# Inventory and Monitoring of Reptiles and Amphibians in the Abbey Pond / Beaver Meadow Region of the Green Mountain National Forest, Addison County, Vermont

March, 1993-November, 1994

with Comments on the Herpetological Significance of the Region

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# Abstract

An inventory of reptiles and amphibians in the Abbey Pond / Beaver Meadow region of the Green Mountain National Forest in Addison County was completed in 1993 and 1994 and monitoring of resident amphibians has begun. The mandates of this inventory and monitoring effort were: to determine the presence and relative abundances of the reptiles and amphibians in the region, assess the herpetological significance of the region, make suggestions specific to the Research Natural Area candidacy of the region relative to reptiles and amphibians, and develop a monitoring scheme for selected species. Six salamander species, six frog species, two snake species and one species of turtle were located. The most abundant species of salamander in this region is the Eastern newt. The most abundant species of frog is probably the Spring peeper. The most abundant species of snake is the Common garter and the only species of turtle located was the Snapping turtle. The species found in this region are typical of what has been found at other mid- to high-elevation sites in the central Green Mountains. However, three amphibian species found in this region (Dusky salamander, Spring salamander, and Pickerel frog) are far less abundant or missing altogether from the lowlands of the Lake Champlain Valley. Relative to the rest of the forested upland regions of the state this area is significant because: it contains an interconnected system of wetlands of a variety of types; it is remote, roadless, and part of a large contiguous piece of forested land, it is located on the western margin of the Green Mountains where habitat not found in the central Green Mountains is found, and it is one of only three areas in the Green Mountains where an amphibian inventory has been carried out and monitoring data has been gathered. I recommend increasing the size of the present Beaver Meadow Special Area and designating it a Research Natural Area. This larger area should include: a larger number and variety of wetlands, more of the habitat used by reptiles and amphibians while not breeding, a larger variety of low-elevation habitat types on the western margin of this region, Fire Brook, and the already existing access roads to the north and south of the region. A monitoring scheme has been developed for this region using drift-fences and egg-mass counts and one years data has been gathered.

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# Introduction

## Mandates

This report is the product of two field seasons in the Abbey Pond / Beaver Meadow area of the Green Mountain National Forest. The mandate of the study was to:

1. Determine the presence and relative abundance of amphibians and reptiles in the region.

2. Assess the significance of the Abbey Pond / Beaver Meadow region in the context of the reptiles and amphibians found in Addison County and the State of Vermont.

3. Make suggestions specific to the Research Natural Area candidacy of the Abbey Pond / Beaver Meadow region as it relates to the reptiles and amphibians of the area.

4. Develop a monitoring scheme for selected amphibians and/or reptiles.

Overlapping this effort were amphibian inventories of two other sites within the main range of the Green Mountains (Lye Brook Wilderness and Mount Mansfield), an inventory of Addison County amphibians, and a compilation of all records of reptiles and amphibians in Vermont. This report draws on the results of these other studies to make comparisons.

## Study site

This region is located in the towns of Middlebury, Bristol, and Ripton in Addison County, Vermont. The core of the region consists of a series of wetlands on small plateaus ranging from 1,600 to 1,800 ft. in elevation. The region has been logged heavily in the past including a clear-cut that approached some of the water bodies with only a small buffer remaining. The vegetation consists primarily of a mix of second growth northern hardwood forests, interspersed with stands of spruce, and beaver meadows. The soils of the plateau tend to be acidic. The western margin of the plateau drains steeply to the west. Drainage to the north and east is more gradual. Robert Frost Mountain, immediately outside of the survey area to the southeast, reaches an elevation of 2,513 ft. The great majority of the survey effort took place between the elevations of 1,400 ft. and 2,000 feet, although sites as low as 700 ft. and as high as 2,122 ft. were visited (Figure 1).

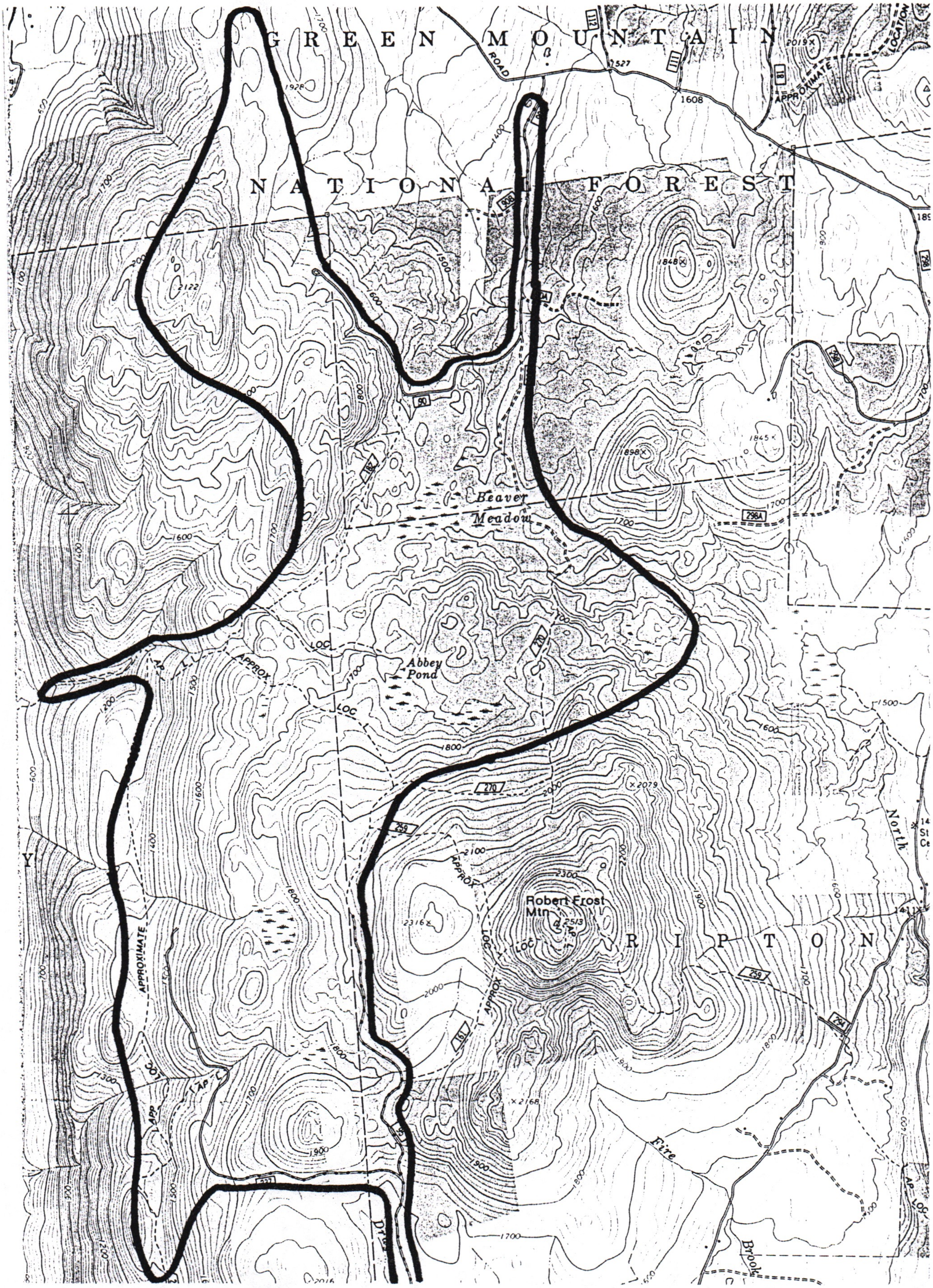


Figure 1. Abbey Pond / Beaver Meadow region surveyed in 1993 and 1994.

# Methods

The methods used in 1993 were designed to inventory the amphibians of the region and to lay the groundwork for gathering amphibian monitoring data in 1994. A limited number of amphibian inventory methods were continued in 1994 at selected sites. Amphibian inventory results from 1994 were not combined with the 1993 totals. The reptile inventory began in 1993. Methods used to inventory reptiles continued into the 1994 field season. All of the monitoring data were gathered in 1994.

## Methods used during the 1993 field season

In the Abbey Pond / Beaver Meadow region eight different methods were used to locate reptiles and amphibians during the 1993 field season.

Active searches are a concentrated effort in a predetermined area to locate amphibians in the leaf litter, under rocks and logs, within rotten logs, or under bark. Each search lasted approximately 1.5 hours.

Cover checks are made along a series of pieces of artificial cover which have been placed in the habitat to be surveyed. They are used to facilitate the location of snakes which hide under the cover. The pieces of cover are left in place and periodically each series is visited and all the pieces of cover lifted. For this study two series were established. One series located in Beaver Meadow (Figure 2) was approximately 1 km long and consisted of 41 floor tile samples (30 x 45 cm) which had been painted black. The second series was placed on the edge of the woods and in the beaver meadow adjacent to what I refer to as Upper Abbey Pond (Figure 2). The second series consisted of 13 black plastic squares (1 $m^2$) that were staked out in the corners. This series was approximately 0.3 km long.

Drift fences are semi-permanent structures built to interrupt the feeding and migratory movements of amphibians on rainy nights or nights immediately after rains. The two used are constructed of 30 m lengths of aluminum flashing (Figure 3). Tangential with the flashing and buried flush with the ground surface are a series of cans and buckets that can be opened prior to evenings of expected amphibian activity. In addition traps that roughly resemble minnow traps made out of window screening are placed parallel to and abutting the fence. A small piece of plywood is used to provide shade for any reptiles and amphibians trapped in them. The traps are only opened during, after, or in anticipation of rainy weather. They are always checked the following day when all amphibians are identified, recorded, and released.

Egg-mass counts consist of searching potential breeding ponds for the egg-masses of early spring breeding amphibians. The egg masses of different anuran and caudate species can be differentiated in the field.

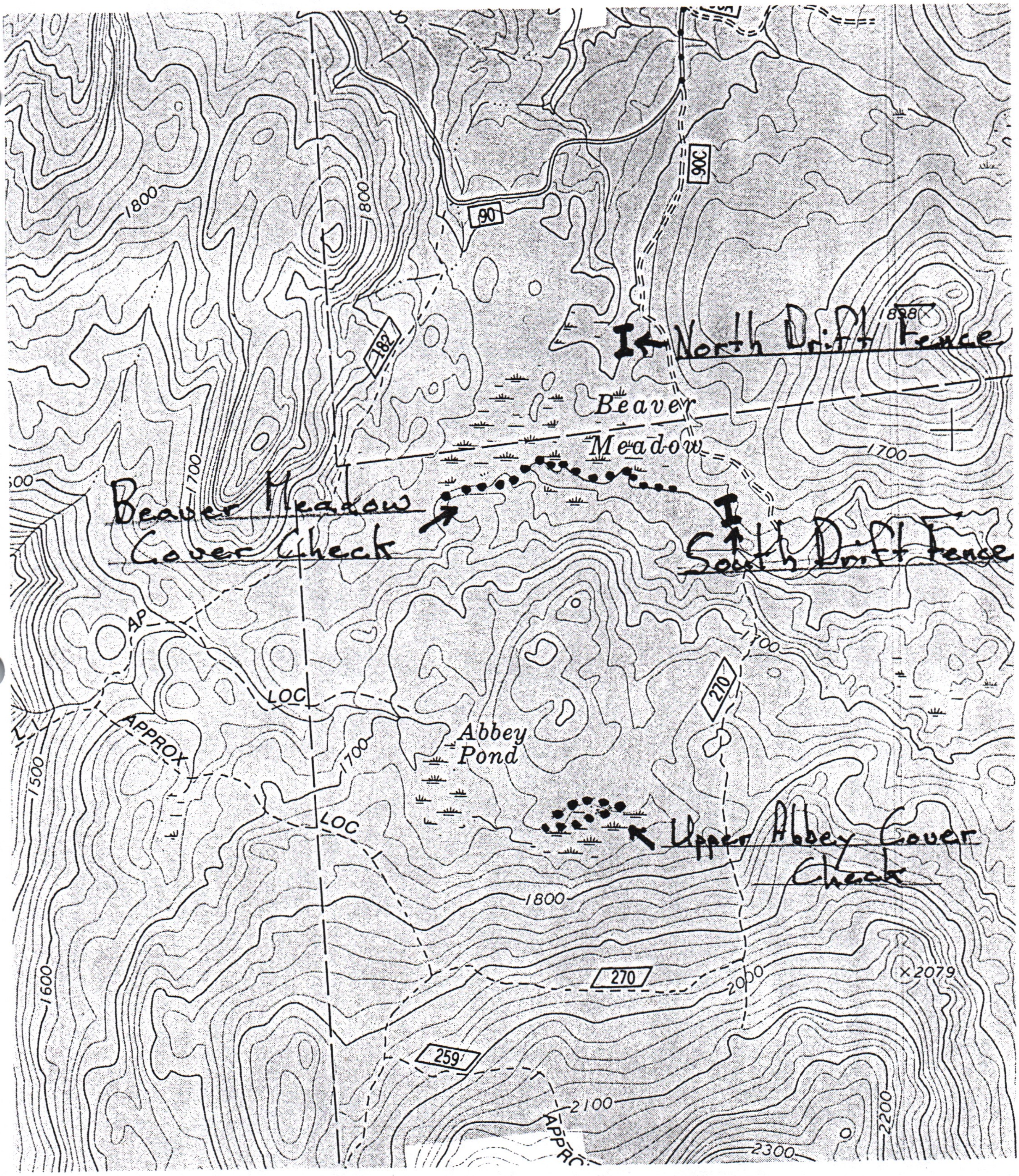


Figure 2. The location of the drift-fences and cover series used in the Abbey Pond / Beaver Meadow region.

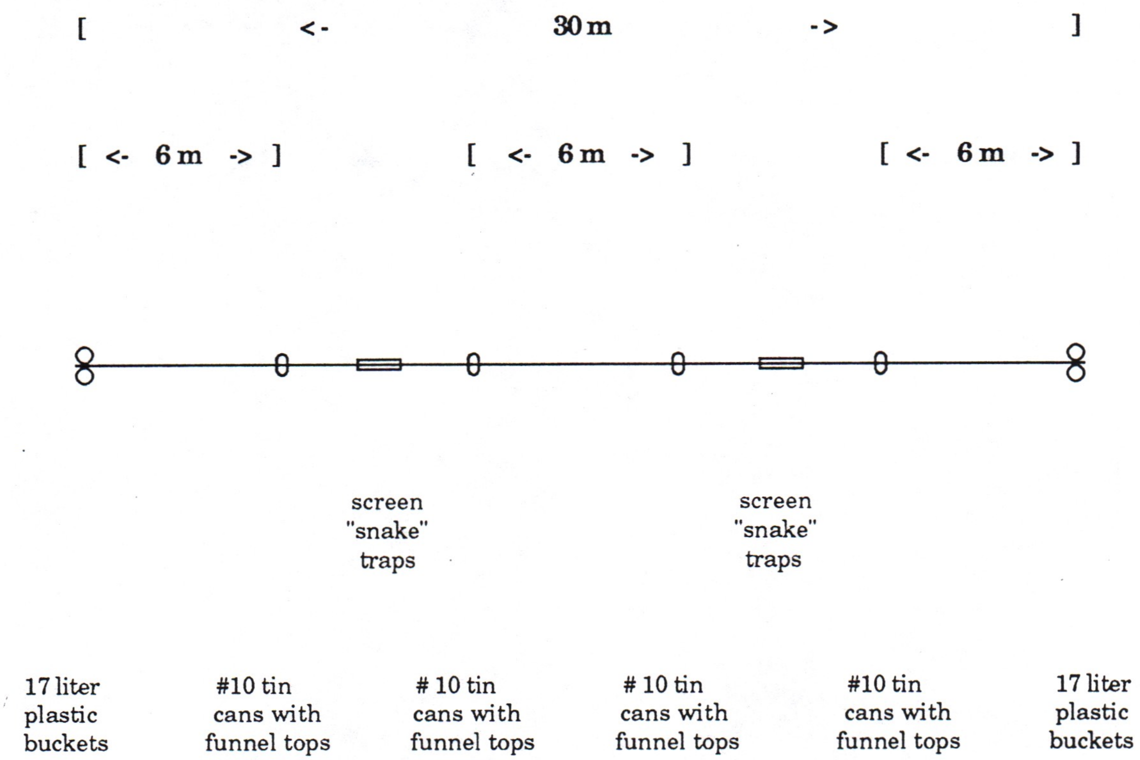


Figure 3. Design of the drift fences used for inventory and monitoring in the Abbey Pond / Beaver Meadow region. Two pairs of snake traps with smaller openings were added between the outer pairs of buckets and the first pairs of cans for the long-term drift fence.

Long-term drift fences make use of the same barriers in the same locations as the drift-fences above but use different traps and protocol. They are designed to catch small snakes. The traps are identical to the snake traps mentioned above except the opening of the funnels on each end of the traps is considerably smaller in diameter (2 cm as opposed to 4 cm). The smaller openings are more effective at holding snakes in the traps over a period of time. To each trap I added large sponges inside plastic heavy duty zip-lock baggies which were open on each end. These were very effective as moisture refugia for any amphibians which were caught in the traps. Unlike the cans, buckets, and unmodified snake traps along the same fences these traps are left open and checked approximately once per week.

Night-time visits are made to selected sites in an effort to hear the calls of breeding and territorial anurans (frogs). The time of the year and the weather conditions are chosen specifically to locate species not already located using other methods.

Site checks are a less localized form of active search that include time spent searching for and traveling between the best microhabitats.

Trapping is done with unbaited Gee traps (commonly known as minnow traps). These traps are placed in potential amphibian breeding pools and checked the following day. I use these traps early in the spring to locate the spring breeding ambystomatids (mole salamanders) which can be difficult to locate by other methods later in the season.

Accidental discoveries are often made while employing a method not intended to locate that specific species or while scouting or working at a site. Individuals located accidentally are identified as such in the data base and in the tables.

None of these methods alone will survey the complete range of amphibians possible in an area. A combination of these methods must be employed in an initial inventory effort.

Soil and water pH were measured with a Nester Instruments portable pH meter. A planar Duraprobe designed for measuring the pH of surfaces was pushed into the soil one to two cm after the litter was removed. Soil pH was measured in at least three locations at any site where it was recorded. A separate probe was used to measure the pH of breeding ponds in at least three locations in each water body and at a depth of approximately 15 cm. The pH meter was calibrated with 4.0 and 7.0 buffer solutions at least once daily.

Other data were gathered and entered into the data base but are not included in this report. They include natural history notes, weather, time of day, and air and water temperatures.

## New methods used during the 1994 field season

Hand-netting was used at upper Abbey Pond to gain further data on the diseased Eastern newts located there.

Turtle trapping was the only entirely new method used during the 1994 field season. Two different sized hoop traps were used. Both traps have 1-inch nylon mesh. The larger traps have three 30-inch hoops with one funnel entrance. The smaller traps have four 20-inch hoops with one funnel entrance. The traps are baited with sardines packed in oil and staked out in potential turtle habitat. They are left open overnight and checked the following day when the turtles can be identified, recorded, and released unharmed.

## Methods continued during the 1994 field season

Active searches and site checks were used at a few sites that I felt needed additional surveying.

Cover checks and long term drift-fences were continued as described in 1993.

Drift-fences which were used as an inventory method in the fall of 1993 were used as a monitoring tool in 1994. They are more easily standardized than many other methods and hence I feel they are a useful method for this purpose. I followed the protocol in Appendix A. They were opened three times per month from April through October with the exception of August. In addition, during 1994 a sub-sampling protocol was established (Appendix A) and size-class data were collected for the first time. For each species individuals under a given total length were considered 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: Spotted salamander (70 mm), Northern two-lined salamander (60 mm), Eastern newt (45 mm), Redback salamander (32 mm), American toad (30 mm), Spring peeper (20 mm), Green frog (41 mm), Pickerel frog (30 mm), and Wood frog (25 mm).

Egg mass counts also followed a strict monitoring protocol at three sites that I have named North Beaver Meadow, Upper Abbey Pond, and Burn Pond (Figure 4). Two transects are located at each site with the location and length of the transects designed to fit the site. At Upper Abbey Pond and the North Beaver Dam two 50 X 2 m transects were surveyed along the margin of the ponds. At Burn Pond the transects were 40 x 2 m and 20 x 2 m. These latter transects were also located along the pond margin. The counts are designed to take place in habitats where Wood frog and Spotted salamander have been previously located and during or shortly after their breeding period. All eggs within these transects were counted on three

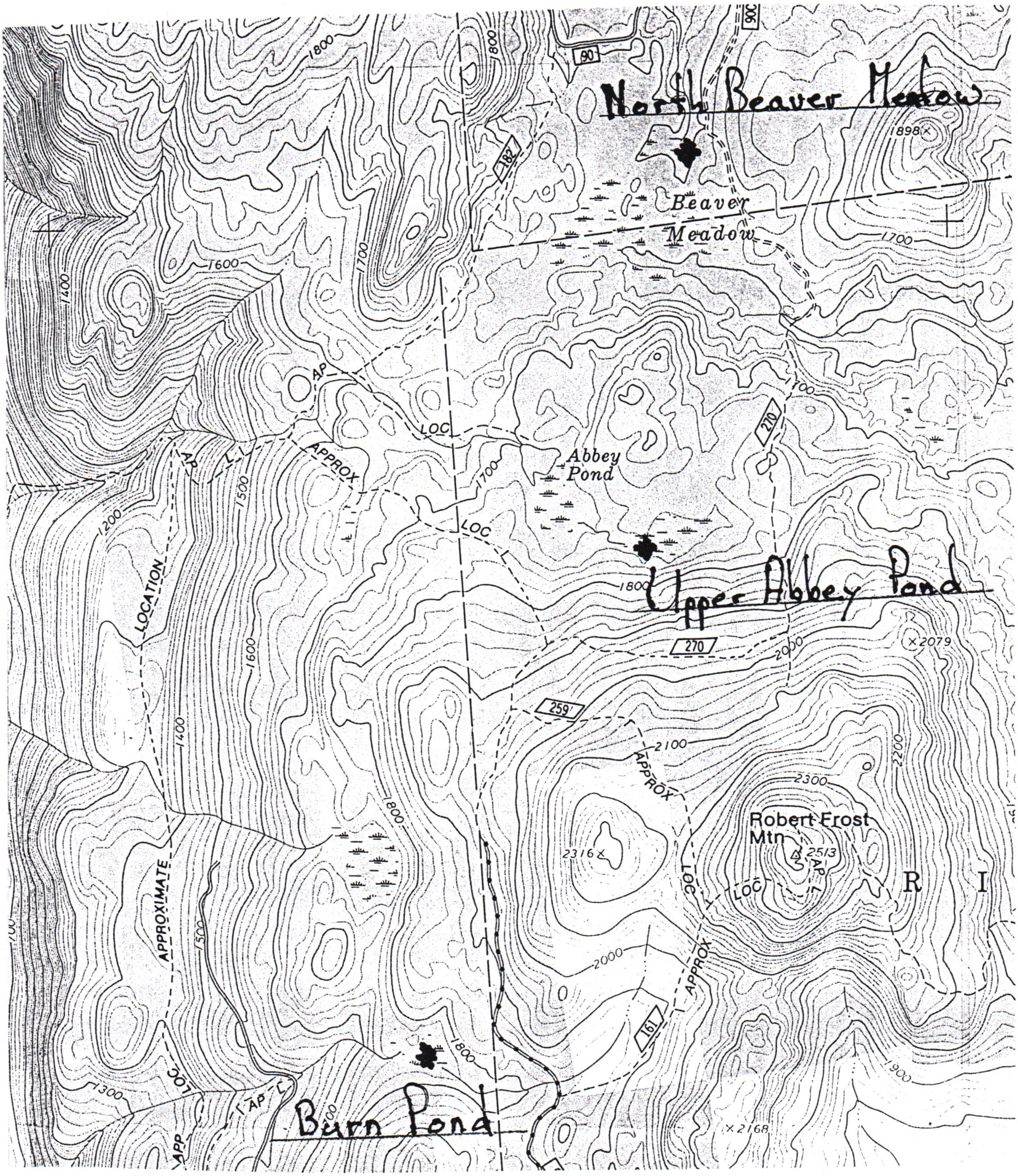


Figure 4. Location of the egg mass survey sites in the Abbey Pond / Beaver Meadow Region.

occasions: once a week for two weeks in the beginning of May (earlier if the ice melted earlier) and once at the end of May or beginning of June when all egg laying should be over. At a handful of other sites egg-mass counts were used for inventory methods only.

Trapping was continued at Upper Abbey Pond to gain further data on the diseased newts that were located there.

Water testing was continued during the 1994 field season. However, additional samples were sent to Jim Kellogg at the Vermont Department of Environmental Conservation Laboratory to test alkalinity, total color, pH and conductivity using their protocols. I recorded pH and temperature using a new Cole-Parmer hand-held pH meter (microcomputer pH vision model #6009). Three measurements were taken from shore at three widely separated locations at an approximate depth of 15 cm. Calibration was checked at each site using premixed buffer solutions.

## Results

### Results of the 1993 field season

During the first year of this inventory project, 6 salamander species, 6 frog species and 2 snake species were located. Field teams visited ~50 sites in the region and located ~2,234 individuals of 14 species. In addition, 359 egg masses, 20 choruses of breeding frogs, and a variety of amphibian larvae were identified. Aside from scouting and building drift fences, data were gathered on 47 different days, using 9 different methods, as a result of a total of 83 data gathering efforts between the dates of April 14th and November 1st, 1993 (Appendix B).

Using the 1993 data from all the methods combined, the 12 amphibian species that were located are listed here according to the percentage of total individuals located (Table 1).

Only two reptile species were located during the 1993 inventory (Table 2). Common garter snake was by far the most abundant reptile of the region. Only a single Redbelly snake was found.

Although turtle trapping did not begin until the spring of 1994, Painted turtles can usually be seen basking if they are present in an area. No turtles were located by sight during the 1993 field season.

It is important to keep in mind that although these percentages serve as a rough indicator of the relative abundance of the species in this region, they are effected by the relative amounts of effort spent using the different methods. In addition, the time of year during which each method was used also has an effect on which species are most likely to be located. In Appendix B I have shown the results relative to the method, time of year, number of sites and amount of effort. For the purposes of long-term monitoring, results need to be compared between the same methods and standardized for the number of sites and amount of effort.

Table 1. The results of the 1993 amphibian inventory of the Abbey Pond / Beaver Meadow region of Addison County, Vermont. Percent individuals are out of a total of 1,767 caudates and 432 anurans located.

| Species | Common name | % of individuals |
|---|---|---|
| **Caudates (salamanders)** | | |
| *Notophthalmus viridescens* | Eastern newt | 76% |
| *Plethodon cinereus* | Redback salamander | 9% |
| *Desmognathus fuscus* | Dusky salamander | 6% |
| *Ambystoma maculatum* | Spotted salamander | 4% |
| *Eurycea bislineata* | Two-lined salamander | 4% |
| *Gyrinophilus porphyriticus* | Spring salamander | 0.1% |
| **Anurans (frogs and toads)** | | |
| *Rana clamitans* | Green frog | 44 % |
| *Rana sylvatica* | Wood frog | 31% |
| *Bufo americanus* | American toad | 12% |
| *Pseudacris crucifer* | Spring peeper | 6% |
| *Rana palustris* | Pickerel frog | 6% |
| *Hyla versicolor* | Gray tree frog | 1% |

Table 2. The results of the 1993 reptile inventory of the Abbey Pond / Beaver Meadow region of Addison County, Vermont. Percent individuals are out of a total of 45 located.

| Species | Common name | % of individuals |
|---|---|---|
| **Serpentes (Snakes)** | | |
| *Thamnophis sirtalis* | Common garter snake | 98% |
| *Storeria occipitomaculata* | Redbelly snake | 2% |

In addition to the above data gathering efforts, the field teams located sites for and installed two drift fences that were designed to be used as long-term monitoring sites as well as inventory devices. A field assistant was hired and trained to open and check both fences as well as record the data. In order to effectively use drift fences for monitoring an individual needs to be continually on call to make trips to open the fences when the right environmental conditions exist. I was fortunate to find a reliable and experienced individual who lives in the vicinity.

Of the many potential breeding sites visited, three sites were selected for long-term monitoring of egg masses (Figure 4). Egg masses of Wood frogs and Spotted salamanders were located at these sites. These species are both early spring breeders with obvious and easily identified egg masses. All the sites chosen are associated with beaver dams or in beaver meadows. Sites that meet the criteria of a classic vernal pool are very rare in this area and not located near the core of the area being studied.

As a result of the presence of a breeding pair of Great blue herons at Abbey Pond, work in that immediate area was limited for most of the spring and summer. No turtle trapping took place there. However, the areas that I did survey immediately adjacent to Abbey Pond probably hold a similar suite of species.

Soil pH testing

Within the study region, soil pH was measured at two sites in May of 1993 and two additional sites in July of 1993. All of the samples that were measured in the dryer upland soils were remarkably consistent. At each site the mean pH from three measurements was 3.6 ± 0.0 SD, n = 3. This is very close to the pH of the soils at another study site of mine in the Green Mountain National Forest in Ripton (Andrews 1995b). At this site the mean pH was 3.5 ± 0.4 SD, n = 60. This contrasts with soil pH values from Addison County locations outside of the Green Mountains. The mean soil pH from one study site on the south end of Snake Mountain in Bridport was 5.7 ± 0.9 SD, n = 45. The mean soil pH from a study site in the northern Taconic Mountains in Orwell was 4.5 ± 0.7 SD, n = 60 (Andrews 1995b). One set of samples was measured in a wetland seepage area in the Abbey Pond / Beaver Meadow region. At this site the mean pH was 6.5 ± 0.4 SD, n = 3.

**Results of the 1994 field season**

Cover checks

Cover checks were begun in 1993 and continued into 1994. Checking the two series of artificial covers in 1994 did not result in the location of any additional snake species. The combined results for 1993 and 1994 are shown in Table 3. Two amphibian species, Eastern newt and Redback salamander were found using the artificial cover.

Drift-fences

The combined results from the two drift-fences can be used both as baseline data for the first full year of monitoring and as a basis for comparison with other sites where the same protocol has been used (Table 4).

The three most frequently caught amphibians in descending order were Eastern newt (51%), Spotted salamander (17%), and Wood frog (13%).

The least frequently caught amphibians in increasing order were Northern two-lined salamander, Pickerel frog and American toad. Each of them made up 1 percent or less of the total catch.

Approximately 80% of all the Eastern newts and Green frogs caught were young of the year. None of the Two-lined salamanders, American toads or Pickerel frogs were young of the year.

Egg-mass counts

The most useful figure that can be generated from these counts for monitoring purposes are the maximum counts of egg masses for each of the two species monitored (Table 5). The Burn Pond transects, although the smallest in area, contained the greatest number of Spotted salamander egg masses (60), followed closely by Upper Abbey Pond (51). The egg mass counts of Wood frogs seem unrealistically low. This may be a result of starting the counts after their egg masses were beginning to degenerate. They can degenerate to the point that they are no longer recognized as egg masses.

Though not part of the egg-mass monitoring effort, egg masses were found at other locations. The largest concentration of egg masses was located in a privately owned man-made pond on May 7, 1994. The pond is located next to a seasonal home west of USFS 90 near the northern end of the access road. In this pond 142 Spotted salamander egg masses were counted. Wood frog egg masses were located at four additional sites during the last week of April and the first two weeks of May. Approximately 30 Wood frog egg masses were located in a vernal pool on April 22 in the extreme northwest corner of the region surveyed. Spotted salamander egg masses were located at four other sites, including Abbey Pond, from the last week of April through the first week of June.
Eggs of other amphibian species were also found. American toad egg masses were seen in May and June in shallow puddles in the overgrown logging roads. Dusky salamander eggs were found once under moss on a log on May 28 and Northern two-lined eggs were found on a few occasions in June attached to the undersides of rocks in the small brooks of the region.

Long-term drift-fences

The long term drift fences were effective on snakes but caught only one species: Common garter snake (Table 6). Although not intended for amphibians these traps caught seven amphibian species. The great majority of the amphibians caught were Eastern newt (82%).

Table 3. Results of cover checks in the Abbey Pond / Beaver Meadow region during the fall of 1993 and the spring of 1994. Two lines of covers were left in place continually and checked approximately once per week for a total of 21 checks.

| Species name | Common name | total # found |
|---|---|---|
| **Reptiles** | | |
| **Serpentes (Snakes)** | | |
| *Storeria occipitomaculata* | Redbelly snake | 1 |
| | Reptile total | 1 |
| **Amphibians** | | |
| **Caudates (Salamanders)** | | |
| *Notophthalmus viridescens* | Red-spotted newt | 9 |
| *Plethodon cinereus* | Redback salamander | 1 |
| | Amphibian total | 10 |

Table 4. Results from two Abbey Pond / Beaver Meadow region drift-fences during 1994. Three trappings per month in April, May, June, July, September, and October are included for a total of eighteen trappings.

| Species name | Common name | # of all ages | # of young of the year[1] | % young of the year | # per trapping[2] | % of total catch |
|---|---|---|---|---|---|---|
| **Caudates (Salamanders)** | | | | | | |
| *Ambystoma maculatum* | Spotted salamander | 175 | 34 | 19 | 9.7 | 17 |
| *Eurycea bislineata* | Northern two-lined | 1 | 0 | 0 | 0.1 | < 1 |
| *Notophthalmus viridescens* | Eastern newt | 527 | 417 | 79 | 29.3 | 51 |
| *Plethodon cinereus* | Redback salamander | 105 | 9 | 10 | 5.8 | 10 |
| **Anurans (Frogs and Toads)** | | | | | | |
| *Bufo americanus* | American toad | 11 | 0 | 0 | 0.6 | 1 |
| *Pseudacris crucifer* | Spring peeper | 39 | 10 | 26 | 2.2 | 4 |
| *Rana clamitans* | Green frog | 35 | 29 | 83 | 1.9 | 3 |
| *Rana palustris* | Pickerel frog | 3 | 0 | 0 | 0.2 | < 1 |
| *Rana sylvatica* | Wood frog | 135 | 26 | 19 | 7.5 | 13 |
| | Totals | 1,031 | 525 | 51 | 57.3 | 100 |

[1]For each species individuals under a given total length were considered 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). *E. bislineata* (60 mm ), *N. viridescens* (45 mm), *P. cinereus* (32 mm), *B. americanus* (30 mm), *P. crucifer* (20 mm), *R. clamitans* (41 mm), *R. palustris* (30 mm), and *R. sylvatica* (25 mm).

[2]Number per trapping are rounded to the nearest 0.1. All other figures are rounded to the nearest whole number.

Table 5. Maximim counts of egg masses from three monitoring locations in the Abbey Pond / Beaver Meadow region in 1994. At Upper Abbey Pond and the North Beaver Dam two 50 x 2 m transects were counted. At Burn Pond transects were 40 x 2 m and 20 x 2 m. Counts may have started too late in the spring to include the majority of *Rana sylvatica* egg masses.

| Site | Ambystoma maculatum | Rana sylvatica |
|---|---|---|
| **Burn Pond** | 60 | 1 |
| count dates: 5/2, 5/9, 6/1 | | |
| **Upper Abbey Pond** | 51 | 2 |
| count dates: 5/2, 5/9, 6/3 | | |
| **North Beaver Dam** | 24 | 1 |
| count dates: 5/5, 5/12, 5/31 | | |

Table 6. Results from two Abbey Pond / Beaver Meadow region long-term drift-fences during the fall of 1993 and the spring of 1994. Snake traps were continually open from July 6, 1993 through November 1, 1993 and May 10, 1994 through July 28, 1994. They were checked 31 times over the course of the trapping period, approximately once per week.

| Species name | Common name | total # caught | # per trapping[1] | % of total catch |
|---|---|---|---|---|
| **Reptiles** | | | | |
| **Serpentes (Snakes)** | | | | |
| *Thamnophis sirtalis* | Common garter snake | 18 | 0.6 | 100 |
| | Reptile totals | 18 | 0.6 | 100 |
| **Amphibians** | | | | |
| **Caudates (Salamanders)** | | | | |
| *Ambystoma maculatum* | Spotted salamander | 15 | 0.5 | 4 |
| *Eurycea bislineata* | Northern two-lined salamander | 2 | 0.1 | 1 |
| *Notophthalmus viridescens* | Eastern newt | 295 | 9.5 | 82 |
| *Plethodon cinereus* | Redback salamander | 26 | 0.8 | 7 |
| **Anurans (Frogs and Toads)** | | | | |
| *Pseudacris crucifer* | Spring peeper | 3 | 0.1 | 1 |
| *Rana clamitans* | Green frog | 1 | 0.1 | < 1 |
| *Rana sylvatica* | Wood frog | 19 | 0.6 | 5 |
| | Amphibian totals | 361 | 11.6 | 100 |

[1]Number per trapping are rounded to the nearest 0.1. Percent of total catches are rounded to the nearest whole number.

Turtle trapping

Four sites which appeared to have the most potential for turtle populations were trapped three times apiece. Three Snapping turtles were caught (Table 7). No evidence of any other turtle species was seen at any time.

Water tests

Although the buffering potential as measured from two sites is low (an alkalinity of 4.3 and 2.3) the present pH of all the egg-mass monitoring ponds is above 5.8 which is well within the safe range (Freda 1986) for not only these species but also for more acid intolerant species, such as Jefferson salamander (Table 8). The lowest level of acidity at which amphibian reproduction has been reported to be negatively affected has a pH of 5.0. Interestingly, the man-made pond in which the largest concentration of egg-masses was located had a mean pH of 7.4 ± 0.6 SD, n = 4, which was the highest of any pond tested in the region. The mean pH values of three other ponds in the region were 5.6 ± 0.6 SD, n = 3, (Abbey Pond), 5.7 ± 0.5 SD, n = 3, (the pond in the old Beaver Meadow), and 6.5 ± 0.6 SD, n = 3 (an unnamed pond). The mean pH values of three brooks sampled were generally much higher (6.3 ± 0.3 SD, n = 4; 7.0 ± 0.5 SD, n = 3; and 7.3 ± 0.3 SD, n = 3). The one exception was the brook draining the Beaver Meadow to the east. This brook had a mean pH of 5.7 ± 0.4 SD, n = 3.

Other methods

The small number of site checks and active searches performed did not reveal any species other than those located in 1993. Two visits were made specifically to sites that seemed to have potential as breeding sites for members of the Jefferson salamander group. One site was a vernal pool on the southwest corner of the region surveyed and the other a vernal pool in the northwest corner of the region surveyed. These sites were the best examples of vernal pools that I could locate (they were both small natural depressions, not beaver dams) in the region surveyed. Neither site contained members of the Jefferson salamander group or any other previously unlocated species.

As a result of a separate survey of Addison County amphibians, I located four Spring salamanders during a night-time road search on May 26, 1991 along the North Branch Road in Ripton. The salamanders were along Fire Brook which drains to the southeast off Frost Mountain. Frost Mountain was not within the region surveyed but is within the larger area presently being evaluated. Although I only located four of this species on a single visit to this brook, this is still the largest concentration of this species that I have located in Addison County.

Table 7. Results of turtle trapping in the Abbey Pond / Beaver Meadow region during May and June of 1994. Three traps were used three times at four locations for a total of 36 trap-nights.

| Species name | Common name | Total caught | # per trap-night[1] |
|---|---|---|---|
| **Testudines (Turtles)** | | | |
| *Chelydra serpentina* | Snapping turtle | 3 | 0.1 |

[1]Number per trap-night are rounded to the nearest 0.1.

Table 8. Water test results from three monitoring locations in the Abbey Pond / Beaver Meadow region in 1994. At least three pH measurements were taken during each count except on days when single water samples were taken for the Vermont DEC.

| Site | Alkalinity - Gran (mg/l)[1] | Color, Total Visual (Pt-Co)[1] | Conductivity (umhos/cm)[1] | Range of mean pH[2] |
|---|---|---|---|---|
| **Burn Pond** | | | | |
| sample dates: 5/2, 5/9, 6/1 | 4.3 | 45 | 6.6 | 6.6-6.7, n = 3 |
| **Upper Abbey Pond** | | | | |
| sample dates: 5/2, 5/9, 6/3 | 2.3 | 35 | 25.7 | 6.1-6.4, n = 3 |
| **North Beaver Dam** | | | | |
| sample dates: 5/5, 5/12, 5/31 | -- | -- | -- | 5.9-6.3, n = 2 |

[1] Results are courtesy of the Vermont Department of Environmental Conservation Laboratory.

[2] One of the samples was analyzed by the Vermont Department of Environmental Conservation Laboratory.

Accidental findings

Hundreds of records were gathered by chance during the course of entering or exiting the research area or while working. The most interesting of these records follow. A Snapping turtle was seen at Burn Pond, May 9, 1994. Gray tree frogs were heard calling at the North Beaver Meadow on June 1, 1994 and at Upper Abbey Pond on June 27, 1994. Since this species is largely arboreal, it is not caught in the drift-fences nor is it found easily during active searches or site checks. It also calls during a very narrow window of time. It is therefore easily overlooked. On days after rains when the vegetation along the old logging roads was still wet I counted many Red efts (juvenile Eastern newts) on the walk into the drift-fences. The highest count was 120 on June 6, 1994.

Diseased *N. viridescens*

Specimens of diseased Eastern newts from Upper Abbey Pond, that were originally discovered there in 1993, were collected in June and sent to Dr. D. Earl Green D.V.M. at the Animal Health Diagnostic Laboratory in College Park, Maryland. Sent along with 7 specimens that showed external evidence of the disease were 4 other specimens from the same site with no apparent symptoms and a control group of 3 newts from a pond approximately 15 miles away in the Lake Champlain Valley. A copy of his final pathology report is included in its entirety in Appendix C. A paper will be published on this disease in the near future. In brief, on June 28, 1994, five adults were found dead at this pond. Four of them showed the characteristic growths of this disease. On July 14, 1994, 7 adults were found dead at this site. Three of them showed the characteristic signs of this disease. On June 28 and 29, adult newts were both netted and trapped from the pond. Of 72 netted, 12 (17%) showed signs of the disease. Of 69 trapped, 9 (13%) showed signs of the disease. One of these was dead in the trap. On July 14, 1994 of 66 netted, six (9%) showed the characteristic growths. Of 66 trapped 6 (9%) also showed signs of the disease. By October 25, 1994 however, of 183 newts caught at Upper Abbey Pond only 4 (2%) showed signs of the disease.

Dr. Green's report states that the swellings are probably the result of a fungus (*Aureobasidium pullulans*). The external symptoms of this disease had been described once in newts from Sleepy Creek Lake in West Virginia by a Dr. Herman, but the cause of the disease was not correctly identified. This fungus was not found in any of the control group of newts from the Lake Champlain Valley, but was located in two of the upper Abbey Pond newts which appeared symptom-free in the field. Dr. Green's report suggests that these two newts were recovering from the fungal infection.

A small group of four visibly diseased newts was taken into my lab along with four healthy control newts from the Lake Champlain Valley-site. Three of the four diseased newts died in the lab. All four of the control group survived. Although the small numbers sampled can not generate a statistically significant result, the result does suggest, as do Dr. Green's findings, that while some newts do die as a result of this disease, others can survive it. This disease may be spread by leeches.

I have now located newts with these symptoms in Nebraska Notch on Mt. Mansfield in the north-central Green Mountains, Silver Lake in the central Green Mountains, and in the Lye Brook Wilderness in the southern Green Mountains of Vermont. So far, I have only found newts with these symptoms at elevations above 1,200 ft.

Other species

While in the field during the course of this inventory, many species other than reptiles and amphibians were seen and identified. Some of these species were recorded in my notes. I have included a list of those species in Appendix D. It is not meant to be inclusive.

Some of the species that make this region unique are present as a result of the complex of wetland habitats. Moose tracks and sign were almost always seen while working in the region and one or two moose were seen on a couple of occasions. Otter tracks were seen on a few occasions and the otter themselves observed at least twice. A Northern saw-whet owl was heard calling during night-time visits in the spring. Pitcher plants and cotton grass were found in sections of Beaver Meadow.

## Discussion

### Discussion of the 1993 Results

The overall diversity found at this site fits well with a pattern that has emerged as a result of work in Addison, Rutland, Chittenden, and Bennington Counties (Andrews 1988a, b, 1990, 1992, 1993, 1995a, b; Trombulak 1994).

The species list generated is almost identical to that of the two other central Green Mountain sites where I have data sets (Mt. Mansfield and Lye Brook). The proportions of each species differ, but the relative percentages are dependant on the mix of methods used for the inventory. A more direct comparison of drift-fence results only will be available after the 1995 field season.

There are approximately 41 species of reptiles and amphibians reported in Vermont. Many of these are either very rare, localized in other regions of the state, or found in habitat types which were not found in this region. Compared to sites outside of the Green Mountains, but still in west central Vermont, this site has a lower diversity of both reptile and amphibian species (Table 9 and 10). Whether this is a result of the decreased buffering capacity of the soils and bedrock, habitat types, elevation, or other direct or indirect effects of a change in microclimate is not yet clear.

Table 9. Amphibian species that have been located in Addison County, but have not been reported from any mid- to high-elevation Green Mountain site, including the Abbey Pond / Beaver Meadow region.

| Species | Common names |
|---|---|
| **Amphibians** | |
| **Salamanders** | |
| *Ambystoma jeffersonianum* | Jefferson salamander |
| *Ambystoma laterale* | Blue-spotted salamander |
| *Hemidactylium scutatum* | Four-toed salamander |
| *Necturus maculosus* | Mudpuppy |
| **Frogs** | |
| *Rana pipiens* | Leopard frog |
| *Rana catesbeiana* | Bullfrog[1] |

[1]This species has been located at the base of Mt. Mansfield at an elevation of 1,200 ft. (Andrews 1995b).

Table 10. Reptiles, not found in the Abbey Pond / Beaver Meadow region, that have been found at other Addison County sites.

| Species | Common names |
|---|---|
| **Reptiles** | |
| **Turtles** | |
| *Clemmys insculpta* | Wood turtle |
| *Chrysemys picta* | Painted turtle |
| *Graptemys geographica* | Map turtle |
| *Sternotherus odoratus* | Common musk turtle |
| **Snakes** | |
| *Diadophis punctatus* | Ringneck snake |
| *Elaphe obsoleta* | Black rat snake |
| *Lampropeltis triangulum* | Milk snake |
| *Nerodia sipedon* | Northern water snake |
| *Opheodrys vernalis* | Smooth green snake |
| *Storeria dekayi* | Brown snake |

I am not surprised by the absence of most of these species from this site based on an emerging picture of habitat preferences. Mudpuppies and Map turtles would be expected primarily in Lake Champlain and its major tributaries, hence not at this site. Other habitats missing, and the species associated with them, are; large, deep, and permanent water bodies with extensive vegetation at low elevations (Northern water snake, Bullfrog, Leopard frog, and Common musk turtle), warm talus slopes near open oak-hickory woods at mid to low elevations (Black rat snake, Timber rattlesnake, and Five-lined skink), oak-hickory woodlands and nearby fields or openings at mid to low elevations (Ringneck snake and Brown snake), mixed woods with open fields (Smooth green snake and Milk snake), flood plains (Blue-spotted salamander), or less acidic soils and waters at low- to mid-elevation oak-hickory woodlands Jefferson salamander). The slope to the west of the region surveyed may have habitat appropriate for a few of the low- to mid-elevation species such as Ring-necked snake. A specimen of this species was located along the North Branch road in Ripton adjacent to an open oak stand at an elevation of 700 ft. Another was described by a hunter from the area immediately west of the region surveyed.

The absence of Four-toed salamanders, Jefferson salamanders and Blue-spotted salamanders from the three Green Mountain sites I have surveyed, is very interesting. It suggests that they are entirely limited in distribution to foot hills and floodplains. I had thought that if we were to locate them at all in the Green Mountains, it might be on the south and west flank of the mountains in those areas that hold oak woodlands. Most of this region is not that type of woodland, but I did survey pockets of American elm and oak on the extreme western edge of this region.

Painted turtles have occasionally been found in the Green Mountains at middle elevations outside of my study sites. I have located them far more frequently however, within the Lake Champlain Lowlands.

Smooth green snakes have been located in or near the open or overgrown fields that remain in Ripton up to at least 1,600 ft. in elevation.

The species listed in Table 11 have been located in Vermont but not in Addison County. Hence their absence from this site is not remarkable. They are all very rare in the state and very localized in distribution.

This is the only site in the state where I am using methods designed specifically to locate snake species. Consequently, it is difficult to compare this site to others. A few of the small woodland species of snake are particularly notorious for being difficult to locate. My long-term drift fence has been successful at catching snakes. However, all the snakes caught have been Common garter snakes. The cover checks, like the long-term drift fences, are designed specifically to locate snakes. The cover checks were the only method that located a Redbelly snake, the one other species of snake which we found. This low diversity of snakes is what we have found at other Green Mountain sites during efforts to locate amphibians. At sites outside of the Green Mountains, the use of these same non-specific methods has resulted in the location of a variety of other snake species. This suggests that other snake species are either absent, very localized or in very low numbers both here and at other forested Green Mountain sites.

Table 11. Reptile and amphibian species that have been located in Vermont, but not in Addison County or in the Abbey Pond / Beaver Meadow region.

| Species | Common names |
|---|---|
| **Amphibians** | |
| *Pseudacris triseriata* | Western chorus frog |
| **Reptiles** | |
| *Apalone spinifera* | Spiny softshell turtle |
| *Clemmys guttata* | Spotted turtle |
| *Coluber constrictor* | Racer |
| *Crotalus horridus* | Timber rattlesnake |
| *Eumeces fasciatus* | Five-lined skink |
| *Thamnophis sauritus* | Eastern ribbon snake |

The high percentages of both Green frogs and Eastern newts are noteworthy (Table 1). Research at other sites in the northeast would lead one to expect that the salamander found in greatest abundance would be the Redback salamander rather than the Eastern newt (Burton and Likens 1975, Wyman pers. comm.). Three factors may be the cause of this result at this site. Redback salamanders have been shown to prefer substrates with higher pH (Wyman and Hawksley-Lescault 1987) whereas Eastern newts have been shown to be quite tolerant of a variety of substrate pH levels (Wyman and Jancola 1992). The soil pH values in this region were consistently low (3.6). Secondly Redback salamanders have been shown to be most abundant in areas of more mature growth (>70 yrs.) (Petranka et al 1993) and most of this area has been regularly logged, some of it relatively recently. Thirdly, the amount and distribution of permanent and semipermanent standing water in this area although slightly acidic, provides an abundance of breeding sites for Eastern newts. In contrast Redback salamanders breed in or under fallen trees and amongst tree roots. Many of the large or rotten trees and branches that might have fallen and provided breeding sites for this species have been removed.

Wood frogs are the species of frog that I would expect to be most abundant in the northern hardwood forests of the state. At this site the apparently higher abundance of Green frogs is probably the result of abundant breeding sites with permanent water. The tadpoles of green frogs overwinter in ponds, lakes, and beaver dams. Without permanent water they can not survive. The wood frog tadpole on the other hand is found in temporary pools and metamorphoses by the end of summer. So, the abundance of permanent water in this area is probably one of the main reasons for the higher percentage of Green frogs. Another possibility could be the existence of fish in the larger breeding sites. Predation on Wood frog larvae from fish, either natural or introduced, is presumed to be one of the reasons that they usually breed in temporary ponds where fish can not survive. Green frogs on the other hand are frequently found in lakes, ponds and streams with fish populations. This suggests that Wood frogs are less tolerant of the presence of fish than Green frogs. Hence, the natural presence or introduction of fish to these ponds may have helped to increase the relative abundance of Green frogs relative to Wood frogs.

Over the course of the field season we located amphibians which were visibly diseased or malformed. Wood frog metamorphs were found on two occasions with one of the rear legs undeveloped. Eastern newt adults were located with large light-colored crippling growths on their bodies, and on a few occasions emaciated individuals were located. I have not been able to locate any additional information on the malformed Wood frogs, however, the disease affecting Eastern newts has been investigated and discussed previously in this report.

**Discussion of selected 1994 results**

Drift-fences

The drift-fence results (Table 4) should not be interpreted as the relative abundances of the amphibians of this region. They are, however, a useful index of the year to year change in abundance of those species on which they are effective. Gray tree frogs are capable of scaling a drift fence with ease. Although one apparently decided to take refuge in one of the pit traps along the fence, the number caught is in no way an indication of their relative abundance. Those species which migrate to and from the breeding ponds would be expected to be caught in greater abundances than those which either do not migrate to breed (e.g., Redback salamanders) or which do not breed in the ponds near which the fences are located (e.g., Northern two-lined salamanders). Despite these limitations, I believe that useful comparisons between drift-fence sites and between years at the same sites can be made.

Long-term drift-fences

The long-term drift-fences caught only one species of snake (Table 6). I believe that if other woodland snake species were present in significant numbers I would have caught at least one of them. It is possible that if drift-fences had been built in the open beaver meadows or on the dryer slopes to the west of the Beaver Meadow they might have caught other species. However, many other methods were used in this region over the period of two years and other than Common garter snakes only one Redbelly snake was found.

Turtle trapping

I have no evidence that any turtle species other than Snapping turtles inhabit this region. If the site were more directly connected to broad lowland valleys, other species might have colonized this habitat. Otter are known turtle predators. If there were a small number of Painted turtles in these wetlands they could have eliminated them. However, I did not find any turtle remains. Abbey

Pond was not trapped due to the nesting Great blue herons. However, I have no reason to suspect any different turtle species inhabit it.

Egg-mass counts

The low numbers of Wood frog egg masses located in 1994 (Table 6) are surprising. This could be the result of beginning the egg-mass counts too late in the spring. If so, than they must have bred unusually early in 1994. Otherwise, they should still have been visible in the breeding ponds. Fortunately in the future the Wood frog egg-mass count results can be checked with the number of adults caught in the drift-fences to see if both methods indicate similar changes in the populations.

The many beaver dams and surrounding woodlands throughout this wetlands complex provide excellent habitat for both Wood frogs and Spotted salamanders.

**Discussion (mandates)**

The four mandates of this inventory and monitoring project are restated below. The Abbey Pond / Beaver Meadow region surveyed was much larger than the present Beaver Meadow Special Area (Figure 1). Most of my comments pertain to the region as a whole not just the Beaver Meadow Special Area. When they pertain to the present special area only, it is explicitly stated.

1. Determine the presence and relative abundance of amphibians and reptiles in the region.

The reptile and amphibian species located in this region (Tables 1 and 2) are consistent with results from other sites within the Green Mountains at similar elevations and should accurately reflect which reptile and amphibian species inhabit the region surveyed. The lower elevation western and southern facing slopes adjacent to the region surveyed probably contain Ringneck snake and may well contain other lower elevation species. Upland meadows such as those found on the private lands north and south of this region may contain populations of Milk snakes and Smooth green snakes.

The percentages shown in Tables 1 and 2 do not accurately reflect the relative abundances of all the reptiles and amphibians in this region in that they are biased by the methods used. However, the relative abundances of these species can be estimated by an examination of the results of the different methods as long as the biases of the individual methods are kept in mind (Table 12).

The relative abundances of reptiles

The relative abundances of the reptiles is clear. The Common garter snake is by far the most abundant snake species. It is followed distantly by the Redbelly snake. Snapping turtles appear to make up 100% of the turtle species inhabiting the area.

Table 12. Estimated relative abundances of the amphibians and reptiles located in the Abbey Pond / Beaver Meadow region. The relative percentages of amphibians are based on those individuals identified using the mix of methods used in the 1993 inventory. Reptile percentages are based on 1993 and 1994 data. Relative percentages are shown for purposes of comparison. They are biased by the methods used. The estimated rankings of relative abundance are speculative but based on a knowledge of the limitations of the methods.

| Species | Common names | % of individuals | Estimated relative abundance |
|---|---|---|---|
| **Caudates (salamanders)** | | | |
| *Notophthalmus viridescens* | Eastern newt | 76% | 1 |
| *Desmognathus fuscus* | Dusky salamander | 6% | 2 |
| *Eurycea bislineata* | Two-lined salamander | 4% | 3 |
| *Plethodon cinereus* | Redback salamander | 9% | 4 |
| *Ambystoma maculatum* | Spotted salamander | 4% | 5 |
| *Gyrinophilus porphyriticus* | Spring salamander | 0.1% | 6 |
| **Anurans (frogs and toads)** | | | |
| *Pseudacris crucifer* | Spring peeper | 6% | 1 |
| *Rana clamitans* | Green frog | 44 % | 2 |
| *Rana sylvatica* | Wood frog | 31% | 3 |
| *Bufo americanus* | American toad | 12% | 4 |
| *Rana palustris* | Pickerel frog | 6% | 5 |
| *Hyla versicolor* | Gray tree frog | 1% | ? |
| **Serpentes (snakes)** | | | |
| *Thamnophis sirtalis* | Common garter snake | 98% | 1 |
| *Storeria occipitomaculata* | Redbelly snake | 2% | 2 |
| **Testudines (turtles)** | | | |
| *Chelydra serpentina* | Snapping turtle | 100% | 1 |

Relative abundances of caudates (salamanders)

Amphibian relative abundances are not as clear-cut. However, they do indicate that the Eastern newt is by far the most abundant species of caudate in this region. As a result of the coloration and diurnal habits of immature Eastern newts (Red efts) they are the easiest salamander to locate. The percentage of this species found using all methods combined is probably higher than its actual percentage in this area. Still, it is the most frequently located species using any method including three (active searches, drift-fences, and long-term drift-fences) which are not biased by these traits.

The results of the combined methods would suggest that the Redback salamander is the second most abundant species in the region. Indeed it has the reputation of being the most abundant terrestrial vertebrate in the northeastern forests (Wyman pers. comm., Burton and Likens 1975). However, active searches would indicate that the Dusky salamander is actually the second most abundant species in the region and drift-fence results would indicate that the Spotted salamander is the second most abundant species. Unfortunately, Spotted salamanders are probably undersampled in active searches due to their fossorial (burrowing) habits and oversampled relative to Redback salamanders at drift-fences due to their migratory habits. At the same time Dusky salamanders and Northern two-lined salamanders are undersampled at drift-fences due to their non-migratory nature and use of isolated microhabitats. Other than the underrepresentation of Spotted salamanders, the active search results are probably the least biased for the salamanders. They show Dusky salamanders as the second most abundant salamander in the region, followed in order by Northern two-lined and Redback salamanders. If the habitats searched are representative, these results can be generalized to the region as a whole. Considering that the high percentage of saturated soils in the area surveyed would favor Dusky and Northern two-lined salamanders, and that the percentage of saturated soils, acidity of the soils, and the young age of the second growth forest would all limit Redback salamanders, this ordering makes sense.

Based on the number caught at drift-fences, the number of breeding sites located, and the number of egg-masses at those breeding sites I believe the Spotted salamander is the next most abundant salamander species.

The Spring salamander is an order of magnitude less abundant than the Spotted salamander. All appropriate methods indicate that it is the least abundant salamander in this region.

Relative abundances of anurans

The combined results, the drift-fence results for 1993, and the active searches all suggest that the Green frog is the most abundant and the Wood frog is the second most abundant anuran in this region. However, Spring peepers are undersampled during active searches due to their small size and secretive habits, and at drift-fences due to their ability to climb. When they are chorusing they can be heard in apparent abundance from most of the wetlands in the region. If the number per chorus were estimated at a very conservative ten individuals per chorus the total number located would make them the most frequently located species using all methods combined. Therefore, I believe that the Spring peeper is the most abundant anuran species in the area.

Green frogs and Wood frogs should thus be considered second and third in relative abundance respectively, American toads rank fourth and Pickerel frogs fifth. The Gray tree frog is difficult to rank. Although it certainly ranks last in active searches, it is almost entirely arboreal and hence not often found using that method. It is easily able to climb over drift-fences and in addition it has a very narrow window of time and weather conditions in which it calls. If a researcher is not at the right site, at the right time (June nights) and under the right weather conditions (warm and humid) this species could go unnoticed. However, even within the narrow window of calling conditions it has been spotty in distribution on the few nights when I have been able to hear it at this elevation at any site within the Green Mountains. Therefore, I suspect that it ranks somewhere among the last three anuran species in abundance in this region.

2. <u>Assess the significance of the Abbey Pond / Beaver Meadow region in the context of the reptiles and amphibians found in Addison County and the State of Vermont.</u>

Significant species in the region

The herpetological significance of this region relative to the rest of the Green Mountain National Forest (GMNF) is not due to any species that are unique to it. As stated previously this site contains the exact species found at two other research sites in the GMNF. The Abbey Pond / Beaver Meadow region has less herpetological diversity than the lowlands and hills of the Lake Champlain and Connecticut River Valleys. Therefore, relative to Addison County or the state of Vermont it has low herpetological diversity. This is partly explained by the fact that Vermont is at the northern extreme of the ranges of many reptile and amphibian species and that small changes in local microclimates (such as increased elevation) can limit their distribution. However, relative to Addison County and the state of Vermont the GMNF contains some of the best habitats for three species of significance.

The Abbey Pond / Beaver Meadow region like much of the GMNF contains habitat for a few amphibian species which are either not found in the lowlands or are only found in small scattered populations within the lowlands. One of these species, the Pickerel frog, was the rarest anuran in my survey of Addison County (Andrews 1995b). In the Abbey Pond / Beaver Meadow region this species was found along the densely shaded margins of the beaver dams and small brooks. It was also found in man-made openings (overgrown logging roads and headers). When found in open habitats it was usually in dense annual vegetation, often near small puddles, ditches, or pools of water. It reportedly breeds in the cool, clear, shallow, clean, waters of bogs and woodland ponds (DeGraaf and Rudis 1983). These wetland types are abundant in the region.

The other two significant species are the Dusky and Spring salamanders. Both are among the rarest in Addison County but they are more common in the mountains. I have frequently located Dusky salamander eggs under moss growing on rotting logs near permanent springs and seepage areas, or along the margins of small brooks. It is also reported to lay its eggs in wet leaf litter (DeGraaf and Rudis 1983) and under rocks (Klemens 1993) in the same habitats. It requires well shaded, permanently wet areas. Klemens (1993) reports that it is particularly abundant in closed canopy habitats where these seeps and springs intersect with surface waters (Brooks). He also states that in Connecticut it is no longer found in areas in which intense development has occurred. Well shaded seeps, springs, and small brooks are abundant in The Abbey Pond / Beaver Meadow region. Consequently, this species was frequently located at many sites in the region surveyed.

I located the Spring salamander in only one brook within the surveyed region. It is the small brook that crosses USFS 90, from east to west, north of the trail-head to Beaver Meadow. The Spring salamander requires permanently wet and shaded areas. It attaches its eggs to the undersides of flat rocks and other debris in small brooks or large springs. The water needs to be cool and well oxygenated. Klemens (1993) suggests that siltation as a result of poor forestry practices, development, and agriculture can degrade the water quality in streams enough to make them unsuitable for this species. He also states that there is a threat of thermal pollution as a result of removing forest canopy or damming of streams. This species may be limited in distribution in this region as a result of the natural damming of brooks, recent clear cutting, and/or the low gradient of the streams. A small group of this species in Fire Brook to the southeast of the region surveyed is the largest concentration of this species in Addison County that I have located. Similarly, at two other research sites in the Green Mountains individual streams have been located in which this species can be located with ease, while other similar-appearing streams have only occasional individuals or none. I have never located this species in the small watersheds or lowlands within the Lake Champlain Valley but I have located it at the foot of the steep western slopes of the Green Mountains (including the small brook that parallels the trail to Abbey Pond from Rte. 116). The three largest concentrations of this species that I have located in the state were within the main range of the Green Mountains.

Significant characteristics of the region

Although the three species discussed set this region apart from most of Addison County and other lowland regions of the state, it is other characteristics of this region that distinguish it from much of the GMNF and upland regions of the state. The concentration and diversity of small wetlands contained within this region, the size of the contiguous piece of habitat in it and surrounding it, the relative absence of roads, and the location of the region on the western margin of the Green Mountains, all serve to make it unique.

In an amphibian study of Addison County (Andrews 1995a), I had one 4-hectare site within the Green Mountains that was intensively inventoried. This site was a second-growth, beech forest that was drained by a single small brook. It contained no wetlands of any other type. As a result it contained very few amphibians of any species. Although small, this site serves as an example of what would be found at much larger sites if they did not contain a diversity of wetland habitats. In contrast, the region surveyed contains numerous beaver dams, small brooks, seepage areas, and forested swamps in a relatively small area. As a result, it contains a wider variety of species and more of them.

Combined with the surrounding forestlands, this region provides a large piece of contiguous habitat that could provide important refugia to not only the three species which are concentrated in the forested uplands, but also to those species which are found both in the lowlands and at higher elevations. The mosaic of wetlands that it contains are not isolated from each other by roads, development, or cleared land. This provides additional security to all the species inhabiting the region. As beaver dams age they become increasingly acidic, they may break during spring rains, or they may be abandoned and new dams built elsewhere. Diseases may be introduced, predaceous vertebrates and invertebrates may move into a pond or the courses of streams may change. These are just a few of the natural changes which can drastically alter local amphibian populations. If a region includes a variety of healthy populations of each species, then they are able to move into and recolonize areas in which they have been extirpated. Genetic diversity and the potential for long term sustainability of the species are increased. If a long-term drought were to occur, the large watersheds of this region could provide important refugia for amphibians that would not survive in the smaller isolated watersheds of the adjacent lowlands. The lowlands are also more at risk of development which could extirpate local populations. A large protected piece of habitat like this region and its surrounding forest could provide an important refuge for not only reptile and amphibian populations but for many other species as well.

The roadless character of this region is unique and of significance to reptiles and amphibians. Regularly traveled roads are a significant threat to local populations of amphibians that migrate to and from breeding sites and to snakes who migrate to and from denning sites. Unfortunately, as snakes seek denning sites after cold nights in the fall, roads often provide a warm sunny spot in which to bask and bring their body temperatures up to an optimum level for activity. Many snakes are killed on roads in this process. For these reasons roadless areas present fewer threats to the long-term viability of local reptile and amphibian populations.

The forested area to the east of the region surveyed is unlikely to include any additional species of reptiles or amphibians, however it does include the Spring salamander population in Fire Brook. In the areas west of the surveyed region, particularly the lower elevation south and west facing slopes, there is a high probability of one lowland species (Ring-necked snake) that would be more unique within the Green Mountains and the GMNF. There is a also a strong possibility that other species not found in the central Green Mountains would be found on these slopes. South- and west-facing slopes receive more sun and reach warmer afternoon temperatures than those facing north or east. As a result reptile and amphibian species that might otherwise be limited by elevation often inhabit them. Evidence of this change in microclimate can often be seen in the different forest cover. Oaks, elms, ashes, and pines are far more common on these south- and west-facing slopes. In addition, the steep nature of the slopes often provides open rocky ledges on which snakes can bask safely.

The fact that a herpetological inventory has been done in this region and that baseline monitoring data has been gathered in it for one full field season makes this area unique in Vermont. This is one of only three locations where amphibian populations are being monitored. Data from this site combined with data from two other sites in the Green Mountains will allow researchers to see if local populations are varying and if so, whether they vary independently of each other or if changes in populations seem to be state-wide. This data combined with that gathered by other researchers will help us to understand the factors that cause population changes. It will not be possible to fairly assess the significance of population changes in developed or logged areas if we don't know the frequency and range of changes in habitats that are not being developed or logged. This is the only site in the GMNF that has had a reptilian inventory.

In summary, the region surveyed is significant because:

1. It supports populations of three amphibian species that are unusual in Vermont outside of this type of habitat.

2. It contains an interconnected system of wetland habitats of a variety of types.

3. It is remote, largely roadless, and surrounded by a large contiguous piece of undeveloped land which makes it capable of sustaining populations over the long term.

4. It is located on the western border of the Green Mountains where an RNA would have the potential of including a wide variety of species and habitats connecting directly with the lowlands of the Lake Champlain Basin.

5. It is one of only three areas in the Green Mountains where an amphibian inventory has been carried out and baseline monitoring data has been gathered. It is the only GMNF site where a reptile inventory has been completed.

3. Make suggestions specific to the Research Natural Area candidacy of the Abbey Pond / Beaver Meadow region as it relates to the reptiles and amphibians of the area.

As stated previously this region is not unique among the Green Mountain National Forest sites that I have surveyed in the species of reptiles and amphibians that it contains. On the contrary it is a good example of the diversity of reptiles and amphibians that are usually found at mid to high elevations in the Green Mountains. In that sense it is a better candidate for a Research Natural Area (RNA) than those areas that do not contain the full range of herpetological diversity that is normal for such a region. If a RNA was established that was large enough to include both south and west facing low elevation slopes (preferably including rock outcroppings, talus slopes, southern species of hardwood and/or better buffered soils) it would then have the added potential of including unique species as well.

## The herpetological significance of creating old growth habitat

There are very few opportunities (if any) in Vermont to study reptiles and amphibians in a large undeveloped complex of wetlands surrounded by mature growth. In order to do so, it would be necessary to allow vegetation in a region such as this to mature. How the herpetological fauna would change as the forest matures beyond the present state is largely a matter of speculation. While Vermont's population continues to grow; visitation from surrounding states continues to put pressure on our recreational resources, privately owned land is divided and sold, and our own demand for resources continues to increase. Large, contiguous, and undeveloped pieces of land, such as this one will become more and more unusual. In the future, as is now the case, most of the private land and large sections of the GMNF will hold young actively managed forests. Much of the privately owned forestland will be in small isolated fragments. Although the GMNF has seen large pieces of land set aside as Wilderness Areas and these pieces make up a considerable percentage of GMNF lands, old growth and future old growth make up a relatively small percentage of Vermont's total land area. Consequently, old growth reptile and amphibian habitat is presently very unusual and likely to become more unusual if action is not taken now to preserve or create it.

The literature and my research suggest that the three species of amphibian which are most unique in this region (Dusky salamander, Spring salamander, and Pickerel frog) all will thrive in a mature forest. Pickerel frogs were found in two habitat types. One of these (small grassy openings) I believe would eventually be replaced by small natural openings that would result from events such as blow-downs and beaver activity. The other habitat type (densely shaded riverbanks and shorelines) should be in abundance. The two salamander species both require cool, well shaded, and wet conditions which would also be conserved if the area were allowed to mature.

There is reason to speculate that some of the more common species which are already benefiting from this large undeveloped region might increase in numbers if it were allowed to mature naturally. For example, the Gray tree frog, which spends much of its year in hollow trees and knot holes, would probably benefit from the increased amount of standing dead timber which would be found in a mature forest. The Redback salamander has been shown to prefer mature forests (>70 years old, Petranka et al 1993). An increased amount of down timber would provide egg laying and foraging sites for this species. Many reptile and amphibian species make use of hollow and rotting logs, and the space between the bark and the trunk of dead trees.

## Preventing road building

To increase the long-term sustainability of reptile and amphibian populations in this area I recommend severely limiting road building. The negative effects of roads on reptile and amphibian populations can be minimized by closing roads to vehicular traffic in early spring (late March and April) and early fall (September and October), by informed location of the roads, or by building tunnels and drift fences in critical migration areas. Clearly the safest and cheapest alternative is not to build any additional roads in a region managed for reptiles and amphibians.

Access

A RNA, unlike a Wilderness Area, does need to be accessible to researchers on a regular basis. In addition, some types of research, such as gathering air quality data, could require structures and special equipment. Instead of bringing roads closer to the core of this region, I recommend bringing the RNA boundaries closer to the access roads to the north and south of the present Beaver Meadow special area. In addition designation of a site accessible by road and on the margin of the RNA where limited small scale habitat alterations could take place would facilitate some types of research.

Preserving all the seasonal habitats used by reptiles and amphibians (not just wetlands)

A common misconception about amphibians is that they spend all or most of their life cycles in wetlands. Although almost all species require wetlands in which to breed, most of them forage during the summer and fall at distances up to a few hundred meters from their breeding sites. A few travel even farther. Even the Green frog, which is most often seen in or near water, forages in nearby uplands during rainy weather. Many amphibians overwinter in the leaf litter or below ground in well-drained forested areas some distance from water. Snakes also may need to move considerable distances between their foraging grounds and an appropriate wintering hibernaculum. Although the wetlands provide a supply of amphibians which makes up a portion of their diet along with slugs, insects, earthworms, and other invertebrates, most snake species need well drained areas in which to get below the frost line to overwinter. For these reasons managing for resident reptiles and amphibians requires leaving a broad margin (200-300 yards) of suitable habitat around wetlands. This habitat surrounding the wetlands also would serve the purpose of maintaining water quality.

The inadequacy of the present Beaver Meadow Special Area relative to reptile and amphibian habitat

The present Beaver Meadow Special Area contains habitat in which most of the species listed here could be found but it does not contain the best examples of that habitat, it does not contain enough adjacent woodland on the north and northeast borders to provide for seasonal usage, and it does not contain the number of wetland habitats that would provide stability. The present Beaver Meadow Special Area is roughly a quarter of the region that I surveyed. My data and their significance have been based on the total region surveyed, not just the current Special Area. Although the Beaver Meadows and the old beaver dam contained within it are certainly biologically unique for other reasons, they are not the most productive reptile or amphibian habitat in the region. The series of younger dams that drain to the north across USFS 90, the series of beaver dams and meadows that drain into Abbey Pond, and the two large wetlands to the west of USFS 95 hold a greater diversity and abundance of amphibians.

I did not find Spring salamanders in any of the streams contained within the present Beaver Meadow special area. Inclusion of habitat for this species would increase the herpetological significance of an RNA. Inclusion of Fire Brook in an RNA would protect the population in that brook and allow for further study of it.

## A proposed RNA boundary

To provide for the long-term sustainability of the widest variety of woodland reptiles and amphibians and provide the opportunity to study them in a maturing forest setting I recommend expanding the Beaver Meadows Special Area to include a greater number of wetlands, a greater variety of wetland types, a larger area of adjacent woodlands, more productive amphibian and reptile habitat, and the monitoring sites that have already been established.

Specifically I recommend extending the area to the north to include a portion of USFS 90; to the northeast to the 1,848 ft. unnamed peak; to the east to border USFS 298a; to the southeast to include the lower beaver meadow, the drainage flowing into "Upper Abbey Pond", the peak of Robert Frost Mountain, and the drainage flowing into Fire Brook; to the south to include Abbey Pond, the end of USFS 95, the drainage into "Burn Pond" and its outlet stream. To the southwest, west, and northwest I recommend extending the boundaries to the lowest possible elevation in order to include the widest variety of habitat types possible (Figure 5).

The extension of an RNA to the Lake Champlain Basin has a variety of advantages. It would include the widest variety of habitat types. It would abut an existing old growth stand, and it would allow for less restricted movement of species in and out of the Green Mountains.

I do not see the present trail to Abbey Pond as a threat to the reptile and amphibian populations of the area. The snowmobile trail is also not a threat to reptile and amphibian populations provided it is not used by all-terrain vehicles outside of the winter months.

## Suggested boundaries are not meant to imply a maximum area

I do not mean to imply by this recommendation that I have any herpetological objections to designating a much larger area as a RNA. On the contrary, from an ecological perspective the larger the area protected, the greater the opportunities for restoring and studying natural processes in a northeastern old growth forest. In addition, the larger the area designated, the greater the number of populations that will be able to interact, the greater the number of microhabitats contained, the greater potential for movement and recolonization and consequently the greater the long-term stability of the native populations.

## The introduction of fish

Fish are major predators of amphibians and their larvae. If a region is to be managed for amphibians, fish should not be introduced into any body of water that does not presently support fish populations.

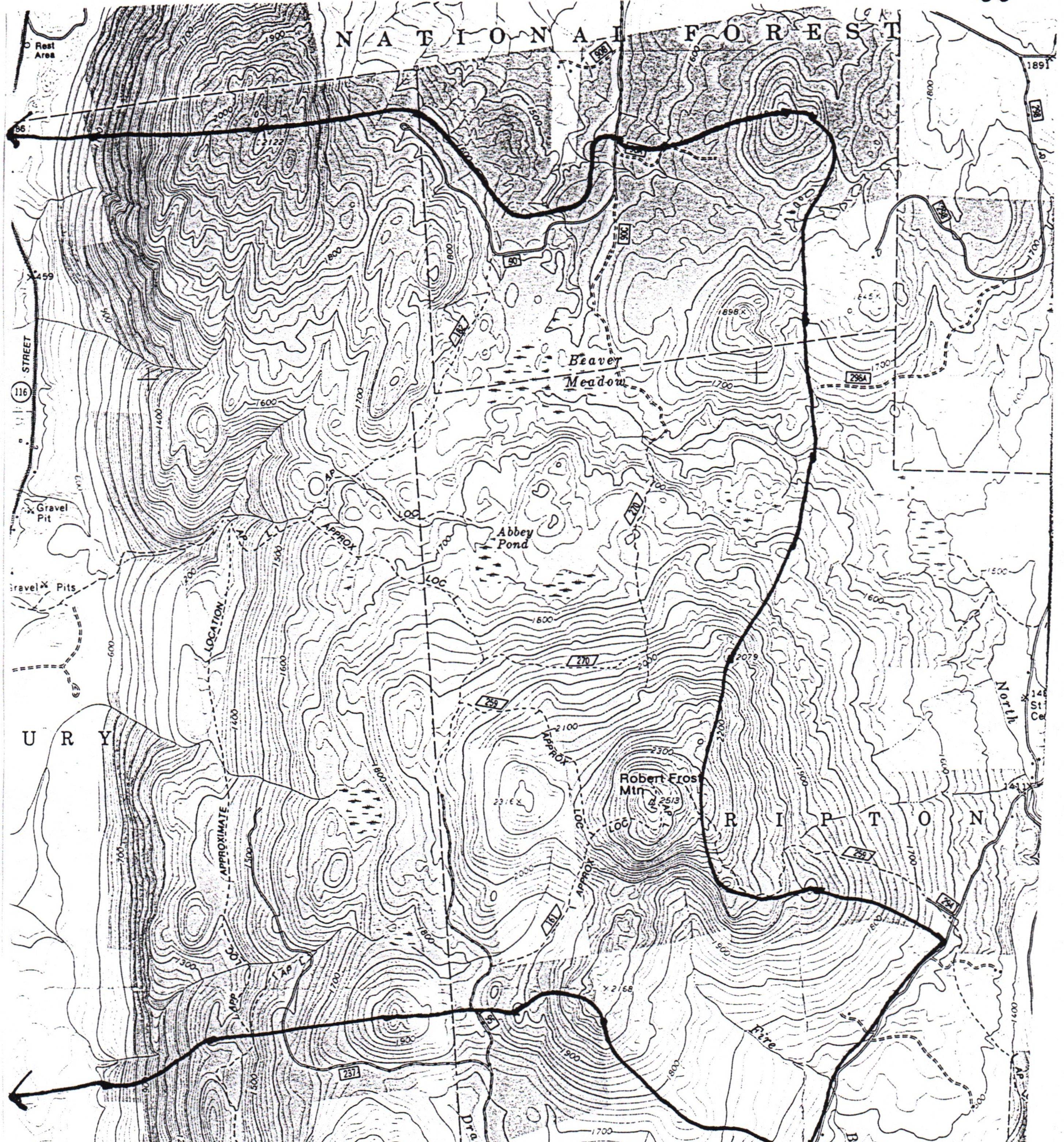


Figure 5. Proposed boundaries for a Research Natural Area in the Abbey Pond / Beaver Meadow region.

The importance of movement corridors

In the same way that the network of connected wetlands within the core of this region increases the long term sustainability of localized populations by allowing unrestricted movement, maintaining forested connections from this region to other protected regions further increases the long-term sustainability of resident populations. In addition, as the scale increases opportunities for movement between populations of larger vertebrates increase. It makes sense to me to maintain some of these connecting corridors along waterways. This serves a variety of wildlife and water quality preservation goals. These waterways, stream valleys, and even small drainage ditches often serve as the natural movement corridors of many species. These corridors would not necessarily be old growth, but I recommend a solid forest canopy and a large number of "overmature" trees with many dead trees both standing and down.

4. Develop a monitoring scheme for selected amphibians and/or reptiles.

A monitoring scheme has been developed for this area and I have gathered one year's data from it and included it in this report. The monitoring scheme consists of egg-mass counts at three selected ambystomatid breeding sites and two drift-fences which were installed in 1993. The methods have been described previously in the methods section of this report but are repeated here.

Egg-mass counts

Egg-mass counts follow a strict monitoring protocol at three sites that I have named North Beaver Meadow, Upper Abbey Pond, and Burn Pond (Figure 3). Two transects are located at each site with the location and length of the transects designed to fit the site. At Upper Abbey Pond and the North Beaver Dam two 50 X 2 m transects are surveyed along the margin of the ponds. At Burn Pond the transects were 40 x 2 m and 20 x 2 m. These latter transects were also located along the pond margin. The counts are designed to take place in habitats where Wood frogs and Spotted salamanders have been previously located and during or shortly after their breeding period. All eggs within these transects are counted on three occasions: twice in the beginning of May or earlier if the ice melts earlier (at least one week apart), and once at the end of May or beginning of June when all egg laying should be over.

Drift-fences

Drift-fences, when used as a monitoring tool, followed the strict protocol in Appendix A. They were opened three times per month from April through October with the exception of August. In addition, during 1994 a sub-sampling protocol was established (Appendix A) and size-class data were collected for the first time. For each species, individuals under a given total length were considered 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: Spotted salamander (70 mm), Northern two-lined salamander (60 mm), Eastern newt (45 mm), Redback salamander (32 mm), American toad (30 mm), Spring peeper (20 mm), Green frog (41 mm), Pickerel frog (30 mm), and Wood frog (25 mm).

Species monitored

These methods do not monitor all species of amphibian nor do they monitor the limited reptilian fauna of the region. Stream and seepage area salamanders such as Spring, Northern two-lined, and Dusky would not be caught often enough to give meaningful monitoring results. The Gray tree frog is arboreal and can easily climb over drift-fences, consequently, it can not be effectively monitored with these fences either. Although schemes could be devised to monitor all resident reptile and amphibian species, I don't believe that it is necessary. The remainder of the amphibian species found in this region, consisting of three caudates (Spotted salamander, Eastern newt, and Redback salamander) and five anurans (American toad, Spring peeper, Green frog, Wood frog, and Pickerel frog), are now being monitored. Data from the drift fences on Spotted salamander and Wood frog can be checked and compared with data from the egg-mass counts.

Time frame

For the monitoring information to provide a useful baseline, I recommend gathering at least three years of monitoring data at this site. For the purposes of studying amphibian population changes and the factors that cause them I recommend ten years of continued monitoring at all three Green Mountain sites. To date we have learned a great deal. I look forward to continuing this type of cooperation with the Green Mountain National Forest on this and other projects which are mutually beneficial.

## Acknowledgements

In addition to the author, many other individuals assisted in the gathering of data at this site through 1994. Catherine Herzog was an invaluable field assistant for the duration of the 1993 field season. Timothy Bernard, a Middlebury College student, assisted over the 1993 summer, supported by a grant from the Howard Hughes Medical Institute. During the 1994 field season Winsor Lowe served as my assistant and Jesse Cunningham worked during the summer supported by Middlebury College and the Howard Hughes Medical Institute. Betina Mattesen has been in charge of opening and checking the drift-fences with help from Jen Jolliff, Kim Hewitt and Kir Talmage. She has been very conscientious about her responsibilities no matter what the weather. In addition thanks to Dr. Steve Trombulak for the continuing use of his lab at Middlebury College and Dr. Sara Cairns for her editorial suggestions.

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# Appendix A

## Protocols

## Guidelines for the Use of the Drift-fences

### When

I would like to get the traps open three times per month for the months of April, May, June, July, September and October. In many months you won't get more than three nights of good activity, so you can not afford to pass up the right conditions very often. Having a back-up person who can open the traps when you can't is essential.

Amphibians are most active at night during and immediately after heavy rains. In the early spring it is possible to get activity associated with a wet snow, particularly if the spring is a little later than normal. Even if it stops raining well before dark, if the surface of the ground is still wet, and the soil and vegetation are saturated, activity could take place. Ideal conditions are a solid steady rain that starts during the day and continues well into the night. In the summer, thundershowers that occur during the evening, during the night, or late enough during the day so that the ground and vegetation are still wet can be good. Frequently you have to gamble that good weather conditions will develop after you open the traps. With the help of the weather radio you often need to make an educated guess on whether or not good conditions are likely to occur over night. Generally I don't open the traps if the ground is still dry and the chance of rain is under 70%. You will occasionally open the traps on dry nights by mistake. It is to be expected. Turn in the data sheets for these nights, but try to get an extra trapping in as well.

On occasion I have gone for a whole month without having good trapping conditions. The best you can do in that situation is open the traps in less than ideal conditions. If things have been really dry for a while and it looks like it may continue that way, open the traps after a lighter rain than you normally would. Also if, for example, you trapped successfully only two times in April, get in an extra trapping in early May. Sometimes there is nothing that you can do about it. It just doesn't rain. Remember that the weather at the trap site may be different from the weather where you are located. Often the higher elevation sites get rain or at least moisture that passes over the valleys.

When necessary, spread your trap-nights out. I am not suggesting that you skip a perfect night, but, if in April (for example), you had three successful trappings in the first week, add an extra trapping later in the month. We don't want to entirely miss the relatively short breeding periods of some species.

I have been impressed with the ability of some species to migrate and breed when there are still patches of snow on the ground and ice on the ponds. These early migrations are particularly important to catch. Some of our species have evolved a strategy of breeding in temporary pools that may dry up over the summer. In order for them to produce young, they need to get their eggs in the pond as early as possible. The first rains of spring will bring out spotted salamanders, wood frogs, and a few other early spring breeders that we may not be fortunate enough to trap later in the year. In the Lake Champlain Valley this activity sometimes starts as early as late March. At lower elevations that are exposed, it usually begins by the second week of April. At very high or shaded sites breeding activity may not begin until early May. As soon as some of the ice has melted around the edges of ponds or around the bases of trees in the swamps, breeding could begin. If large areas of ground are free from snow, and moisture can reach the wintering amphibians in the soil, some of them will move. Some of the sites will be hard to get to in the spring. Get there as early as you safely can.

**How**

When you open the traps make sure the bottom of the snake traps (screening) are placed flush with the fence, covered, and weighted down. Plug all other avenues of travel with leaves or soil debris to direct the amphibians into the traps. Spread a few leaves in the entrance to the traps as well.

Remove any branches that have fallen on the fence, as well as vegetation that has grown next to it. We don't want any bridges which might allow amphibians to get over the fence.

Open the traps before dark or very soon after and check them the next day.

It is safer, much more efficient, and more fun, to open and check traps with a partner. If you can't go with a partner, at least let someone know when and where you are checking or opening traps. Many fences are remote and accidents can happen.

When checking the pit-traps check under the funnel rims carefully. In some traps this requires a pencil or sharp stick to clear the area that your fingers are too large to reach. The bottom of the trap needs to be very carefully checked by sight and by feel. Small salamanders such as redbacks can easily swim around your fingers as you feel in the water. Use a cup to bail as much water as possible. In any remaining water move your fingers around in circles while touching the bottom and corner of the can in one direction (say clockwise) than quickly change to the other direction (counter-clockwise). Feel carefully for any momentary contact with anything in the trap. Remove all leaves and debris that your fingers come into contact with. Look for salamanders that may be half way up the sides of the can as well.

In the snake traps very carefully check the corners around the funnels at both ends. Small salamanders curled in these corners are easy to miss. Remove all debris, spiders, slugs, etc. that may accumulate in the traps.

Cover all traps securely, snapping the covers into place tightly. Put a rock on a lid if you think that it might not be secure. Hang the snake traps in the trees by the clips with the port open. We don't want to catch and kill creatures by accident while we are not using the fences.

**Data**

Take down data carefully while you are checking the pit traps. Do not wait until after you have checked a few. Do not risk forgetting or confusing some of the data.

Carefully identify all reptiles and amphibians caught in the traps. If you have any doubt at all about the identity of a species, put it in a plastic container with wet paper towels and take it out so that we can look at it. Store them in a cool dark place. Label the container with a wax pencil so that you will be sure to remember where you found it.

Any species that is not listed on the species list as either common or occasional at that site should be put in a plastic container as well. We need to verify any new or unusual species ourselves.

Identify species by the first letter of their genus name (capitalized) and their full specific epithet (not capitalized) for example; *A. maculatum*. Familiarize yourself with the measuring protocol (see the separate information sheet). Keep a running tally of the numbers of each size group of each species. When you are finished at the site, total up each size group, write the total at the end of the line, and circle it.

Fill out all appropriate blanks on the data sheets; remember, some don't apply to your situation (water temp., person time, specific location, and habitat type). Take the air temperature in the shade. Leave the thermometer in place for at least five minutes. Describe the weather conditions over the last 24 hours with particular emphasis on the timing and amount of rain; for example; (a heavy rain started yesterday around noon and continued all night). If you have some idea of how much rain fell, by all means put it down, but this is not critical.

Create a section near the end of your data sheet titled Accidentals. In this section list all amphibians and reptiles that you found while checking the drift fence that were not in the traps themselves. Individuals that were found in the mouths of traps, along the fence, or that were seen or heard on the way to or from the fences should be listed here along with any accompanying details.

Also create a section at the end of your data sheet titled Other Species. In this section list (or describe) species, other than reptiles or amphibians, that were caught in the traps. With a little practice you should be able to identify the small mammals in the traps (see the separate mammal identification sheet). We will help you learn to identify these. They usually fall into the basic categories of voles, mice, jumping mice, short-tailed shrews, and other shrews. Any unknown or unusual small mammals should be sealed in a plastic bag and frozen until we can look at them. At Mt. Mansfield fences all small mammals should be frozen and labeled with the location of the drift fence they originated from.

At the end of each month make photocopies of your data sheets and send me the originals.

**Protocol for Sampling and Measuring Amphibians Captured in the Drift-fences**

By keeping track of the sizes of amphibians caught we can begin to see a picture of survivorship, reproductive success, and perhaps health of the species as well as obtain data about the size at metamorphosis, maximum size and average adult sizes. However we don't want to have to measure all the amphibians caught, for example on days when 50 *N. viridescens* metamorphs are found in the traps. At the same time we need a standard method of deciding which ones to measure, so that apparent changes from year to year are not the result of different sampling or measuring methods.

So, **measure the first three individuals of each size class of each species at each drift fence.** For example if you get a trap full of *N. viridescens* metamorphs (tiny individuals that have just left the water this year for the first time), measure the first three of those. In a different can, you find a red eft that is much larger and is probably from last years crop of young. Measure that one and the next two of that size range that you find. If you then find an individual that is visibly larger than the efts you already measured, then that is a new size class and you should measure the first three of those as well. What you may be seeing is metamorphs, efts that left the water one year ago, others that left the water two years ago, and some others that are adults. In the case of adult toads and frogs you may also find that some look considerably larger than others. Instead of being a function of age this may be a function of sex. I suspect that most of the time in the late summer and fall you will catch many young of the year and relatively few adults. In the spring you will probably find that very few of the young have survived to be caught. Clearly this method requires some judgement on your part on whether or not an individual belongs to a separate size class. Short of measuring all of the individuals, there is no way around this that I can see. If you have the time and want to measure all of the amphibians, go right ahead. Write on your data sheet whether you measured all individuals or the first three of each size class. If you measure less than all of them, use this system.

All salamanders that you measure should be measured in two ways. You should measure their total length (from the tip of their nose to the tip of their tail) and their snout-vent length (from the tip of their nose to the beginning of their vent (cloaca). In frogs these two measurements are usually the same, unless the frog retains some of its tail immediately after changing from a tadpole. You need to measure only from the tip of their nose to the end of their body and write it in the snout vent box on the data sheet. Measure both lengths with any snakes that you find as well. With turtles measure the length of the shell on the bottom (plastron). Check your field guide on the green end papers for diagrams of these measurements. We differ only in measuring to the beginning of the vent, instead of to the end as shown in the book.

Even though you are only measuring a certain sample of those individuals you catch, you should still group all unmeasured amphibians and reptiles with the others of the same size class, so that I can see for example that there were twenty of a certain size class, three of which you measured. Also continue to write in the notes section whether they were metamorphs, juveniles and adults. Refer to the book if you aren't sure whether or not an individual is adult size.

# Appendix B

## Field Efforts and 1993 Results by Method

Table B1. A summary of field efforts in the Abbey Pond / Beaver Meadow Region during the 1993 inventory.

| Month | Active Searches | Cover Checks | Drift-fence nights | Egg-mass Counts | Long-Term Drift Fence | Trapping | Night Visits | Site Checks | Accidental Discoveries & Other Methods | Total Visitation Days |
|---|---|---|---|---|---|---|---|---|---|---|
| April | | | | 27 | | 14, 16, 22 | | 27 | 21, 22, 27 | 5 |
| May | 4, 5, 7, 20, 28 | | | 5, 19, 28 | | | 6 | 4, 7, | 5, 7, 19, 20, 28 | 7 |
| June | 1, 3, 4 | 1, 4, 18, 23, 25 | | 1, 18 | | | 3, 18 | | 1, 3, 4, 10, 18, 22, 23, 25 | 8 |
| July | 16 | 6, 29 | 30 | | 6, 13, 23, 29 | | | 15, 16 | 6, 13, 16, 23, 29, 30 | 8 |
| August | | | | | | | | | | 0 |
| September | 22 | 8, 20, 27 | 10, 16, 24, 28 | | 13, 15, 20, 27 | | | 22 | 8, 13, 20, 22, 24, 27 | 10 |
| October | 5, 20, 26 | 4, 11, 18, 25 | 13, 18, 22 | | 4, 11, 13,18, 22, 25 | | | 5 | 18, 20 (DTRS), 25 | 8 |
| November | | | | | 1 | | | | | 1 |
| Total # of times each method was used | 24 times on 13 days | 14 times on 14 days | 8 times on 8 nights | 8 cnts. over 8 weeks on 6 days | 15 checks over 13 weeks | 3 times on 3 days | 3 nights on 3 days | 7 checks on 7 days | 158 data pts. on 30 days, one other method tried once | 83 data gathering efforts, on 47 days |

Table B2. Results by method for the 1993 inventory of the Abbey Pond / Beaver Meadow Region.

| | Active Searches | Cover Checks | Drift-fence | Egg-mass Counts | Long-Term Drift Fence | Traps | Night Visits | Site Checks | Accidental | Totals |
|---|---|---|---|---|---|---|---|---|---|---|
| **# of times each method was used** | 24 | 14 | 8 | 8 | 15 checks over 13 weeks | 3 | 3 | 7 | 1 DTRS | 83 Efforts on 47 days |
| **# of sites** | 24 | 2 | 2 | 7* | 2 | 3 sites | 1 | 7 | 1 | ~50 sites |
| **Significant units** | 60.5 person - hours | 2 strings, ~1 km w/41 covers, & .3 km w/13 covers | 16 fence nights | 10.5 person-hours | 26 trap-weeks | 11 traps per night = 33 trap-nights | 3 visits on one route ~1.5 km | 29.25 person-hours at 7 sites | 1.5 person-hours | |

* Three of these sites were selected for potential long term monitoring. Protocol at these sites is more rigid for the purposes of future comparisions.

Table B3. Frogs located in the Abbey Pond / Beaver Meadow Region during the 1993 inventory.

| Species | Active Searches | Cover Checks | Drift-fence | Egg-mass Counts | Long-Term Drift Fence | Traps | Night Visits | Site Checks | Accidental | Totals | % of All Frogs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Bufo americanus*** **American toad** | 14 | | 2 | | 1 | | 2<br>2 tadpole sites | 4 | 30<br>6 egg masses<br>4 tadpole sites | **53**<br>**6 egg masses**<br>**4 tadpole sites*** | **12** |
| ***Hyla versicolor*** **Gray tree frog** | | | 1 | | | | 3<br>1 chorus | | 1 | **5**<br>**1 chorus** | **1** |
| ***Pseudacris crucifer*** **Spring peeper** | 7 | | 5 | | | | 6<br>14 choruses | 1 chorus | 8<br>4 choruses | **25**<br>**19 choruses** | **6** |
| ***Rana clamitans*** **Green frog** | 56 | | 26 | | | | 8 | 32 | 69+ | **191** | **44** |
| ***Rana palustris*** **Pickerel frog** | 3 | | 3 | | | | | | 19 | **25** | **6** |
| ***Rana sylvatica*** **Wood frog** | 22<br>2 egg masses | | 12 | 20 egg masses | 17 | | 9 | 20<br>15 egg masses | 53 | **133**<br>**37 egg masses** | **31** |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **# of species** | 5 | 0 | 6 | 1 | 2 | 0 | 5 | 4 | 6 | **6** | |
| **# individuals** | 102 | 0 | 49 | | 18 | 0 | 27 | 56 | 180 | **432** | |
| **# of egg masses** | 2 | | | 20 | | | | 5 | 6 | **43** | |
| **# of choruses** | | | | | | | 15 | 1 | 4 | **20** | |
| **# tadpole sites** | | | | | | | 2 (dupl.) | | 4 | **4** | |
| **% of all frogs** | 83 | 0 | 100 | 17 | 33 | 0 | 83 | 67 | 100 | | |

Table B4. Salamanders located in the Abbey Pond / Beaver Meadow Region during the 1993 inventory.

| Species | Active Searches | Cover Checks | Drift-fence | Egg-mass Counts | L-term Drift Fence | Trap-ping | Night Visits | Site Checks | Accidental Discoveries | Totals | % of All Caudates |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Ambystoma maculatum*** **Spotted salamander** | 1 | | 56 | 106 egg masses | 12 | | | 2<br>206 egg masses | 4 | **75**<br>**312 egg masses** | **4** |
| ***Desmognathus fuscus*** **Dusky salamander** | 84<br>2 egg masses | | | | | | | 18 | 4 | **106**<br>**2 egg masses** | **6** |
| ***Eurycea bislineata*** **Two-lined salamander** | 64<br>2 egg masses | | 5 | | 2 | | | 1 | 3 | **75**<br>**2 egg masses** | **4** |
| ***Gyrinophilus porphyriticus*** **Spring salamander** | 2 | | | | | | | | | **2** | **0.1** |
| ***Notophthalmus viridescens*** **Eastern newt** | 230 | 6 | 251 | | 247 | 39 | 15 | | 455+ | **1345** | **76** |
| ***Plethodon cinereus*** **Redback salamander** | 53 | | 28 | | 21 | | | | 3 | **164** | **9** |
| **# of species** | 6 | 1 | 4 | 1 | 4 | 1 | 1 | | 5 | **6** | |
| **# individuals** | 434 | 6 | 340 | | 282 | 39 | 15 | 182 | 428 | **1767** | |
| **# egg masses** | 4 | | | 106 | | | | 206 | | **316** | |
| **% of caudates** | 100 | 17 | 67 | 17 | 67 | 17 | 15 | 83 | 83 | | |

Table B5a. Reptiles located in the Abbey Pond / Beaver Meadow Region during the 1993 inventory.

| Species | Active Searches | Cover Checks | Drift-fence | Egg-mass Counts | Long-term Drift Fence | Traps | Night Visits | Site Checks | Accidental | Totals | % of All Snakes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Storeria occipitomaculata* Redbelly snake | | 1 | | | | | | | | 1 | 2 |
| *Thamnophis sirtalis* Common garter snake | 11 | | | | 11 | | 2 | 1 | 19 | 44 | 98 |
| # of species | 1 | 1 | | | 1 | | 1 | 1 | 1 | 2 | --- |
| # of individuals | 11 | 1 | | | 11 | | 2 | 1 | 19 | 45 | --- |
| % of all snake species | 50 | 50 | | | 50 | | 50 | 50 | 50 | | --- |

Table B5b. Combined totals for all amphibians and reptiles found during the 1993 inventory of the Abbey Pond / Beaver Meadow Region.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| # of species | 12 | 2 | 10 | 2 | 7 | 1 | 7 | 9 | 12 | 14 | --- |
| # of individuals | 547 | 7 | 389 | | 311 | 39 | 44 | 239 | 627 | 2234 | --- |
| # of egg masses | 2 | | | 126 | | | | 211 | 6 | 359 | --- |
| # of choruses | | | | | | | 15 | 1 | 4 | 20 | --- |
| # tadpole sites | | | | | | | 2 (dupl.) | | 4 | 4 | --- |
| % of all reptile & amphibian species | 86 | 14 | 71 | 14 | 50 | 7 | 50 | 64 | 86 | 100 | --- |

# Appendix C

## Dr. Green's Pathology Report

MARYLAND DEPARTMENT OF AGRICULTURE
Animal Health Laboratory
8077 Greenmead Drive
College Park, Maryland 20740
301-935-6074

**FINAL**
**PATHOLOGY REPORT**

Date: 16 January 1995
Submission Date: 7 & 28 June 1994

Accession No. CP4-4083 & CP4-4502
94P251 94P287

Veterinarian: None listed.

Owner: Jim Andrews
Department of Biology
Middlebury College
Middlebury, VT 05753

Species: Amphibian, Caudata, Notophthalmus viridescens (red-spotted newts)
Age: >7 yrs Sex: 5-F, 6-M Weights & Lengths (see Table A)
Specimen: Live animals No. Submitted: 14
Morbidity: Unknown Mortality: Unknown Group size: Unknown
Locations: Two ponds: Upper Abbey Pond, Ripton, VT
& Andrews Home Pond, Bridport, VT
Collector: Jim Andrews
Dates of Euthanasias: 7-9 June 1994
28-9 June 1994
Dates of Necropsies: 7-9 June 1994
28-9 June 1994

Significant Findings and Remarks:
HISTORY: For at least the last two breeding seasons (1993 & 1994) red-spotted newts in Upper Abbey Pond have been observed with swellings (lumps) in the muscles of the pelvis. Morbidity and mortality rates were not known.

NECROPSY FINDINGS: See Tables A & B (page 2).

PARASITE EXAMINATIONS: See Table B (examinations of stained blood smears are in progress).
FLUORESCENT ANTIBODY TESTS (F.A.T.):
1. Chlamydia psittaci ("psittacosis"): Negative in 3 of 3 newts.
2. Leptospirosis: Negative in 3 of 3 newts.

BACTERIA & FUNGUS CULTURE RESULTS: See Table C (on page 3).
CYTOLOGIC EXAMINATIONS & WHITE BLOOD CELL COUNTS: See Table D (on page 3).
HISTOLOGIC EXAMINATIONS: See also Tables E & F on page 8.
1. Skeletal muscles: Mycotic granulomatous myositis, subacute to chronic, multifocal to disseminated, minimal to severe, in 9 of 14 newts. Etiology probably Aureobasidium pullulans fungus infection.
2. Small intestines: Protozoal enteritis, multifocal to disseminated, mild, in 4 of 14 newts. Etiology suggestive of coccidiosis (Eimeria, Isospora, or similar apicomplexan protozoa).
3. Small intestines: Protozoiasis, luminal, disseminated, mild to moderate, in 4 of 14 newts. Etiology: luminal protozoan about the size and shape of Hexamita or diplomonads.
4. Small intestines: Verminous enteritis, focal or multifocal, very mild, in 2 of 14 newts. Etiology: small nematodes and flukes.
5. Stomach: Protozoal gastritis, diffuse, mild to moderate, in 1 of 14 newts. Etiology suggestive of Cryptosporidium-like infection.
6. Liver: Hepatitis, eosinophilic, reactive & sinusoidal, diffuse, mild to moderate, in 3 of 14 newts. Etiology not detected but probably reactive to the fungal infection in the muscles.

COMMENTS: Fungi were isolated in pure cultures from the muscles of 3 newts submitted on 28 June 1994. Two of these fungal isolates were submitted to the National Veterinary Services Laboratory in Ames, Iowa, and both were identified as Aureobasidium pullulans. An exhaustive literature search has yet to be done on this fungus, but at present, I can find no reports of this fungus causing infections in animals or man. Neither can I find any histologic descriptions of fungi resembling Aureobasidium in animals, except for the single report by Herman (1984) in which the organism in newts from West Virginia was described as an Ichthyophonus-like infection. Histologic features of the fungus in Herman's report and your Vermont newts are identical, but are not typical of Ichthyophonus infection. I have contacted Dr Herman by telephone, and he has not done any further work on the disease, and is not aware of any other studies or publications. He does however, think the infection has recurred in newts from his locality (Sleepy Creek Lake, West Virginia) yearly for at least 20 years. I have examined newts from at least 4 ponds in Virginia in the last 5 years and have never seen this condition. So, although the disease cannot be considered "new", the one description in the literature has some errors, incorrect assumptions, is incomplete, and the organism was not isolated in cultures. Hence, this fungal disease is definitely worthy of publication.

This fungal infection has many very unusual features and associations. You submitted 14 newts from 2 ponds, but the infection was detected in only newts from Upper Abbey Pond. At necropsy, gross lesions were observed in 7 of 14 newts (Tables A & B). However, histologic examinations showed that 9 newts had mycotic (fungal) infections of the muscles (Table E). As detected at necropsy, the muscles of the posterior body, pelvic region, hindlimbs, and anterior tail were most heavily affected. Much fewer numbers of fungi were found in the muscles of the tail tip, anterior body, forelimbs, and neck. In two newts, fungal cysts were detected within the skin (epidermis). The fungi were not detected in any internal organs (or tissues) of the body. Ichthyophonus fungi infect a wide variety of internal organs (heart, liver, intestines, etc) so this feature is a major clue that the fungus in the newts was not Ichthyophonus. The cause for the selective (topistic) vulnerability of muscles is unknown, but it is possible that this region of the body was the site of invasion by the fungus. For reasons which are explained below, it is suggested (speculated) that this fungus may be spread by wounds or bites of leeches or some other predator. A key piece of information that might link this infection to leeches would be if leeches prefer to attach to newts in the pelvic region.

It appears based on histologic examinations, that some newts have an intense inflammatory reaction to the fungi in the muscles. However, this inflammatory reaction (granulomatous inflammation) may be slow to develop, because some newts had no inflammatory cells around the infected muscle cells, while some newts had intense inflammation around nearly all fungi. And some newts had both. The two newts in which the fungus infection was not suspected at necropsy had extensive inflammation around the fungi with collapse of the fungi and loss of their internal contents. It is logical to assume these two newts were in the healing, and, perhaps, recovery stages of this infection. Those newts with heavily infected muscle cells but little or no evidence of inflammatory reaction may be those animals which would have succumbed to the infection.

The morphology of the fungi in the muscle cells was most unusual and may be unique. This infection should be easily recognized histologically, and readily distinguished from other fungal infections. One problem which has not been resolved is the proper name or terminology for the fungal elements in the muscle cells. This problem may be resolved when a literature search is completed. Names such as spores, endospores, chlamydospores, sphaerules, spherical forms, cysts, pseudocysts, sporangia, and sporangiophores were considered. Although we probably may name the fungal elements in histologic sections whatever we choose, the terms spores, cysts or simply fungal elements are probably best. The shape of the fungal elements in the muscle cells was fusiform or cigar-like. Basically, the fungi seemed to conform to the shape of the muscle cells. In cross sections, however, the fungi were distinctly round. The size of the fungi was measured in unstained fresh crush smears of the infected muscles, and in histologic sections; measurements of the fungi are shown in Table F. The fungi never showed hyphae, budding, daughter spores, or any significant internal structures; absence of such features is important for distinguishing this fungus from other fungal infections. All fungi appeared to have moderately thick walls, and in one newt the fungi appeared to have very thick mucinous capsules. Color of the fungi was variable: unstained fresh smears showed the fungi to be slightly to mildly brown while in stained histologic sections the fungi lost the brown color and took up various colors from the stains. Characteristics of the fungi in special stains are listed in Table G.

The inflammatory reaction to the fungi in the muscles was highly variable. In some newts there was little inflammatory cell reaction despite the presence of massive numbers of fungi. Other newts had intra-muscular fungi with no inflammatory cell reaction, while nearby areas had intense granulomatous inflammation. A few newts had inflammatory reaction around all fungi. In some regions of the pelvic and lower body muscles, over 90% of muscle cells were infected by fungi. It is merely assumed that those newts with massive numbers of fungi and little or no inflammation had infections which would have been fatal. Those newts in which all fungi had inflammation probably would have recovered. The prognosis for those newts which had fungi with and without inflammation is uncertain.

The presence of the fungal infection appeared strongly correlated with the presence of trypanosomiasis (Table E). Out of 9 newts with trypanosome infections, 8 (89%) had fungal infections; of the 5 newts without trypanosome infections, 4 (80%) did not have fungal infections. The one newt which had fungal infection without trypansomes, actually may have had trypanosome infection but it was simply not detected. This strong correlation between trypanosomiasis and this fungal infection implies that the leeches may be the proximate cause of the fungal infection. In newts, trypanosomiasis is transitted by leeches. It is possible the fungus enters the newts at the bite wound(s) of leeches. It cannot be determined whether this fungus infection is an opportunistic infection of the leech's bite wound, or whether the fungus is present in the leeches and is transmitted in a method similar to the trypanosomes. It would be very interesting to examine newts from Sleepy Creek Lake (West Virginia) [Herman, 1984] to determine if they have a similar correlation of trypanosomiasis and fungal infections. Many newts which have been examined from ponds in Virginia have had trypanosomiasis but no fungal infection, so the presence of trypanosomiasis or leeches is not the only factor in the transmission of the fungus infection.

The newts from the two ponds in Vermont had a variety of intestinal helminthic parasites (cestodes, trematodes, and nematodes) and at least three species of protozoan parasites. Further identification of some helminthic parasites is being attempted at the Zoological Society of London. A sample of the helminths was submitted in early December; the amount of time necessary for identification of these parasites is unknown, but results will be transmitted to you as soon as they are received. Two of the protozoan parasites were present entirely in the lumen of the intestines and on the surface of the the intestinal mucosal cells; these protozoa actually may have been part of the normal intestinal fauna. One luminal protozoan was probably a flagellate and the other a ciliate. No specific disease or illness can be attributed to the luminal parasites. However, the third protozoan had invaded the cells of the intestinal mucosa; the parasite resembled the disease of animals called coccidiosis. Coccidia are apicomplexan protozoa, all of which are considered parasites in the strictest sense. Eimeria and Isospora are the most common coccidia of mammals and birds. Three species of Eimeria have been described from newts in North American: E. longaspora, E. megaresidua and E. grobbeni; only the first two species have been documented in red-spotted newts. It was not possible to identify the coccidia of these newts to the genus or species level. All coccidian infections in these newts were considered mild, so it is unlikely they were causing illness. Finally, one newt had unusual tiny structures on the surface of the mucosal cells of the stomach; these structures may have been parasites of the genus Cryptosporidium. These organisms are so small the only certain method of identification is by electron microscopy.

Two potential disease-producing bacteria were isolated from the intestines of 2 newts: Yersinia sp. and Aeromonas hydrophila. Histologic examinations of both newts failed to detect any lesions which could be attributed to infection by these bacteria. Therefore, these two bacteria were probably inocuous in these newts, were transient in the intestines, or, were part of the normal intestinal and/or environmental flora.

SUMMARY & CONCLUSIONS: Nine of eleven newts from Upper Abbey Pond had fungus infections limited to the skeletal muscles. The fungus was cultured from 3 newts and was identified at a reference laboratory as Aureobasidium pullulans, a species which, to my knowledge, has never been described as causing infections in amphibians. However, this fungal infection in newts has been previously described (albeit poorly) and the fungus was mis-identified as an Ichthyophonus fungal infection. Therefore, a publication re-describing this infection and the fungus are warranted.

These newts had at least 4 protozoan parasites, as well as nematode, cestode, and trematode parasites. The blood protozoan was Trypanosoma diemyctyli and one intestinal protozoan may have been either Eimeria longaspora or E. megaresidum. Two protozoa were intraluminal organisms and were probably innocuous; these luminal protozoa could not be identified but probably were a flagellate and a ciliate. Some of the helminthic worms presently are being identified at the Zoological Society of London. None of these parasites were considered serious or life-threatening infections. However, there was a striking correlation between the occurrence of trypanosome infections and the fungus infections, suggesting the two organisms may have had the same vector (ie, leeches). Two potentially pathogenic bacteria (Yersinia and Aeromonas hydrophila) were isolated from the intestines of two newts; histologically, neither newt showed lesions which could be attributed to infection by these bacteria, therefore, disease cannot be attributed to these two bacteria.

FINAL PRIMARY DIAGNOSES:

1) Skeletal muscles: Mycotic myositis, in 9 of 14 newts; etiology: Aureobasidium pullulans fungus infection.
2) Blood: Internal parasite: Trypanosoma diemyctyli protozoa in 8 of 14 newts.

FINAL SECONDARY & INCIDENTAL DIAGNOSES:

3) Intestines: *Yersinia sp.* bacterial infection (culture diagnosis only).
4) Intestines: Internal parasite: Coccidiosis in 4 of 14 newts.
5) Stomach & intestines: Internal parasite: Flukes in 5 of 14 newts.
6) Intestines: Internal parasite: Nematode worms in 4 of 14 newts.
7) Duodenum: Internal parasite: Tapeworm in 3 of 14 newts.
8) Urinary bladder: Internal parasite: Nematode worm in 1 of 14 newts.

D Earl Green

D. EARL GREEN, D.V.M.
Diplomate, A.C.V.P.

CC: J Andrews
SR: 56 (1,4)\deg
ST: All organs of 14 newts

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**TABLE A: Signalments, Morphometry, & Gross Necropsy Findings in 14 Newts**

| Newt ID No. | Date of Necropsy | Pond Site | Sex | Weight | SVL | Tail Length | Necropsy Lesions: Muscle Fungi | Spleno-megaly | Black Liver |
|---|---|---|---|---|---|---|---|---|---|
| 251A | 7 June | AHP | M | 2.3 | ND | ND | 0 | 0 | 0 |
| 251B | 7 June | AHP | F | 1.45 | ND | ND | 0 | 0 | 0 |
| 251C | 7 June | AHP | F | 2.08 | ND | ND | 0 | + | 0 |
| 251D | 7 June | UAbP | NR | 2.62 | ND | ND | +++ | 0 | 0 |
| 251E | 8 June | UAbP | M | 2.75 | 47 | 53 | +++ | ++ | ++ |
| 251F | 8 June | UAbP | NR | 2.12 | 44 | 46 | ++ | 0 | +++ |
| 251G | 9 June | UAbP | M | 2.48 | 46 | 48 | ++ | +++ | +++ |
| 251H | 8 June | UAbP | NR | 2.37 | 46 | 48 | 0 | 0 | 0 |
| 251I | 9 June | UAbP | F | 2.31 | 49 | 55 | 0 | ++ | +++ |
| 251J | 9 June | UAbP | F | 1.72 | 41 | 43 | 0 | 0 | 0 |
| 251K | 9 June | UAbP | M | 1.82 | 43 | 46 | 0 | + | + |
| 287A | 28 June | UAbP | M | 2.5 | 46 | 49 | +++ | + | ++ |
| 287B | 29 June | UAbP | M | 2.1 | 44 | 46 | ++++ | 0 | +++ |
| 287C | 29 June | UAbP | M | 2.0 | 44 | 44 | ++++ | 0 | +++ |

NR= Not recorded; the sex of all newts will be confirmed histologically from the histologic slides at a later date.
ND= Not done
SVL = Snout-vent length (in millimeters)
Weights are in grams.
F = Female
M = Male
+ = minimal
++ = mild
+++ = moderate
++++ = severe
AHP = Andrew's home pond
UAbP = Upper Abbey pond

**TABLE B: Parasites in 14 Newts**

| Newt ID No. | Blood: Trypanosoma diemyctyli | Muscle: Fungus Spores | Stomach & Intestine: Duodenal Tapeworm | Stomach Flukes | Intestine Flukes | Jejunal Nematodes | Bladder: Nema-tode |
|---|---|---|---|---|---|---|---|
| 251A | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 251B | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 251C | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 251D | 0 | +++ | 0 | 0 | 0 | 0 | 0 |
| 251E | ++ | +++ | 0 | 0 | 0 | 4 | 0 |
| 251F | + | ++ | 0 | 0 | 0 | 1 | 0 |
| 251G | +++ | ++ | 0 | 0 | 0 | 0 | 1 |
| 251H | +++ | 0 | 0 | 0 | 1 | 0 | 0 |
| 251I | +++ | 0 | 0 | 2 | 0 | 0 | 0 |
| 251J | 0 | 0 | 0 | 0 | 5 | 1 | 0 |
| 251K | + | 0 | 1 | 0 | 2 | 1 | 0 |
| 287A | ++ | +++ | 1 | 0 | 0 | 0 | 0 |
| 287B | 0 | ++++ | 1 | 0 | 0 | 0 | 0 |
| 287C | ++ | ++++ | 0 | 0 | 0 | 0 | 0 |

Numbers represent the number of helminthic parasites found.
+ = minimal ++ = mild +++ = moderate ++++ = severe

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**TABLE C: Bacteria & Fungus Culture Results**

| Newt ID No. | Exam Date | Site | Rump Skin & Muscle | Liver | Intest/Colon |
|---|---|---|---|---|---|
| 251A | 7Jun | AHP | ND | No growth | No growth |
| 251B | 7Jun | AHP | ND | No growth | No growth |
| 251C | 7Jun | AHP | ND | *S.liquefaciens | Hafnia alvei |
| 251D | 7Jun | UAbP | ND | No growth | No growth |
| 251E | 7Jun | UAbP | ND | No growth | Hafnia alvei |
| 251F | 8Jun | UAbP | ND | No growth | Hafnia alvei |
| 251G | 9Jun | UAbP | ND | No growth | Hafnia alvei |
| 251H | 8Jun | UAbP | ND | No growth | Hafnia alvei |
| 251I | 8Jun | UAbP | ND | No growth | Yersinia sp.<br>Escherichia coli<br>**Ps. putida |
| 251J | 8Jun | UAbP | ND | No growth | No growth |
| 251K | 9Jun | UAbP | ND | No growth | No growth |
| 287A | 28Jun | UAbP | ****A.p. | No growth | ***Aero. hydrophila |
| 287B | 29Jun | UAbP | ****A.p. | ND | Hafnia alvei |
| 287C | 29Jun | UAbP | **** | No growth | ND |

* = S. is the bacterial genus Serratia
** = Ps. is the bacterial genus Pseudomonas
*** = Aero. is the bacterial genus Aeromonas
**** = A.p. is the fungus _Aureobasidium pullulans_

**TABLE D: White Blood Cell Counts in 14 Red-spotted Newts**

| Newt ID No. | Site | Trypanosomes Wet* | Trypanosomes Dry* | Smear Type | Differential WBC Counts: Lymph-ocytes | Foamy Lymph's | Mono-cytes | "PMNs" | Eosin-ophils | Baso-phils |
|---|---|---|---|---|---|---|---|---|---|---|
| 251A | AHP | 0 | 0 | Heart | 21 | 0 | 3 | 52 | 6 | 18 |
| 251B | AHP | 0 | 0 | Chest | 32 | 6 | 14 | 46 | 0 | 2 |
| 251C | UAbP | 0 | 0 | Clot | 12 | 4 | 12 | 40 | 8 | 24 |
| **251D | UAbP | 0 | 1 | Tail | 24 | 20 | 0 | 48 | 4 | 4 |
| **251E | UAbP | ++ | 5 | Tail | 24 | 14 | 6 | 44 | 4 | 4 |
| **251F | UAbP | + | 0 | Tail | 40 | 10 | 8 | 36 | 0 | 6 |
| **251G | UAbP | +++ | 0 | Tail | 16 | 10 | 2 | 50 | 4 | 18 |
| 251H | UAbP | +++ | 1 | Tail | 20 | 36 | 10 | 30 | 0 | 4 |
| 251I | UAbP | +++ | 0 | Tail | 20 | 18 | 6 | 44(+2) | 8 | 2 |
| 251J | UAbP | 0 | 0 | Tail | 36 | 4 | 12 | 36 | 6 | 6 |
| 251K | UAbP | + | 0 | Tail | 20 | 8 | 18 | 46 | 6 | 2 |
| **287A | UAbP | ++ | 2 | Tail | 4 | 12 | 20 | 58 | 0 | 2 |
| **287B | UAbP | 0 | 0 | Heart | 28 | 0 | 14 | 48 | 4 | 6 |
| **287C | UAbP | ++ | 6 | Tail | 10 | 12 | 2 | 76 | 0 | 0 |

* = _Wet_ refers to fresh whole blood examined as a wet mount and unstained; trypanosomes were easily detected by their movement. _Dry_ refers to air dried, stained blood smears; the number refers to the actual number of trypanosomes observed during counts of the white blood cells.
** = These 7 newts had grossly evident fungal infections in their pelvic muscles.
PMNs = Polymorphonuclear cells, also referred to as neutrophils.
WBC = White blood cells (leucocytes); numbers in the columns are percentages.
( ) = Number in parenthesis refers to band (immature) neutrophils.

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## TABLE E: HISTOLOGIC (and CYTOLOGIC) FINDINGS

| | | CYTOLOGIC FINDINGS | | | HISTOLOGIC FINDINGS — MUSCLE FUNGI BY LOCATION | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Newt ID No. | Site | Trypanosomes Wet* | Trypanosomes Dry* | Smear Type | Neck C | Neck G | Body C | Body G | Cloaca /Rump C | Cloaca /Rump G | Tail C | Tail G | Leg C | Leg G |
| 251A | AHP | 0 | 0 | Heart | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 251B | AHP | 0 | 0 | Chest | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - |
| 251C | UAbP | 0 | 0 | Clot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **251D | UAbP | 0 | 1 | Tail | 0 | 0 | + | + | ++ | + | ++ | + | + | + |
| **251E | UAbP | ++ | 5 | Tail | 0 | 0 | - | - | ++ | ++ | ++ | + | 0 | 0 |
| **251F | UAbP | + | 0 | Tail | 0 | 0 | + | ++ | + | ++ | + | 0 | + | ++ |
| **251G | UAbP | +++ | 0 | Tail | 0 | + | 0 | ++ | 0 | + | 0 | + | 0 | 0 |
| 251H | UAbP | +++ | 1 | Tail | 0 | 0 | + | 0 | 0 | 0 | 0 | ++ | 0 | 0 |
| 251I | UAbP | +++ | 0 | Tail | 0 | ++ | 0 | + | 0 | + | 0 | + | 0 | 0 |
| 251J | UAbP | 0 | 0 | Tail | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 251K | UAbP | + | 0 | Tail | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **287A | UAbP | ++ | 2 | Tail | 0 | 0 | ++ | ++ | ++ | ++ | + | + | 0 | 0 |
| **287B | UAbP | 0 | 0 | Heart | + | 0 | ++ | 0 | ++ | + | ++ | + | + | + |
| **287C | UAbP | ++ | 6 | Tail | 0 | 0 | ++ | ++ | ++ | ++ | + | + | + | + |

C = Cysts lacking inflammatory cell reaction
G = Granulomatous inflammation around fungal elements
* & ** = See Table D.

## TABLE F: SIZES OF FUNGAL ELEMENTS IN MUSCLES.

| Newt No. | FRESH DIAMETER | FRESH LENGTH | HISTOLOGIC SECTIONS CROSS SECTION | HISTOLOGIC SECTIONS LONGITUDINAL SECTION |
|---|---|---|---|---|
| 94P251D | 70 (74.2) [50-113] | 155.5 (175) [95-360] | 74.5 (74.9) [36-135] | 236.5 (231.7) [144-302] |
| 94P251E | ND | ND | 93 (91.1) [43-149] | 212 (216.7) [135-351] |
| 94P287A | ND | ND | 101.5 (98.4) [59-135] | ND |
| 94P287B | ND | ND | 103.5 (104.4) [54-144] | 241 (245) [158-315] |
| 94P287C | ND | ND | 99 (97.1) [63-135] | ND |

( ) = Mean
[ ] = Range
All measurements in microns

**TABLE G:** COMPARATIVE MORPHOLOGY & SPECIAL STAINING FEATURES OF AUREOBASIDIUM IN RED-SPOTTED NEWTS AND OTHER AMPHIBIAN INFECTIONS.

| | | | | | | HISTOLOGIC STAINS | | |
|---|---|---|---|---|---|---|---|---|
| AGENT | Location in Host | Size* | Shape | Internal Structures | Natural Color | Hematoxylin & Eosin (H&E) | P.A.S. | Giemsa |
| *Aureobasidium pullulans* | Skeletal muscle | 35-150 x 135-360 | Spindle | None | Lt brwn | Lt red or blue | ++ | Blue |
| *Basidiobolus* | Ventral skin | NR | Sphere | None | NR | NR | + | NR |
| *Mucor amphibiorum* | MO, liver, bladder | 5 to 36 | Sphere | Daughter spherules | NR | Blue | ++ | NR |
| *Ichthyophonus spp.* | Hrt, Liv, Kid, MO | 4 to 23 | Sphere | Multi-nucleate | NR | NR | + | |
| Chromomycosis | Skin, MO | 3 to 17 | Hyphae & yeast | Sparingly septate | Brn to black | Brn to black | | Brn to black |
| Saprolegniasis | Skin, muscle | 2 to 4 | Hyphae | Sparingly septate | Clear | Clear to lt blue | + | Blue |
| *Dermocystidium spp.* | Skin | >250 | Sphere, U-shape | Spores | NR | NR | NR | |
| *Dermosporidium spp.* | Skin | >250 | Sphere | Spores | NR | NR | NR | |
| *Prototheca spp.* | NR | 2 to 20 | Sphere | 4 endo-spores | Clear | Clear | + | NR |
| *Pleistophora danilewskyi* | Muscle | NR | Spindle | Spores | Clear | Blue | NR | NR |

Brn= brown
MO = many organs
NR = not reported

Lt = light
PAS= Periodic acid Schiff's reaction
* = all measurements in microns

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# Appendix D

## Other Species

Table D1. Other species that were noted in the region. This is not meant to be a comprehensive list. Only those species that were recorded in my field notes for any reason are included. Unusual species are in bold type.

## Mammals

**Moose**
White-tailed deer
Black bear
**Otter**
Coyote
Masked shrew
Short-tailed shrew
Beaver
Porcupine
Eastern chipmunk
Redback vole
Jumping mice
Peromyscus sp.

## Birds

Great blue heron
Canada goose
Mallard
American black duck
Wood duck
Hooded merganser
Red-tailed hawk
Sharp-shinned hawk
Turkey vulture
Ruffed grouse
American woodcock
Spotted sandpiper
**Northern saw-whet owl**
Barred owl
Belted kingfisher
Yellow-bellied sapsucker
Northern flicker
Hairy woodpecker
Pileated woodpecker
Olive-sided flycatcher
Tree swallow
Blue jay
American crow
Common raven
Black-capped chickadee
White-breasted nuthatch
Winter wren
Hermit thrush
American robin
Cedar waxwing
Common yellowthroat

## Birds continued

Black-throated green warbler
Black-throated blue warbler
Blackpoll warbler
Mourning warbler
Ovenbird
Rose-breasted grosbeak
Northern junco
White-throated sparrow
Red-winged blackbird
Common grackle
Northern oriole
American goldfinch
Purple finch

## Fish

Creek chub
Northern redbelly dace
Bullhead

## Plants

**Cotton grass**
**Pitcher plant**
Clintonia
Moccasin flower

## Invertebrates

Caddisflies
Dragonflies
Crickets
Daddy-long legs
Water beetles
Water boatmen
Whirly gig beetles
Wooley bear caterpillars
Ground beetles
Spiders
Hair worms
Slugs
Leeches
Centipedes
Millipedes