Amphibian Monitoring in the Lye Brook Wilderness Region of the Green Mountain National Forest 1995-2001

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Update

Background

An inventory of amphibians in the Lye Brook Wilderness Region of the Green Mountain National Forest in Bennington County was begun in 1993 and completed in 1995. Monitoring of selected amphibian species began in 1994. 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) compare population changes between this site and other monitoring locations in the Green Mountains, (4) look for correlations between amphibian populations and other data gathered at this site, (5) monitor changes in the number or type of obvious external abnormalities, (6) gather inventory data for the Vermont Herp Atlas, and (7) gather basic natural history information on the species present. Five species of salamander (Eastern Newt, Northern Two-lined Salamander, Eastern Red-backed Salamander, Spotted Salamander, Spring Salamander) and five species of frog (American Toad, Green Frog, Pickerel Frog, Spring Peeper, Wood Frog) are monitored using drift-fences, egg-mass counts, and stream surveys. Seven years of data have been collected at the drift-fences. Eight years of monitoring data have been gathered using egg-mass counts and stream surveys. For details on methods and locations see the 1995 VForEM annual report.

Changes for 2001

Every year, mice, shrews, and voles die in the pitfall traps. Although our data show no declines in small mammal numbers, we would like to minimize these non-target mortalities. Therefore, this year we placed dowels into the pitfall traps to hopefully allow the escape of small mammals, without allowing amphibians to escape. The data suggest that the dowels did not allow the escape of amphibians. Unfortunately, it also appears that the dowels did not allow small mammals to escape, as the data do not show a decline in small mammal mortality. Although not a change, the weather this year was particularly dry, which could potentially affect data collected. At the time of this report, precipitation data was not available for the Lye Brook Wilderness Region. However, the Mt. Mansfield summit (between April and October) received 20% (8.73 inches) less precipitation than the average over those months (43.59 inches, 1955-2000).

Stream surveys and egg-mass counts

The pH at the stream survey site has increased slightly (by 0.3 to 4.1) from last year (Table 1). After quite a few years of declining pH (since 1994, disregarding 1998), this is the second year we have seen an increase in the pH. The number of Spring Salamanders increased to more normal numbers this year (7), up from an all-time low of two last year.

The pHs at two of the three egg-mass count sites (North Alder Dam and the pond near drift-fence #2) decreased from last year (Table 2). These values, however, were not as low as they had been in the past. At North Alder Dam, the pH of 5.0 was tied for the third highest, and at the pond near

drift-fence #2, the pH of 5.7 was tied for the second highest. At Benson Pond, pH increased from last year, to its third lowest. Although there is no clear trend in pH at these ponds, it is important to watch the number of Spotted Salamander young of the year, as low pH has been shown to limit their survival. Freda (1986) summarized literature on the effects of low pH on amphibian survival. The three laboratory studies he looked at for Spotted Salamanders (Pough and Wilson 1977, Freda and Dunson 1985, and others), showed that at a pH of between 4.0 and 4.5, 100% of Spotted Salamander embryos die. At between 4.5 and 5.0, hatching success declines below levels in neutral water. Fifty percent mortality occurs between pH's 5.0 and 7.0 (Pierce 1985). Mortality due to low pH is caused by two mechanisms. First, embryos may stop developing soon after exposure to very low pH levels. At higher (but still lethal) pH levels, embryos become curled within the egg and fail to hatch (Freda and Dunson 1985). Quite a few studies have correlated embryo mortality with low acidity in breeding pools or laboratory-controlled situations (Pough 1976, Dale et al. 1985, Clark 1986). However, Cook (1983) found no correlation between pond pH and percent embryonic morality in the Connecticut Valley of Massachusetts, and suggested that in this area, *Ambystoma* have evolved acid tolerance. Ireland (1991) suggested that inhibition of growth in Spotted Salamanders is not only a function of the hydrogen ion concentration (pH), but also of anions associated with acids. The majority of these studies suggest that the low pH values we see occasionally could cause severe mortality of Spotted Salamander embryos. This year, the number of Spotted young of the year at the lower fence dropped slightly to 1 young of the year out of 6 Spotteds caught total (17% of the Spotteds caught), compared to last year's 2 young of 12 total (17% of the Spotteds caught). At the upper fences, the number of Spotteds increased greatly to 89 young of the year of 147 total (61%), up from last year's 37 of 145 (26%). This is the highest number of Spotted Salamander young of the year we have ever seen, surpassing the previous high of 72 in 1998. Since 1998 the number of Spotted Salamander young of the year had been generally decreasing. This year's data (relatively high pH values, and high numbers of young of the year) may suggest a correlation between pH and the number of Spotted Salamander young of the year. However, the correlation coefficient between average pH (between the three count sites) and total number of Spotted Salamander young of the year is not significant (0.25). Despite the lack of a correlation across these seven years of data, the occasional low pHs are worrisome, and their effects on Spotted Salamander embryos need to be monitored closely.

The number of egg-masses of Spotted Salamanders were down from last year's count at all three sites (Table 2). Near Benson Pond, the two egg-masses were the lowest number we had ever seen, and at North Alder Dam and the pond near drift-fence #2, the 16 and 39, respectively, were the third lowest counts. The number of Wood Frog egg-masses were down at both North Alder Dam and the pond near drift-fence #2 to their third lowest counts (dropping 57% at North Alder Dam). The number of Wood Frog egg-masses near Benson Pond rose slightly to the third lowest count. However, the Benson Pond results are not very reliable because the area surveyed each year has changed due to flooding of the site.

Power

This year, in addition to using linear regressions to show potential trends in the abundance indices, I used the Monitor.exe freeware program to estimate the reliability of the apparent trends. These statistics are shown in Tables 7-9. The likelihood that an apparent trend reflects a true trend in population numbers is referred to as power. Statistically it is defined as the likelihood of correctly rejecting the null hypothesis (no trend). My goal is to achieve a power of 90% or greater. The powers of these data sets are dependent upon a number of variables: the length of the series of data-gathering units (at this point 7 years, though I also predicted power after 10 years), the number of indices on which variation is based (3, see description below), the number of locations from which data are gathered (in this case one, because although three fences are used, the data are combined), the variability of the data collected (differs for each species, see below), the starting value of the abundance indices (differs for each species), how small a trend I hope to be able to detect (5% annually), and what statistical level of significance is acceptable: alpha = 0.10 (10%

chance of incorrectly rejecting the null hypothesis). The variability (standard deviation) of the data collected for each species is an estimate of how much the index varies, not how much a species varies from year-to-year. Therefore, it was not reasonable to calculate standard deviation across years. It was also not reasonable to calculate it based on individual days within a year, due to seasonal differences in amphibian movement. Consequently, standard deviation was calculated using numbers from two successful trappings per month in years that had the maximum of 18 successful trappings per year. Different combinations of two trappings per month gave three different indices, from which standard deviation was calculated. Therefore, the standard deviation is based on the three indices rather than the 12 to 18 times data were gathered each year. It is assumed that the standard deviation value I used is higher than the actual SD, since it is based on only two trappings per month instead of three, which is what the actual index is based on. Because the upper and lower fences are opened at different times each month, and for a different number of times each year, different years were used to calculate standard deviation for the upper and lower fences. 1995 was used for the upper fences, and 1997 for the lower fence. Power was also calculated for the combined data from all three fences. In this case, data were combined, and standard deviation was calculated from combined indices. The starting value used in the Monitor.exe program was a weighted average of all three fences (see the 1999 VMC report for an explanation of this average). The power figures shown were generated using the Monitor.exe freeware program written by James P. Gibbs and available on the National Biological Survey's Inventory and Monitoring website (www. mp1-pwrc.usgs.gov/powcase/). Also available through this site is a more extended discussion of power and the rationale for the power and alpha values used here.

Upper drift-fences

Seven years of monitoring data have been gathered at the upper drift-fences. The biggest change this year was a large increase in the number of Eastern Newts caught at the upper fences. Numbers jumped from 10.0 caught per trapping last year to an all-time high of 49.0 per trapping this year (Tables 3 and 5). This high was up from the previous peak of 29.5 per trapping in 1996. The large number caught this year was enough to reverse the strong downward trend we had been seeing at the upper fences through last year (Figure 3). As shown in Table 7, we have the power (greater than 90% after these 7 years of monitoring) to see this trend (an 18% annual increase). Besides the Eastern Newt, there are two other species showing an upward trend over the seven years: the Spotted Salamander (Figure 1) and the Green Frog (Figure 3). Spotteds held steady this year at 9.8 per trapping. We have 100% power to see this 8% annual increase (Table 7). Green Frogs, despite a slight decline from last year's numbers, are still showing a slight upward trend over the seven years. However, we do not have the power to detect this 4% annual increase. This is primarily due to a large standard deviation in relation to the starting value. Overall, salamanders and amphibians are both showing an upward trend (11% and 4%, respectively). For both species we have 100% power to detect these trends.

Three of the species we can reliably monitor are showing a downward trend. Eastern Red-backed Salamanders showed a slight increase from last year, but are declining slightly over the long term (Figure 1). However, we do not currently have the power to confirm this decline. After 10 years of monitoring, though, we will have 97% power to see this 14% decline. This decline appears to be a local phenomenon, because at Mt. Mansfield in northern Vermont, Eastern Red-backed Salamanders are increasing slightly. Although American Toad numbers increased slightly from last year's numbers, the overall trend is still downward (Figure 4). Power values for American Toad are strong, with 100% power to accurately detect the 16% decline we are seeing. Like the decline seen in Eastern Red-backed Salamanders, the American Toad decline also appears to be a local phenomenon, with Toads at both the lower fence and Mt. Mansfield showing an upward trend overall. Wood Frog numbers this year at the upper fences dropped to their lowest ever, leading to a slight downward trend over the long-term (Figure 5). We do not have the power to detect this 5% decline annually, but power values are very close (87%) to the goal of 90%, and

after 10 years of monitoring we will have 100% power. Spring Peepers show a slight decrease annually (-3%), but because this decline is small, it is difficult to accurately detect. In 10 years, our power will have increased to nearly acceptable levels (89%) to detect a 5% change, which is our goal. The low power levels for this species are primarily due to a low starting value in 1995. Northern Two-lined Salamanders and Pickerel Frogs show no appreciable trend over the long term (Figures 2 and 4). However, the fences are not set in appropriate habitat to regularly catch Two-lined Salamanders, and we catch so few Pickerel Frogs, that these species are very difficult to accurately monitor. Overall, frogs show a 4% annual decline, but we do not have the statistical ability to accurately see this trend. After 10 years, however, it appears that our power will increase to acceptable levels for anurans.

Lower drift-fence

Last year at the lower fence, I was worried about a decline in Eastern Newt young of the year. This year, it appears that these numbers have rebounded for Newts. We caught seven Newt young of the year in 2001. This was up from 0 last year, and was the highest number caught since 1997, when the apparent decline started (28 young of the year). Although it is reassuring to see that we have caught some young Newts at the lower fence this year, these numbers need to continue to be watched closely.

Spotted Salamanders decreased slightly this year (Figure 6) to their second highest number per trapping, and continue to show an upward trend (9% annually, with 100% power, Table 8). American Toads also continue to show an upward trend despite a slight decline from last year's numbers (Figure 9). We have 98% power to see their 14% annual increase. Spring Peepers (Figure 11) show a very slight upward trend as well, but because of low starting values and a very large standard deviation, we do not have the power to detect this trend. Wood Frogs (Figure 10) also show an upward trend, but because of a high standard deviation to starting value ratio, we have low power for this species at this fence. Green Frogs (Figure 8) have shown an increase over the long-term, despite a decrease from last year's high count. Again, the power to detect this 22% annual change is not yet at an acceptable level, but after 10 years will increase to 100%, allowing us to accurately detect an increase of 10% or greater. Overall, anurans show a 4% annual increase, although their numbers dropped slightly from last year. We do have the power (96%) to see this change.

The other species that we catch at the lower fence show a negative trend overall. Eastern Newts, despite a slight increase from last year's numbers (Figure 8) and increased numbers of young of the year, still show a strong downward trend (-11% annually, 100% power). Pickerel Frogs have increased from last year's all-time low, but this was not enough to flip the overall downward trend we have been seeing (Figure 9). We do not have the power to detect this downward trend, which is primarily due to a large standard deviation in relation to the starting value. Eastern Red-backed Salamanders (Figure 6) show a larger amount of annual fluctuation at the lower fence than at the upper fences. There is little annual percent change overall (-3%), and we do not have the ability to accurately see this change. We do, however, have the power to detect a 5% decline in this species, if it existed. Overall, salamanders have dropped to an all-time low this year, and are showing a –8% annual decline (100% power). Similarly, amphibians have also dropped to an all-time low this year, and are showing a –6% annual decline (100%).

Combined drift-fences

In addition to graphing the upper and lower fences separately, a weighted average of all three fences was calculated for each species and graphed (Figures 12-16). For an explanation of this calculation, see the 1999 VMC report.

Overall, three species appear to be increasing: Spotted Salamanders, Eastern Newts, and Green Frogs. For all of these species except Green Frogs, we have the power to detect the overall trends (Table 9). Interestingly, Eastern Newts show the largest positive trend (11%), due to the large number caught at the upper fences this year. This has completely reversed the trend seen over the past few years of a decline in Eastern Newt populations. In addition, salamanders and amphibians are increasing over the long-term, and for both, we have the power to detect the trend.

Five species appear to be declining, but of these, we only have the power to detect the trend for three: Eastern Red-backed Salamanders, American Toads, and Wood Frogs. American Toads show the largest overall trend (-15% annually). Species and groups that appear to be declining but for which we do not have acceptable power are Spring Peeper, Pickerel Frog, and frogs in general.

Abnormalities

In 2001, there were a total of four amphibian abnormalities. This is equivalent to 0.3% of the amphibians we caught, which is well within the expected range. One Eastern Newt out of 817 caught at the upper fences had diminutive toes on the right front foot (brachydactyly). One Spotted Salamander of the 199 caught at the upper fences was missing its front left leg, and had toes growing out of the place where the leg attaches to the body (phocomelia). One Wood Frog of the 42 caught at the upper fences was missing its right eye (anophthalmia). One American Toad of the 16 caught at the lower fence was missing its left front leg (amelia). All of these abnormalities occurred in adults. This year's abnormality rate in young of the year was 0%. However, there were also very few anuran young of the year caught at the upper fences (18, compared to a previous low of 68 in 1996, and 164 last year). This is a more significant concern than abnormalities in the long run.

Summary

This year, power was calculated in order to examine the reliability of the trends we see. We currently have power to detect the trends for 5 species (Spotted Salamander, Eastern Newt, Eastern Red-backed Salamander, American Toad, and Wood Frog), and both salamanders and amphibians as groups. We are lacking the power to detect these trends for 3 species (Spring Peeper, Green Frog, and Pickerel Frog) and anurans as a group, but an increase in the number of years spent monitoring will increase these weak power levels. The largest change in 2001 was a reversal of the decline of Eastern Newts at the upper fences. The trend is now a positive one, and one that we can reliably detect. Newts continue their decline at the lower fences, but overall (all fences combined) are increasing. American Toads continue to decline at the upper fences, driving an overall decline as well. The Toad decline appears to be a local phenomena, because at Mt. Mansfield in northern Vermont, American Toads are increasing. The pH at the stream survey site has increased for the second year in a row, after a long decline. The number of Spring Salamanders increased from last year's low numbers to more average numbers. Spotted Salamander egg-mass numbers dropped at all three egg-mass count sites this year, while Wood Frog egg-masses dropped at two of the three sites. The pH at two of the egg-mass count sites has again dropped, but there does not appear to be any visible effect on the number of Spotted Salamander young of the year. The lowered pH and its possible effects, however, will continue to be watched closely.

Acknowledgments

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Table 1. Results of three 50-meter stream-transects in Branch Pond Brook in the Lye Brook Wilderness Region from 1994-2001. Only adult *Gyrinophilus porphyriticus* (Spring Salamander) and *Eurycea bislineata* (Northern Two-lined Salamander) are included in the table.

Year	Spring Salamander	Northern Two-lined Salamander	pH[1]	Water temp. in °C[1]	Max. water depth[2] in cm
1994					
(7/18/94)	10	11	4.9 (N = 3)	17.4 (N = 2)	20
1995					
(7/24/95)	6	1	4.4 (N = 5)	17.4 (N = 3)	26
1996					
(8/6/96)	3	0	4.0 (N = 3)	16.1 (N = 3)	21
1997					
(7/11/97)	7	3	3.8 (N = 2)	15.6 (N = 3)	27
1998					
(7/14/98)[3]	11	3	5.0 (N = 1)	16.3 (N = 3)	26
1999					
(7/19/99)	8	1	3.4 (N = 3)	22.8 (N = 3)	19
2000					
(8/21/00)[4]	2	1	3.8 (N = 3)	14.5 (N = 3)	
2001					
(8/10/01)[5]	7	2	4.1 (N = 3)	19.6 (N = 3)	20

[1]Temperature and pH were taken two meters downstream from the downstream end of the first transect.

[2]Reference point is the deepest point between the two large rocks which constrict the channel approximately two meters downstream from the beginning of the first transect.

[3]pH measurements were taken on August 5, 1998.

[4]No depth measurements were taken in 2000.

[5]In 2001, pH and temperature measurements were taken once at the beginning of each survey transect. The pH and temperature averages here are means of those three values.

Table 2. Maximum counts of egg masses from monitoring locations in the Lye Brook Wilderness region from 1994 through 2001. At the site near Benson Pond the entire pond is surveyed. At North Alder Dam a four-meter strip around all of the pond except the swampy north end is surveyed. At the Pond Near Drift-fence #2, a four-meter strip around the entire pond is surveyed.

Site	Spotted Salamander	Wood Frog	Mean pH[2]
Near Benson Pond			
1994 count dates: 4/26, 5/10, 5/25	10	67[1]	7.3 (N = 1)
1995 count dates: 4/24[2], 5/12	3	19	6.8 (N = 1)
1996 count dates: 4/24, 4/27, 5/7, 5/8, 5/15	73	2	6.9 (N = 3)
1997 count dates[3]: 4/27, 5/5, 5/12	16	97	6.1 (N = 3)
1998 count dates[5,6]: 4/21, 4/28, 5/5	33	96	7.5 (N = 1)
1999 count dates: 4/12, 4/19, 4/27	85	129	6.7 (N = 3)
2000 count dates: 4/4, 4/13, 4/17	9	1	6.2 (N = 3)
2001 count dates: 4/30, 5/7, 5/14	2	8	6.6 (N = 3)
North Alder Dam			
1994 count dates: 5/11, 5/25, 6/8	97	225	5.0 (N = 2)
1995 count dates: 4/24[2], 5/12, 6/9	292	3	5.1 (N = 2)
1996 count dates: 5/8, 5/15, 5/25	176	3	5.0 (N = 3)
1997 count dates[4]: 5/20, 5/27, 6/3	0	44	4.2 (N = 3)
1998 count dates[6]: 5/4, 5/12, 5/19	9	256	4.8 (N = 1)
1999 count dates: 5/11, 5/17, 5/29	120	252	4.1 (N = 3)
2000 count dates: 5/3, 5/11, 5/17	60	111	6.9 (N = 3)
2001 count dates: 5/17, 5/24, 5/31	16	63	5.0 (N = 3)
Pond Near Drift-fence #2			
1994 count dates: 5/11, 5/25, 6/9	6	3	5.7 (N = 2)
1995 count dates: 4/24[2], 5/12, 6/9	70	152	5.6 (N = 2)
1996 count dates: 5/8, 5/15, 5/25	78	62	5.2 (N = 3)
1997 count dates: 5/20, 5/27, 6/3	55	77	5.0 (N = 3)
1998 count dates[6]: 5/4, 5/12, 5/19	13	30	5.5 (N = 1)
1999 count dates: 5/11, 5/17, 5/29	90	119	4.9 (N = 3)
2000 count dates: 5/3, 5/11, 5/17	86	143	6.7 (N = 3)
2001 count dates: 5/17, 5/24, 5/31	39	41	5.7 (N = 3)

[1]Hatched by May 10

[2]All readings taken on April 24, 1995 were believed to be erroneus and are not included in the mean. All pH measurments taken during 1996 at the site near Benson Pond were taken in May. Each reading used in the average is itself composed of three measurements taken from different areas of the ponds. All pH means have been rounded to the nearest 0.1.

[3]Site has been flooded over. Three newly created adjacent puddles were included in the count along with the original site.

[4]Water level much higher due to new beaver activity. Visibility poor.

[5]Two flooded stream areas were included in the count along with the original site and the 3 puddles included last year.

[6]pH readings were taken on August 5, 1998.

Table 3. Monitoring results from the upper two drift-fences in the Lye Brook Wilderness Region during 2001. Traps were opened whenever conditions were appropriate for amphibian movement from April through October.[1] The three most successful trappings per month (+/- 7 days) are included. Conditions did not allow successful trapping in April, so it is not included in this table. Data from 15 out of 30 trap-efforts are used. Data used are from May 13, 19, and 23; June 3, 12, and 17; July 12, 25, and 27; September 1, 11, and 21; and September 26, October 15 and 24. Abnormality, maximum size, and first metamorph data are taken from all 30 trappings.

Common name	Scientific name	# of all ages	# of young of the year [2]	% young of the year	date of first metamorph [3]	largest adult (total length in mm)	# per trapping [4]	% of group	% of total catch	# abnormal/ total [5]
Salamanders										
Eastern Newt	*Notophthalmus viridescens*	735	639	87%	September 1	89	49.0	81%	70%	1 / 817
Spotted Salamander	*Ambystoma maculatum*	147	89	61%	August 28	205	9.8	16%	14%	1 / 199
E. Red-backed Salamander	*Plethodon cinereus*	13	1	8%	October 24	92	0.9	1%	1%	0 / 16
N. Two-lined Salamander	*Eurycea bislineata*	9	1	11%	July 12	88	0.6	1%	1%	0 / 9
Group totals		904	730	81%	NA	NA	60.3	100%	87%	2 / 1041
Frogs and Toads										
Green Frog	*Rana clamitans*	81	11	14%	August 18	76	5.4	57%	8%	0 / 115
Wood Frog	*Rana sylvatica*	34	3	9%	August 18	60	2.3	24%	3%	1 / 42
Spring Peeper	*Pseudacris crucifer*	13	4	31%	August 11	35	0.9	9%	1%	0 / 42
American Toad	*Bufo americanus*	13	0	0%	NA	81	0.9	9%	1%	0 / 17
Group totals		141	18	13%	NA	NA	9.4	100%	13%	1 / 216
Amphibian totals		1045	748	72%	NA	NA	69.7	NA	100%	3 / 1257

[1]Starting in 1999, fences were opened regularly in August in order to gather additional data on abnormalities and metamorphs. Data sets between August 8 and 24 are not used for calculating the index in order to maintain consistency with previous years.

[2]For each species, individuals under a given total length were considered potential young of the year. The chosen length was based on the timing of their appearance, gaps in their size continuum, and records in the literature. The cutoff sizes used were *A. maculatum* (70 mm), *D. fuscus* (30 mm), *E. bislineata* (60 mm), *N. viridescens* (45 mm), *P. cinereus* (32 mm), *B. americanus* (23 mm), *H. versicolor* (26 mm), *P. crucifer* (20 mm), *R. clamitans* (44 mm), *R. palustris* (34 mm), and *R. sylvatica* (27 mm). In addition, it was necessary to examine the minimum possible development time for each species. Individuals shorter than the cutoff lengths clearly overwinter (possibly as larvae for *N. viridescens* and *A. maculatum)* and show up in very early spring. These are not counted as young of the year.

[3]Data from trapping that took place between August 8 and 24 were used for date of first metamorph, maximum size, and abnormality data only.

[4]Numbers per trapping are rounded to the nearest 0.1. All other figures are rounded to the nearest whole number. As a result of this, group totals may not be equivalent to the sum of the individual species' values.

[5]These may contain old deformities (traumatic) as well as malformities (developmental). Salamanders missing all or portions of their tails are not included. The total number checked may contain specimens that were caught more than once.

Table 4. Monitoring results from the lower drift-fence in the Lye Brook Wilderness Region during 2001. Traps were opened whenever conditions were appropriate for amphibian movement from April through October.[1] The three most successful trappings per month (+/- 7 days) are included. Data from 15 out of 31 trap-efforts are used. Data used are from May 6, 13, and 23; June 3, 12, and 22; June 24, July 18 and 27; August 28, September 1 and 21; and October 15, 24, and November 1. Abnormality, maximum size, and first metamorph data are taken from all 31 trappings.

Common name	Scientific name	# of all ages	# of young of the year [2]	% young of the year	date of first metamorph [3]	largest adult (total length in mm)	# per trapping [4]	% of group	% of total catch	# abnormal/ total [5]
Salamanders										
E. Red-backed Salamander	*Plethodon cinereus*	26	1	4%	November 1	92	1.7	54%	29%	0 / 28
Eastern Newt	*Notophthalmus viridescens*	16	7	44%	September 5	81	1.1	33%	18%	0 / 32
Spotted Salamander	*Ambystoma maculatum*	6	1	17%	September 11	180	0.4	13%	7%	0 / 8
Group totals		48	9	19%	NA	NA	3.2	100%	53%	0 / 68
Frogs and Toads										
Wood Frog	*Rana sylvatica*	20	3	15%	August 18	61	1.3	48%	22%	0 / 22
American Toad	*Bufo americanus*	11	0	0%	August 11	79	0.7	26%	12%	1 / 16
Spring Peeper	*Pseudacris crucifer*	3	1	33%	August 11	20	0.2	7%	3%	0 / 11
Green Frog	*Rana clamitans*	1	0	0%	August 11	44	0.1	2%	1%	0 / 3
Pickerel Frog	*Rana palustris*	7	7	100%	August 18	35	0.5	17%	8%	0 / 12
Group totals		42	11	26%	NA	NA	2.8	100%	47%	1 / 64
Amphibian totals		90	20	22%	NA	NA	6.0	NA	100%	1 / 132

[1]Starting in 1999, fences were opened regularly in August in order to gather additional data on abnormalities and metamorphs. Data sets between August 8 and 24 are not used for calculating the index in order to maintain consistency with previous years.

[2]For each species, individuals under a given total length were considered potential young of the year. The chosen length was based on the timing of their appearance, gaps in their size continuum, and records in the literature. The cutoff sizes used were *A. maculatum* (70 mm), *D. fuscus* (30 mm), *E. bislineata* (60 mm), *N. viridescens* (45 mm), *P. cinereus* (32 mm), *B. americanus* (23 mm), *H. versicolor* (26 mm), *P. crucifer* (20 mm), *R. clamitans* (44 mm), *R. palustris* (34 mm), and *R. sylvatica* (27 mm). In addition, it was necessary to examine the minimum possible development time for each species. Individuals shorter than the cutoff lengths clearly overwinter (possibly as larvae for *N. viridescens* and *A. maculatum)* and show up in very early spring. These are not counted as young of the year.

[3]Data from trapping that took place between August 8 and 24 were used for date of first metamorph, maximum size, and abnormality data only.

[4]Numbers per trapping are rounded to the nearest 0.1. All other figures are rounded to the nearest whole number. As a result of this, group totals may not be equivalent to the sum of the individual species' values.

[5]These may contain old deformities (traumatic) as well as malformities (developmental). Salamanders missing all or portions of their tails are not included. The total number checked may contain specimens that were caught more than once.

Table 5. A comparison of data from the upper two drift-fences in Lye Brook Wilderness, Sunderland, Bennington County, Vermont. Data are taken from the 1995, 1996, 1997, 1998, 1999, 2000, and 2001 field seasons. Fences were opened at least three times per month.

Common name	# per trapping [1]							% of total catch						
	95	96	97	98	99	00	01	95	96	97	98	99	00	01
Caudates (Salamanders)														
Blue-spotted Salamander Group	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0%	0%	<1%	0%	0%	0%	0%
Spotted Salamander	8.7	4.7	5.7	7.9	10.5	9.7	9.8	20%	9%	14%	17%	32%	27%	14%
Northern Two-lined Salamander	0.8	0.3	0.3	0.2	0.1	0.5	0.6	2%	6%	1%	<1%	<1%	1%	1%
Eastern Newt	12.7	29.5	19.4	10.5	4.6	10.0	49.0	29%	57%	49%	23%	14%	28%	70%
Eastern Red-backed Salamander	2.0	3.3	1.5	3.3	0.8	0.9	0.9	5%	7%	4%	7%	2%	3%	1%
Group Totals	24.2	37.1	27.1	21.9	15.9	21.1	60.3	56%	74%	68%	48%	49%	59%	87%
Anurans (Frogs and Toads)														
American Toad	4.3	2.7	2.0	1.1	0.6	0.5	0.9	10%	5%	5%	2%	2%	1%	1%
Spring Peeper	0.8	1.2	1.8	2.3	1.6	0.7	0.9	2%	2%	5%	5%	5%	2%	1%
Green Frog	6.8	2.9	3.1	7.3	8.2	5.8	5.4	15%	6%	8%	16%	25%	16%	8%
Pickerel Frog	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0%	0%	0%	<1%	0%	0%	0%
Wood Frog	8.2	6.3	6.0	13.4	6.3	7.9	2.3	18%	13%	15%	29%	19%	22%	3%
Group Totals	20.0	13.1	12.8	24.1	16.6	14.9	9.4	45%	26%	32%	52%	51%	41%	13%
Amphibian Totals	44.2	50.2	39.9	46.1	32.6	36.1	69.7	100%	100%	100%	100%	100%	100%	100%

[1]Numbers per trapping are rounded to the nearest 0.1. All other figures are rounded to the nearest whole number. As a result of this, group totals may not be equivalent to the sum of the individual species' values. There were a total of 18 trappings counted in 1995, 15 in 1996, 15 in 1997, 15 in 1998, 16 in 1999, 15 in 2000, and 15 in 2001.

Table 6. A comparison of data from the lower drift-fence in Lye Brook Wilderness, Manchester, Bennington County, Vermont. Data are taken from the 1995, 1996, 1997, 1998, 1999, 2000, and 2001 field seasons. Fences were opened at least three times per month.

Common name	# per trapping [2]							% of total catch						
	95 [1]	96	97	98	99	00	01	95	96	97	98	99	00	01
Caudates (Salamanders)														
Spotted Salamander	0.4	0.2	0.3	0.3	0.3	0.7	0.4	3%	2%	3%	4%	4%	7%	7%
Northern Two-lined Salamander	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0%	0%	0%	1%	1%	<1%	0%
Eastern Newt	8.3	1.9	4.7	2.1	2.8	0.9	1.1	56%	28%	51%	23%	41%	10%	18%
Eastern Red-backed Salamander	4.1	2.2	1.1	4.9	1.1	4.4	1.7	28%	32%	11%	54%	16%	48%	29%
Group Totals	12.8	4.3	6.1	7.4	4.3	6.1	3.2	87%	62%	65%	82%	62%	65%	53%
Anurans (Frogs and Toads)														
American Toad	0.4	0.7	0.7	0.7	1.2	0.9	0.7	3%	10%	7%	7%	18%	10%	12%
Spring Peeper	0.1	0.2	1.1	0.3	0.4	0.7	0.2	<1%	3%	12%	3%	5%	8%	3%
Green Frog	0.1	0.1	0.1	0.2	0.0	0.5	0.1	<1%	2%	1%	2%	0%	5%	1%
Pickerel Frog	1.1	0.8	0.7	0.2	0.2	0.1	0.5	7%	12%	7%	2%	3%	1%	8%
Wood Frog	0.4	0.8	0.7	0.3	0.8	1.1	1.3	3%	11%	8%	3%	12%	11%	22%
Group Totals	2.1	2.6	3.3	1.7	2.6	3.3	2.8	13%	38%	35%	18%	38%	35%	47%
Amphibian Totals	14.9	6.9	9.3	9.1	6.9	9.4	6.0	100%	100%	100%	100%	100%	100%	100%

[1]In 1995, there were only 10 successful trappings. Dates used were April 20; June 16; July 1 and 18; September 10, 14, and 15; and October 6, 15, and 28.

[2]Numbers per trapping are rounded to the nearest 0.1. All other figures are rounded to the nearest whole number. As a result of this, group totals may not be equivalent to the sum of the individual species' values. There were a total of 10 trappings counted in 1995, 18 in 1996, 18 in 1997, 18 in 1998, 17 in 1999, 18 in 2000, and 15 in 2001.

Table 7. Statistical analyses of the Lye Brook Wilderness upper drift-fences data from 1995 through 2001. Percentages in bold type are generated with a power greater than 90% after 7 years of monitoring. Not included in the table are Blue-spotted Salamander, Northern Dusky Salamander, Northern Two-lined Salamander, Spring Salamander, Pickerel Frog, and Gray Treefrog, as they are not caught in large enough numbers to accurately monitor their populations.

Common name	Starting value (1995) [1]	Statistics and trends [2]									
		SD [3]	Mean [3]	CV [3]	7 years		10 years		Power (x%) [6]	Annual change	Annual % change
					Power 10% decline [4]	Power 5% decline [4]	Power 10% decline [5]	Power 5% decline [5]			
Caudates (Salamanders)											
Spotted Salamander	8.7	1.09	8.67	0.13	1.00	0.92	1.00	1.00	1.00 (8%)	0.696	**8.00%**
Eastern Newt	12.7	0.60	12.67	0.05	1.00	1.00	1.00	1.00	1.00 (10%)	2.336	**18.39%**
E. Red-backed Salamander	2.0	0.58	2.00	0.29	0.73	0.37	0.97	0.70	0.73 (-10%)	-0.285	-14.26%
Group totals	24.2	1.04	24.17	0.04	1.00	1.00	1.00	1.00	1.00 (10%)	2.747	**11.35%**
Anurans (Frogs and Toads)											
American Toad	4.3	0.93	4.33	0.21	1.00	0.97	1.00	1.00	1.00 (-10%)	-0.686	**-15.95%**
Spring Peeper	0.8	0.17	0.78	0.22	0.93	0.58	0.99	0.89	0.30 (-3%)	-0.023	-2.85%
Green Frog	6.8	2.10	6.78	0.31	0.68	0.32	0.93	0.66	0.36 (4%)	0.275	4.04%
Wood Frog	8.2	1.09	8.17	0.13	1.00	0.87	1.00	1.00	0.87 (-5%)	-0.431	-5.26%
Group totals	20.0	3.30	20.06	0.16	0.98	0.76	1.00	0.98	0.61 (-4%)	-0.865	-4.33%
Amphibian totals	44.2	2.69	44.22	0.06	1.00	1.00	1.00	1.00	1.00 (4%)	1.882	**4.26%**

[1]This is the number caught per trapping in 1995. It is used both in the Monitor.exe freeware program to calculate power, and in the far right column to calculate annual percent change.

[2]Trends are taken from a linear regression (see Figures 1-5). Annual change is shown in individuals per trapping and is the slope of the regression line. Percentage of change is based on the annual change's percent of the starting population.

[3]This standard deviation (SD), mean, and coefficient of variation (CV) are based on three indices, each of which used 2 dates from every month. The mean is an average of the three indices. This standard deviation value was used in the calculation of power using the Monitor.exe freeware program.

[4]This is the power to detect a 10% and 5% annual population decline after 7 years of monitoring, as determined using the Monitor.exe freeware program using linear regressions (with an alpha of 0.10).

[5]This is the power to detect a 10% and 5% annual population decline after 10 years of monitoring, as determined using the Monitor.exe freeware program using linear regressions (with an alpha of 0.10).

[6]This is the power to detect the percent change indicated in the parentheses after 7 years of monitoring. This percent change is equivalent to the value in the column "Annual % Change" (rounded to the nearest whole number), except when the annual percent change is greater than 10%. Because the Monitor.exe program does not calculate power for an annual change greater than 10%, the power in these cases is equal to the power at 10% increase or decrease.

Table 8. Statistical analyses of the Lye Brook Wilderness lower drift-fence data from 1995 through 2001. Percentages in bold type are generated with a power greater than 90% after 7 years of monitoring. Not included in the table are Blue-spotted Salamander, Northern Dusky Salamander, Northern Two-lined Salamander, Spring Salamander, and Gray Treefrog, as they are not caught in large enough numbers to accurately monitor their populations.

Common name	Starting value (1995) [1]	Statistics and trends [2]									
		SD [3]	Mean [3]	CV [3]	7 years		10 years		Power (x%) [6]	Annual change	Annual % change
					Power 10% decline [4]	Power 5% decline [4]	Power 10% decline [5]	Power 5% decline [5]			
Caudates (Salamanders)											
Spotted Salamander	0.4	0.05	0.28	0.17	1.00	0.92	1.00	1.00	1.00 (9%)	0.034	**8.58%**
Eastern Newt	8.3	0.74	4.67	0.16	1.00	1.00	1.00	1.00	1.00 (-10%)	-0.934	**-11.26%**
E. Red-backed Salamander	4.1	0.46	1.06	0.43	1.00	0.95	1.00	1.00	0.31 (-3%)	-0.107	-2.60%
Group totals	12.8	0.82	6.00	0.14	1.00	1.00	1.00	1.00	1.00 (-8%)	-1.007	**-7.86%**
Anurans (Frogs and Toads)											
American Toad	0.4	0.13	0.72	0.18	0.67	0.34	0.94	0.58	0.98 (10%)	0.058	**14.43%**
Spring Peeper	0.1	0.38	1.11	0.35	0.10	0.10	0.11	0.09	0.13 (10%)	0.019	19.40%
Green Frog	0.1	0.05	0.06	0.87	0.37	0.20	0.66	0.35	0.80 (10%)	0.022	22.22%
Pickerel Frog	1.1	0.17	0.67	0.25	0.44	0.22	0.72	0.38	0.44 (-10%)	-0.141	-12.81%
Wood Frog	0.4	0.29	0.72	0.41	0.22	0.16	0.36	0.21	0.51 (10%)	0.124	30.88%
Group totals	2.1	0.24	3.28	0.07	1.00	0.95	1.00	1.00	0.96 (4%)	0.082	**3.90%**
Amphibian totals	14.9	1.10	9.28	0.12	1.00	1.00	1.00	1.00	1.00 (-6%)	-0.925	**-6.21%**

[1]This is the number caught per trapping in 1995. It is used both in the Monitor.exe freeware program to calculate power, and in the far right column to calculate annual percent change.

[2]Trends are taken from a linear regression (see Figures 6-11). Annual change is shown in individuals per trapping and is the slope of the regression line. Percentage of change is based on the annual change's percent of the starting population.

[3]This standard deviation (SD), mean, and coefficient of variation (CV) are based on three indices, each of which used 2 dates from every month. The mean is an average of the three indices. This standard deviation value was used in the calculation of power using the Monitor.exe freeware program.

[4]This is the power to detect a 10% and 5% annual population decline after 7 years of monitoring, as determined using the Monitor.exe freeware program using linear regressions (with an alpha of 0.10).

[5]This is the power to detect a 10% and 5% annual population decline after 10 years of monitoring, as determined using the Monitor.exe freeware program using linear regressions (with an alpha of 0.10).

[6]This is the power to detect the percent change indicated in the parentheses after 7 years of monitoring. This percent change is equivalent to the value in the column "Annual % Change" (rounded to the nearest whole number), except when the annual percent change is greater than 10%. Because the Monitor.exe program does not calculate power for an annual change greater than 10%, the power in these cases is equal to the power at 10% increase or decrease.

Table 9. Statistical analyses of the Lye Brook Wilderness combined drift-fences data from 1995 through 2001. Percentages in bold type are generated with a power greater than 90% after 7 years of monitoring. Not included in the table are Blue-spotted Salamander, Northern Dusky Salamander, Northern Two-lined Salamander, Spring Salamander, and Gray Treefrog, as they are not caught in large enough numbers to accurately monitor their populations.

Common name	Starting value (1995) [1]	Statistics and trends [2]									
		SD [3]	Mean [3]	CV [3]	7 years		10 years		Power (x%) [6]	Annual change	Annual % change
					Power 10% decline [4]	Power 5% decline [4]	Power 10% decline [5]	Power 5% decline [5]			
Caudates (Salamanders)											
Spotted Salamander	5.9	0.92	8.94	0.10	0.99	0.81	1.00	0.99	1.00 (8%)	0.476	**8.02%**
Eastern Newt	11.2	2.58	17.33	0.15	0.88	0.50	1.00	0.82	1.00 (10%)	1.246	**11.09%**
E. Red-backed Salamander	2.7	0.29	2.56	0.11	1.00	0.97	1.00	1.00	1.00 (-8%)	-0.226	**-8.36%**
Group totals	20.4	1.88	30.17	0.06	1.00	1.00	1.00	1.00	1.00 (7%)	1.496	**7.33%**
Anurans (Frogs and Toads)											
American Toad	3.0	0.24	5.06	0.05	1.00	1.00	1.00	1.00	1.00 (-10%)	-0.438	**-14.60%**
Spring Peeper	0.6	0.48	1.89	0.25	0.19	0.13	0.30	0.20	0.10 (-2%)	-0.009	-1.54%
Green Frog	4.6	2.13	6.83	0.31	0.40	0.21	0.68	0.37	0.25 (4%)	0.191	4.18%
Pickerel Frog	0.4	0.17	0.67	0.25	0.44	0.22	0.72	0.38	0.44 (-10%)	-0.047	-12.82%
Wood Frog	5.6	0.41	8.89	0.05	1.00	1.00	1.00	1.00	1.00 (-4%)	-0.246	**-4.40%**
Group totals	14.0	1.80	23.33	0.08	1.00	0.90	1.00	1.00	0.79 (-4%)	-0.549	-3.91%
Amphibian totals	34.4	1.00	54.06	0.02	1.00	1.00	1.00	1.00	1.00 (3%)	0.947	**2.75%**

[1]This is the number caught per trapping as a combined weighted index of the upper and lower drift-fences. The number caught per trapping in 1995 at the upper fences (see Table 3) was multiplied by 2 (because there are 2 fences), and added to the number caught per trapping in 1995 at the lower fence (see Table 4). This sum was then divided by 3 (because there are a total of 3 fences) in order to give the combined index in this column. The starting value is used both in the Monitor.exe freeware program to calculate power, and in the far right column to calculate annual percent change.

[2]Trends are taken from a linear regression (see Figures 12-16). Annual change is shown in individuals per trapping and is the slope of the regression line. Percentage of change is based on the annual change's percent of the starting population.

[3]This standard deviation (SD), mean, and coefficient of variation (CV) are taken from a combination of data from both upper and lower fences. The measures of variation are between three indices, each of which used 2 dates from every month. The mean is an average of the three indices. This standard deviation value was used in the calculation of power using the Monitor.exe freeware program.

[4]This is the power to detect a 10% and 5% annual population decline after 7 years of monitoring, as determined using the Monitor.exe freeware program using linear regressions (with an alpha of 0.10).

[5]This is the power to detect a 10% and 5% annual population decline after 10 years of monitoring, as determined using the Monitor.exe freeware program using linear regressions (with an alpha of 0.10).

[6]This is the power to detect the percent change indicated in the parentheses after 7 years of monitoring. This percent change is equivalent to the value in the column "Annual % Change" (rounded to the nearest whole number), except when the annual percent change is greater than 10%. Because the Monitor.exe program does not calculate power for an annual change greater than 10%, the power in these cases is equal to the power at 10% increase or decrease.

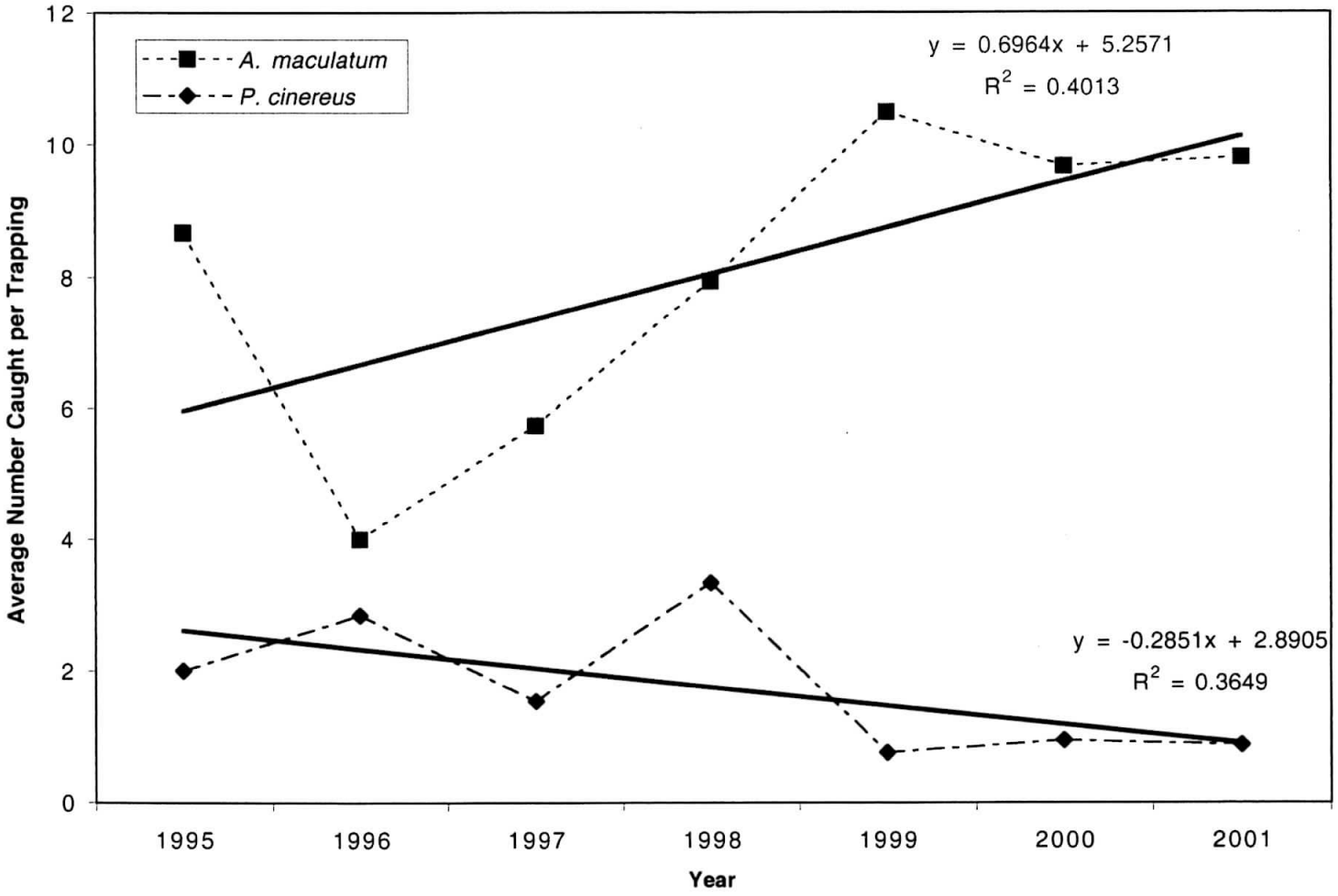

Figure 1. Spotted *(Ambystoma maculatum)* and Eastern Red-backed Salamander *(Plethodon cinereus)* population indices from the upper two drift-fences in the Lye Brook Wilderness, Sunderland, Vermont, 1995-2001.

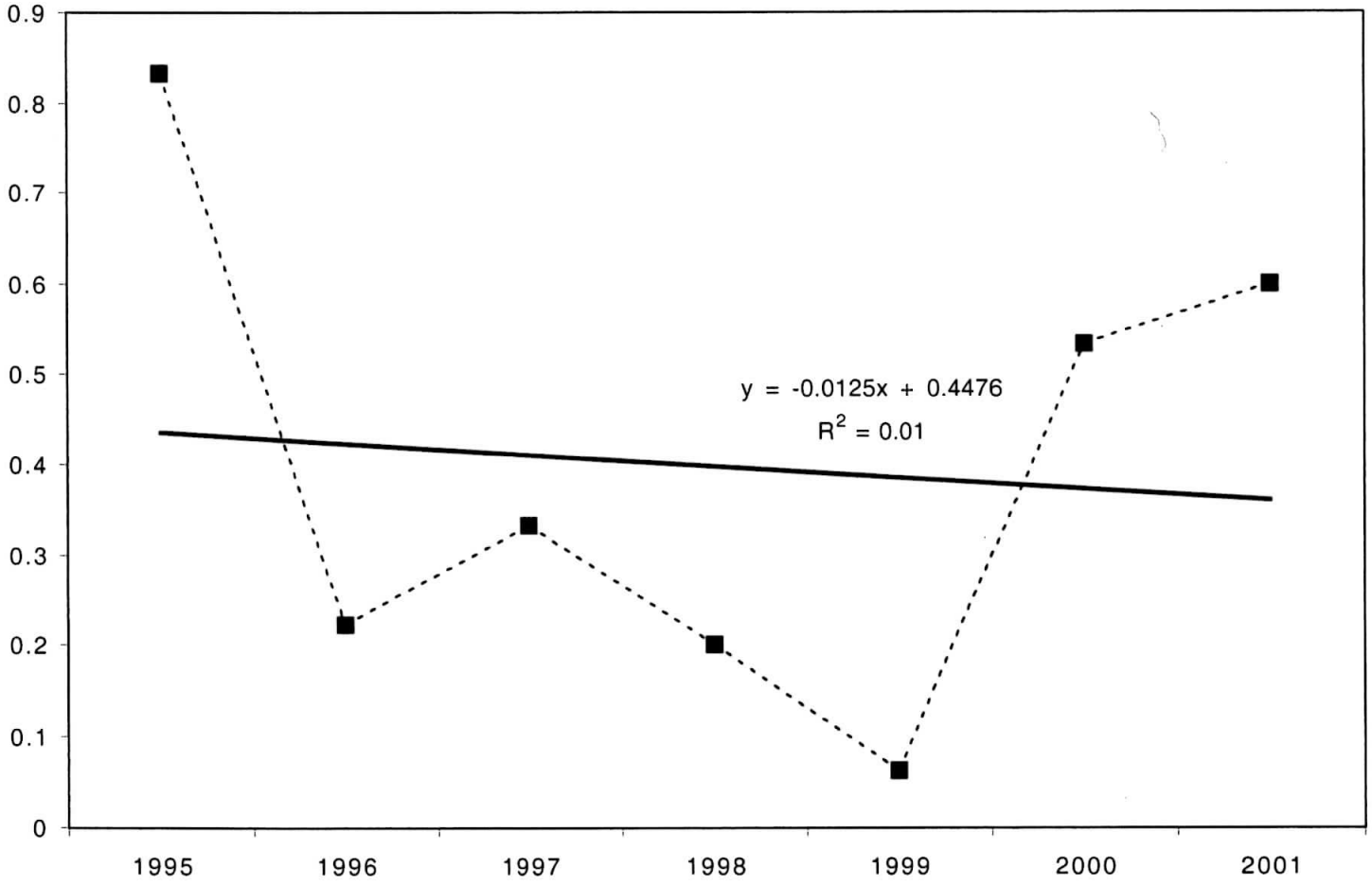

Figure 2. Northern Two-lined Salamander *(Eurycea bislineata)* population indices from the upper two drift-fences in the Lye Brook Wilderness, Sunderland, Vermont, 1995-2001.

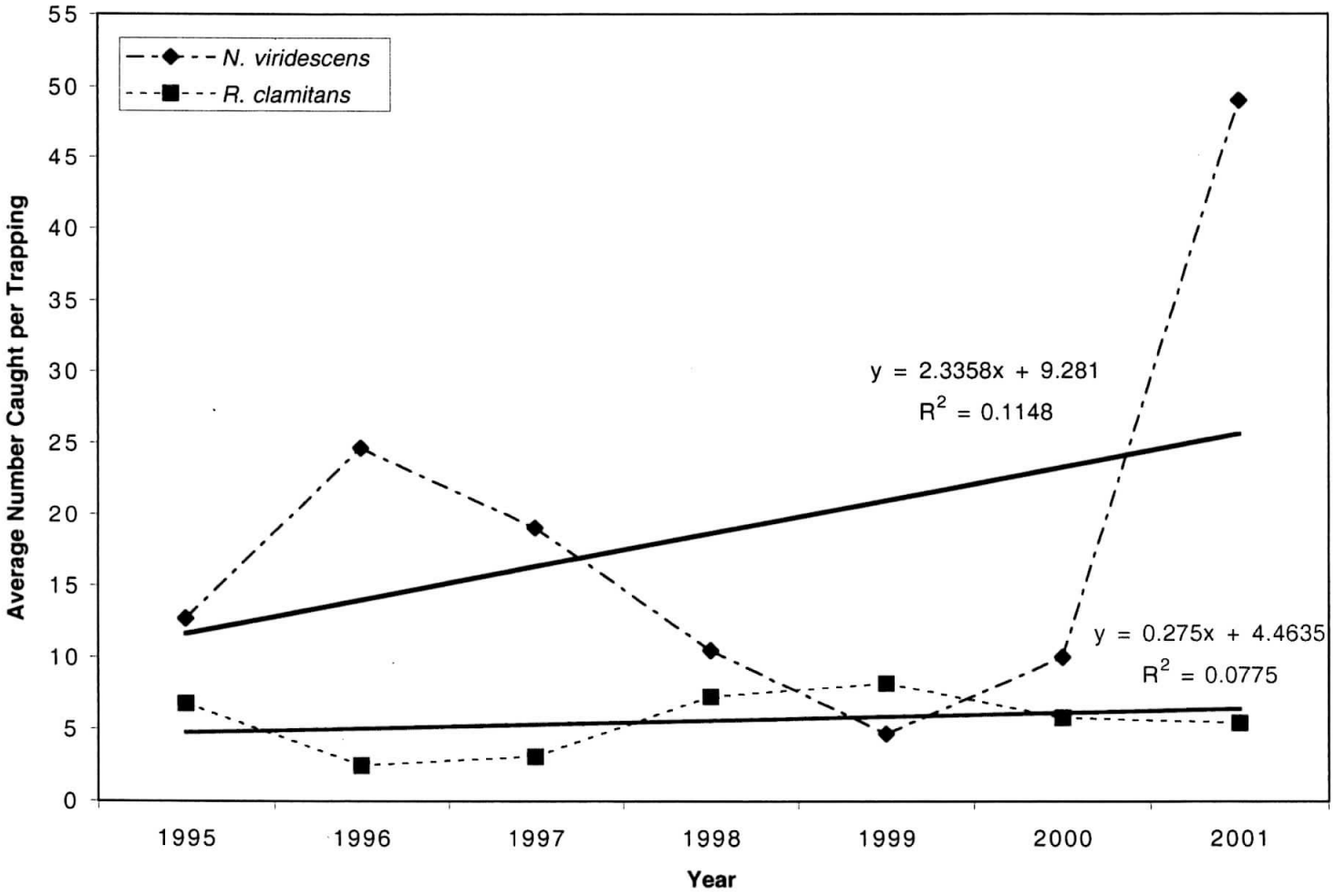

Figure 3. Eastern Newt *(Notophthalmus viridescens)* and Green Frog *(Rana clamitans)* population indices from the upper two drift-fences in the Lye Brook Wilderness, Sunderland, Vermont, 1995-2001.

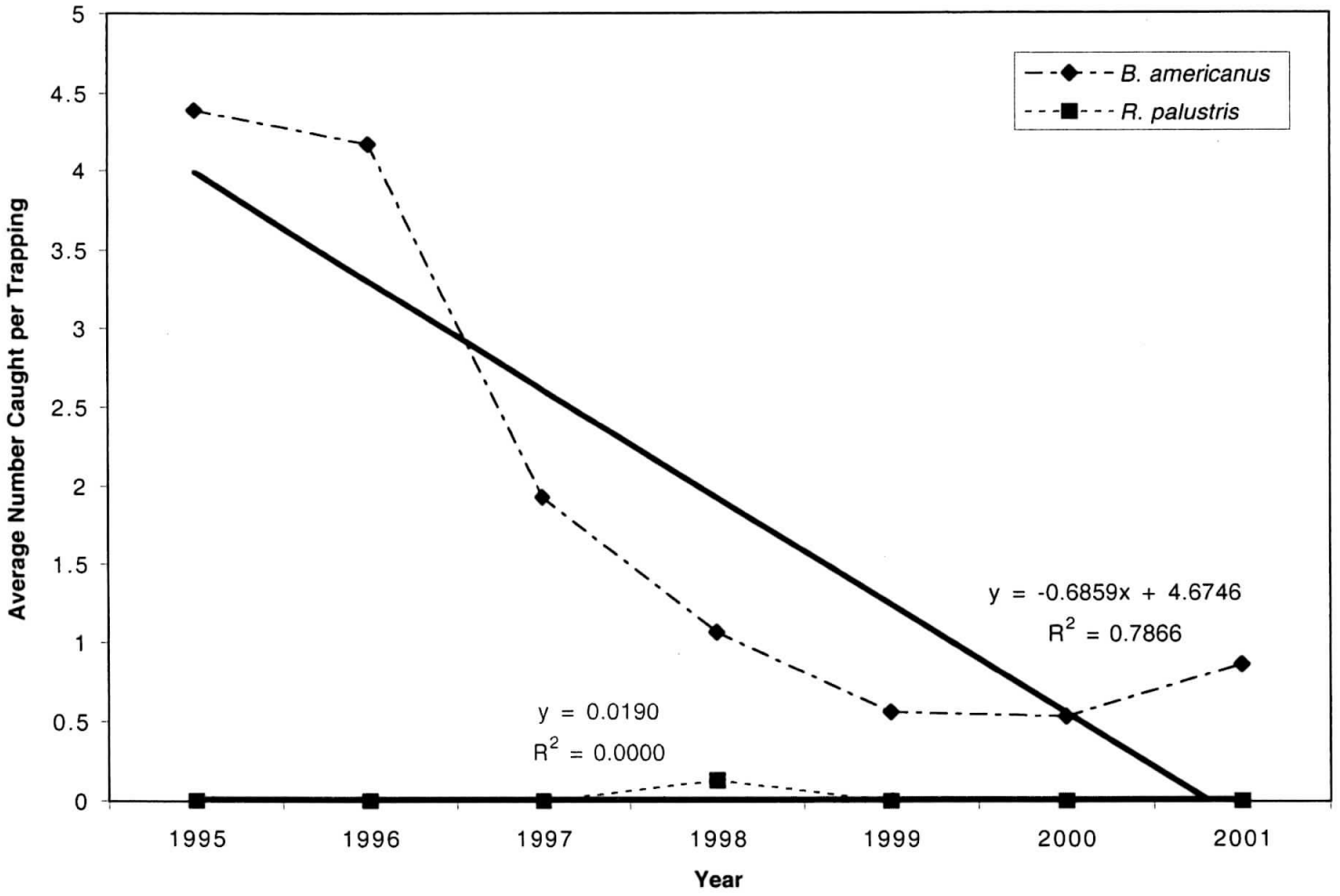

Figure 4. American Toad *(Bufo americanus)* and Pickerel Frog *(Rana palustris)* population indices from the upper two drift-fences in the Lye Brook Wilderness, Sunderland, Vermont, 1995-2001.

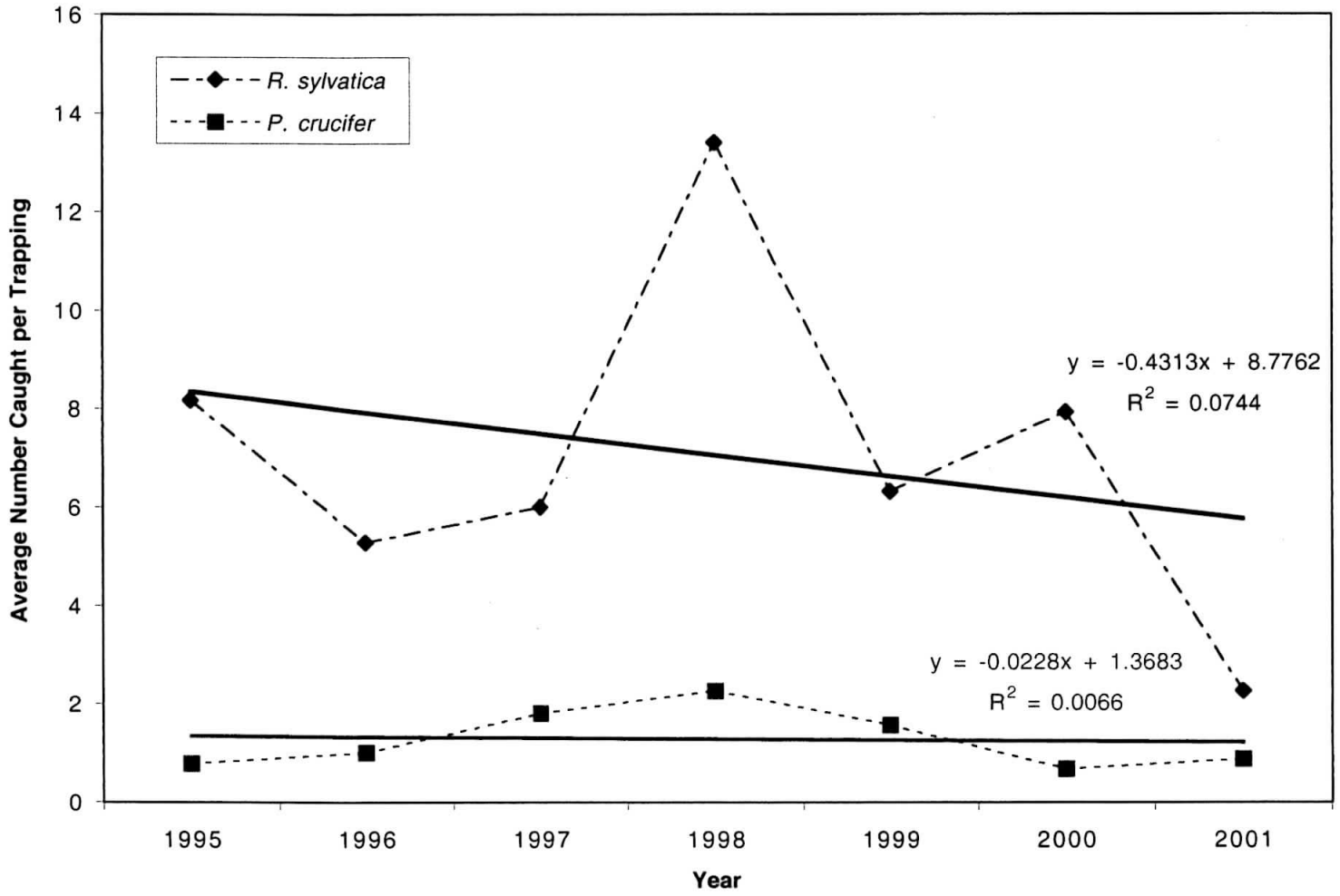

Figure 5. Wood Frog *(Rana sylvatica)* and Spring Peeper *(Pseudacris crucifer)* population indices from the upper two drift-fences in the Lye Brook Wilderness, Sunderland, Vermont, 1995-2001.

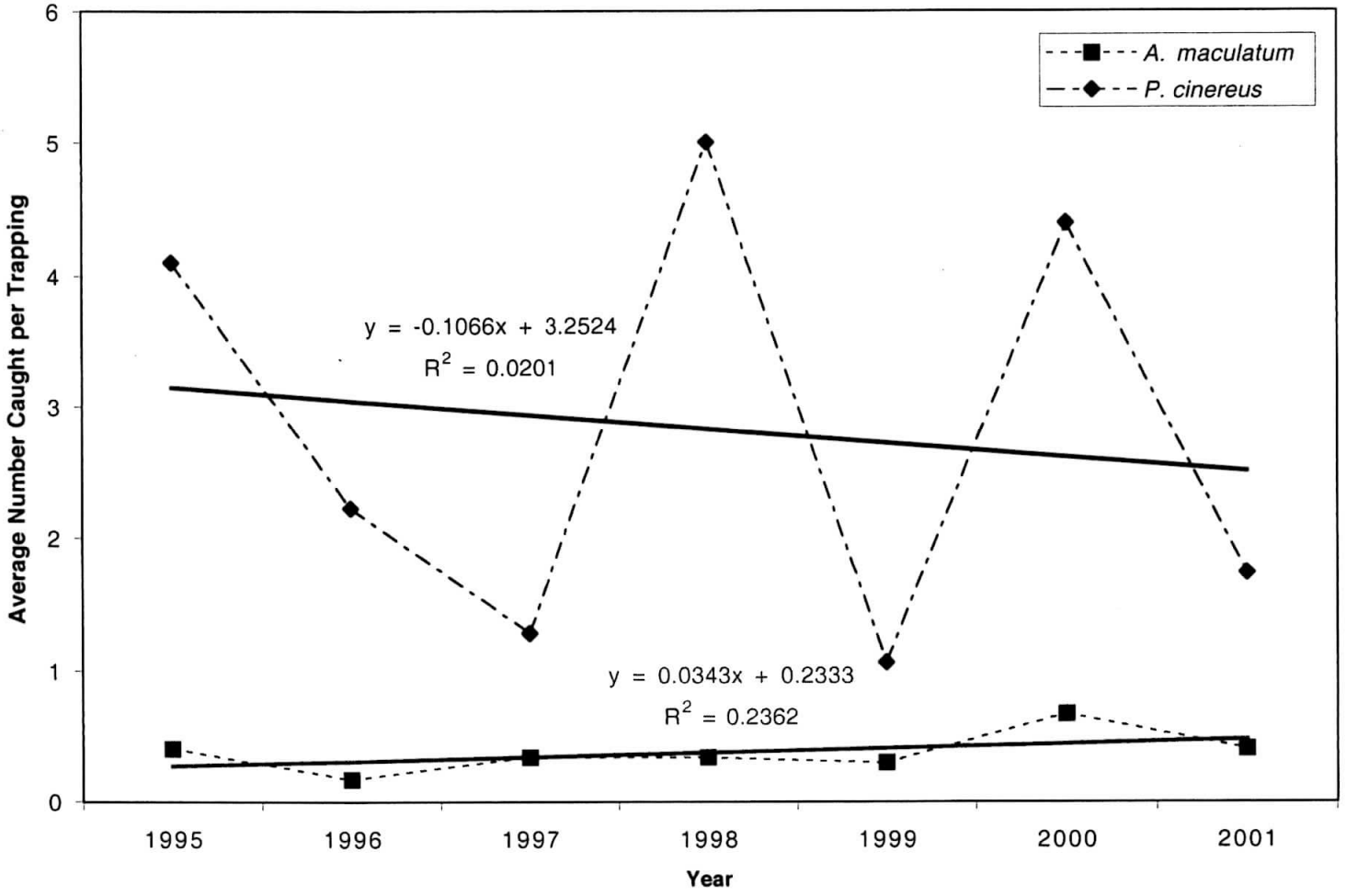

Figure 6. Spotted *(Ambystoma maculatum)* and Eastern Red-backed Salamander *(Plethodon cinereus)* population indices from the lower drift-fence in the Lye Brook Wilderness, Manchester, Vermont, 1995-2001.

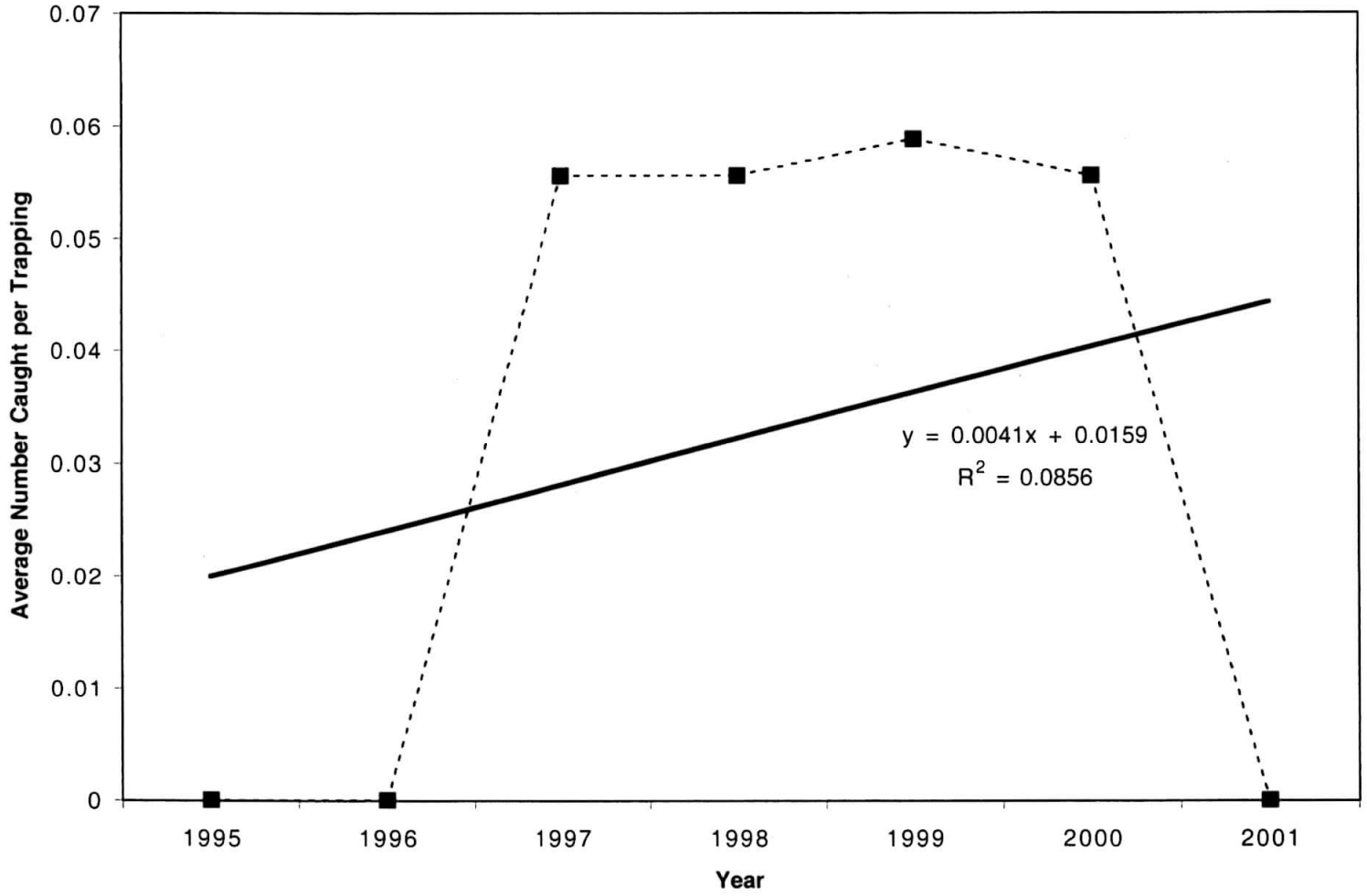

Figure 7. Northern Two-lined Salamander *(Eurycea bislineata)* population indices from the lower drift-fence in the Lye Brook Wilderness, Manchester, Vermont, 1995-2001.

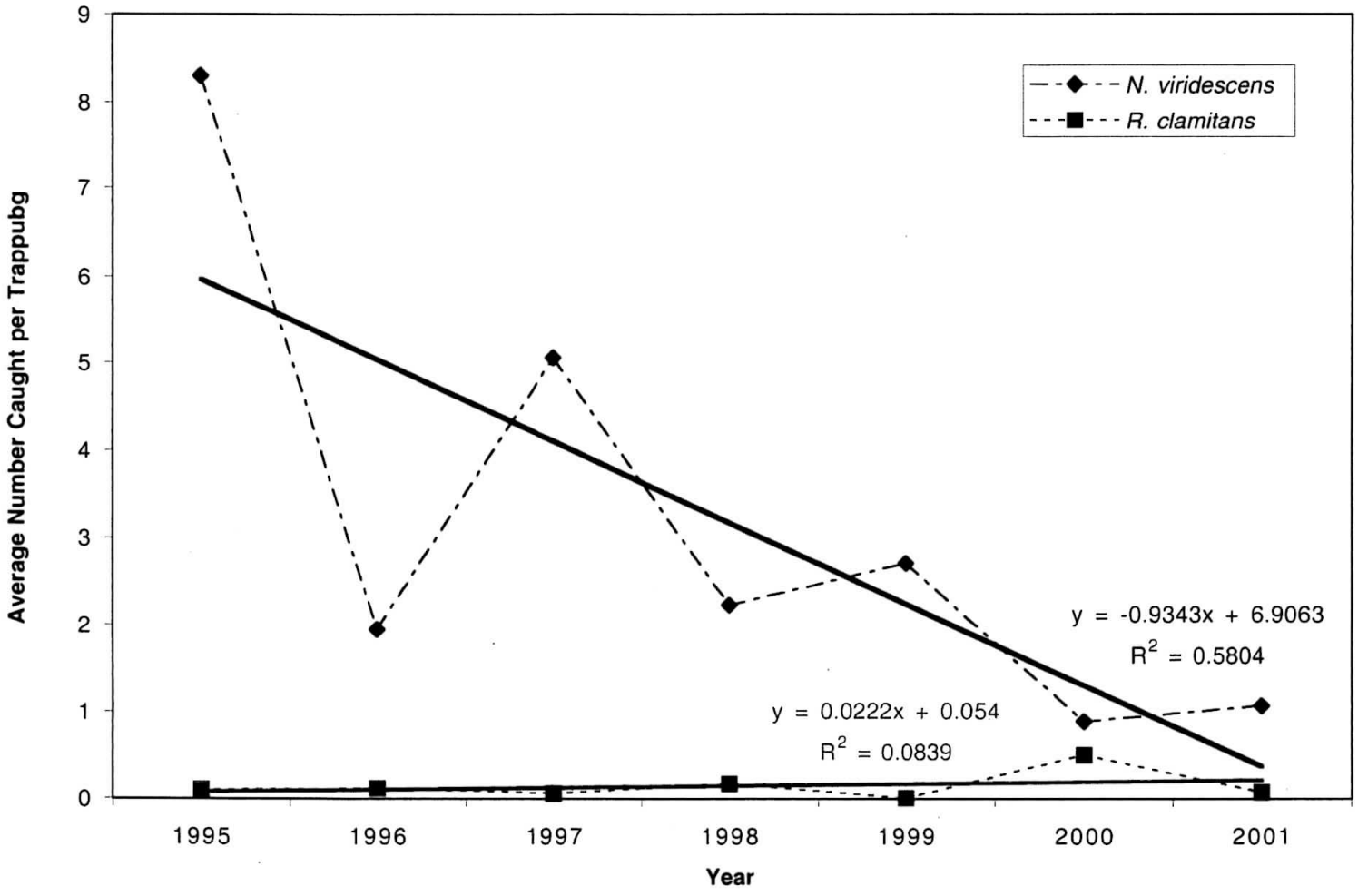

Figure 8. Eastern Newt *(Notophthalmus viridescens)* and Green Frog *(Rana clamitans)* population indices from the lower drift-fence in the Lye Brook Wilderness, Manchester, Vermont, 1995-2001.

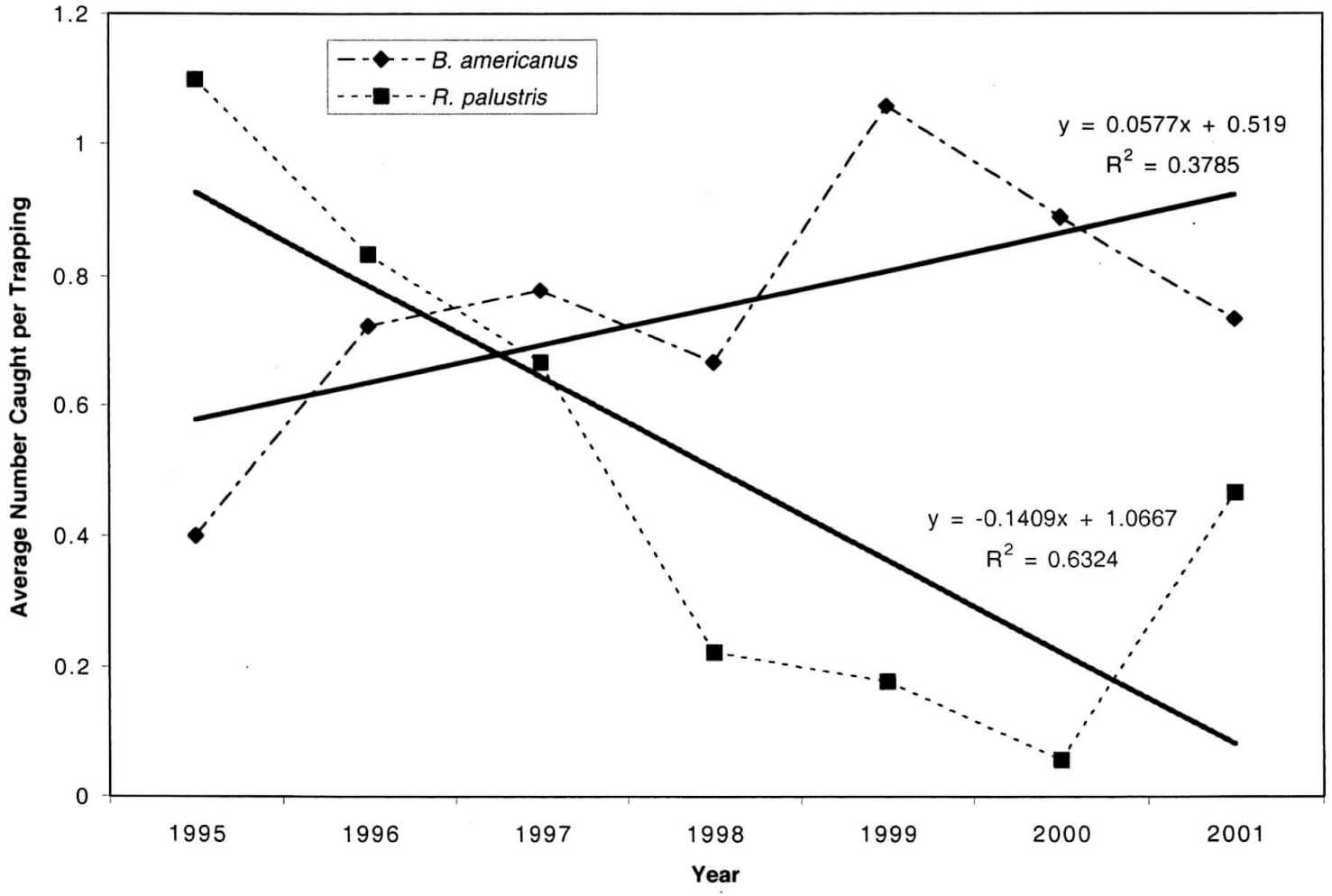

Figure 9. American Toad *(Bufo americanus)* and Pickerel Frog *(Rana palustris)* population indices from the lower drift-fence in the Lye Brook Wilderness, Manchester, Vermont, 1995-2001.

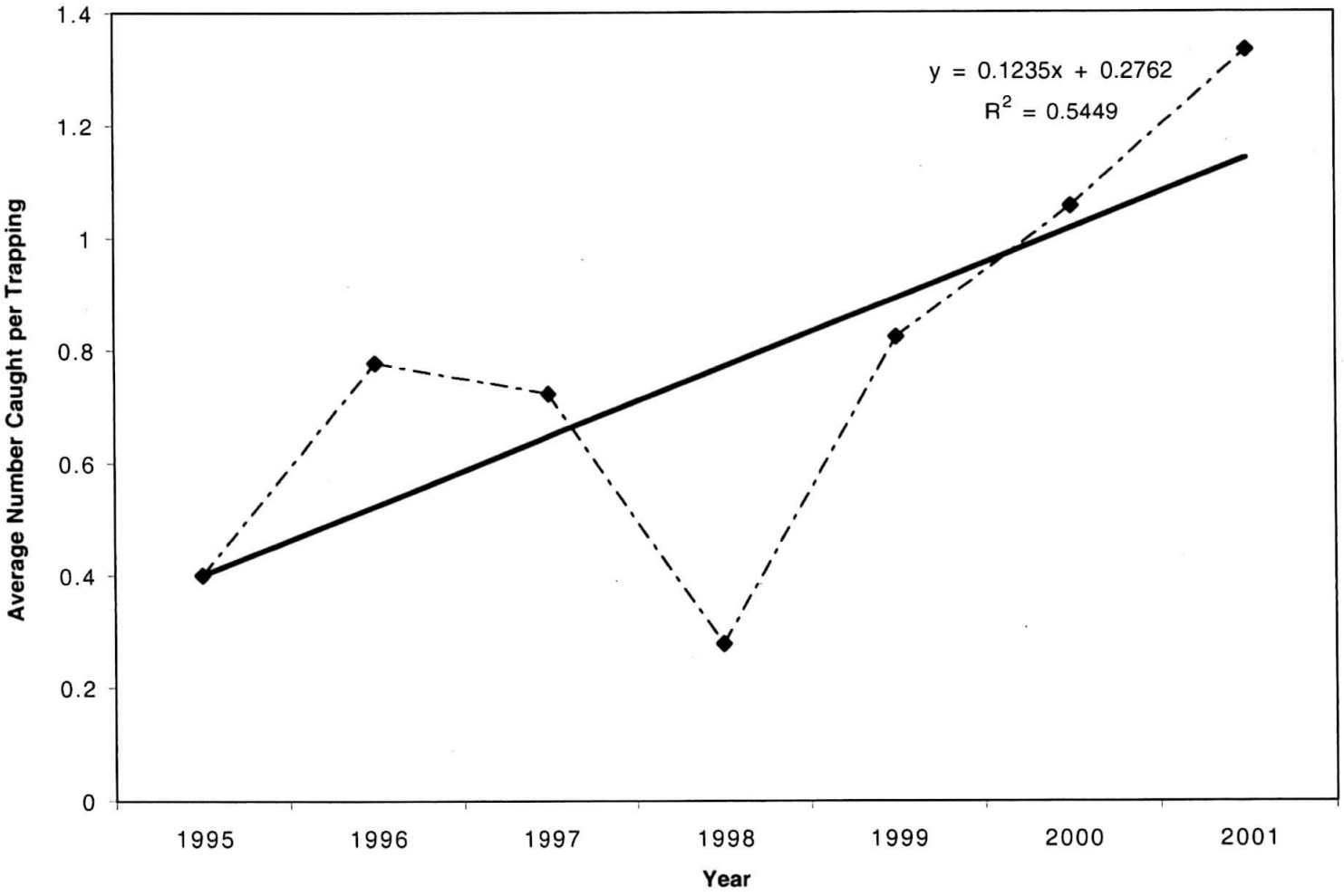

Figure 10. Wood Frog *(Rana sylvatica)* population indices from the lower drift-fence in the Lye Brook Wilderness, Manchester, Vermont, 1995-2001.

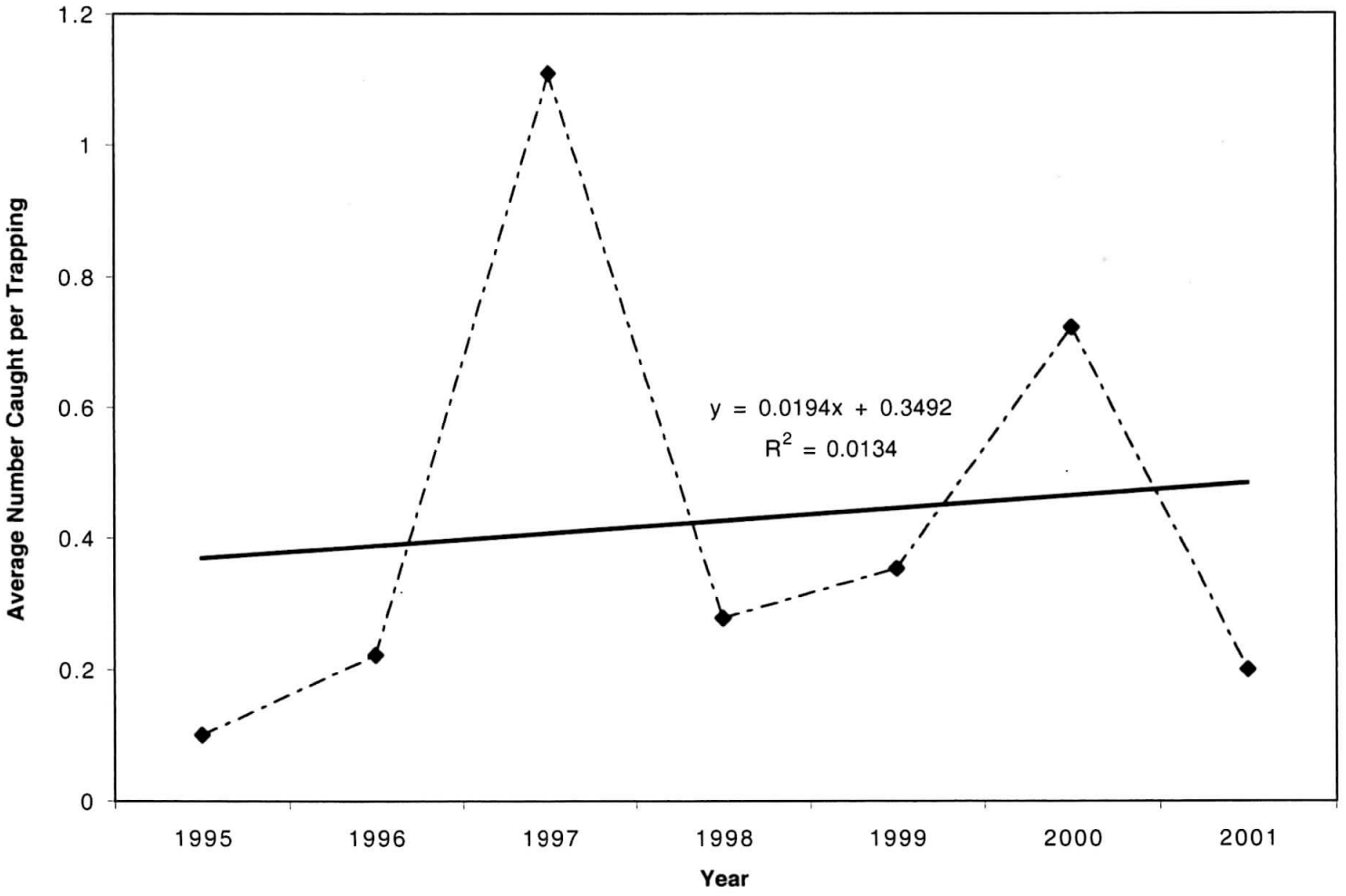

Figure 11. Spring Peeper *(Pseudacris crucifer)* population indices from the lower drift-fence in the Lye Brook Wilderness, Manchester, Vermont, 1995-2001.

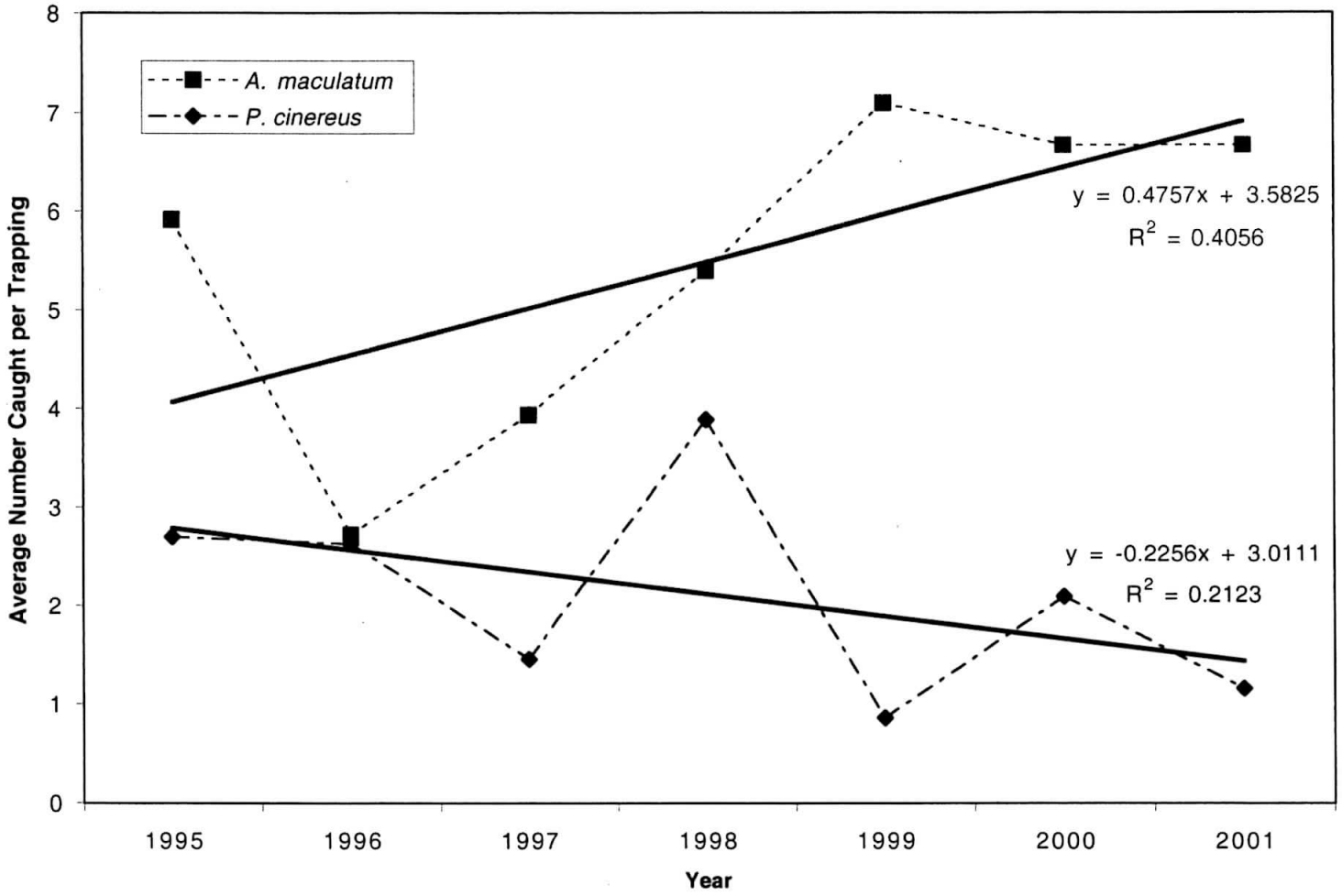

Figure 12. Spotted *(Ambystoma maculatum)* and Eastern Red-backed *(Plethodon cinereus)* Salamander population indices from the three drift-fences in the Lye Brook Wilderness, Sunderland and Manchester, Vermont, 1995-2001.

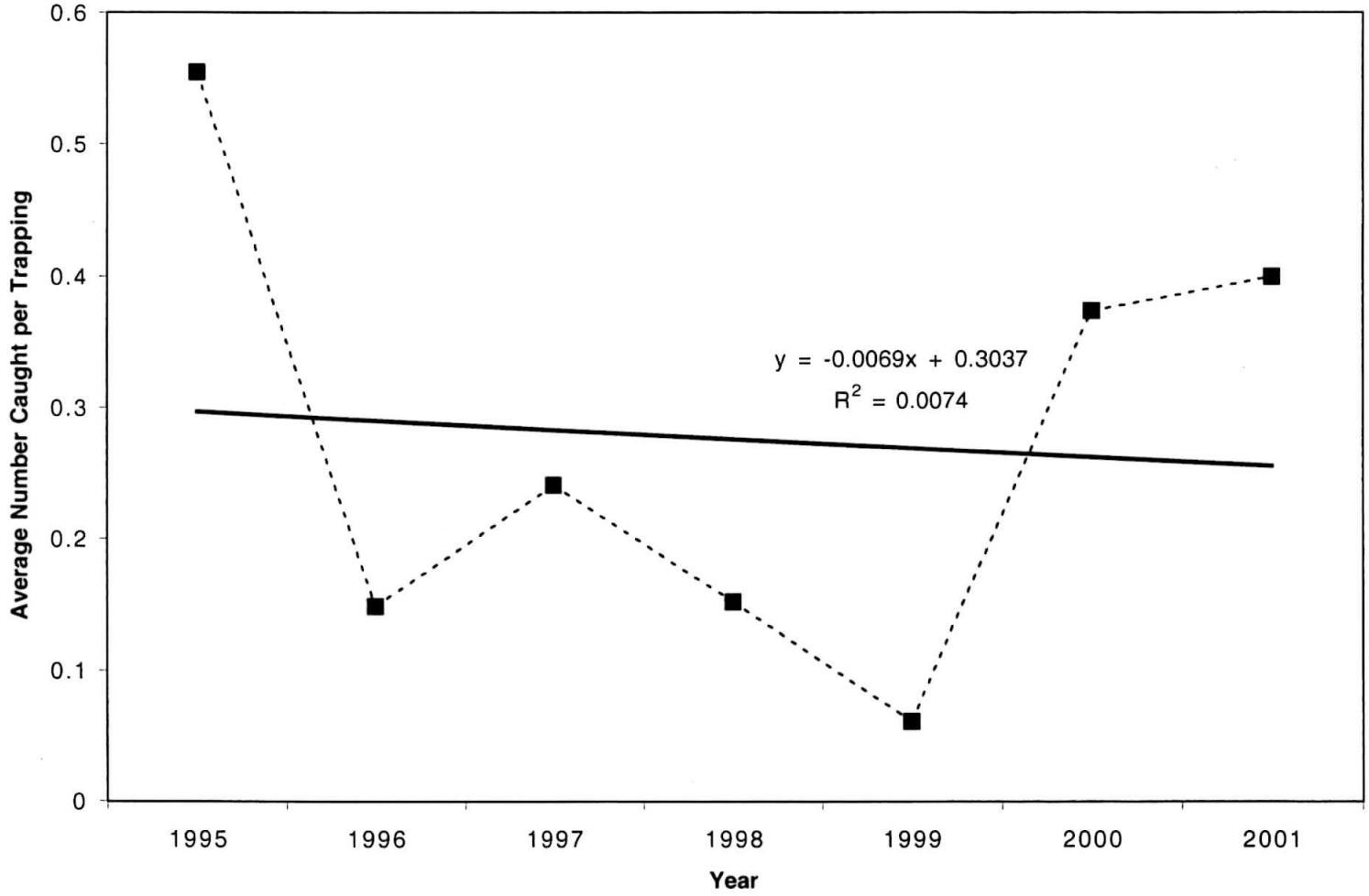

Figure 13. Northern Two-lined Salamander *(Eurycea bislineata)* population indices from the three drift-fences in the Lye Brook Wilderness, Sunderland and Manchester, Vermont, 1995-2001.

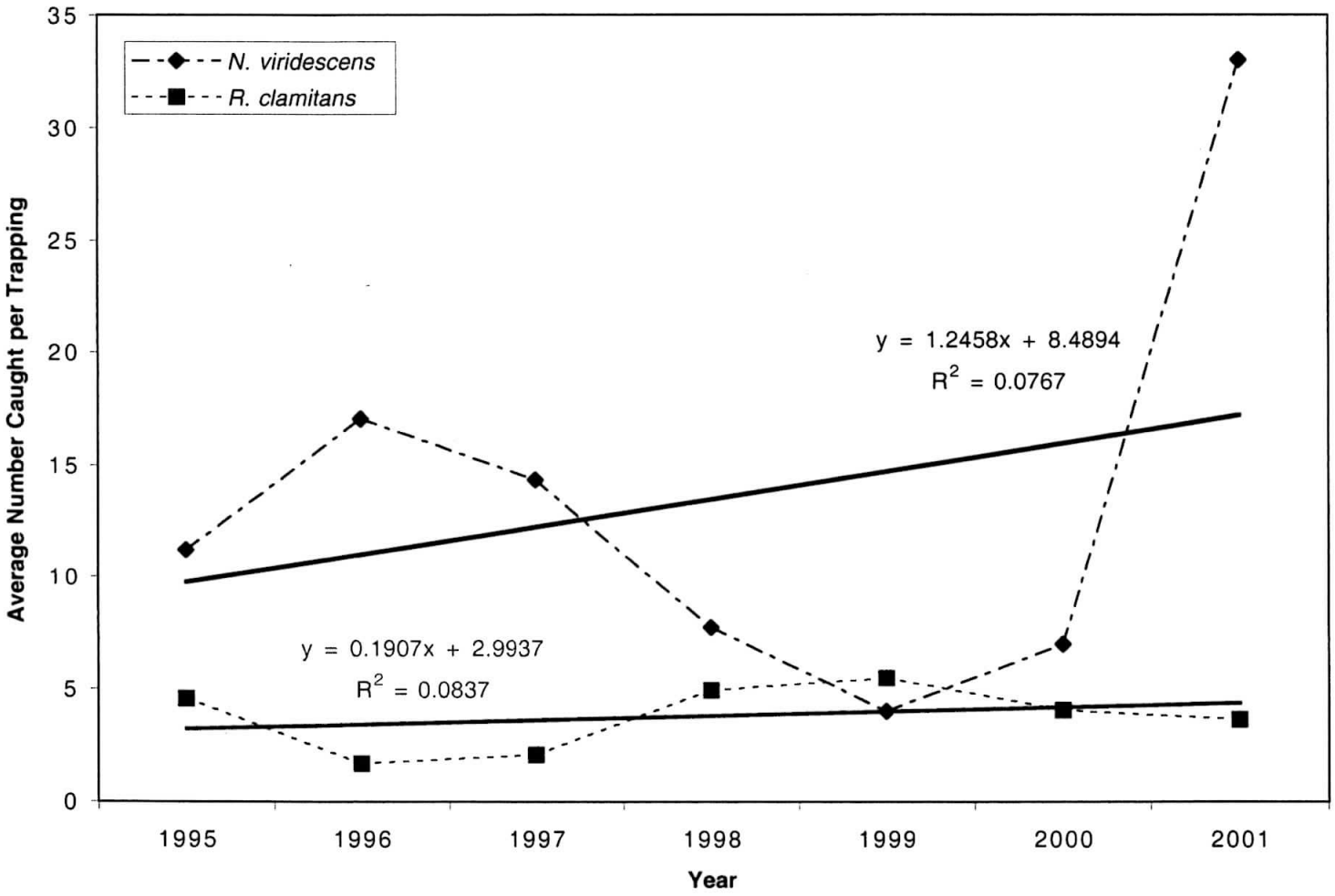

Figure 14. Eastern Newt *(Notophthalmus viridescens)* and Green Frog *(Rana clamitans)* population indices from the three drift-fences in the Lye Brook Wilderness, Sunderland and Manchester, Vermont, 1995-2001.

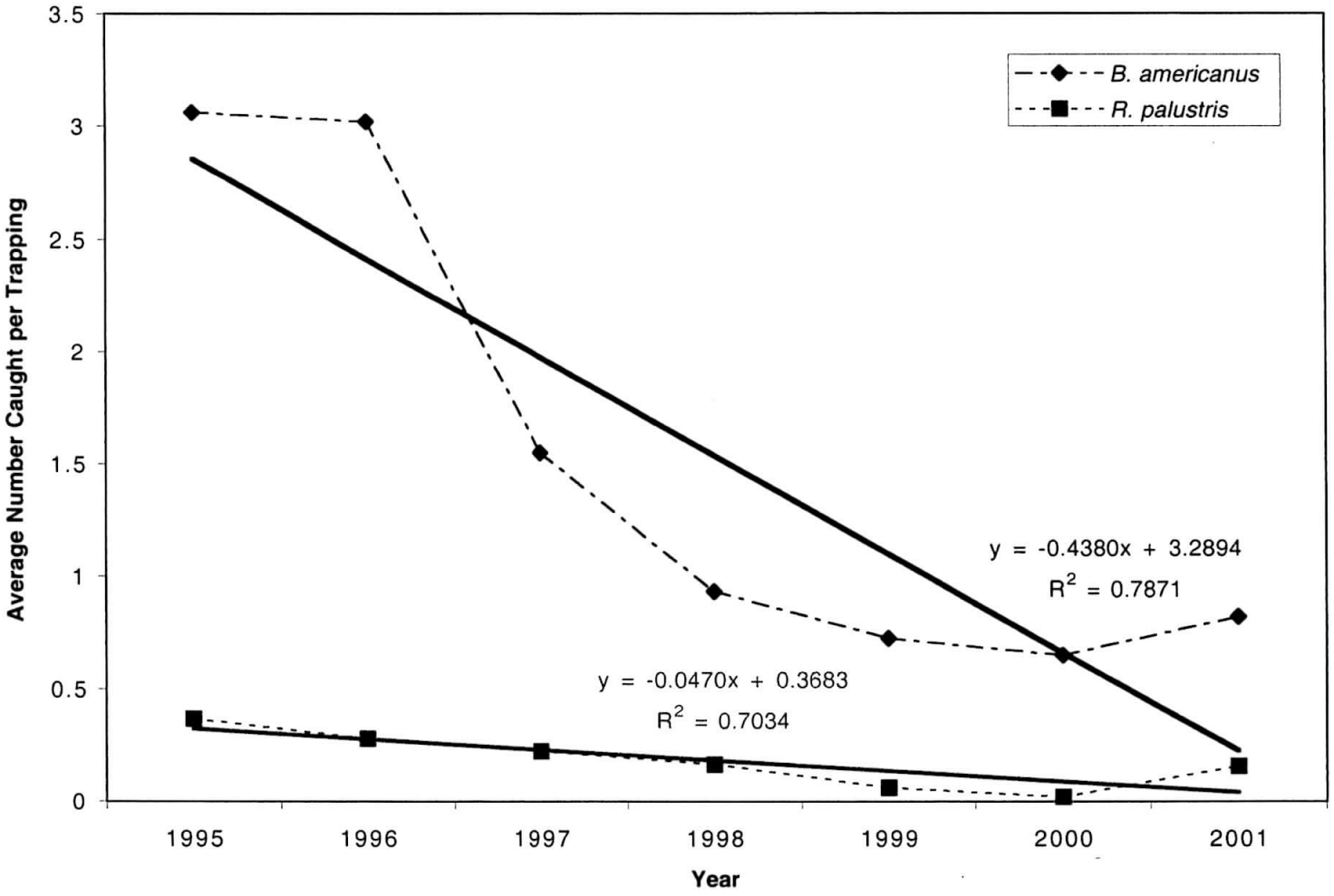

Figure 15. American Toad *(Bufo americanus)* and Pickerel Frog *(Rana palustris)* population indices from the three drift-fences in the Lye Brook Wilderness, Sunderland and Manchester, Vermont, 1995-2001.

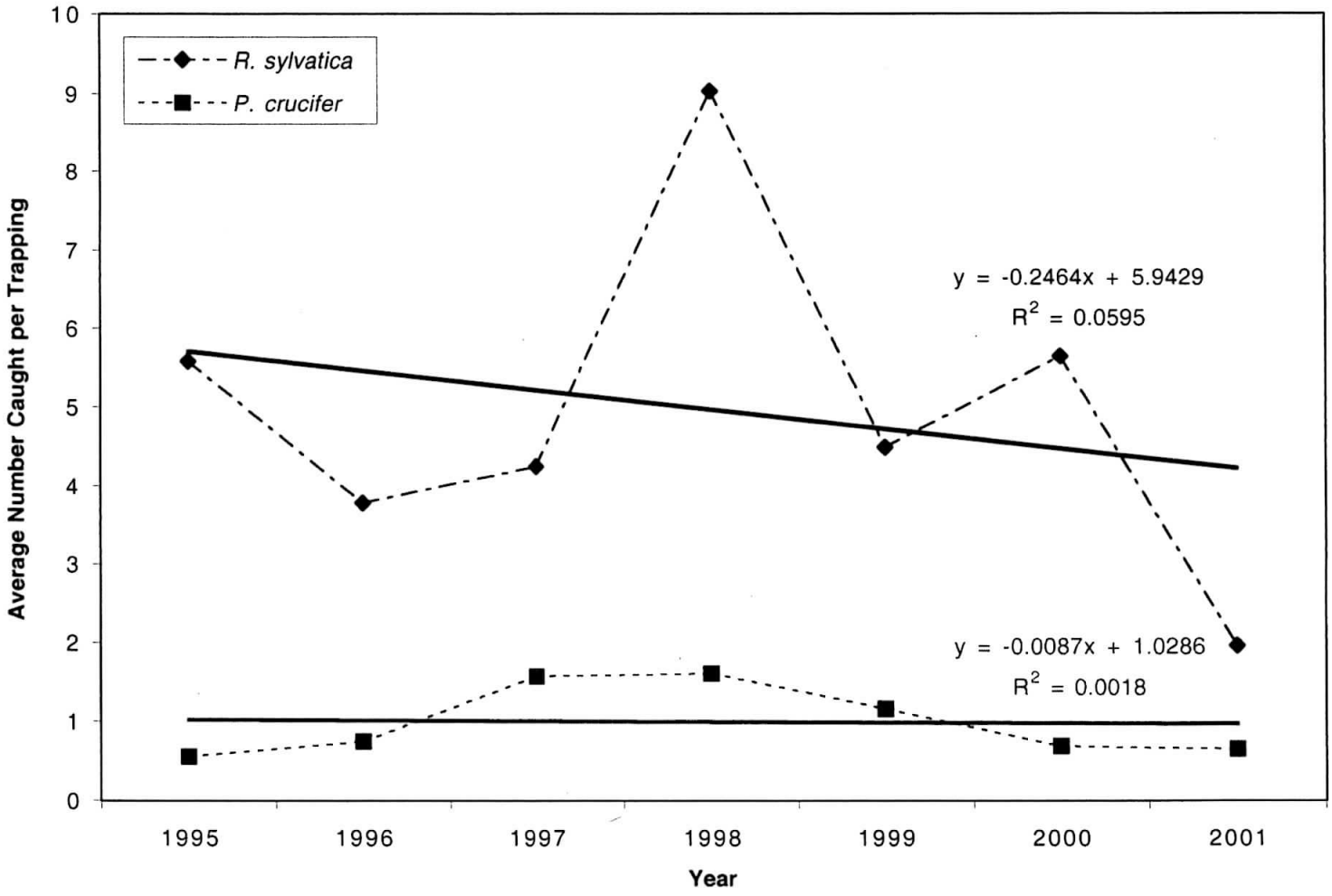

Figure 16. Wood Frog *(Rana sylvatica)* and Spring Peeper *(Pseudacris crucifer)* population indices from the three drift-fences in the Lye Brook Wilderness, Sunderland and Manchester, Vermont, 1995-2001.