Amphibian Monitoring on Mt. Mansfield, Vermont
1993-2006

Background

Populations of amphibian species are monitored annually on Mount Mansfield using drift-fences. The goals of the monitoring are to (1) establish a baseline data set of abundance indices for the amphibian species caught in the fences, (2) monitor year-to-year changes in their abundance indices, (3) monitor changes in the number and type of obvious external abnormalities, (4) gather inventory data for the Vermont Herp Atlas, and (5) gather basic natural history information on the species present. Amphibians are targeted for this kind of study because their multiple habitat usage and permeable skin make them especially sensitive to changes in environmental conditions. Thirteen years of data have now been gathered at this site. This is the longest-running set of amphibian monitoring data in the state. Three fences are opened and checked up to five times per month during rain events throughout the field season (April through October excluding August). The abundance indices are generated using the three most successful trap-nights per month. For more detailed information on methods, locations of fences, and survey results, see the 1995 VForEM annual report.

Between April 1 and October 31, 2006, the Burlington International Airport, VT received a total of 33.57 inches of rain, 9.01 inches more than the average of 24.56 inches/year. This was 5.91 inches more rainfall then the same time period in 2005 (weather data provided by the NOAA National Climatic Data Center local climatological data).

Young of the Year and Population Trends

In 2006 the percentage of young of the year for all amphibians was 41%, which was slightly higher than the 33% found in 2005. Since 2002 the percentage of young of the year has been as low as 33% (2005) and has high as 74% (2002). This year, 86% of all of the young of the year were anuran.

In 2006 the percentage of young of the year in the salamander population was 13%. In 2005 it was 12%, slightly down from 2003 when it was 14%. In 2003, no young Eastern Newts or Red-backed Salamanders were caught, and all of the young salamanders were either Spotted or Northern Two-lined Salamanders. In 2005 young Spotted Salamanders, Eastern Newts, Northern Two-lined, and Red-backed Salamanders were found. In 2006 young Spotted Salamanders, Eastern Newts, and Red-backed Salamanders were found.

Depending on life history and weather, young of the year appear at different times. Using data from all years and all drift fences, young of the year for the Spring Peeper can appear as early as the end of May; and, the bulk of the Spring Peepers captured throughout the summer are young of the year. The percentage captured diminishes as fall and winter approach (Table 1 and Figure 8). The Green Frog has a similar trend. Salamanders tend to take longer to develop and young of the year don't show up, or comprise the bulk of the population, until later in the summer. Spotted Salamander young often start showing up in July, while young Eastern Newts show up in September and October (Table 1 and Figure 8).

Green Frog

Linear regressions most closely fit most of the data plots, so they were used to show potential trends in the abundance indices for all species caught from 1993-2006 (Figures 1-6). The data gathered suggest that two of the seven species abundant enough to monitor show an average increase over this thirteen-year period: Green Frog and American Toad (Figures 1 and 2). The number of Green Frogs has increased since 1993 with a slight dip in 2001. In 2002 there was a dramatic increase from 1.9 per trapping to 22.1, for a total of 350 Green Frogs captured. In 2003 there was a dramatic decrease from 2002 but still a relatively high number of Green Frogs (3.7) were caught, and a similar number (3.5) were caught in 2005. Although only

3.1 were captured per trapping in 2006 the trend remains positive (Figure 1 and Table 2). In 2003 and 2005 all Green Frog records except for one were from the fences at 1200 feet elevation. In 2006 Green Frogs were only captured at 1200 feet; and over the course of this study 99% of all Green Frogs have been captured at this elevation (Figure 7). The two fences at the 1200 feet elevation are the Proctor Maple Research Center fence (PMRC) and the Pleasant Valley Road fence (PVR). Although the number of Green Frogs has varied considerably over the years, it is interesting to examine where the majority of the frogs are coming from each year. In 1998, 1999, 2000, and 2001 the majority of Green Frogs captured were from the PMRC drift fence, 94%, 94%, 60%, and 76% respectively. This trend was reversed in 2002, 2003, 2005, and 2006 with only 15%, 30%, 21%, and 17% of the total Green Frogs captured were from the PMRC drift fence. The Green Frog is a permanent-water breeder and needs to overwinter for one or two winters under the ice as a tadpole before metamorphosis. It seems likely that the increase at the Pleasant Valley Road fence must be due to a change in water permanence (more rain, new dam) and/or overwintering success near that fence. The beavers did rebuild an old beaver dam, but it is closer to the PMRC fences. At the seven fences at Ward Marsh in southern Vermont, Green Frogs were holding relatively steady for five years, but had a fairly dramatic jump in 2003 from 0.7 to 18.7 per trapping event, like the Green Frogs at Mt Mansfield in 2002, a high percentage of these were young of the year. The numbers of young that emerge in a given year may be the result of weather conditions during the previous two winters or summers. Two wet summers (or deeper ponds) combined with one or two mild (depth of freeze) winters could produce a large crop of young. If these spikes reoccur, they should be examined more fully. In 2006 80% of Green Frogs captured were young of the year, and they were first seen in June. By July the young make up almost 95% of all Green Frogs captured (Figure 8).

American Toad

The number of American Toads appears to fluctuate in a cyclical way with peaks in the population shown in 1998 (3.6 per trapping) and 2005 (2.8). After each peak the number of captures has dropped the next year. In 2001 it fell to 1.6 and in 2006 it fell to 1.5. Although the population does fluctuate a great deal, the overall trend is positive (Figure 2 and Table 2). It will be interesting to continue to watch this species to see if these dramatic fluctuations persist. Unlike some of the other species the American Toad does not appear to show a preference for any drift fence and they are caught at all three fences (Figure 7).

Wood Frog

Wood Frogs appear to have great year-to-year fluctuations (Figure 3 and Table 2). In 2000 we reported that the Wood Frog was showing a slight decline; in 2001 and 2002 the number of Wood Frogs increased, and by 2003 the population was showing a slight increase. Unfortunately, in 2005 and in 2006 their per trapping rate again fell to (1.9 and 2.1), and they are now showing a slight downward trend. Wood Frogs are found at all three drift fences (Figure 7). Over the course of this study young Wood Frogs generally start showing up at the fences in June; although in 2006 the first young of the year was found on July 23 (Table 1). The percentage of young of the year in the total population peaks in July (Figure 8).

Spring Peeper

Although the numbers vary from year-to-year, the overall trend for Spring Peepers has been downward (Figure 3). Local changes in breeding habitat could be one possible explanation for a localized long-term decline, but we have no data to support a significant change in habitat. The Spring Peeper, like the Green Frog is found exclusively in the 1200 feet drift fences (Figure 7). Although, unlike the Green Frog the Spring Peeper's numbers are going down. We hypothesize that some changes are occurring in the breeding pools that have positively affected the breeding for the Green Frog and negatively affected the Spring Peepers. It could also be a result of a species interaction, as a Spring Peeper would make a nice meal for a Green Frog (Figures 1 and 3). In 2006 no Spring Peeper young of the year were captured but over the course of the study they have been found as early as late May and make up almost all of the captures in July (Figure 8).

Eastern Newt

The Eastern Newt fluctuates from year-to-year with a slight decrease in overall numbers (Figure 4). A higher percentage of Eastern Newts are found at the 1200 feet drift fences then the 2200 feet fences (Figure 7). Young of the year start to show up in the drift fences in June, and comprise more than 70% of the Eastern Newt captures in September and October (Figure 8).

Eastern Red-backed Salamanders
Like the other amphibian species found at this site, the Eastern Red-backed Salamander population appears to fluctuate from year-to-year, showing a slight increase overall (Figure 5). The Eastern Red-backed is found more often than expected at the higher fence then at the two lower fences (Figure 7). That is an interesting finding as we generally assume this species is fairly ubiquitous throughout the forest. It would be interesting to correlate where this species is found to the forest management practices or land history around the different fences. Few young of the year are captured, but when captured it is most often in the fall with increasing numbers in late fall (Figure 8).

Spotted Salamander
The Spotted Salamander appears to be showing a slight downward trend, with some variation from year-to-year (Figure 5). The Spotted Salamander is found more often then expected at the lower two fences which may be due to the greater abundance of breeding habitat in that area (Figure 7). Fifty percent of the Spotted Salamanders captured in 2006 were young of the year. The young of the year make up a larger percentage of the population in July that diminishes into the fall, most likely because many young of the year don't make it into the first winter (Figure 8).

Pickerel Frogs
We catch so few Pickerel Frogs (>1.0 per trapping) that although it appears the population is declining slightly, since the number of captures is so low, it is not possible to draw any meaningful conclusions (Figure 2 and Table 2).

Northern Two-lined Salamanders
In the past we have also caught very few Northern Two-lined Salamanders. Last year (2005) showed a great increase to 1.1 per trapping, but this year a more typical number for this species was captured (0.2 per trapping), (Figure 6 and Table 2). This salamander is generally caught in such low numbers that a significant increase or decrease in population can't be reliably shown at this time (Figure 6). The fences are not located in appropriate locations to monitor for this species.

Abnormalities

The number of abnormalities continues to be low. In 2002 only one abnormal amphibian was caught, out of 526 (<0.1%). In 2003 there were zero amphibians with abnormalities out of 167 caught (0%). In 2005 there were zero amphibians with abnormalities out of 189 caught (0%). Again, in 2006 there were no abnormalities out of 187 caught (0%). The numbers of abnormalities at this site have always been well below a level of concern. From 1998 through 2006, the total number of amphibians showing abnormalities from all captures has been 11 individuals. The last reported abnormality was in 2002 when a young Northern Two-lined Salamander was found who was completely missing its right eye, including the socket. Previous to that, the last reported abnormalities in 2000 were on a Northern Dusky Salamander who was missing the toes on its left rear leg, and on a Spring Peeper who was also missing the toes on the left rear leg.

Use of dowels in drift fences

When checking the trap, each target-individual is removed, measured, checked for abnormalities, and released unharmed on site. In the years of this study we have captured 3476 amphibians. Non-target mammals are often captured. An average of 300 non-target small mammals have been caught per year over the last four field seasons. Non-target small mammals are not injured. They have either drowned in a wet trap or are alive and active in a trap that leaked, evaporated, or did not receive any rainfall. If alive, they are assisted out with an additional stick or dowel on which they climb out and escape. There has been no need for euthanasia. Non-target mortality is an issue that we have been attempting to reduce over the years. In 2002 we attached dowels to the side of half of the buckets and half of the stainless steel cylinders to allow an escape route for the non-target small mammals. We put the dowels in half of the traps and left the other half as our control. We had hoped that after a period of three years we would be able to generate a series of reliable conversion factors. We could then multiply the number of amphibians of different

species and age classes caught in traps with dowels by the appropriate conversion factor to calculate what would have theoretically been caught in a trap without dowels. As it turned out this was not possible. For 2002, 2003, and 2005 field seasons, when examining the trends in populations we disregarded the amphibians caught in traps with dowels and multiplied the numbers caught in traps without dowels by two. We did continue to use the measurements of all amphibians in all traps for natural history and age class information. The dowels reduced the non-target small mammal mortality by 81%, 86%, and 81% respectively at the three fences over three years. Although there is a benefit of the dowels; unfortunately there is an overall reduction of amphibians captured at the same time. The reduction of total amphibians captured in 2002, 2003 and 2005 were 26%, 58%, and 64% respectively. In addition, the dowels inordinately affect some of the species that we are monitoring for long-term trends. In 2002, 2003, and 2005 Eastern Red-backed Salamanders were reduced by 83%, 100% and 100%, American Toads by 55%, 63%, and 38%, Spring Peepers 100%, 50% and 100%, and Wood Frogs by 42%, 50%, and 50%. With almost 100% reductions in Eastern Red-backed Salamanders and Spring Peepers in buckets with dowels, it would be impossible to monitor them in a system of all dowels. Declines in the numbers of other species would reduce the statistical power of our analysis. After considerable literature review, thought, and discussion we decided to remove the dowels for the 2006 field season and return to our original methods of no dowels. To calculate population trends with power analysis it is important that we are able to compare all the year's data. Anytime we adjust our methods it is very important that we know the effects of these changes. In an ideal situation, protocols for long-term monitoring are kept the same for the length of the study. If we were able to develop a consistent and reliable way to adjust the data, the addition of dowels would have been an excellent improvement in our protocol. Unfortunately it was not possible. In addition, during the three-year course of this experiment we have weakened our data by using only data from 1/2 of our buckets to compare with past years. We also do not know for sure if the buckets with dowels had any impact on captures in buckets without dowels. It seemed a better use of resources and statistically safest to remove the dowels and be able to use data from all buckets at these sites. Consequently, the dowels were removed for the 2006 field season.

Summary

Although always rare at this site, the number of abnormalities remains very low.

In 2001 power was re-evaluated for all species (see 2001 VForEM annual report). At that time, three species (American Toad, Green Frog, and Wood Frog) were increasing overall, and we had the statistical power to confidently report those trends. Those trends continue for the Green Frog and the American Toad, but the trend has reversed for the Wood Frog. The downward trend for Spring Peepers also continues, and we will have to watch the Eastern Newt to see if it is also decreasing long-term or if the past few year's decline is part of a multi-year fluctuation. In the next few years we will be able to re-evaluate power for all species.

These data and this project are extremely important. It has been necessary to close the drift fence arrays at Ward Marsh and Lye Brook. The drift fence array at Mt. Mansfield is not only the longest running amphibian monitoring in the state, it is also the only long-term monitoring occurring at this time. Lye Brook has been closed for the last few years but in 2007 we will reinstall the fences and monitoring will begin again in 2008 thanks to funding through the Vermont Monitoring Cooperative (VMC).

Acknowledgments

Long-term monitoring at this site for 2006 was supported by the Vermont Department of Forests, Parks, and Recreation through the Vermont Monitoring Cooperative (VMC). Field personnel for 2006 were Irene Linde, Robert Robbins, and Warren Ellison.

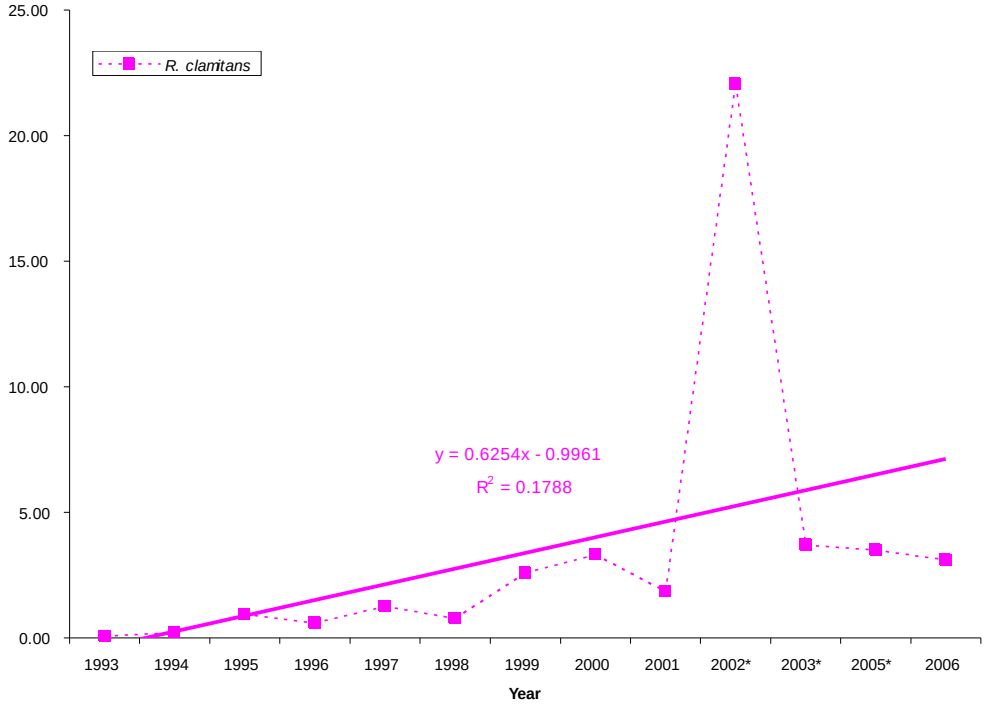

Figure 1. Green Frog *(Rana clamitans*) population indices from Mt. Mansfield, Underhill, Vermont, 1993-

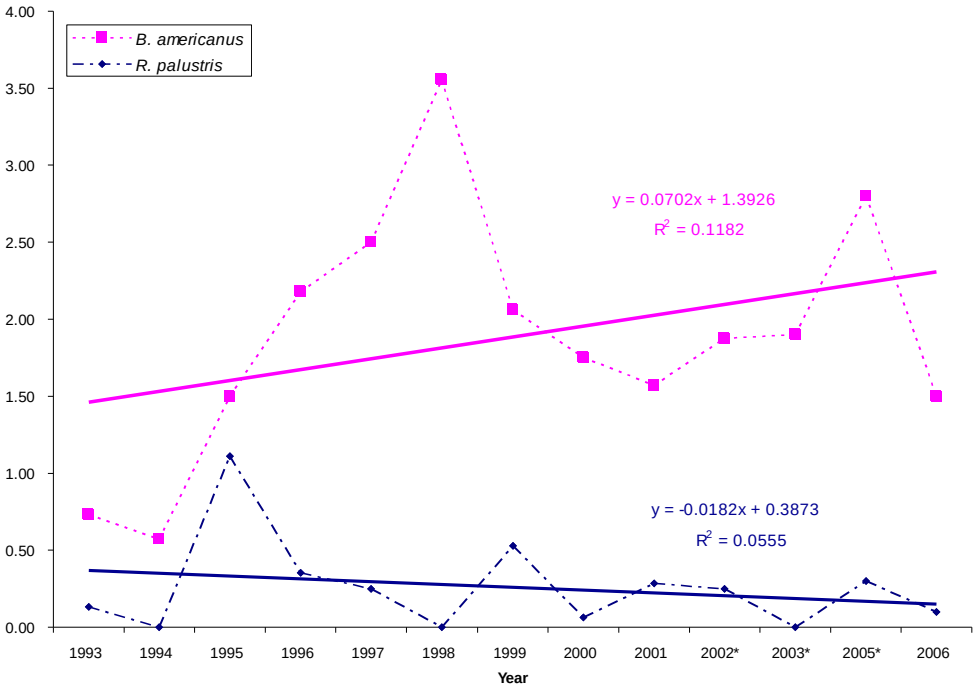

Figure 2. American Toad *(Bufo americanus*) and Pickerel Frog *(Rana palustris*) population indices from Mt. Mansfield, Underhill, Vermont, 1993-2006. The numbers for the Pickerel Frog are too low to draw any meaningful conclusions.

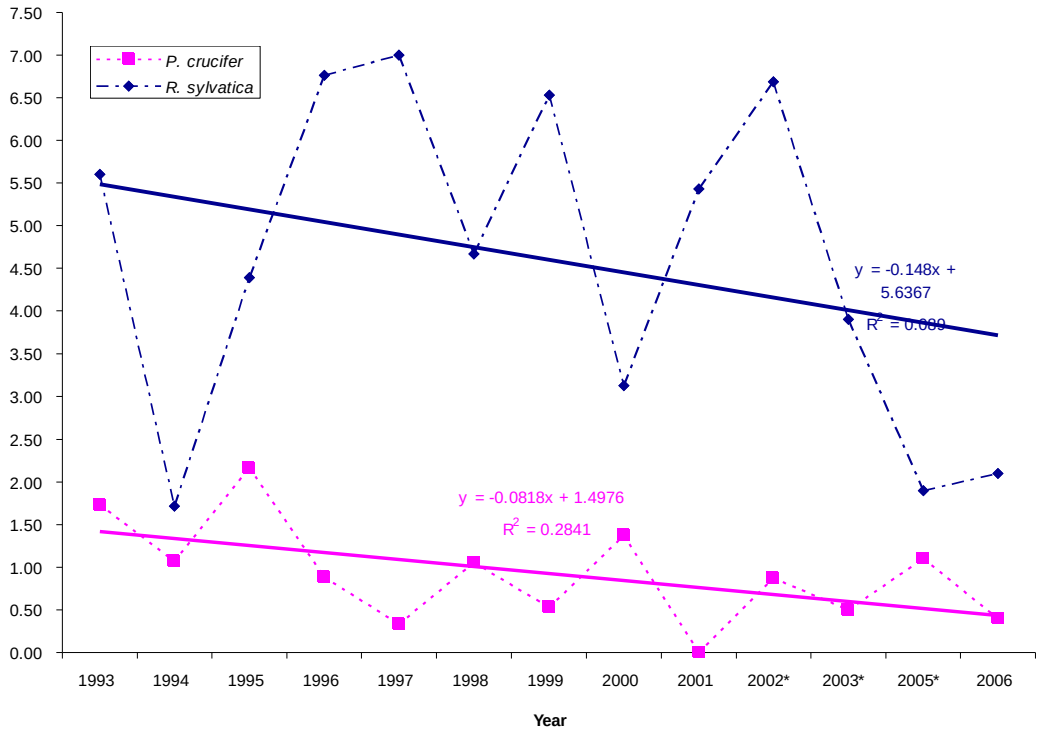

Figure 3. Wood Frog *(Rana sylvatica)* and Spring Peeper *(Pseudacris crucifer)* indices from Mt. Mansfield, Underhill, Vermont, 1993-2006.

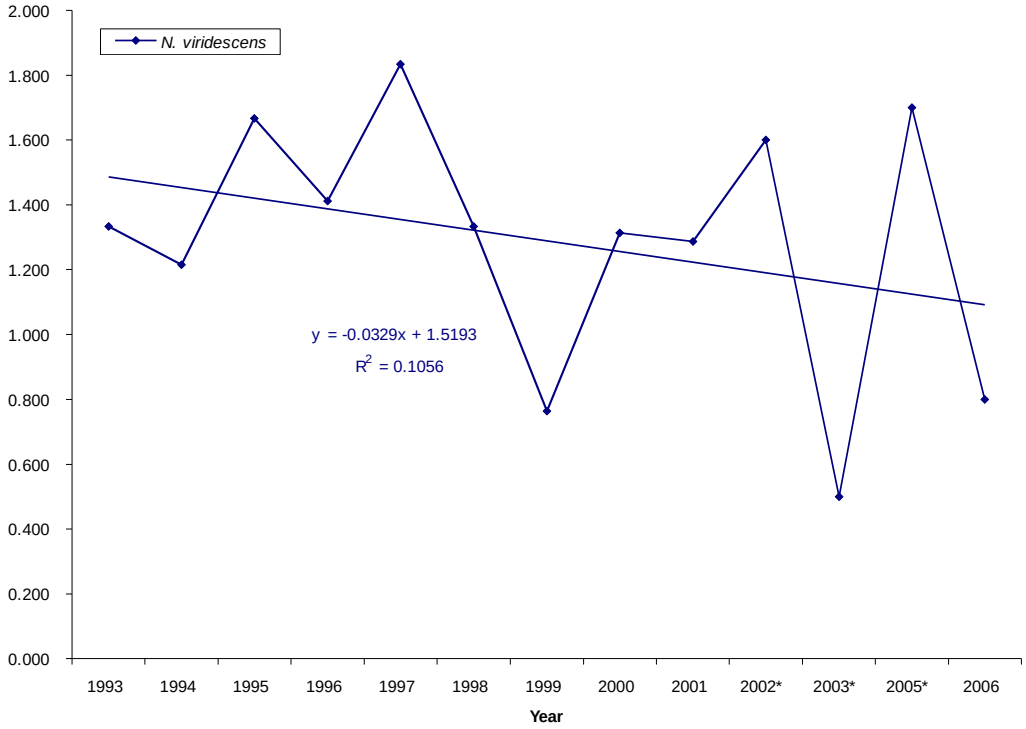

Figure 4. Eastern Newt *(Notophthalmus viridescens)* population indices from Mt. Mansfield, Underhill, Vermont, 1993-2006.

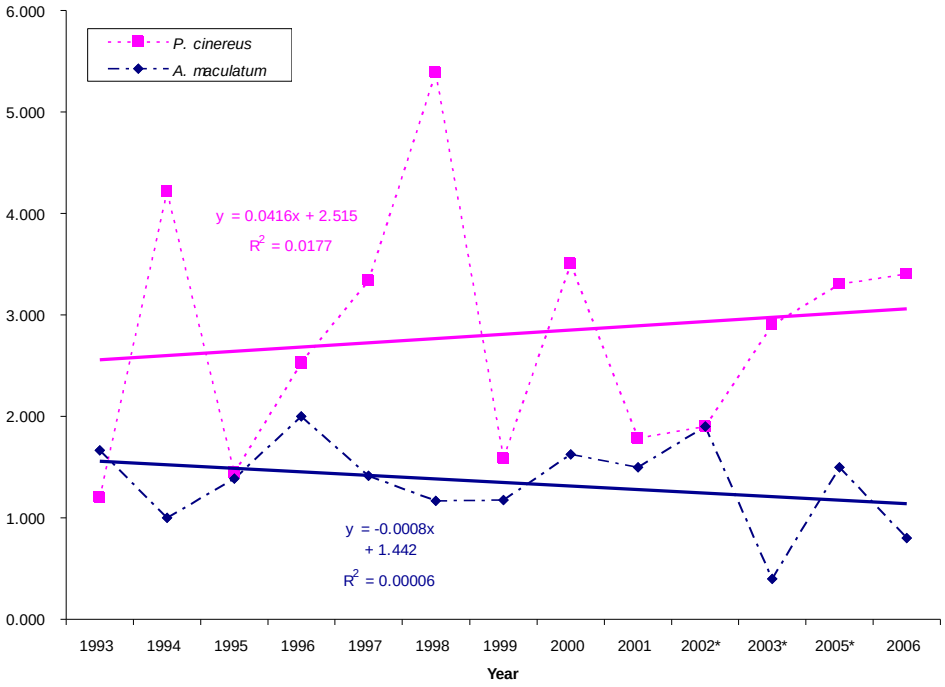

Figure 5. Spotted *(Ambystoma maculatum)* and Eastern Red-backed *(Plethodon cinereus)* Salamander population indices from Mt. Mansfield, Underhill, Vermont, 1993-2006.

Figure 6. Northern Two-lined Salamander *(Eurycea bislineata)* population index from Mt. Mansfield, Underhill, Vermont, 1993-2006. Capture rates are too low to draw meaningful conclusions about long-term trends for this species.

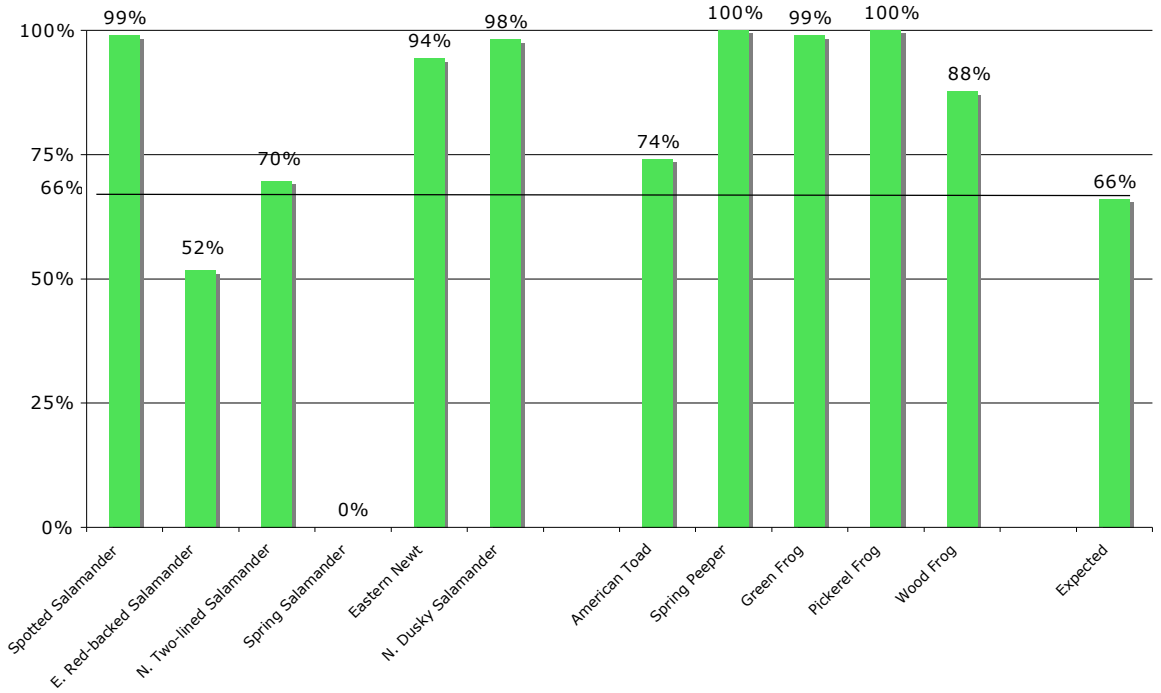

Figure 7: The percentage of captures at the two 1200' drift fences from Mt. Mansfield, Underhill, Vermont, 1993-2006. Since there are three fences total, expected distribution is 66%.

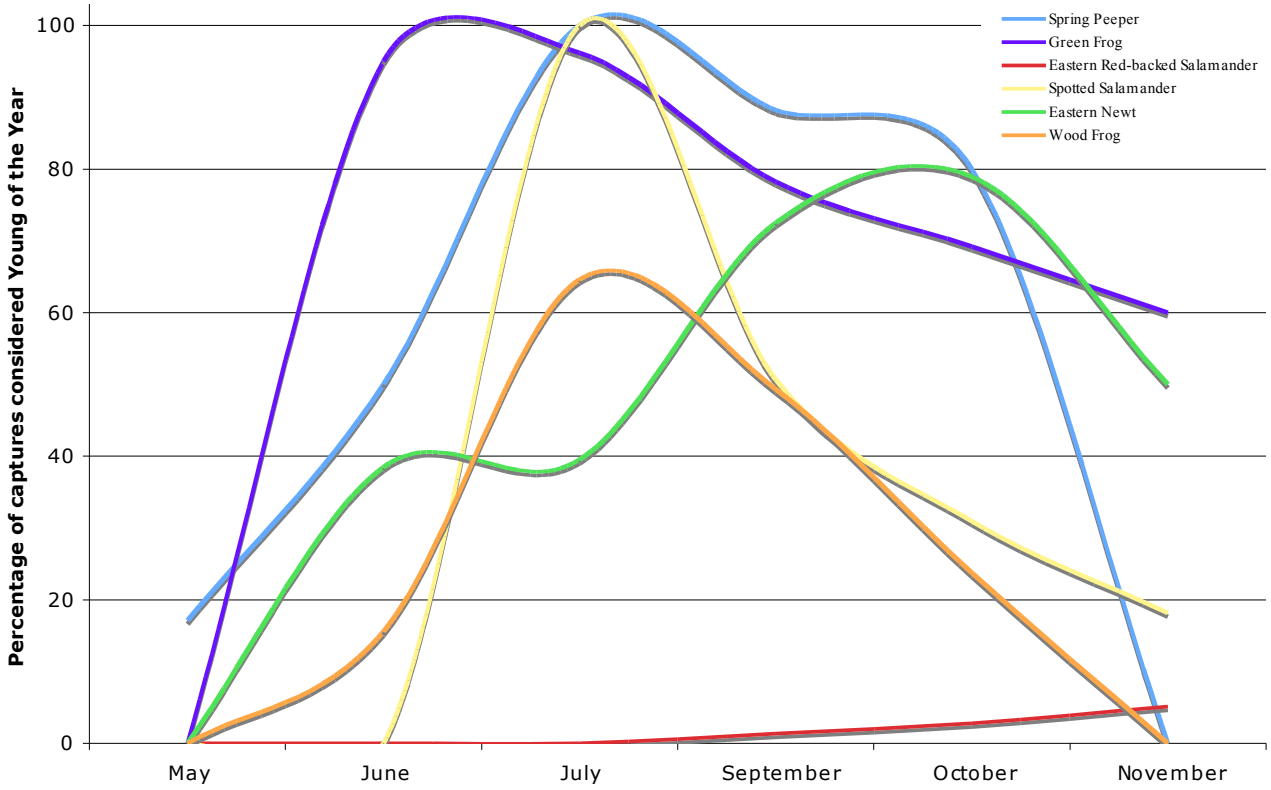

Figure 8. Percentage of drift fence captures that were considered young of the year from Mt. Mansf Underhill, Vermont, 1993-2006.

Vermont Reptile and Amphibian Atlas Project
2006

Introduction

Amphibian monitoring at Mt. Mansfield provides locally intensive data on a subset of amphibian species. While this data is particularly valuable and allows us to see year-to-year population changes of the monitored species at this site, it will not allow us or future researchers to see more widespread changes in the distribution and/or natural history (calling times, migration dates, etc.) of the full range of reptiles and amphibians statewide. While monitoring amphibian populations at Mt. Mansfield should reflect changes in forest health at that site, it will not allow us to see the impacts of forest fragmentation and consumption on a larger scale. One of the goals of the Vermont Reptile and Amphibian Atlas is to help us gather baseline distribution and natural history data throughout the state. This state-wide project has been funded periodically by the Vermont Monitoring Cooperative. As a result of a transition to a new funding year, this aspect of our monitoring was added back into our agreement for 2004/2005 and maintained for subsequent agreements. Leaving it in the goals of the 2006 agreement allows us the flexibility to use these funds for the statewide projects as funds allow.

The goals for the 2006 agreement were: (1) to gather data for the Vermont Reptile and Amphibian Atlas; (2) to create individual species pages on the Atlas website; (3) to update selected documents on the site; (4) review and enter current and previous year's herpetological reports; (5) forward hard and soft copies of the most recent calendar year's data to the VT Non-game and Natural Heritage Program; and (6) to respond to daily requests for information on the identification, conservation, natural history, and management of Vermont's reptiles and amphibians.

Background

The Vermont Reptile and Amphibian Atlas is an effort begun in 1994 by the Reptile and Amphibian Scientific Advisory Group for the Vermont Endangered Species Committee. The atlas project initially began as an effort to gather data for use by this committee. Data were needed in order to make informed recommendations regarding the appropriate status and conservation of these species. Since then, the goals have widened to incorporate education, citizen involvement, and dissemination of information. **The ultimate goal of the Atlas is to gather and disseminate data on the reptiles and amphibians of Vermont in a way that involves and informs Vermont individuals and organizations so that they will become more informed and effective stewards of wildlife habitat**. The Atlas Project has grown since its inception in 1994 to involve over 3,000 volunteers, thirty-five private organizations and government agencies, and over 61,000 records. With the help of organizations, agencies, volunteers, and staff members, we are continuing to collect information and broaden our knowledge base regarding the natural history, distribution, and effective conservation of Vermont's reptiles and amphibians.

Progress for 2006

Although the current funding agreement began during the fall of 2006 and continues into the spring and summer of 2007, for consistency and convenience we agreed to report here on the activities of the entire 2006 season (not including the spring and summer of 2007).

All the goals listed in the introduction above were completed in 2006. A portion of the funding was also used to support some upgrades to our website. Abundance tables, updated lists of resources (see attached), and individual species pages for all Vermont's native reptiles were completed in 2006 and posted to our website. In 2007 we are working to complete web pages for Vermont's native amphibians, the Atlas in the news, and other natural history pages. The website can be viewed at http://community.middlebury.edu/~herpatlas/index.html.

During 2006 we entered just over 4100 new records of Vermont's reptiles and amphibians into our

database. These records represent every county in Vermont and over 165 Vermont towns, gores, and cities. Over 360 volunteers contributed reports, and the Vermont reports included all known species of Vermont herptiles except for Western Chorus Frog and Fowler's Toad. These reports included important new records of some of our rarest species. Heritage S1 species (rarest state category) included the Five-lined Skink, Eastern Racer, Timber Rattlesnake, and Spiny Softshell (turtle). S2 species (rare) included Jefferson Salamander, Four-toed Salamander, Mudpuppy, Eastern Ratsnake, Eastern Ribbonsnake, and Stinkpot (turtle). S3 species (unusual) included Blue-spotted Salamander, Northern Watersnake, Wood Turtle, and Northern Map Turtle. Almost all of the contributors were individually contacted, thanked, and urged to continue contributing records. During this contact, conservation suggestions were regularly made. Hard and soft copies of records entered in 2006 have been forwarded to the VT Nongame and Natural Heritage Program.

We discovered the only known denning area of the Eastern Racer, Vermont's rarest snake, in the fall of 2004. In the spring of 2005 we located and PIT-tagged seven racers leaving this area. In 2006 we located five of the seven found in 2005 and one additional racer. Some of the snakes we have been following for a number of years. As we continue this project we will be able to start calculating growth rates and develop a better understanding of this species natural history. The racer-site lies under a power line and the power company (National Grid USA), the VT Department of Transportation, the VT Department of Forest, Parks, and Recreation, and the VT Department of Fish and Wildlife are all working with us to create and preserve habitat for this species. This is an unprecedented example of voluntary cooperation not forced by the regulatory process. This work continued through 2006. Some highlights in 2006 were the creation of habitat specifically designed for safe passage of the snakes down the corridor they typically use, and to increase the amount of foraging areas available to this population. In 2007 the project will continue and we are experimenting with tape-on transmitters, which we hope will enable us to follow females and to potentially locate egg-laying sites.

The above cooperation is largely the result of an ongoing training program that we are providing to the employees of the VT Department of Transportation on transportation and wildlife issues. This is a field-training program run jointly by our organization, Keeping Track, and the VT Department of Fish and Wildlife. By the end of 2006, we had completed three years of training and we are seeing a much greater willingness to participate in conservation actions on the part of VTRANS. In 2006 the training continued in Vermont and expanded into New Hampshire.

One of the many organizations we cooperated with again this year was Audubon Vermont. As in the past, we worked with a group of teenagers from around the country for an eight-day period of herptile surveys in Vermont. With this group we managed to survey Cavendish, Danville, Elmore, Springfield, Warren, Washington, Weathersfield, and to turtle trap in Orwell. As a result, we added many new species to our database that had not been previously documented from these towns. In all, they gathered over 260 new records.

Some of the atlas survey work completed in 2006 was through a collaboration with a graduate intern from Antioch New England who focused on surveying for turtles.

In 2006 we continued our work with a Vermont Commons High School intern; who is now an undergraduate at the University of Vermont. In 2005 she produced an educational poster of the snakes and lizards of Vermont. In 2006 she completed another educational poster focused on Vermont turtles. (Poster will be mailed under separate cover.) With funds from the Vermont Monitoring Cooperative and the Colby Hill Ecological Project we printed 600 of each poster. Many individuals, libraries, state agencies, and conservation organizations have already purchased these posters. VT Fish and Wildlife purchased 20 of each for use in their offices and displays. They are available for sale on our website and all proceeds generated will be used to print two additional posters covering Vermont frogs and salamanders.

We have kept our contacts going with the media. Some highlights over the year include an article by Matt Crawford in the *Burlington Freepress* in March. Jim Andrews was heard on Carol Groom's *Crossroads* Radio show in March. Although the show was recorded on a small independent radio station; the show is available on-line as a podcast. At the end of December, Louis Porter wrote an excellent article that was

printed in the Sunday Magazine of the *Rutland Herald/Times Argus*, and then remained on-line. This article was picked up by the Associated Press and subsequently found at ABC.com and Washingtonpost.com. We took advantage of all of these opportunities to promote awareness and conservation of herptiles as well as participation in the Vermont Reptile and Amphibian Atlas Project.

We finished the second draft of the recovery plan for Timber Rattlesnakes in Vermont during the summer off 2006. We have set up a recovery team, including national and regional experts that we are very pleased with.

Interest in our spring amphibian crossing educational and research events is continuing to grow and spread to other organizations and locations.

We continue to provide conservation information to a wide variety of private individuals, companies, and organizations, as well as governmental units. For example, biologists from the Green Mountain National Forest recently contacted us for information and advice on how they could improve management and monitoring for reptiles and amphibians on the National Forest in Vermont. Many private foresters now consider the needs of herptiles and their movements in their management plans. Citizens have taken action to increase the permeability of roads. The Vermont Department of Transportation works with us regularly to help them meet the needs of herptiles. Critical habitat for Spotted Turtles will soon be purchased. New habitat for the Eastern Racer has been created within a state wildlife management area. The town of Monkton is investigating the designs and locations for what would be Vermont's first amphibian underpass/es. We have played a direct or indirect role in all of these and many more conservation actions that benefit not only herptiles but also many other species. We expect them to continue as a result of our efforts.

2007 and Beyond

With the help of VMC funding and other funding sources our work continues. In addition to distribution and abundance data we are continually collecting data on lengths, masses, calling times, birthing and/or egg laying times, habitats, road crossings, and other natural history information for all of Vermont herptiles. We also plan to continue our educational efforts. We envision continuing to update our website, creating additional educational posters and a possible reptile and amphibian book, and continuing to collaborate with local and regional organizations to continue to gather and disseminate data on the reptiles and amphibians of Vermont as a vehicle for habitat conservation and more informed herptile stewardship.

At the same time, our knowledge of the current distribution and natural history of Vermont's reptiles and amphibians needs to be steadily improved. These data are essential as a reliable baseline for any changes that may occur in the future. It is impossible to show range changes and/or extirpations if you don't have the baseline data as a reference.

Acknowledgments

Website upgrades were made by Kir Talmage. Kaile Burgess created the educational posters. Erin Talmage helped with all aspects of the field and lab work. Cindy Brown assisted with data entry and other office work. Many volunteers and collaborating organizations also contributed and we are very grateful for their help.

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