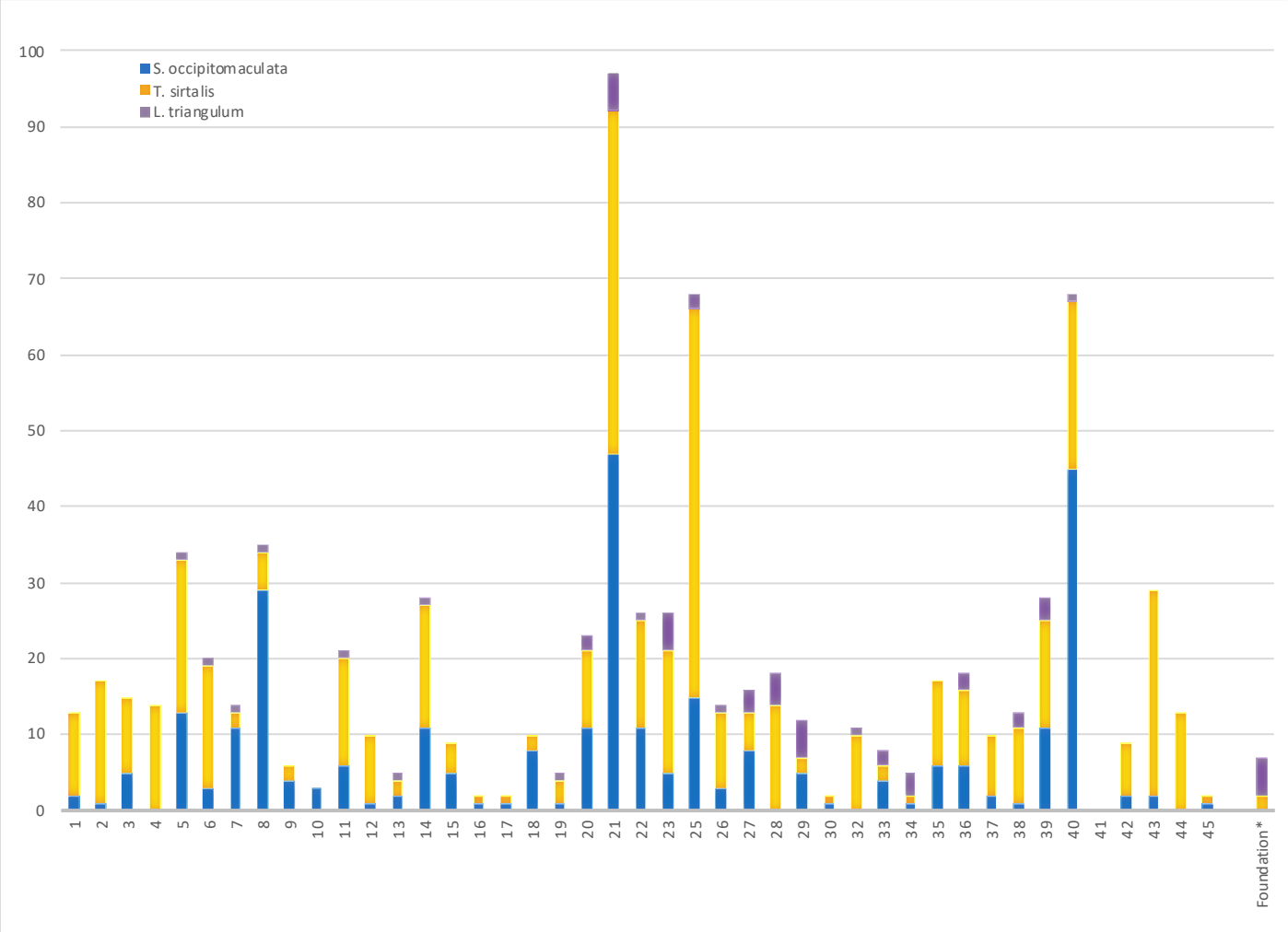
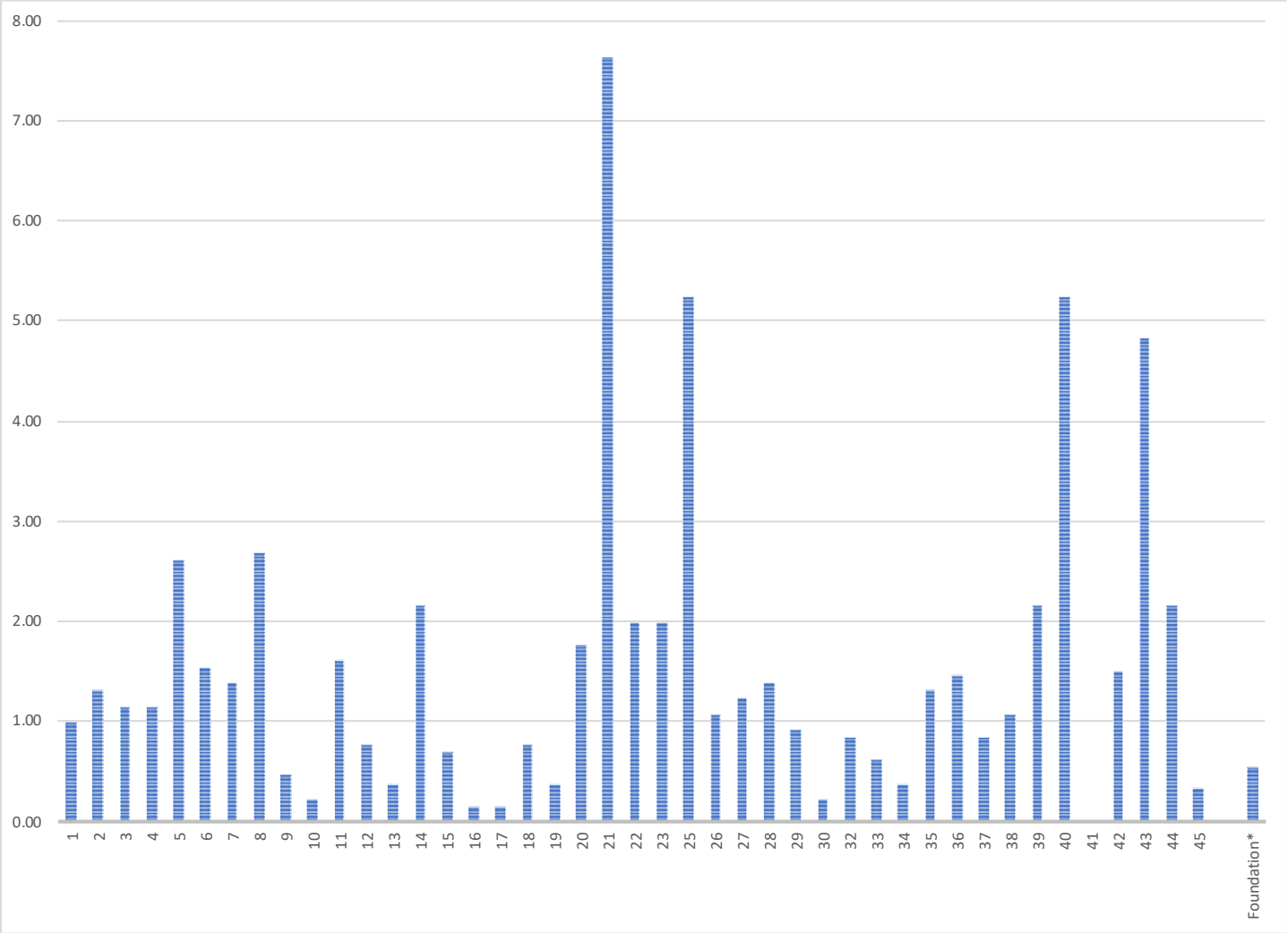


Figure 12: Total snakes divided by number of years cover board has been checked. Cover boards -40 have been checked 13 times starting in 2001. Cover boards 41-45 have been checked 6 times starting in 2008.



Snake-covers: Summary

We have thirteen solid years of data from the snake-covers and we can begin to look at population trends for all three species. The numbers of young Common Gartersnakes had been increasing (with annual variation) until 2008, although the numbers of surviving adults only showed very slight changes during the same time period (Figure 8). However, from 2008 through 2013 there was a period of steady decline of the total number of Common Gartersnakes. Then in 2015 and in 2017, a greater than average number of gartersnakes were captured, reversing the trend.

Overall, trend lines suggest a very slight decrease in the population of Red-bellied Snakes since 2017 with a high peak in 2006. Only two Red-bellied Snakes were detected during our survey in 2015, but 11 were detected in 2017. None were seen during cleaning in 2016, 2017, nor in 2018, which may be due to the high number of Eastern Milksnakes detected. (Figure 9A and 9B). We saw evidence of recent breeding when we found five YOY under one coverboard in 2018 ((see Appendix Figure 3b).

Eastern Milksnakes continue to be very rare at the transect site at Guthrie; although numbers jumped in 2015 and continued increasing through 2017. 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 for salamanders: Methods

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 and 2018. 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 (alongside 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 2018 we checked only the B covers and left the A covers undisturbed.

Cover-boards for salamanders: Basic species information

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

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.

Cover-boards for salamanders: Results and Discussion

The cover-boards were not monitored during 2011, 2013, 2015, nor 2017 field seasons, but were checked in 2012, 2014, 2016, and 2018. 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 2018, during two days of maintenance (July 18 and July 24) 84 Eastern Red-backed Salamanders, one Northern Dusky Salamander, and seven Eastern Newts were detected. In 2017, during a day of maintenance in July 19, 63 Eastern Red-backed Salamanders, and three Eastern Newts were detected. In 2016 during the two days of maintenance (August 2 and August 3), 74 Eastern Red-backed Salamanders were seen, along with three Eastern Newts and one Northern Dusky Salamander. In 2015, during the two days of maintenance (August 7 and August 27), a total of 88 Eastern Red-backed Salamanders and three Northern Dusky Salamander were found. During maintenance, the cover-boards are not checked using the same protocols as used for monitoring but even anecdotally these numbers are considerably lower than what was noted during cleaning in the summer of 2014 and 2013 when 158 and 121 salamanders were detected.

In 2018 the cover-boards were checked on ten dates: Sept. 3, 10, 17, and 24, Oct. 1, 8, 15, 22, and 29, and Nov. 5 (Table 10). This year we 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 B cover-boards in 2018). 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 two dates in 2018. One was found on Oct. 29 under cover-board 10B. It contained at least 11 eggs. Another Northern Dusky was found the same day under cover-board 12B. We were not able to see eggs nor were we able to detect testes in this individual. A single Northern Dusky salamander was also found during maintenance on July 27, 2018 under cover board 10A.

Over all, Northern Dusky Salamanders have been found under the cover-boards twelve times during the regular monitoring and have been found ten times while performing maintenance. They were found at cover-board #10 (ten times), cover-board #11 (twice), cover-board #12 (six times), and cover-board #16 (one time), and specific location not recorded (three times). This section of cover-boards is in a particularly wet area and saturated soils are the preferred habitat for 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.

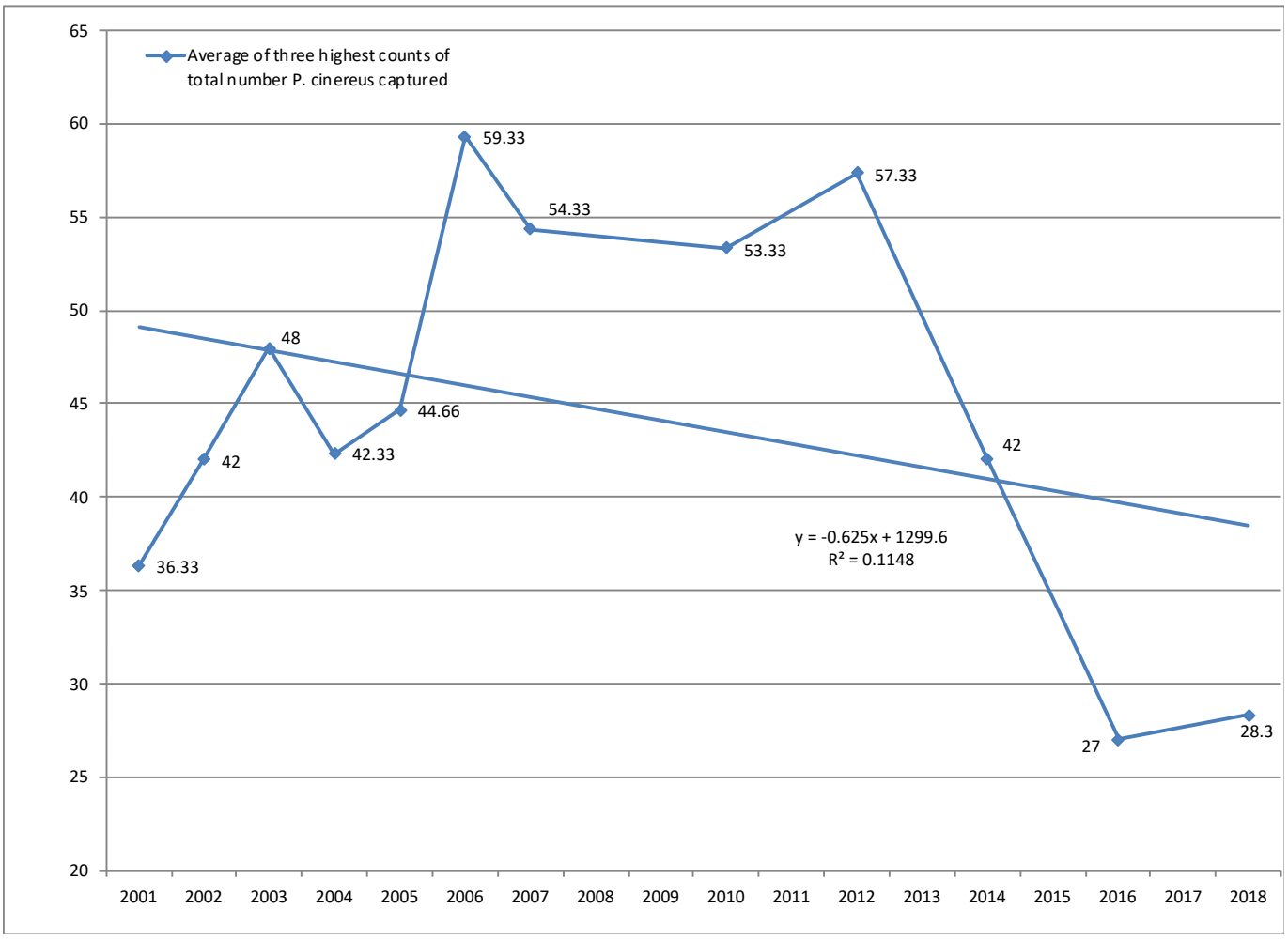
In 2018 the high count for numbers of Eastern Red-backed Salamanders was 41 (Sept 10, Table 10). In 2016 the high count of Eastern Red-backed Salamanders on one day was 32 (Sept. 6, Table 10). During the three checks from 2010 – 2014 our one-day high counts were 63, 60, and 50 respectively. To adjust 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 13. The high counts are often the first three counts in September, but occasionally include a count taken in October. In 2018, the high counts were Sept 10, 17, and 24. The high count of 41 was the second lowest (following 2016 results) that we have had over the course of the study.

Table 10. Fall 2018 cover-board results from the Lester Anderson lands on the Bristol/Lincoln border in Vermont. The species being monitored is Eastern Red-backed Salamander (*P. cinereus*). Only the B cover-boards of each pair were checked in 2018 (10 visits). 241 were counted in 2014 (7 visits), 134 were counted in 2016 (8 visits).

	Snout to Vent Length						
Date	1-20 mm	21-30 mm	31-40 mm	41-50 mm	51-60 mm	Unk.[1]	Total
Sept. 3	0	4	10	2	0	0	16
Sept. 10	0	6	26	7	0	2	41
Sept 17	0	3	14	3	0	0	20
Sept. 24	0	2	20	2	0	0	24
Oct 1	0	4	15	1	0	0	20
Oct 8	0	1	16	2	0	0	19
Oct. 15	0	1	9	1	0	0	11
Oct. 22	0	1	5	3	0	0	9
Oct 29	0	1	4	0	0	0	5
Nov 5	0	2	2	1	0	0	5
Total	**0**[2]	**25**[2]	**121**[2]	**22**[2]	**0**[2]	**2**[2]	**170**[2]

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

Figure 13. Average number of Eastern Red-backed Salamanders (*P. cinereus*) captured during the three highest counts[1] during cover-board monitoring on the Lester Anderson lands on the Bristol/Lincoln border in Vermont (2001-2018).



The highest count has been the first count in the fall during close to 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 overwintering 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

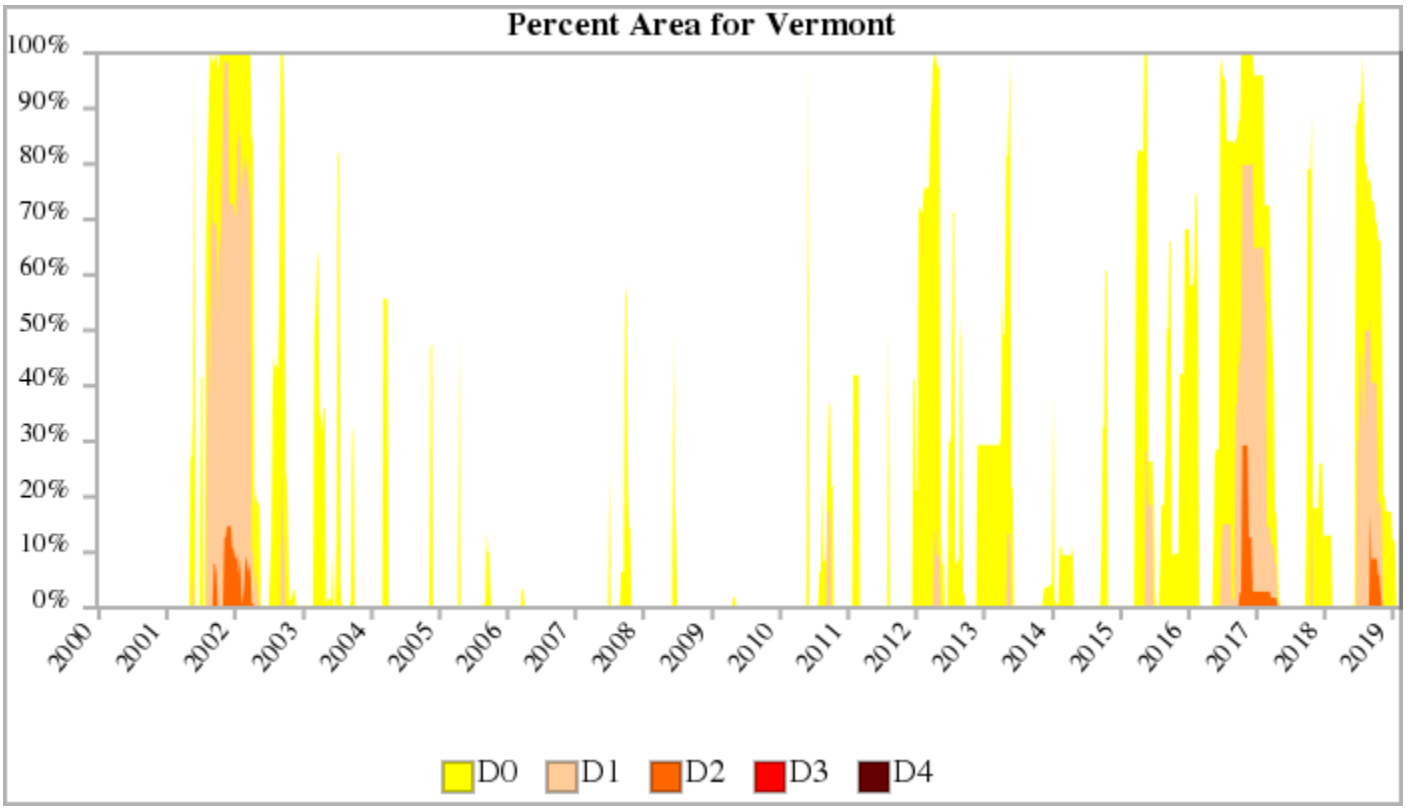
keep sperm in their cloacae through late April (Petranka 1998). Perhaps the high early-fall numbers are related to salamanders moving for mating purposes before disappearing underground for overwintering.

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 during the last few study years (2014, 2016, and 2018) totals were higher in the summer than our fall 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 found four recently hatched young with an adult on September 3, 2014.

Cover-boards for salamanders: Population Indices

In 2014, although below-average numbers of salamanders were detected, our index still showed an increasing population. As shown in Figure 13, that no longer appears true when the 2016 and the 2018 data are incorporated into the chart. Conditions do not appear to be changing significantly for this species in the immediate monitoring area, yet the numbers using the cover-boards are dropping. 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 ten inches below the mean precipitation) may have influenced the 2016 results. 2018 was also dry with some parts of Vermont experiencing severe drought conditions (Figure 14). These drought conditions 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 at our Mt. Mansfield monitoring site show an overall increasing population; although, fewer were found in 2018 as compared to 2017, perhaps due to the very dry summer. 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.

Figure 14: Percentage of Vermont experiencing drought from 2001-2018. (D0-abnormally dry, D1-moderate drought, D2 severe drought). Data from Drought.gov (accessed Feb 13, 2019)



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 14 and 15, 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 13), 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 15). It does not appear that the age class structure is stable at the present time, as we are still seeing fluctuation, especially between 2016 and 2018 (Figure 15). 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.

Table 11. Totals[2] for each cohort of Eastern Red-backed Salamanders (*P. cinereus*) found on the three highest count days during cover-board monitoring on the Lester Anderson lands on the Bristol/Lincoln border in Vermont (2001-2018).

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
2018	0	11	60	12	0	2
Average/Year	**2.1**	**22.1**	**78**	**30.9**	**0.3**	**0.8**

[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, 2018, and odd numbered cover-boards in 2004.

Table 12. Percentage of totals for each cohort of Eastern Red-backed Salamanders (*P. cinereus*) found on the three highest count days during cover-board monitoring on the Lester Anderson lands on the Bristol/Lincoln border in Vermont (2001-2018).

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%
2018	0.00%	83.53%	14.12%
Average/Year	**1.41%**	**75.33%**	**22.81%**

[1]Salamanders escaped before measurements were taken.

Figure 15: Percentage of totals for each cohort of Eastern Red-backed Salamanders (*P. cinereus*) found on the three highest count days during cover-board monitoring on the Lester Anderson lands on the Bristol/Lincoln border in Vermont (2001-2018).

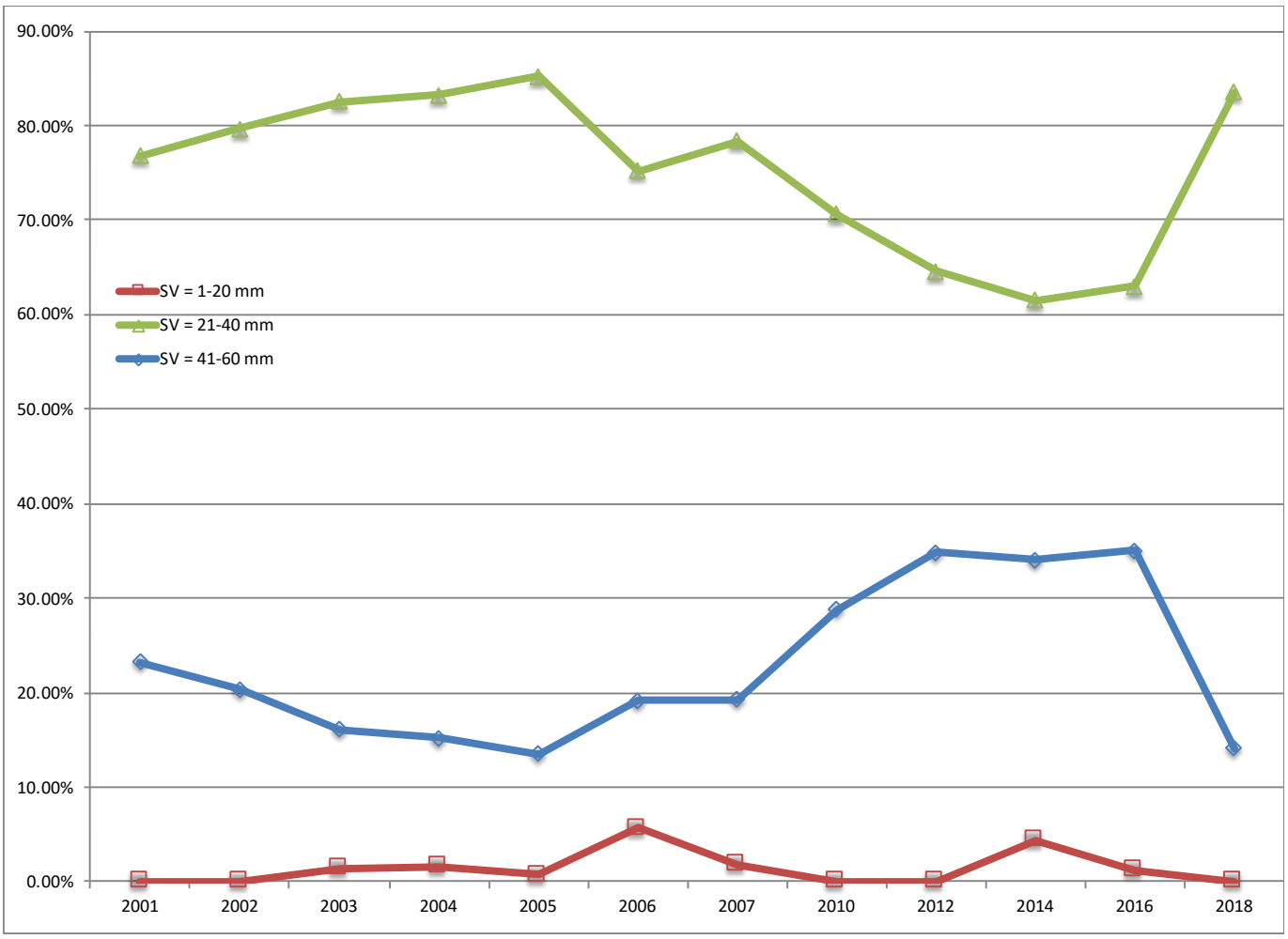


Figure 16: SV lengths for all Eastern Red-backed Salamanders (*P. cinereus*) found during cover-board monitoring on the Lester Anderson lands on the Bristol/Lincoln border in Vermont (2001-2018) n = 4347 captures.

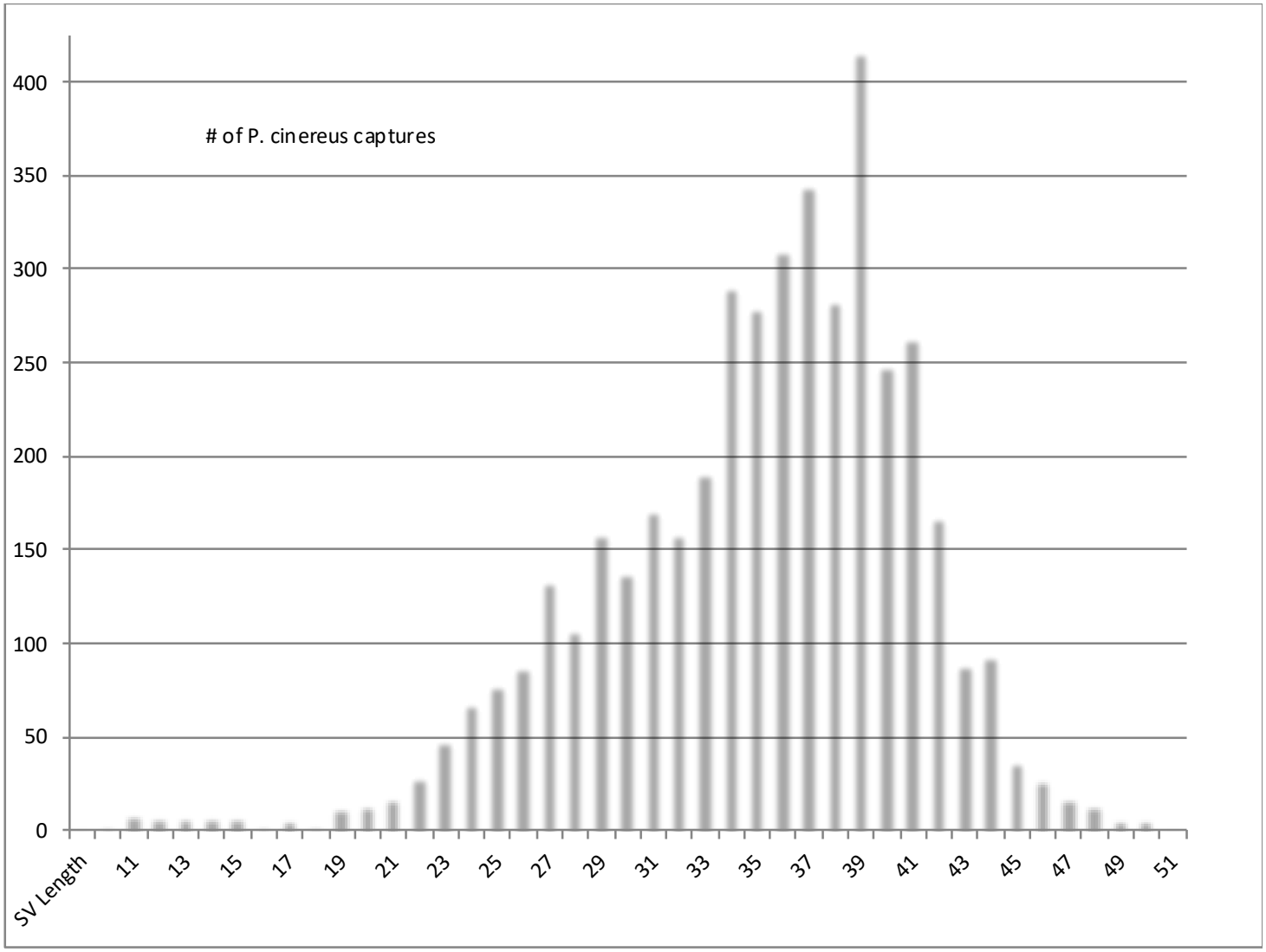
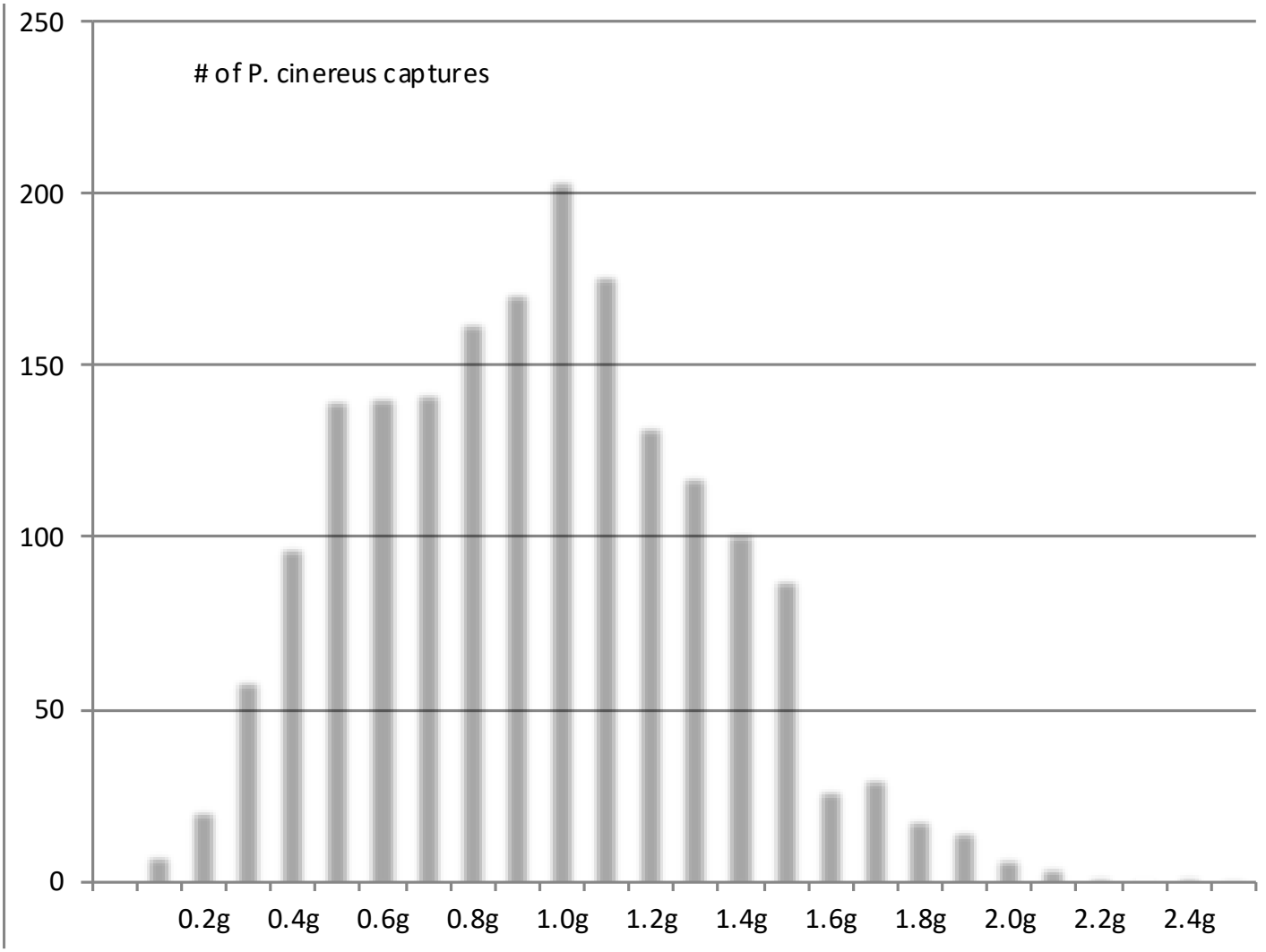
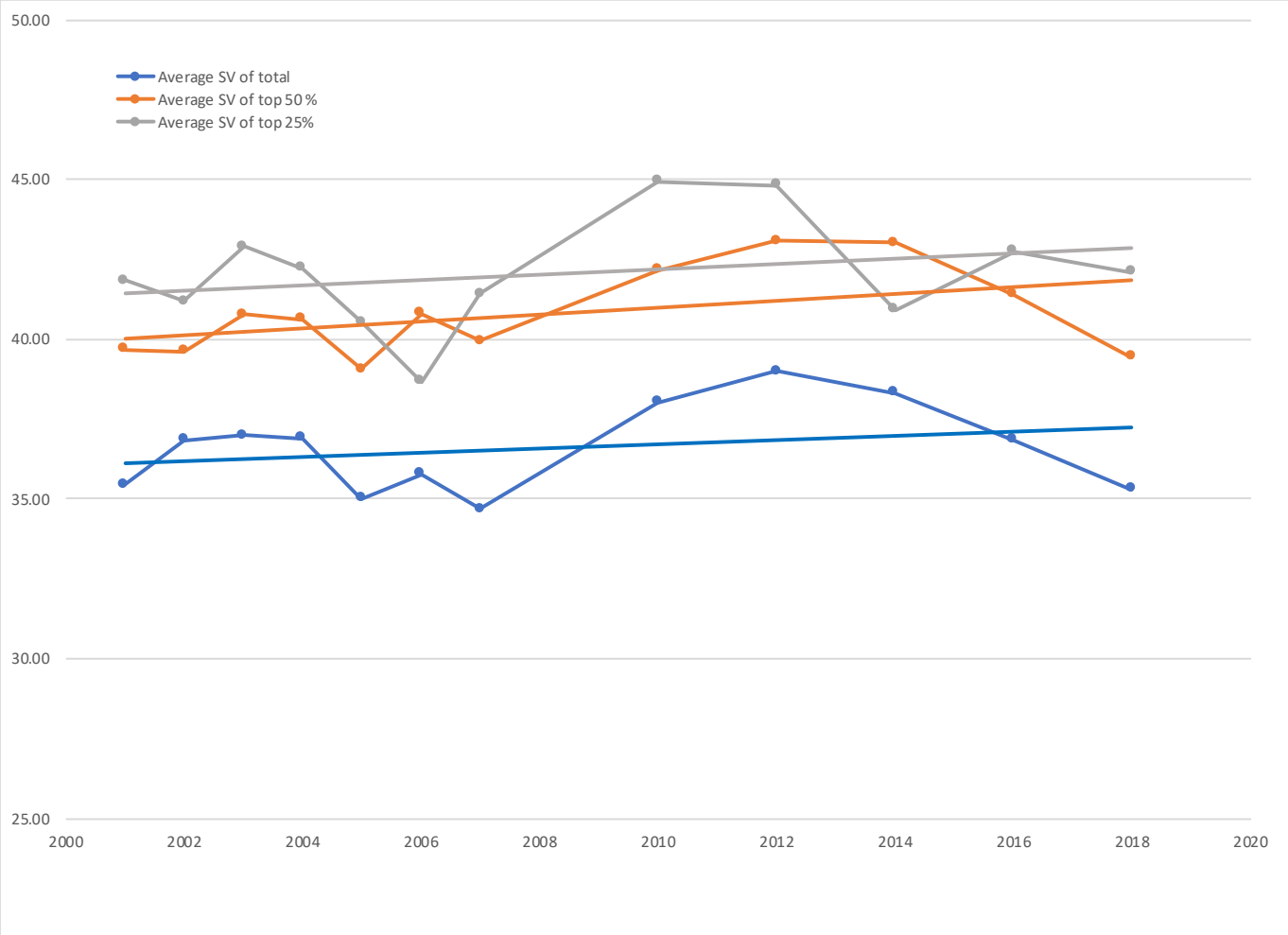


Figure 16: Mass in grams for all Eastern Red-backed Salamanders (*P. cinereus*) for which mass was measured during cover-board monitoring on the Lester Anderson lands on the Bristol/Lincoln border in Vermont (2006-2018) n = 1703 captures.



A study was done in 2015 (Caruso et al.) showing a reduction in body sizes of adult salamanders in response to climate change. The authors compared historic and contemporary size measurements in 15 *Plethodon* species and found that six species, including Eastern Red-backed Salamanders showed significant reduction over 55 years. To see if the animals at our study site showed similar results we compared average SV lengths of all salamanders greater than 20 mm captured on the top three days by year (Figure 16). We did not find similar results, but our sample sizes were smaller and we were looking over a shorter time span. It will be interesting to revisit this question in five or ten years.

Figure 18: Average SV of all Eastern Red-backed Salamanders (*P. cinereus*) greater than 20 mm captured on the top three days each year (some salamanders may be counted more than once).



Cover-boards for salamanders: Summary

Eastern 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 since 2012. Using data collected through 2018, we have not detected overall size changes in this population.

Notes on Other Species

Many invertebrates were found using the cover-boards. In 2018 we found red ants, slugs, beetles, centipedes, Camel Cricket, and maple leaf cutters. We noted a few earthworms but did not find any (that we knew of) of the invasive snake worms. Most weeks we walked down from the snake covers in Lincoln. On our walk we found moose scat and bear sign on the edge of the field, and on one occasion a dead mouse on the edge of the field. We heard and/or saw a Black-capped Chickadee, Blue Jay, Brown Creeper, Common Raven, Eastern Wood-pewee, Pileated Woodpecker, Red-tailed Hawk, and Ruffed Grouse.

Future Study

Our current schedule is as follows: we schedule an annual maintenance day or two 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 additional Eastern Milksnakes. Data on gravid females are otherwise not available during fall checks. In spring 2017 we wrote a full report and monitored the snake covers in the fall. In 2018, we monitored egg-masses and one-half the cover boards but did not write a report. In early 2019 we wrote this report and plan to monitor the snake covers in the fall. In 2020 we plan to monitor the egg-masses in spring and one-half the cover-boards (the As) 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. In addition it could allow for the addition of extra data collecting.

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 we are aware of.

Acknowledgments

Jim Andrews, Kate Kelly, Linda Andrews, and Erin Talmage helped gather data with some regularity. Amy Alfieri, Abigail Barnes, Morgan Barnes, Marta Ceroni, Simone Demicheli, Deb Laramie, A. Outwater, Levi Smith, Cindy Sprague, also helped at least once with data collection. Jory Connors, Jack Leonard, Jude Dickerson, Kate Kelly and Caroline Greenberg helped with maintenance. Erin Talmage reviewed all the data and drafted this report.

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Appendix

Appendix Table 1. Spring 2018 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
April 11	0 No eggs or spermatophores	0	Still winter, flurries last night, frost on car window Visibility excellent. Polarizing lasses used.
April 17	0 One small clump and a few individuals one	10 One had white eggs in it, probably from last Friday.	Visibility good, this layer of slush that we moved away, so we could see into water, polarizing glasses worn.
April 24	14	88 One mass looked pretty old and covered with dirt	Visibility excellent. Polarizing glasses worn.
May 2	112	286 Some are floating, and some are pretty fresh, a few on the bottom don't look very good.	Visibility excellent, polarizing glasses used, can see to bottom.
May 10	171 A few with non-viable white eggs.	0 Most masses hatched, green, and floating. Greater than 1000 tadpoles seen.	Sunny and warm after late spring, weather shifting went from sunny to cloudy. Visibility not great, cloudy with slight breeze, leaves and other debris on pond surface.
May 16	176 A few new fresh masses	0 >7300 tadpoles.	Visibility ok to good, hard to see out in deeper are, a little murky.
May 24	160 All masses more than a week old.	0 One or two look like they are getting legs, >6700 tadpoles	Visibility good to excellent depending on sun and clouds and debris floating on top. Polarizing gasses used, used long stick for moving vegetation.

Appendix Table 2. Spring 2018 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
April 11	0	0	Still winter, flurries last night, frost on car window Visibility poor, still iced over, cannot see through ice on southwest side, algae mat is being lifted up.
April 17	0	0	Visibility poor, ice covered pond, a layer of slush above the ice.
April 24	2	6	Visibility excellent. Polarizing glasses worn.
May 2	40	42 Some old, some very fresh, some are out within cattails and have duckweed on top, so a little hard to count	Visibility excellent, polarizing glasses worn, lots of plant growth.
May 10	56	0 Our experimental egg mass that we left upside down is all hatched with tadpoles around.	Visibility ok to excellent, slight breeze, polarizing glasses worn.
May 16	56	0 >6500 tadpoles	Visibility ok (slightly murky in some areas), polarizing glasses worn, and stick used.
May 24	50 Can see embryos, no new masses	0	Visibility ok to good depending on sun. Polarizing glasses used, long stick used for moving vegetation.

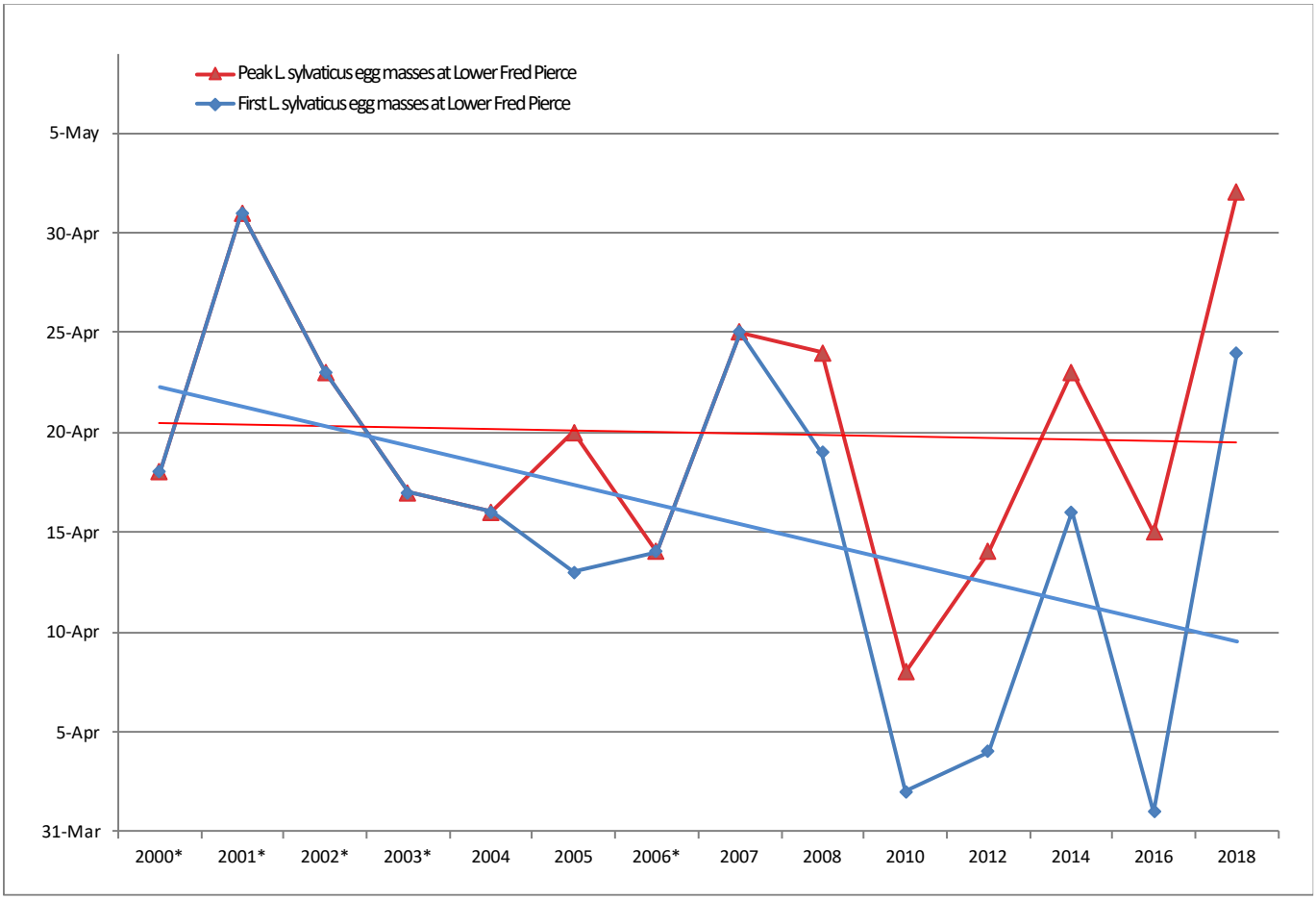
Appendix Table 3. Spring 2018 egg-mass data from Guthrie Pond on Lester Anderson lands in Lincoln, Vermont.

Date	*Ambystoma maculatum* egg-masses	*Lithobates sylvaticus* egg-masses	**Notes**
April 11	0	0	Still winter, flurries last night, frost on car window. Visibility excellent, this layer of ice on edge, polarizing glasses word. Saw a burr-reed and lots of bassweed on bottom (neither of us remember seeing this before).
April 17	0	0	Visibility ok, had to remove slush from surface. But water was clear once removed. Weather History: Unpleasant, unseasonable cold with snow and ice and temps below freezing, Some movement in the valley last Thursday (April 12).
April 24	4 .	10 .	Visibility good to excellent, polarizing glasses worn.
May 2	173 a few pretty fresh, one opaque, one with dead eggs.	465 Eleven were old, the rest, especially the ones in bug clump were pretty fresh.	Visibility excellent, polarizing glasses worn, slight breeze, Jim moved cattails aside so we could see.
May 10	235	10 Old masses mostly hatched or full of dead eggs, huge cloud is just a mass covered with tadpoles, >19,000 tadpoles.	Visibility excellent, polarizing glasses worn, there is a slight breeze that made it hard to see in one area.
May 16	264 Nothing very fresh.	0 Lots of tadpoles, more spread out than last week.	Weather History: late spring, scattered showers yesterday. Visibility excellent, polarizing glasses worn, big stick used to move cattails.
May 24	238 Most masses green, no new masses	0	Visibility good, cloudy, tadpoles creating a lot of ripples, polarizing glasses shared, and a long stick used for moving vegetation.

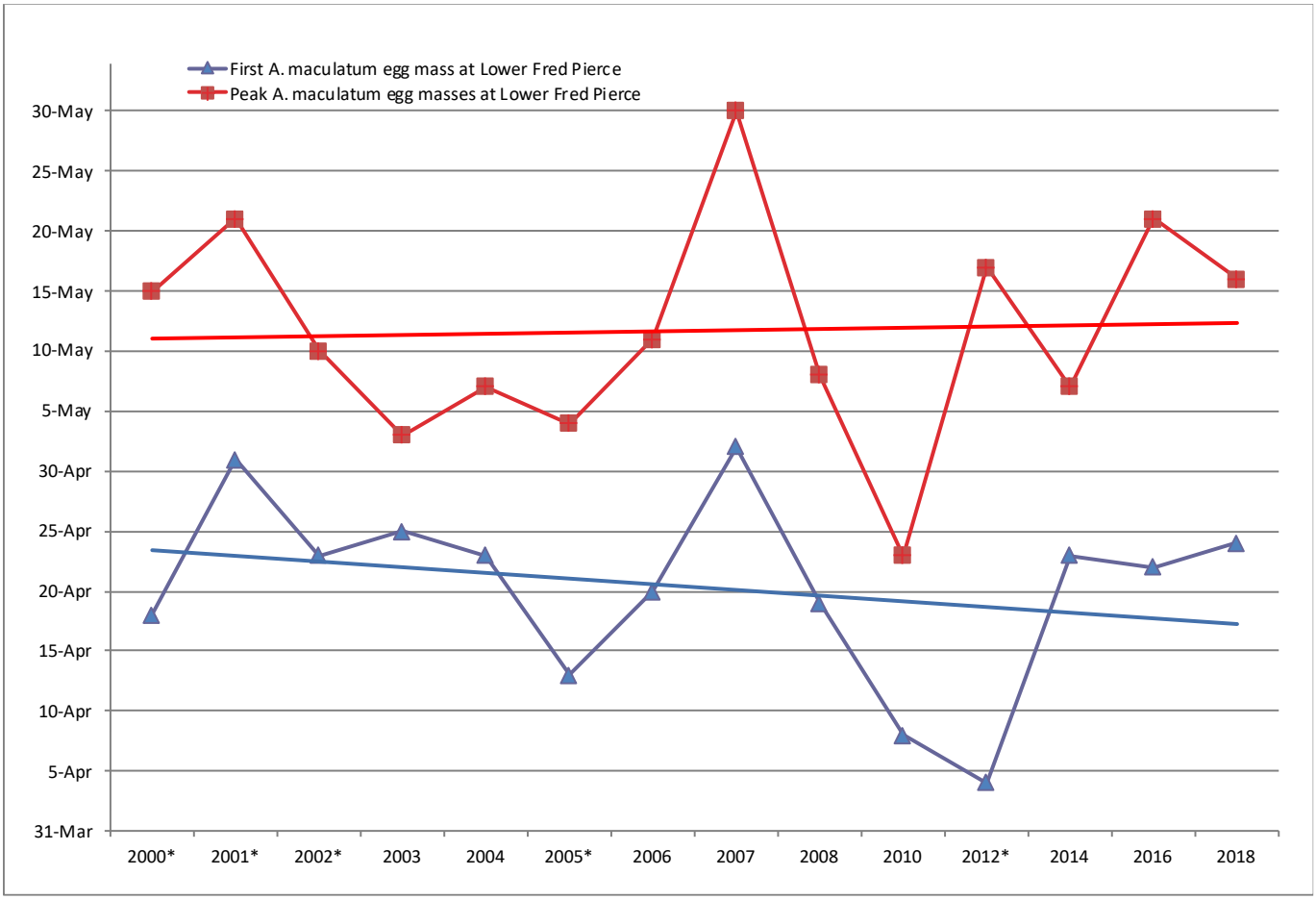
Appendix Table 4. Spring 2018 egg-mass data from Wells Pond on Lester Anderson lands in Lincoln, Vermont.

Date	*Ambystoma maculatum* egg-masses	*Lithobates sylvaticus* egg-masses	Notes
April 11	0	0	Still winter, flurries last night, frost on car window Visibility excellent, polarizing glasses worn. Tree tipped over along edge, thin layer of ice on pond.
April 17	0	0	Visibility ok, had to remove slush from surface, but water was clear once removed. Weather History: Unpleasant, unseasonable cold with snow and ice and temps below freezing, Some movement in the valley last Thursday (April 12).
April 24	13 Pretty fresh, some in grasses on bottom.	0	Visibility good to excellent - polarizing glasses worn, Slight breeze, we broke up some large bryozoan, so we would not confuse then with masses.
May 2	151	165	Polarizing glasses worn.
May 10	206 A few appear pretty fresh (~4).	0 Most egg masses have hatched, some still in a clump but either dead eggs or tadpoles on top of masses, no new ones.	Visibility ok, breezy.
May 16	172	0 Did not notice any tadpoles.	History: chilly with light frost a few days ago. Yesterday was sunny Visibility excellent.
May 24	125 Had to count through all that tadpoles that were all over them, mostly green with embryos, no new ones.	0 Like a school of fish, all swimming in one direction, many more around the *A. maculatum* egg masses.	Visibility ok, cloudy with a slight breeze, polarizing glasses used, long stick used for moving vegetation.

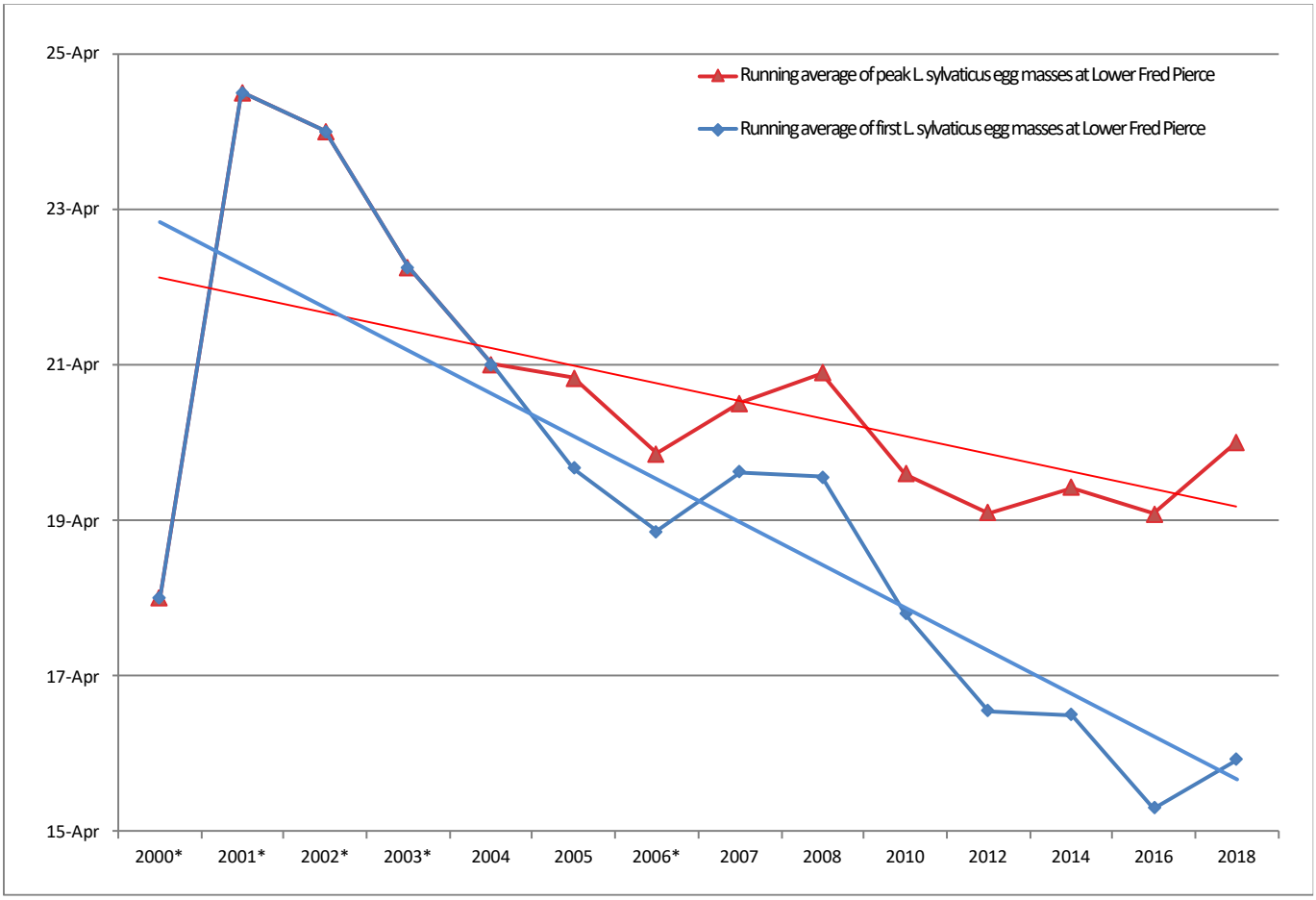
Appendix Figure 1: First egg-masses detected and peak egg-masses (with trend lines) for *L. sylvaticus* at Lower Fred Pierce on Lester Anderson Lands, Lincoln, Vermont (2000-2018).



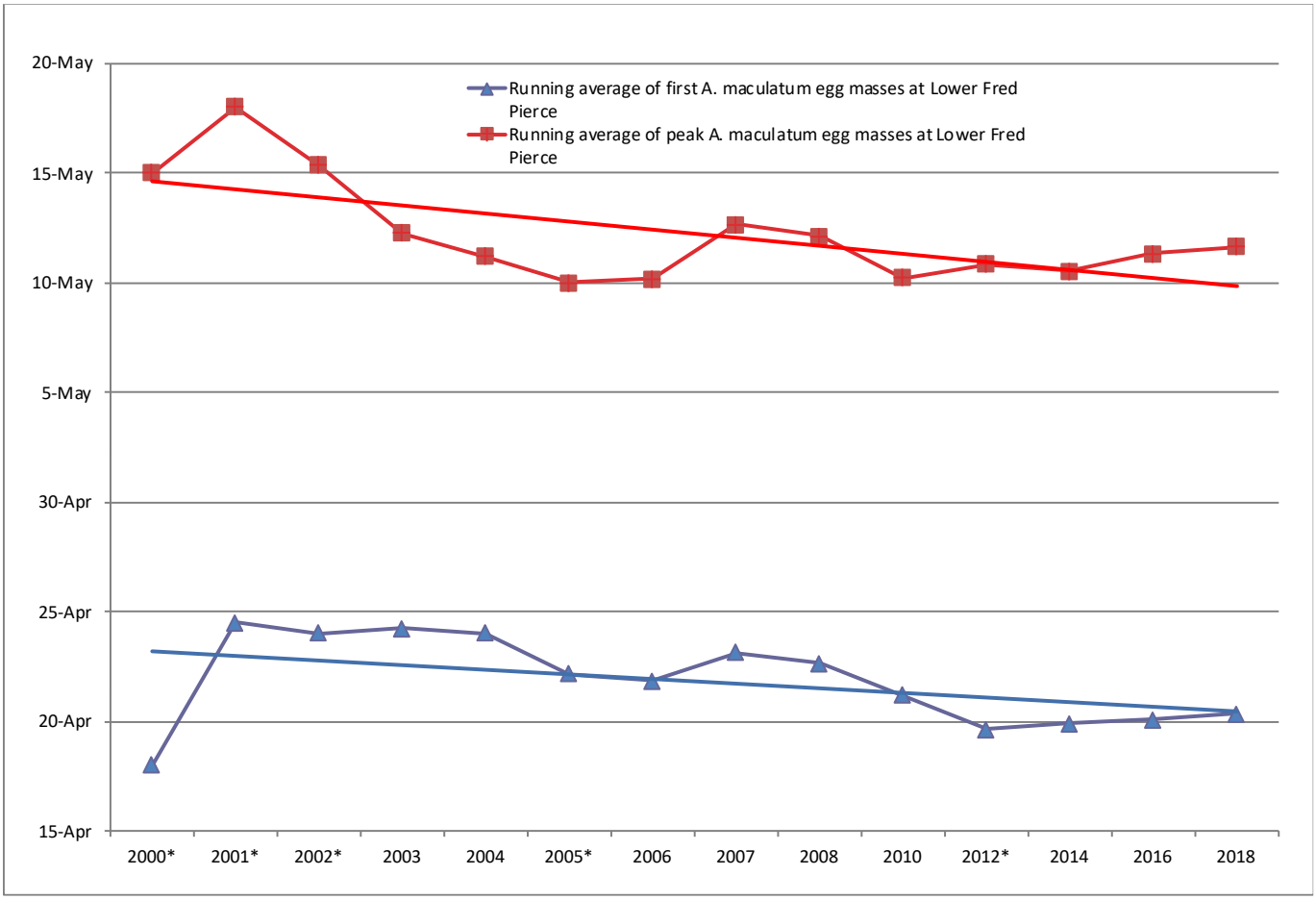
Appendix Figure 2: First egg-masses detected and peak egg-masses (with trend lines) for *A. maculatum* at Lower Fred Pierce on Lester Anderson Lands, Lincoln, Vermont (2000-2018).



Appendix Figure 3 Running average of first egg-masses detected and peak egg-masses (with trend lines) for *L. sylvaticus* at Lower Fred Pierce on Lester Anderson Lands, Lincoln, Vermont (2000-2018).

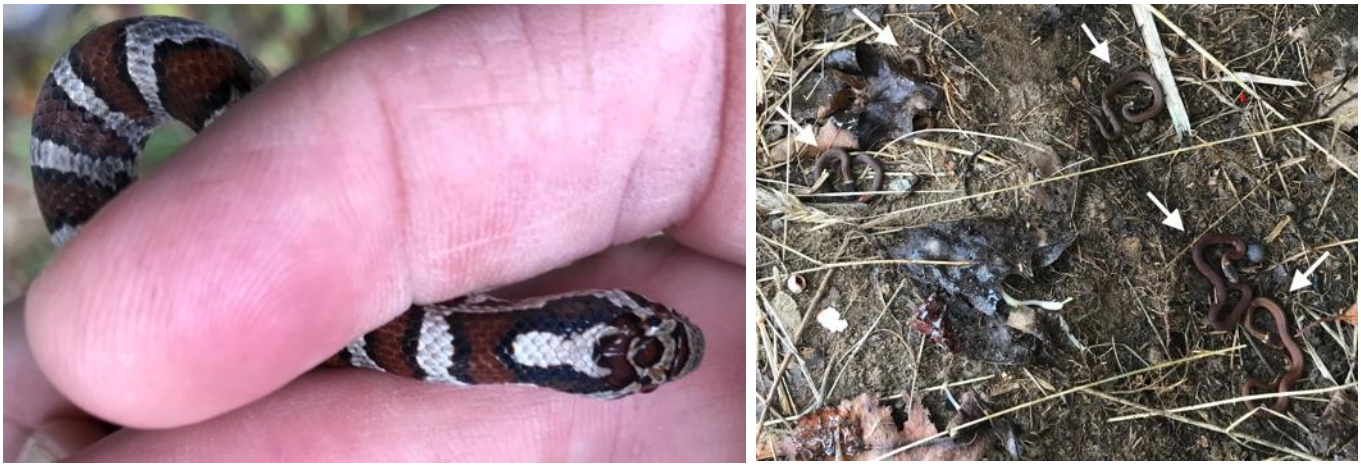


Appendix Figure 3 Running average of first egg-masses detected and peak egg-masses (with trend lines) for *A. maculatum* at Lower Fred Pierce on Lester Anderson Lands, Lincoln, Vermont (2000-2018).



Appendix Figure 3a: Clockwise: Bryozoan found at Wells, Wood Frog egg mass that we flipped over, Red-winged Blackbird nest seen at Guthrie, Unusual Green Frog found at Guthrie.

Appendix Figure 3b: Eastern Milksnake showing head with complete Y, Five young of year Red-bellied Snakes.



Appendix Figure 3c: Clockwise: Using flashlight to look for reproductive organs in a Northern Dusky Salamander, Eastern Newt shedding its skin, Northern Dusky Salamander post exam of reproductive organs.