A Survey of the Lands Surrounding
OMYA's Proposed Mining Site (Baker Brook Region)
in Danby and Tinmouth, VT

for

Reptiles and Amphibians

Prepared for

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Introduction

The purpose of this effort was to perform a herpetological survey of the lands surrounding OMYA's proposed mining site (Baker Brook region) in Danby and Tinmouth, Vermont. The goals of the survey were to locate any rare, threatened, or endangered reptiles or amphibians, and to perform general herpetological surveys in the area. I will here report on all reptiles and amphibians (herptiles) located in the study (Table 1) paying particular attention to those with a Vermont State Heritage rank of S3 or lower. In addition, vernal, ephemeral, and semipermanent pools found in the study are located on maps (Appendix A).

Pools such as these serve as breeding grounds and/or egg-laying sites for amphibians. Although permanent water bodies also serve as breeding and/or egg-laying sites, the pools are generally more productive because they dry up from time to time, killing many of the predators (fish and large invertebrates) that would otherwise limit larval amphibian survival. The definition of a vernal pool which I will use is: a temporary pool which has no permanent inlet or outlet and is filled by local surface water or ground water in the spring and which dries during years of average rainfall in late summer or fall. Ephemeral pools differ only in that they dry up most years before the young salamanders and frogs have time to metamorphose (lose their external gills, develop legs, and leave the pool to forage on land). Only in wet years do ephemeral pools serve as successful breeding sites for amphibians. Semipermanent pools hold water throughout the year in most years of average rainfall and dry only during drought conditions. It has been my experience that semipermanent pools are both more diverse and more productive than vernal and ephemeral pools.

Methods

No one method will inventory the complete range of reptiles and amphibians occurring in an area. A combination of methods must be employed over a variety of seasons. I used six herp-survey methods, starting fieldwork with salamander trapping on April 6 and finishing in the field with active searching on June 21, 2001. In addition, a flyover of the site was made on May 6. As much as possible, visits were timed to be during the optimal window of opportunity to locate the widest variety of reptile and amphibian species in the area. However, limited time did not allow us to search during the fall, which is the ideal for finding snakes. A total of twelve days were spent on the ground at the site: six days in April, two in May, and four in June. All work was performed by the author working alone or supervising volunteers or interns.

The six **herp-survey** methods used in this inventory are described below.

An active search is a concentrated effort in a predetermined area to locate reptiles and amphibians by raking leaf litter, looking under rocks and logs, looking within rotten logs or under any items, natural or unnatural, that provide moist and shady retreats during the day. Active searches were primarily performed near the end of field work in the area, June 19-21, 2001.

A site check is a less localized form of active search that includes time spent searching for and traveling between the best micro-habitats. Site checks were most often used while traveling to set salamander or turtle traps.

A night-time road search consists of driving roads at a speed of 10-15 mph with the vehicle window open to hear calling anurans (frogs), and with eyes on the road and road margins to see herptiles crossing the route. Road searches were performed when the surface of the road was wet or the night was relatively warm and humid. When herptiles were heard or spotted, the car was stopped, the organisms identified and counted, and their locations

noted. The small roads in the area made this a very useful survey method, and many amphibians were located during the night-time road searches.

Salamander trapping involves the use of a series of unbaited minnow traps placed at selected locations in shallow water around the margin of potential breeding pools and swamps. It was used to locate caudates (salamanders) that bred in pools in the spring. It is a very effective method for locating amphibians but is only useful during a narrow window of time (April-May). Since I did not have permission to trap the ponds on OMYA lands, these traps were used primarily in the spring-fed pond on Old Otis Road, but also in the fen. One to eight traps were used per breeding site depending on its size. This method caught few spring-breeding amphibians; night-time road searches were more useful for locating these species.

Turtle trapping was performed both at locations that appeared to be prime turtle habitat (Danby Pond), and in the brook that drains the fen. Up to eight 30-inch hoop traps with 1 inch mesh were baited with sardines and left for approximately 24 hours.

Interviews are useful in gathering important leads on areas where unusual or rare herptiles may be located now or were historically. I conducted three interviews in person of residents who lived in the area. The number of interviews conducted were time- and budget-limited; this method would be more effective with more time or a larger budget. As it was, I spent more time searching for herptiles than interviewing residents about them.

In addition to the above methods I used the Vermont Herp Atlas records. As coordinator of the Herp Atlas Project, all known records of Vermont herptiles current or historic are on a database on my computer. These records were accessed to check for all other records from the Baker Brook region and surrounding towns.

Two methods were used to locate **vernal, ephemeral, and semipermanent pools**.

A low-elevation flyover prior to leaf emergence, if timed properly, can provide a very efficient survey of amphibian breeding locations (including vernal pools). Some of these locations are mapped on National Wetland Inventory Maps but many are too small or temporary to have been mapped. The timing and flight conditions of the May 6 flyover combined to provide excellent visibility. The goal of this flyover was to locate pools on or near the proposed mine site. No pools were located on the ridge or in the woods to the west of the proposed site. This strongly suggests that the farm pools at Breton Farm (the proposed mine site) are very important for amphibian breeding, because there are no other pools in the woods or on the ridge. Photos from this flyover are included (Appendix B).

Ground surveys in this region consisted of searching for breeding sites while performing other amphibian survey methods at sites selected for other reasons. In the early spring (April-May) calling Wood frogs (*Rana sylvatica*) often lead surveyors to pools.

Results: reptiles and amphibians located, basic ecology, relative abundance, and ranks

Fifteen species of herptile were located in the area: six species of salamander, six species of frog (& toad), two species of turtle, and one species of snake. All of these sightings, with state ranks and statuses, the number of sightings (records) and the number of sites at which they were located are summarized in Table 1. A site in this table is defined as a location at least 0.5 kilometers distant from the nearest known location for the same species. Details regarding number of choruses, individuals, egg masses, and larvae are given in Table 2. Also included in this table are data regarding other species I found or heard in the area. No state or federally listed species were located, although Jefferson Salamanders (S2, SC, a rare species in Vermont) were located at three sites.

Six **caudate** (salamander) species were located in the project area. *Ambystoma maculatum* (Spotted Salamander) was the most frequently located salamander and the only

widespread salamander species at the site. I located adults and egg masses 16 times at 8 sites. This species was most often seen crossing the roads in early spring during night-time road searches, and uses the farm ponds at Breton Farm, the fen, and probably the margins of Danby Pond for breeding.

Four *Plethodon cinereus* (Eastern Red-backed Salamander) were located at four sites. This is the only salamander species in Vermont that does not require standing or running water. Hence it can be dispersed widely in woods well away from pools, ponds, and streams. This species is intolerant of flooding and low soil pH (Wyman and Hawksley-Lescault, 1987). Therefore, it was most often found in moist hardwood uplands with a deep litter layer. Because I did not spend as much time actively searching as I did doing night-time road searches, I did not locate as many *P. cinereus* as I did *A. maculatum*.

Seven *Notophthalmus viridescens* (Eastern Newt) were located at three different sites. Adults were seen only in the spring-fed pond on Old Otis Road, but the Red Eft (terrestrial) stage was occasionally located in the woods or along the roads.

Desmognathus fuscus (Dusky Salamander) was located six times at 3 sites. This species' habitat is along the margins of small streams and in or near seepage areas. The best habitat appears to be within hardwoods. Appropriate habitat occurred just west of Danby Pond in the stream running into it, in the spring feeding the pond on Old Otis Road, and in the stream running along the proposed road between North Hill and Raymond Roads.

Three *Ambystoma jeffersonianum* (Jefferson Salamander) were located at three sites. This species is similar to *A. maculatum* in that it uses vernal and semipermanent pools as breeding sites in the early spring, and otherwise spends much of its time in mature upland hardwoods. This species has a state rank of S2, meaning that it is rare, generally having 6 to 20 occurrences that are believed to be extant and/or having some factor(s) making it vulnerable to extirpation in the state. Although it is not listed as threatened or endangered in the state, it is considered a species of special concern by the Vermont Reptile and Amphibian Scientific Advisory Group. This label has no legal or regulatory status, but identifies species that the group feels may be at risk. In the Baker Brook region, a live specimen was found during a night-time road search near the lower ponds at Breton Farm (0.65 miles south on Old Otis Road from the intersection with Hoisington Crossroad, and 0.5 miles north of the intersection with Fisk Road). In addition, a dead *A. jeffersonianum* was found just south of the spring-fed pond on Old Otis Road (0.3 miles north of the intersection with Rickett's Road), and a live individual was found on Mountain View Road 0.35 miles west of the intersection with Danby-Tinmouth (East) Road. The location of the individuals near Breton Farm and south of the spring-fed pond strongly suggests that this species is using the woodlands to the west of Old Otis Road for foraging and overwintering.

Two *Eurycea bislineata* (Northern Two-lined Salamander) were located at two sites. It uses habitat similar to *D. fuscus* (well-oxygenated streams within hardwoods) and was therefore found at primarily the same sites as *D. fuscus*.

Other than *A. jeffersonianum*, none of these salamanders are rare in Vermont or the US. The Dusky Salamander (*Desmognathus fuscus*) is ranked as an S4 species. The other four (Spotted, Eastern Newt, Eastern Red-backed, and Northern Two-lined) are all S5 species in Vermont.

Six species of **anurans** (frogs and toads) were located in the project areas. *Pseudacris crucifer* (Spring Peeper) was recorded 76 times at 28 different sites and was the most frequently located herptile species. It is clearly widespread within the Baker Brook area; however, it is also among the easiest to locate as a result of its loud clear piercing call and long calling period. This species is more often heard then seen. Some reports of this species are of choruses which may include scores of individuals. It breeds in a variety of still waters from ditches to beaver dams.

Rana sylvatica (Wood Frog) was located at 19 sites as egg masses, tadpoles, adults, or choruses (35 records total). It was most often seen crossing the roads during spring night-

time road searches, but was occasionally heard calling or seen during active searches. Like the Spotted Salamander, it breeds in vernal and semipermanent pools, and beaver dams. After breeding, adults return to the woods to forage and overwinter.

Bufo americanus (American Toad) was located 40 times at 15 sites. It was often heard calling, and was occasionally seen on night-time road or active searches. It breeds in a variety of water types, and requires that the water be deep enough to allow the tadpoles to metamorphose into young toads before it dries up.

Rana clamitans (Green Frog) was located at 13 different sites (22 records), generally in the vicinity of Danby Pond, the fen, or other permanent water. It was occasionally found crossing the road, and was often heard calling. It breeds in still permanent water with surrounding vegetation but travels widely as long as it can stay moist. Green Frogs can not successfully breed in vernal pools since their tadpoles require two to three winters to mature, but young adults often can be found feeding in pools.

Hyla versicolor (Gray Treefrog) was located 20 times at eleven sites in the area. It was most often heard during night-time road searches in mid-June. It was also seen once on Mountain View Road. It is an arboreal species and hence it is very difficult to find during active searches. It is most easily located by its call.

Rana palustris (Pickerel Frog) was located at four different sites (8 records). This species likes dense annual vegetation near clean permanent water. Open beaver meadows or bog mats near ponds or lakes are often ideal habitat combinations. Its call is weak and is sometimes given from underwater so it is easy to miss with calling surveys. It was found in the spring-fed pond, and was seen crossing the roads occasionally during night-time road searches. The Pickerel Frog state rank was recently changed (January 1997) to an S4.

All the anuran (frog) species located other than *R. palustris* are listed as S5 species in Vermont. Additional information on the field marks, habitat, and natural history of all Vermont amphibians is contained in Appendix C.

Reptiles are rarely as abundant as amphibians in Vermont. As expected they were located much less frequently. On a landscape scale, reptile diversity usually increases as you move down drainage. Danby Pond was the most appropriate Painted and Snapping Turtle habitat in the area. In addition, there was a possibility of finding some of the rare turtle species in the area of the fen, which was trapped and actively searched. The Spotted Turtle (*Clemmys guttata*, S1, Endangered) has been located in two towns in the south-east corner of Vermont, and recently in a third town (Arlington) in the south-west corner of the state. It is possible that this turtle could be found in the fen, which is appropriate habitat for it. The Bog Turtle (*Clemmys muhlenbergii*) has never been reliably reported from Vermont, but is found just to the south and west of us in Massachusetts and New York, and therefore is also a possibility for the fen. The other rare species (S3, SC) I expected to find in the fen is the Wood Turtle (*Clemmys insculpta*). During my active searches and turtle trapping, I found none of these three rare species, although (as described later) Eric Sorenson reported a Wood Turtle from the southern fen area.

Chrysemys picta (Painted Turtle) was located at Danby Pond. The Painted Turtles were relatively abundant in the pond, as established by trapping success (0.8 Painted Turtles per trap per night). This aquatic turtle is often seen basking on logs near the water's edge to warm up its body temperature, but otherwise spends most of its time in the water. It lays its eggs on land, ideally in sandy or soft soils.

Chelydra serpentina (Snapping Turtle) was also located in Danby Pond. This species is almost entirely aquatic except when laying its eggs. It is rugged and adaptable. It inhabits all types of permanent water. Both of these turtles are S5 species in Vermont.

One species of **snake** was confirmed in the area. *Thamnophis sirtalis* (Common Gartersnake) was located four times at four sites. This species is by far the most abundant and adaptable snake species in Vermont and hence has a state rank of S5. It was most often seen on the road during night-time road searches, although was also located during an active

search. It is very probable that other snake species would be found in the area if timing (being able to search in the fall) and budget allowed more searching. As it was, the amount of effort put in to looking for snakes was inadequate to locate all species in the area.

Table 1. Combined results of the reptile and amphibian inventory of the Baker Brook region in Danby and Tinmouth, Vermont. Records are from 12 days between April 6, 2001 and June 21, 2001. Six field methods were used: active searches, interviews, night-time road searches, salamander trapping, site checks, and turtle trapping. For exact locations of species found, see Appendix A.

Species name	Common name	State Rank	State Status	# of records	# of sites
Salamanders					
Ambystoma maculatum	Spotted Salamander	S5		16	8
Plethodon cinereus	E. Red-backed Salamander	S5		4	4
Notophthalmus viridescens	Eastern Newt	S5		7	3
Desmognathus fuscus	N. Dusky Salamander	S4		6	3
Ambystoma jeffersonianum	Jefferson Salamander	S2	SC	3	3
Eurycea bislineata	N. Two-lined Salamander	S5		2	2
Frogs and Toads					
Pseudacris crucifer	Spring Peeper	S5		76	28
Rana sylvatica	Wood Frog	S5		35	19
Bufo americanus	American Toad	S5		40	15
Rana clamitans	Green Frog	S5		22	13
Hyla versicolor	Gray Treefrog	S5		20	11
Rana palustris	Pickerel Frog	S4		8	4
Turtles					
Chrysemys picta	Painted Turtle	S5		5	1
Chelydra serpentina	Snapping Turtle	S5		2	1
Snakes					
Thamnophis sirtalis	Common Gartersnake	S5		4	4

Table 2. Detailed results of the reptile and amphibian inventory of the Baker Brook region in Danby and Tinmouth, Vermont. Records are from 12 days between April 6, 2001 and June 21, 2001. Six field methods were used: active searches, interviews, night-time road searches, salamander trapping, site checks, and turtle trapping. For exact locations of species found, see Appendix A.

Species name	State Rank	State Status	Choruses	Individuals	Egg-masses	Larvae
Salamanders						
Ambystoma maculatum	S5			21	2	
Plethodon cinereus	S5			8		
Notophthalmus viridescens	S5			12		
Desmognathus fuscus	S4			8		
Ambystoma jeffersonianum	S2	SC		3		
Eurycea bislineata	S5			3		
Frogs and Toads						
Pseudacris crucifer	S5		47	39		
Rana sylvatica	S5		2	67	7	>100
Bufo americanus	S5		21	27		
Rana clamitans	S5		4	25		
Hyla versicolor	S5		16	5		
Rana palustris	S4			14		
Turtles						
Chrysemys picta	S5			4		
Chrysemys serpentina	S5			2		
Snakes						
Thamnophis sirtalis	S5			4		
Other Species						
Song sparrow, Swamp sparrow, Yellow warbler, Yellow-rumped warbler, Nashville warbler, Wood thrush, Winter wren, Ovenbird (and nest with eggs), Yellow-bellied sapsucker (and nest with young), Warbling vireo, Red-eyed vireo, Killdeer, Spotted sandpiper, Red-winged blackbird, Eastern kingbird, Least flycatcher, Mourning dove, Canada goose, Common snipe, American woodcock, Barred owl, Eastern cottontail, Gray fox, Striped skunk, Caddisfly sp., Snail sp. (aquatic), Predaceous diving beetle (*Dytiscus sp.*)						

Species reliably reported from surrounding towns but not located during the survey

Reliable reports of six additional species are found from Danby, VT in the Vermont Herp Database: one record of *Clemmys insculpta* (Wood Turtle – S3), three records of *Gyrinophilus porphyriticus* (Spring Salamander – S5), four records of *Diadophis punctatus* (Ring-necked Snake – S5), one record of *Lampropeltis triangulum* (Milksnake – S5), one record of *Opheodrys vernalis* (Smooth Greensnake – S4), and one record of *Storeria occipitomaculata* (Red-bellied Snake – S5). A Wood Turtle was seen by Eric Sorenson on June 26, 2001 near Baker Brook in the southern fen area (located in Appendix A, last map). This rare S3 species of special concern overwinters and takes refuge in streams with sand or gravel bottoms. It spends a great deal of time feeding on land up to 250 m or more from the river (Parren 2000, unpub. data). The attached factsheet (Appendix D) gives more information regarding this turtle. The Spring Salamander lives in streams (or springs), as its name suggests, and prefers cool, well-oxygenated waters. The slow-moving water of the fen is not likely to contain this species, but brooks on steeper slopes may. Milksnakes and Smooth Greensnakes were reported during interviews with landowners in the area, in addition to being previously reported in the database. The Smooth Greensnake prefers upland pastures and overgrown fields, of which there are plenty in the region. The Milksnake is often found around old foundations, barns, and rock walls, and could easily be found in the area. The Red-bellied Snake is a secretive woodland species, and the Ring-necked Snake is often found in rockpiles or rock walls. All of these snake species do best in habitat with small openings and abundant amphibian or invertebrate prey species. Hence, any of them could feasibly be found in the Baker Brook Region. It is probable that with more work, especially active searching and driving the roads in the fall when snakes are migrating from feeding to overwintering habitat, I would find the above species.

Records from nearby towns that could possibly be found in the Baker Brook region include *Storeria dekayi* (Dekay's Brownsnake – S4), *Thamnophis sauritus* (Eastern Ribbonsnake – S2), and *Hemidactylum scutatum* (Four-toed Salamander – S2). *S. dekayi* has been reported from Clarendon and Wells, *T. sauritus* from Wells and Mt. Tabor, and *H. scutatum* from Wells. These species are primarily lowland species, but could possibly be in the Baker Brook region.

The other species that I might have expected to see or hear but did not is *Rana catesbeiana* (American Bullfrog – S5). Danby Pond looked like ideal habitat for this species, and if it was there I should have either heard or seen it, as I was doing night-time road searches during ideal calling periods.

Another species that has been reported from a surrounding town is *Coluber constrictor* (Eastern Racer – S1, SC). It was reported by a reliable source in 1983 from Mt. Tabor. This and any other large black snake would be of great interest as both *C. constrictor* and our other black snake, *Elaphe obsoleta* (Eastern Ratsnake), have state ranks of S1 and S2 respectively, both are of special concern, and the Eastern Ratsnake has been proposed for threatened status. Local homeowners should keep their eyes open for any black snake and send reports to the Vermont Herp Atlas.

It is not possible to prove the absence of rare species that I did not find. It is still possible that species other than those mentioned above exist in low numbers in the area. However, given the distribution and amount of field effort combined with interviews of individuals who have spent a great deal of time in the area, it is unlikely that species not already discussed have viable populations within the region. A list of all known Vermont species of reptiles and amphibians along with their protective status and state ranks is contained in Appendix E.

Interested people who live in the area can easily help locate species that I may not have found in my limited search time on the ground. Getting people interested in and looking for herptiles can be accomplished by doing a slide show and/or field trip in the area. This increases peoples' awareness to what they see around them, and to the fact that what they

see may be important. One method that residents could use to help bolster the weak snake data is to drive the roads during the day in the fall. During this time, snakes often have to cross roads to migrate from feeding to overwintering habitat, and are often found alive and dead on the road.

Conservation (herps)

The only S2 species that is known to use the area is ***A. jeffersonianum* (Jefferson Salamander)**. In Vermont it is a species of special concern. I fear that if the rate of habitat consumption in this state continues (6,500 acres per year, EPA figures), increased habitat fragmentation and traffic will increase the pressures on this species and slowly eliminate populations. Clearing, further development, and roads are threats to this and other herptile species. The other species of special concern in the area is ***C. insculpta* (Wood Turtle–S3)**. Mike Klemens (2000) points out that among the many threats worldwide to turtles, the primary threats to this species are habitat destruction, fragmentation, and illegal collection. In the Baker Brook region, development in the area and increased traffic and number of roads are potential threats to this species.

The **clearing** that has taken place so that the mining can occur destroys important upland hardwood habitat for many herptiles. Many studies have examined the relationships between different timber management practices and amphibian richness and abundance (see review by deMaynadier and Hunter 1995). Most work supports the finding that amphibian richness and abundance decrease with clearcuts and similar shelter wood cuts (Ash 1988, Howard and Caschetta 1999, Petranka et al. 1993) but gradually return to pre-cut levels with time (60 to 120 years) as long as source populations and travel corridors are maintained intact. deMaynadier and Hunter (1998) also showed that these declines extend 25-35 m beyond the edges of the affected area cut. General recommendations for the maintenance of reptile and amphibian habitat relative to timber harvesting practices are included in the handout Forest Management Practices to Minimize the Negative Impacts on Vermont Reptiles and Amphibians. I have included a copy (Appendix F).

The Jefferson Salamander, like most other herptiles, requires (in addition to its breeding sites) wooded upland areas in which it overwinters and forages. These breeding sites and overwintering sites must be connected in order to ensure the survival of the population. The destruction of woodland areas not only directly decreases the amount of suitable habitat available to such species as the Jefferson Salamander, but also fragments the habitat, making it harder for the species to move between breeding and overwintering sites. The Jefferson Salamander found on the road near Breton Farm suggests that this species was using the pond near the road as a breeding site, and using the woodlands to the west of this as an overwintering site. Further clearing of these woodlands would cause declines in this S2 species.

Clearing not only directly affects the woods and those species that use them, but also indirectly affects species that require vernal or semipermanent pools in which to breed (such as the Jefferson Salamander, Wood Frog, and Spotted Salamander). **Vernal pools** are the result of a fine balance between the amount of water received and the rate at which it is lost. If they are exposed to more sunlight than they normally receive, they may evaporate too fast to provide habitat through metamorphosis in June or July. Hence it is important that these pools remain shaded (if in the shade at present) and that the drainage is not altered in such a way as to prevent them from receiving and/or holding as much run-off. A minimum 30 m **buffer** of uncut trees should be left to conserve shade.

The need to maintain such buffer strips around pools is clear but sometimes obscures the equally important concept of protecting foraging and overwintering habitat for the species that breed in those protected water bodies. Semlitsch (1998) reviewed travel distances of many amphibian species and determined that a protected distance of 164.3 m would include 95% of the salamander population using a given pond. This is clearly short, however, of the total distance traveled by *R. sylvatica* and *N. viridescens*, and does not consider recolonization distances. Amphibians breeding in the pools may be coming from as far away as 400 meters. deMaynadier and Hunter (1995) recommend that no more than 25% of the basal area should be cut in a 100 m 2nd-tier buffer that extends beyond the no-cut zone around a pool.

Heavy equipment should be kept out of the pools and they should not be filled with debris. Fish should not be introduced into any pools, beaver ponds or lakes that have significant breeding populations of spring breeding amphibians. The introduction of salmonids in the western US to high elevation lakes has been shown to be the cause of precipitous declines of both salamanders and frogs (Gillespie and Hero 1999).

As a result of their moist permeable skin, amphibians absorb water, and any substance that is dissolved in it, directly through their skin. Any species that feed upon amphibians, such as herons, raccoons, and snakes, can then be affected by these chemicals as well. Although many **biocides** have been shown to be toxic to amphibians (Power et al. 1989), the short-term toxic effects of most chemicals (herbicides, pesticides, fungicides, etc.) have not been tested on amphibians. The long-term and/or sublethal effects are almost never tested prior to commercial use. Information regarding the effects of different biocides on amphibians and reptiles may be found at www.on.ec.gc.ca/herptox/. The proposed reclamation area is close enough to the pond/brook that any runoff with biocides or other chemicals in it could potentially affect the large number of amphibians using the area. In addition, runoff from the site could potentially affect the important breeding pools at Breton Farm. Jefferson Salamanders are not tolerant of habitat acidification. The number of eggs that adults deposit, and egg and larval survival rates are correlated with water acidity (Petranka 1998). Changes to these pools could potentially affect the population viability of the Jefferson Salamander and other amphibian species.

In the Baker Brook region, there is a high diversity of amphibians and reptiles. One of the reasons for this diversity is the current connectivity of habitat types; herptiles can easily move between overwintering, breeding, and foraging grounds. They can move relatively freely through or around private and agricultural lands, and the amount of direct road mortality is relatively low. As mentioned earlier, as **development** (and clearing) increases, so does the fragmentation of the habitat, making it more and more difficult for these species to move to and from their required habitats. Not only does increased development affect an individual herptile moving from one habitat type to another, it can also affect an entire population. As patches of suitable habitat are destroyed or broken into smaller and smaller pieces, local diminished populations die off, and recolonization and immigration (the ability of an existing population to "rescue" the declining or extinct population) decreases. As cited in Sjogren 1991, "the fragmentation process poses a twofold extinction threat at local and regional levels. In addition to the increased risk of extinction following the reduction in population size, increased isolation of the remaining populations beyond a critical degree is likely to increase the risks of local and regional extinction further" (Sjogren 1991, 144). Therefore, "reserves should include sets of interconnected local populations and vacant suitable habitats, or be located in groups so that connectivity is achieved" (Sjogren 1991, 144). The mining proposed by OMYA is a step down the road of further development and habitat fragmentation, which could easily lead to decreased population viability of the Jefferson Salamander, the Wood Turtle, and other herptiles.

The development in the area of Breton Farm would destroy the farm pools used as breeding sites by Jefferson Salamanders and a wide variety of other amphibians, including Gray Treefrogs, Green Frogs, Spring Peepers, and American Toads. Because no pools were located on the ridge or in the woods during the flyover of the area, it is very probable that these farm pools are important breeding sites. Destroying them or changing them would cause a decline in the Jefferson Salamander population in the area.

In addition to the clearing and fragmentation of habitat, **direct road mortality** is a problem for many herptiles, including Jefferson Salamanders. I found one Jefferson dead on the road just south of the spring-fed pond on Old Otis Road. I also found two live Jeffersons on the roads. These salamanders were moving from wintering areas to breeding pools on the first rainy nights of spring. With increased road traffic (from both trucks and workers) and numbers of roads, the chances of road mortality of the spring-breeding Jeffersons are much greater. Again, even if the farm pools were left intact for breeding, adult Jeffersons using the

pool and young leaving the pool in late summer would be affected by the increased traffic in the area. Ideally, traffic on these roads would be limited, especially in early spring (April through early May nights), and no new roads would be built. This would at least limit adult mortality in the spring, although young would still need to leave the ponds in June to August. Direct road mortality is a large problem for Wood Turtles, because they spend much of their time foraging on land. The Wood Turtles using the fen area wander up and down the Baker Brook drainage as far as 250 meters from the stream. This would easily put them close to the roads in the area. Increased traffic on these roads would increase direct road mortality, and decrease Wood Turtle populations. The Wood Turtle is a long lived, low reproductive capacity species (it lives up to 40 years in wild populations, Lovich et al. 1990, and does not breed until it reaches an age of ~14 years, Ernst et al. 1994). The removal of one or two breeding adults per year would be enough to cause a decrease in the population.

During my night-time road searches eight species of herps were found dead in the road including seventeen *R. sylvatica* (Wood Frog) (of which 13 were killed in one night), four *B. americanus* (American Toad), and two *T. sirtalis* (Common Gartersnake). Many of these dead herptiles were found on Danby-Tinmouth Road, although some were also found on Mountain View, Old Otis, and Colvin Hill Roads.

The building of the **proposed road** between North Hill Road and Raymond Road could be a threat to a variety of herptiles. This area contains at least six species of herptiles (found during an active search). Along the path and in the woods I found American Toads (*Bufo americanus*), Wood Frogs (*Rana sylvatica*), the red eft stage of Eastern Newts (*Notophthalmus viridescens*), and Eastern Red-backed Salamanders (*Plethodon cinereus*). A Spring Peeper (*Pseudacris crucifer*) was heard calling from this area (the east side of North Hill Road). In the stream that runs alongside the proposed road, both Northern Two-lined Salamanders (*Eurycea bislineata*) and Northern Dusky Salamanders (*Desmognathus fuscus*) were found. All of these species have a state rank of S5, except for the Northern Dusky, which has a rank of S4. The proposed road would probably cross or at least disturb the stream, interrupting the habitat and egg-laying sites of both of these stream salamanders. Sedimentation of streams diminishes the abundance and diversity of salamanders present (Bury and Corn, 1988 and Corn and Bury, 1989) and the effects may last for many years. Among other effects, silt fills the spaces in stream beds where larval amphibians hide and feed.

In addition to the effects of the proposed road on the stream, the road could affect pools in the area. An ephemeral pool (that fills then dries early in the spring) was found to the north of the proposed road, in a slight valley between two hills. Nothing was found in this dried-up pool, but it is possible that on a wetter year it could hold water long enough to be a breeding site for amphibians, and could be affected by the road-building. A semi-permanent pool was discovered just north of the proposed road site, on the west side of North Hill Road. This pool was not actively searched, but Green Frogs (*Rana clamitans*) were heard calling from it, suggesting that it is an important breeding site. From personal experience, a semipermanent pool such as this is often more productive than a vernal pool, and could serve as a breeding site for a wide variety of species. Pools are essential for maintaining herptile diversity and population viability. As Semlitsch and Bodie (1998) concluded, "small, isolated wetlands are extremely valuable for maintaining biodiversity, [and] the loss of small wetlands will cause a direct reduction in the connectance among remaining species populations" (Semlitsch & Bodie 1998, 1129). The proposed road in this area could potentially affect a wide variety of species that use the stream, woods, or pools as egg-laying and/or foraging sites.

<u>Road impacts on herptiles in general</u>

If the interests of local wildlife populations were our primary and only concern, traffic on roads in the area would be limited and controlled. Road mortality is a serious threat to a wide variety of wildlife through direct mortality, migrational barriers, hydrologic disruption,

pollution, construction impacts, spread of exotics, and increased human usage (Trombulak and Frissell, 2000). Much of the February 2000 issue of Conservation Biology is dedicated to the ecological effects of roads and a variety of websites have sprung up with useful bibliographies (see End of the Road: www.nrdc.org/publications). As traffic increases, so do the negative effects on local amphibian densities (Fahrig et al, 1995). Heine (1987) calculated that 26 cars per hour could reduce the survival rate of toads crossing roads to zero.

Ideally, development and traffic in the area would be limited in order to maintain herptile biodiversity and population viability. If traffic cannot be limited and/or new roads are built, properly designed **amphibian tunnels** built under roads can guide young and adult amphibians under roads. This involves the combined use of fencing or walls and underpasses for reptiles, amphibians, (Langton 1989) and some small to medium sized mammals. Underpasses have been very effective when carefully designed and strategically placed. I would suggest additional studies to locate and evaluate movement corridors of the most sensitive species or greatest numbers of species. The largest amount of amphibian movement across roads seems to occur on the east side of Danby Pond (on Danby-Tinmouth Road), and this seems like the most reasonable place for an underpass. Showcasing wall and underpass technology would be useful in Vermont but only if the underpasses were used. Websites with additional information on wildlife underpasses are listed below. They are expensive. The design that makes the most sense based on my experience and observations would be that used in Payne's Prairie in Florida (reptile wall and culverts). The continuous wall is a valuable addition to the design and it is aesthetically more pleasing than a fence.

Critter Crossings (Federal Highway Administration)
www.fhwa.dot.gov/environment/wildlifecrossings/index.htm
see the chapters on Tortoise Underpasses, Salamander Tunnels, and Amphibian-Reptile wall and culverts

Proceedings of the Third International Conference on Wildlife Ecology and Transportation (Florida Dept. of Transportation)
www.dot.state.fl.usemo/sched/icowet_III_pdf

Other construction-related threats are amphibian **breeding traps**. These can result when pools are created in gravel pits, construction sites, or road beds that hold water long enough to entice amphibians to breed but not long enough for the young to metamorphose. Even if these pools hold water through the time of metamorphosis, some of them are too frequently disturbed by vehicles to produce metamorphs. The drainage of man-made pools that are frequently disturbed (road beds) should be altered so that they do not gather any water in the spring. Pools could also be created in areas that are not disturbed. I don't suggest this as a method to replace significant pools but as a way to enhance amphibian breeding at disturbed sites such as old logging headers. If so, care should be taken to make sure they are deep enough to hold water through July of most years (>70 cm).

Other concerns with road design that are not presently an issue here but that planners should be aware of is that high curbs trap amphibians on roads and storm drains, if not carefully designed, act as **pit traps**. Alternative designs for storm drains are available were they proposed in this region. Vertical walled mines would also act as large pit traps. Amphibians would fall in but not be able to return to foraging and overwintering habitat. Young would be unable to emerge and colonize the area.

Other options to minimize road impacts on herptiles in critical areas include signage to alert traffic to wildlife of all types and to ask drivers to avoid or assist wildlife crossing roads, lowered speed limits, speed control bumps, narrowing of roads, removal of blacktop, closing of roads after dark or on rainy evenings after dark, limiting the amount or type of vehicles (bicycles instead of cars), and hiring or training volunteers to act as conservation officers.

Clearly, the impact on wildlife of building, improving, or relocating roads should be taken into consideration and the effects of increased traffic flow should also be taken into account.

Summary of potential impacts of the mine site on herptile populations

The direct development at the mine site has the potential to affect a wide variety of species, especially those using the pools at Breton Farm as breeding sites. Destruction or alteration of these pools, without other pools available in the woodlands to the west of the site, would most likely decrease herptile population viability in the area. Habitat fragmentation caused by the development of the mine site would make it harder for species such as Jefferson Salamanders to move between the variety of habitat types required for survival. Clearing of the woodlands surrounding the mine site would directly reduce the amount of habitat available for overwintering and foraging for a wide variety of species. The possibility of lowered water quality caused by runoff from the mine site could affect a wide variety of herptile species using the Baker Brook region. The building of new roads in the Baker Brook region and increased traffic associated with the mine site would increase direct road mortality of Jefferson Salamanders, Wood Turtles, and other herptile species. Such roads would also contribute to habitat fragmentation and increase sedimentation in streams, thereby limiting stream salamander populations. There is a possibility of creating amphibian breeding traps in roads and pit traps in vertical walled mines, thereby limiting juvenile recruitment and adult survival. Overall, the mine site and the related development in the Baker Brook region have the potential to negatively impact many herptile species, including rare species.

General thoughts on conservation design from the herp perspective

Most mobile species use a variety of community types over the course of the year and over the course of their lives. In addition, they need to be able to recolonize areas where populations have been eliminated due to drought, winter kill, disease, or anthropogenic forces. They need to be able to find alternative cover, food sources, breeding, or overwintering sites when natural disasters occur. Genetic diversity also needs to be maintained by allowing different populations to interact. Permeability is a term that I think should be used when thinking of the ability of a species to move comfortably across the landscape. Does the intended use leave the landscape permeable to the wide variety of species you wish to maintain? When details about the permeability of landscape uses are not known for many species, I believe that the safest and most logical way to proceed to maintain natural biodiversity is to maintain a network of interconnected sites where natural processes are allowed to occur. This network currently exists in the Baker Brook region, where populations are separated only by the occasional road that has relatively little traffic. However, further development in the area (the building of new roads and structures, the increase of traffic, and clearing) could potentially impact a wide variety of herptile species, by direct road mortality, loss of habitat, and habitat fragmentation and alteration. Not all human uses need to be curtailed in the region but they simply should not interfere with the regular movement of species. Then, Jefferson Salamanders will be able to move without harm from breeding to overwintering grounds, and Eastern Red-backed Salamanders will be able to travel through moist deep deciduous leaf litter under a mature canopy of trees.

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Trombulak, S.C., and C.A. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14:18-30.

Wyman, R. L., and D. Hawksley-Lescault. 1987. Soil acidity affects distribution, behavior, and physiology of the salamander *Plethodon cinereus*. Ecology 68: 1819-1827.

Other Useful Sources of Information on New England Reptiles and Amphibians

Identification. A few good field guides to reptiles and amphibians exist. These help you identify herptiles but do not give you life history information. One that is easy to find, and up to date is:

Conant, R., and J.T. Collins. 1998. A field guide to reptiles and amphibians of Eastern and Central North America. Third Edition, expanded, Houghton Mifflin Company, Boston Massachusetts 616 pp.

Natural History. These guides focus less on identification and more on natural history, local distribution, and conservation.

DeGraaf, R.M., and D.D. Rudis. 1983. Amphibians and reptiles of New England. The University of Massachusetts Press, Amherst, Massachusetts 85 pp.

Harding, J.H. 1997. Amphibians and reptiles of the Great Lakes Region. The University of Michigan Press, Ann Arbor, Michigan 378 pp. (Lake Champlain is part of the Great Lakes Drainage so we share most of the same species.)

Hunter, M.L., A. Calhoun, and M. McCullough (eds.). 1999. Maine amphibians and reptiles. The University of Maine Press, Orono, Maine 272 pp. (This edition includes a CD of local frog calls. Call 207-581-1408 to order.)

Klemens, M.K. 1993. Amphibians and reptiles of Connecticut and adjacent regions. State Geological and Natural History Survey of Connecticut, Bulletin No. 112 318 pp. (call 203-566-7719 to order)

Tyning, T.F. 1990. A guide to amphibians and reptiles. Little, Brown and Company. Boston Massachusetts 400 pp.

Calls. A very useful tape to help you learn the calls of frogs and toads is:

Eliot, L. 1992. The calls of frogs and toads; Eastern and Central North America. Nature Sound Studio. Ithaca New York.
(call 1-800-336-5666 to order)

Websites. Many useful sites exist. Some provide more reliable information than others. A few reliable sites to get you started:

North American Amphibian Monitoring Program (NAAMP).
http://www.im.nbs.gov/amphibs.html

North American Reporting Center for Amphibian Malformations (NARCAM).
http://www.npsc.nbs.gov/narcam/

Society for the Study of Amphibians and Reptiles (SSAR).
http://falcon.cc.ukans.edu/~gpisani/SSAR.html

The Snakes of Massachusetts (a useful identification key).
http://klaatu.oit.umass.edu/umext/snake/

Additional Reading on Reptiles and Amphibians

Amphibians

Bishop, S.C. 1941 (June). The Salamanders of New York. New York State Museum Bulletin No. 324. The University of the State of New York, Albany, New York 365 pp. (This book is currently out of print, but contains excellent information on Vermont's salamanders.)

Bishop, S.C. 1994. Handbook of Salamanders: The Salamanders of the United States, of Canada, and of Lower California. Comstock Publishing Associates, A Division of Cornell University Press, Ithaca, New York 555 pp. (A reprint of an old classic. It does not contain as much information on each species as The Salamanders of New York.)

Dickerson, M.C. 1969. The Frog Book: North American Toads and Frogs, with a Study of the Habits and Life Histories of those of the Northeastern States. Dover Publications, Inc., New York 253 pp. (A reprint of an old classic. Still excellent information but some of it is outdated. No newer comprehensive works on frogs are available.)

Epple, A.O. 1983. The Amphibians of New England. Down East Books, Camden, Maine 138 pp. (A good book for the beginner but without plates or photos.)

Petranka, J.W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC 587 pp. (The most current source for detailed information on salamanders).

Pfingsten, R.A. and F.L. Downs. 1989. Salamanders of Ohio. Bulletin of the Ohio Biological Survey Vol. 7, No. 2. College of Biological Sciences, The Ohio State University, Columbus, Ohio 315 pp, 29 plates. (This contains detailed information on the many species of salamander that we share with Ohio.)

Wright, A.H. and A.A. Wright. 1995. Handbook of Frogs and Toads of the United States and Canada. Comstock Publishing Associates, A Division of Cornell University Press, Ithaca, New York 640 pp. (A reprint of an old classic. No newer comprehensive works on frogs are available.)

Reptiles

Carr, A. 1995. Handbook of Turtles: The Turtles of the United States, Canada, and Baja California. Comstock Publishing Associates, A Division of Cornell University Press, Ithaca, New York 542 pp. (A reprint of an old classic.)

Ernst, C.H. and R.W. Barbour. 1989. Snakes of Eastern North America. George Mason University Press, Fairfax, Virginia. 282 pp. (The best current source for detailed information.)

Ernst, C.H., J.E. Lovich, and R.W. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington 578 pp. (The best current source for detailed information.)

Klauber, L.M. 1982. Rattlesnakes: Their Habits, Life Histories, & Influence on Mankind, Abridged Edition. University of California Press, Berkeley and Los Angeles, California 350 pp. (An edited reprint of an old classic.)

Klemens, M. (ed.) 2000. Turtle Conservation. Smithsonian Institution Press. Washington 334 pp. (A current discussion of conservation challenges.)

Mitchell, J.C. 1994. The Reptiles of Virginia. Smithsonian Institution Press, Washington 352 pp. (This book provides excellent information on the species of reptile that we share with Virginia; most of our species are found in this book.)

Smith, H.M. 1995. Handbook of Lizards: Lizards of the United States and Canada. Comstock Publishing Associates, A Division of Cornell University Press, Ithaca, New York 557 pp. (A reprint of an old classic.)

Wright, A.H. and A.A. Wright. 1994. Handbook of Snakes of the United States and Canada, Volumes 1 and 2. Comstock Publishing Associates, A Division of Cornell University Press, Ithaca, New York 1105 pp. (A reprint of an old classic.)

Texts

Duellman, W.E. and L. Trueb. 1994. Biology of Amphibians. The Johns Hopkins University Press, Baltimore, Maryland 670 pp. (The standard text for amphibians.)

Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L-A. C. Hayek, and M.S. Foster. 1994. Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians. Smithsonian Institution Press, Washington 364 pp. (Useful information for researchers.)

Mitchell, J.C. 2000. Amphibian Monitoring Methods and Field Guide. Smithsonian National Zoological Park's Conservation & Research Center, Front Royal, Virginia 56 pp. (Very accessible, designed for citizen scientists.)

Stebbins, R.C. and N.W. Cohen. 1995. A Natural History of Amphibians. Princeton University Press, Princeton, New Jersey 316 pp. (Lots of interesting information in an accessible and easy to read format.)

West, L. and W.P. Leonard. 1997. How To Photograph Reptiles & Amphibians. Stackpole Books, Mechanicsburg, Pennsylvania 118 pp.

Zug, G.R. 1993. Herpetology: An Introductory Biology of Amphibians and Reptiles. Academic Press, A Division of Harcourt Brace & Company, San Diego, California 527 pp. (A standard text.)

Novels

Phillips, K. 1994. Tracking the Vanishing Frogs: An Ecological Mystery. St. Martin's Press, New York 244 pp. (A good background read on amphibian decline.)

Other Regional Atlases

Bider, J.R. and S. Matte. 1996. The Atlas of Amphibians and Reptiles of Quebec. St. Lawrence Valley Natural History Society and Ministere de l'Environnement et de la Faune du Quebec, Direction de la faune et des habitats, Quebec 106 pp.

Taylor, J. 1993. The Amphibians and Reptiles of New Hampshire with Keys to Larval, Immature and Adult Forms. Nongame and Endangered Wildlife Program, New Hampshire Fish and Game Department, Concord, New Hampshire 71 pp. (Contains some simple and useful keys.)

Appendix A

Maps of Herptiles and Pools Found in the Baker Brook Region, April 6-June 21, 2001

Key to Abbreviations Used on Maps

Abbreviation = Species Name (Common Name)	State Rank	State Status
A. ma = *Ambystoma maculatum* (Spotted Salamander)	S5	
A. je = *Ambystoma jeffersonianum* (Jefferson Salamander)	S2	SC
B. am = *Bufo americanus* (American Toad)	S5	
C. pi = *Chrysemys picta* (Painted Turtle)	S5	
C. se = *Chelydra serpentina* (Snapping Turtle)	S5	
D. fu = *Desmognathus fuscus* (Northern Dusky Salamander)	S4	
E. bi = *Eurycea bislineata* (Northern Two-lined Salamander)	S5	
H. ve = *Hyla versicolor* (Gray Treefrog)	S5	
N. vi = *Notophthalmus viridescens* (Eastern Newt)	S5	
P. ci = *Plethodon cinereus* (Eastern Red-backed Salamander)	S5	
P. cr = *Pseudacris crucifer* (Spring Peeper)	S5	
R. cl = *Rana clamitans* (Green Frog)	S5	
R. pa = *Rana palustris* (Pickerel Frog)	S4	
R. sy = *Rana sylvatica* (Wood Frog)	S5	
T. si = *Thamnophis sirtalis* (Common Gartersnake)	S5	

Arrows indicate the direction from which the amphibians were heard.

Vermont Nongame & Natural Heritage Program

Department of Fish & Wildlife

Explanation of Legal Status & Information Ranks

State Status: As per the Vermont Endangered Species Law

E:	Endangered--In immediate danger of becoming extirpated in the state.
T:	Threatened--High possibility of becoming endangered in the near future.

Information Categories: Not established by law

PE:	Proposed for endangered.
PT:	Proposed for threatened.
SC:	Special Concern--rare; status should be watched.

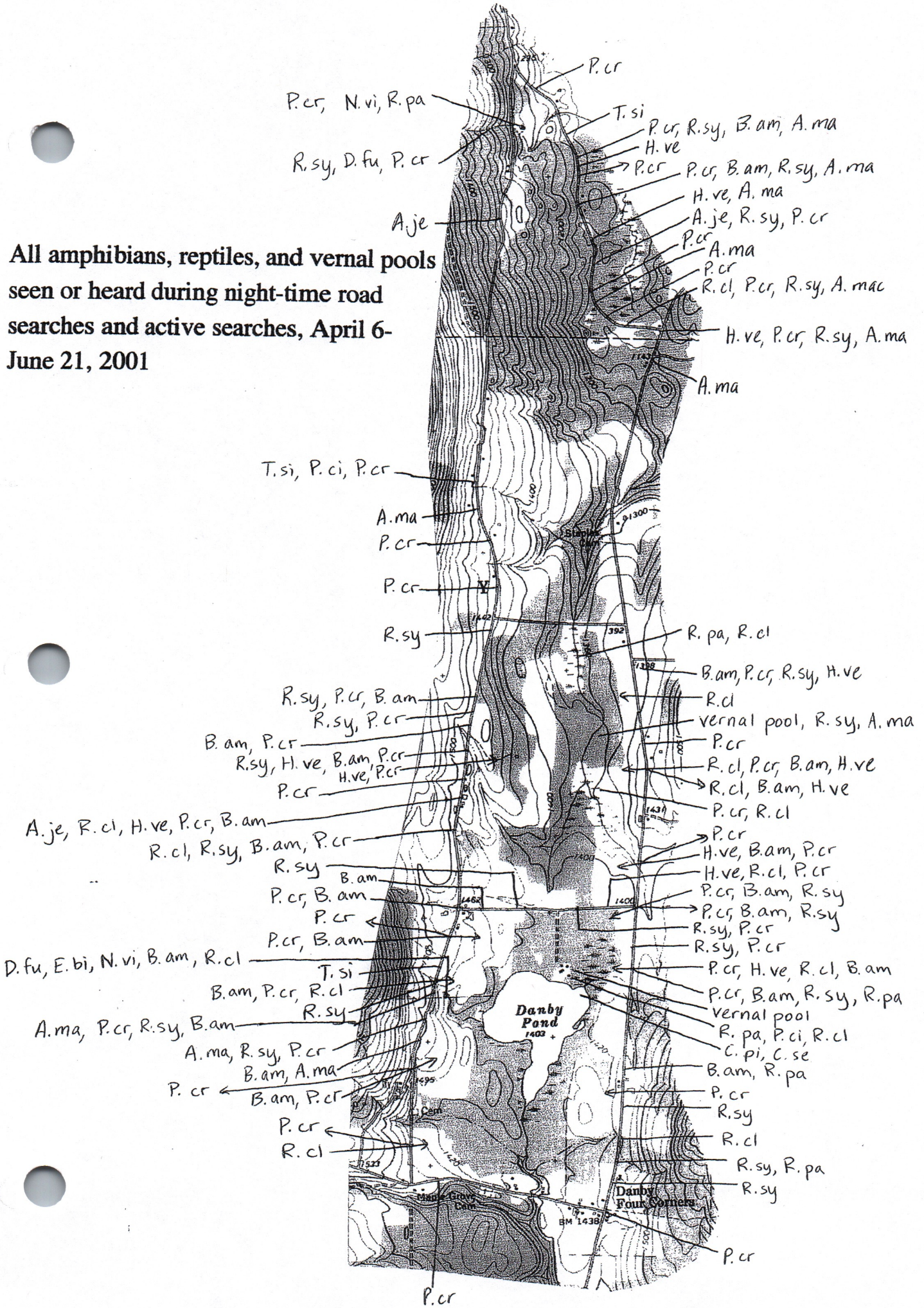
State Ranks of Plants, Animals, and Natural Communities

State ranks are assigned by the Nongame & Natural Heritage Program based on the best available information. They are not established by law. Ranks are reviewed annually.

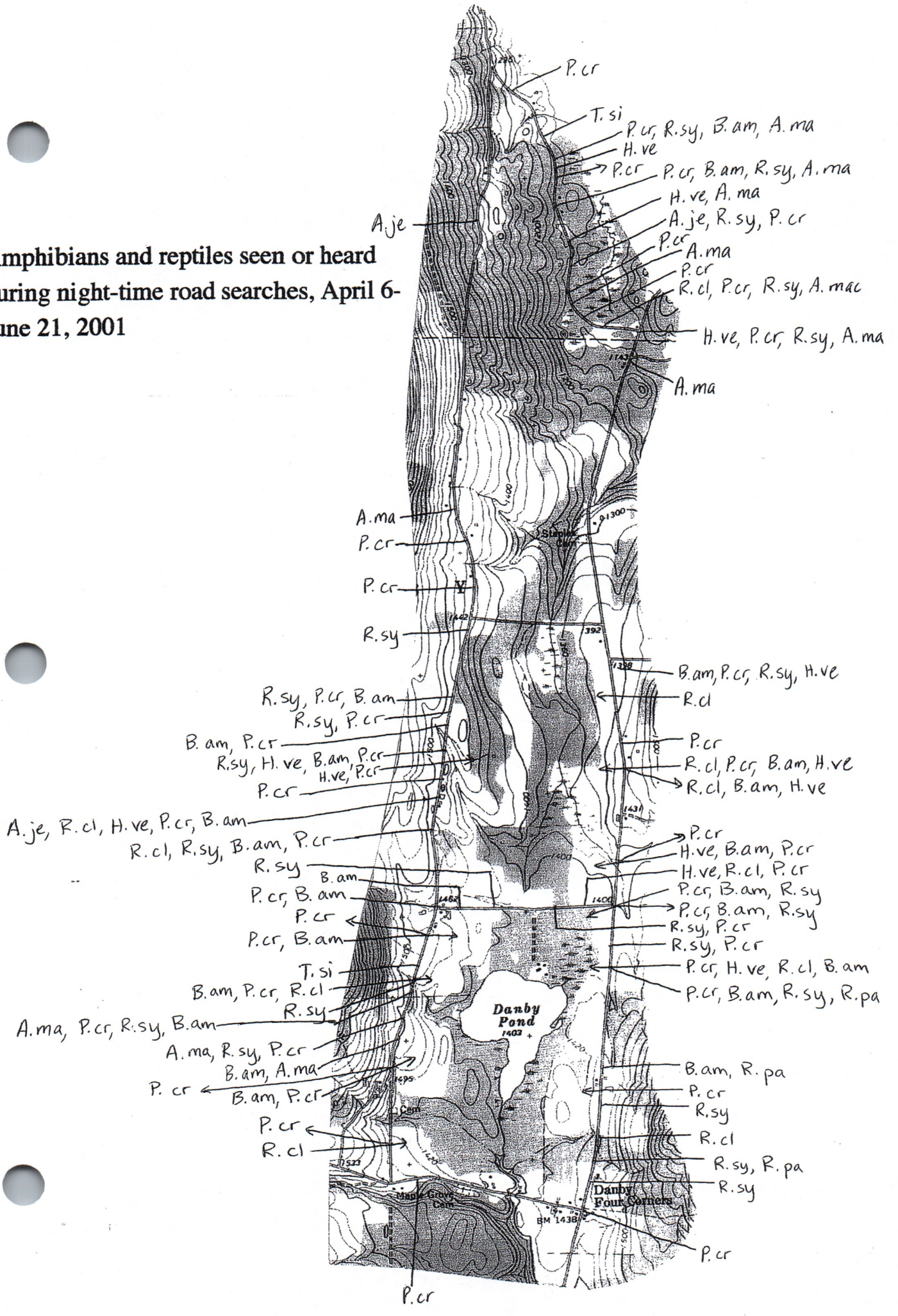
S1:	Very rare, generally 1 to 5 occurrences believed to be extant and/or some factor(s) making it especially vulnerable to extirpation from the state.
S2:	Rare, generally 6 to 20 occurrences believed to be extant and/or some factor(s) making it vulnerable to extirpation in the state.
S3:	Uncommon, believed to be more than 20 occurrences and/or there is some threat to it in the state.
S4:	Apparently secure in the state, often with more than 100 occurrences.
S5:	Demonstrably secure in the state.

SA:	Accidental in the state.
SE:	An exotic established in the state.
SH:	Known from historical records only.
SR:	Reported from the state, but without persuasive documentation.
SRF:	Reported in error, but this error persisted in the literature.
SP:	Possible in the state but no reported or documented records.
SSYN:	No longer considered a taxon in the state.
SZ:	Not of practical conservation concern because there are no definable occurrences.
SX:	Extirpated from the state.
SU:	Status uncertain.
?:	Denotes provisional rank.

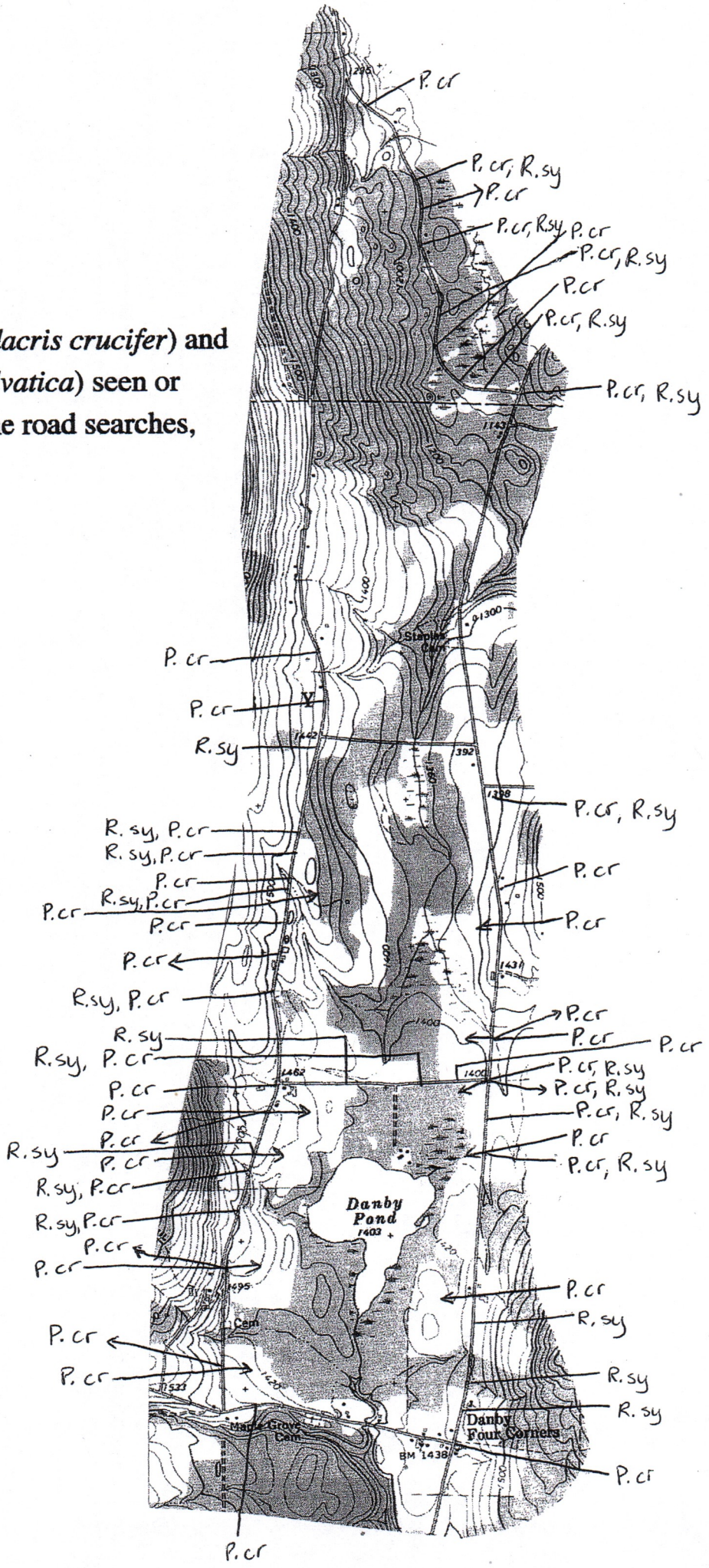
All amphibians, reptiles, and vernal pools seen or heard during night-time road searches and active searches, April 6-June 21, 2001



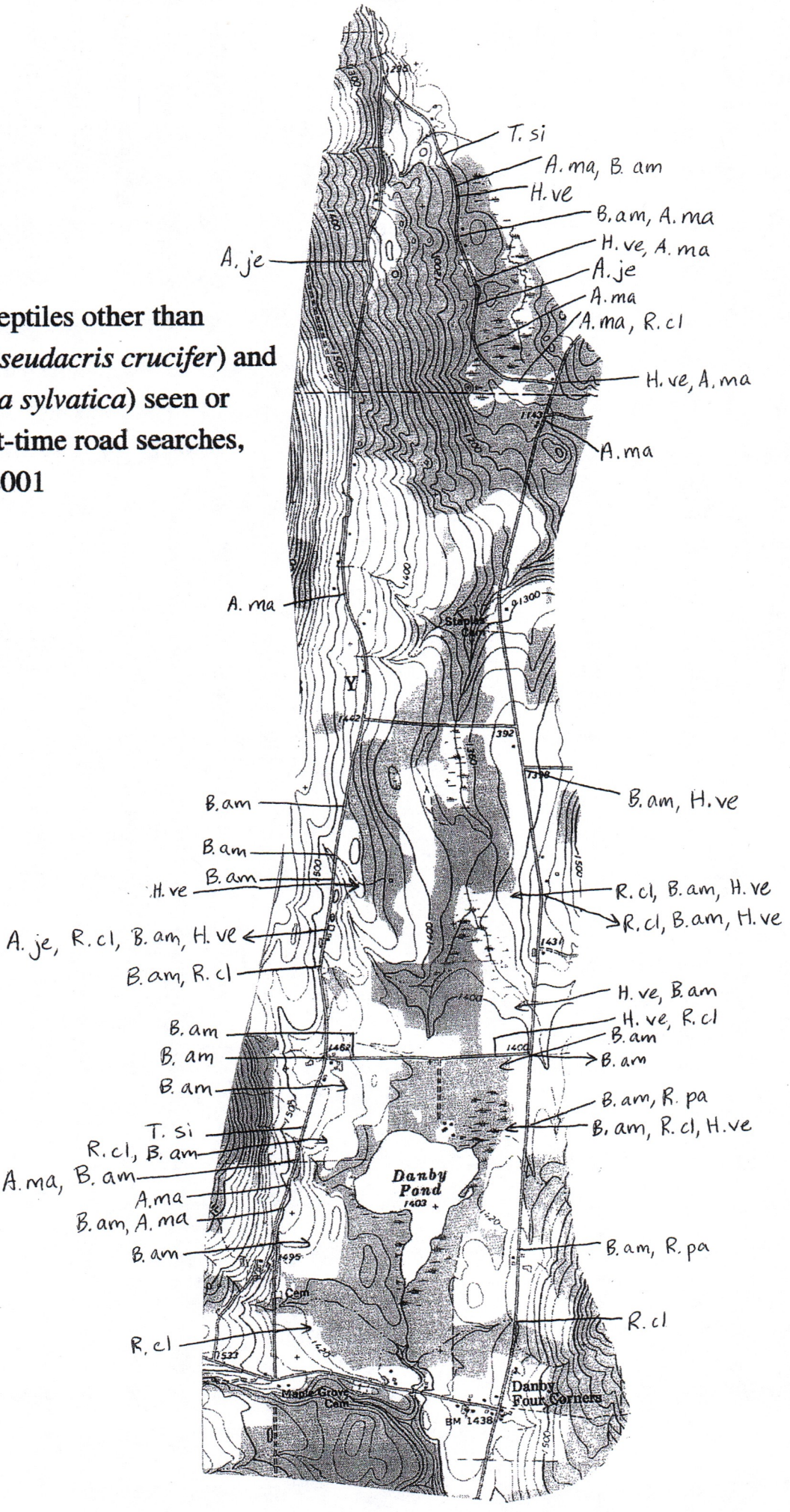
Amphibians and reptiles seen or heard during night-time road searches, April 6-June 21, 2001



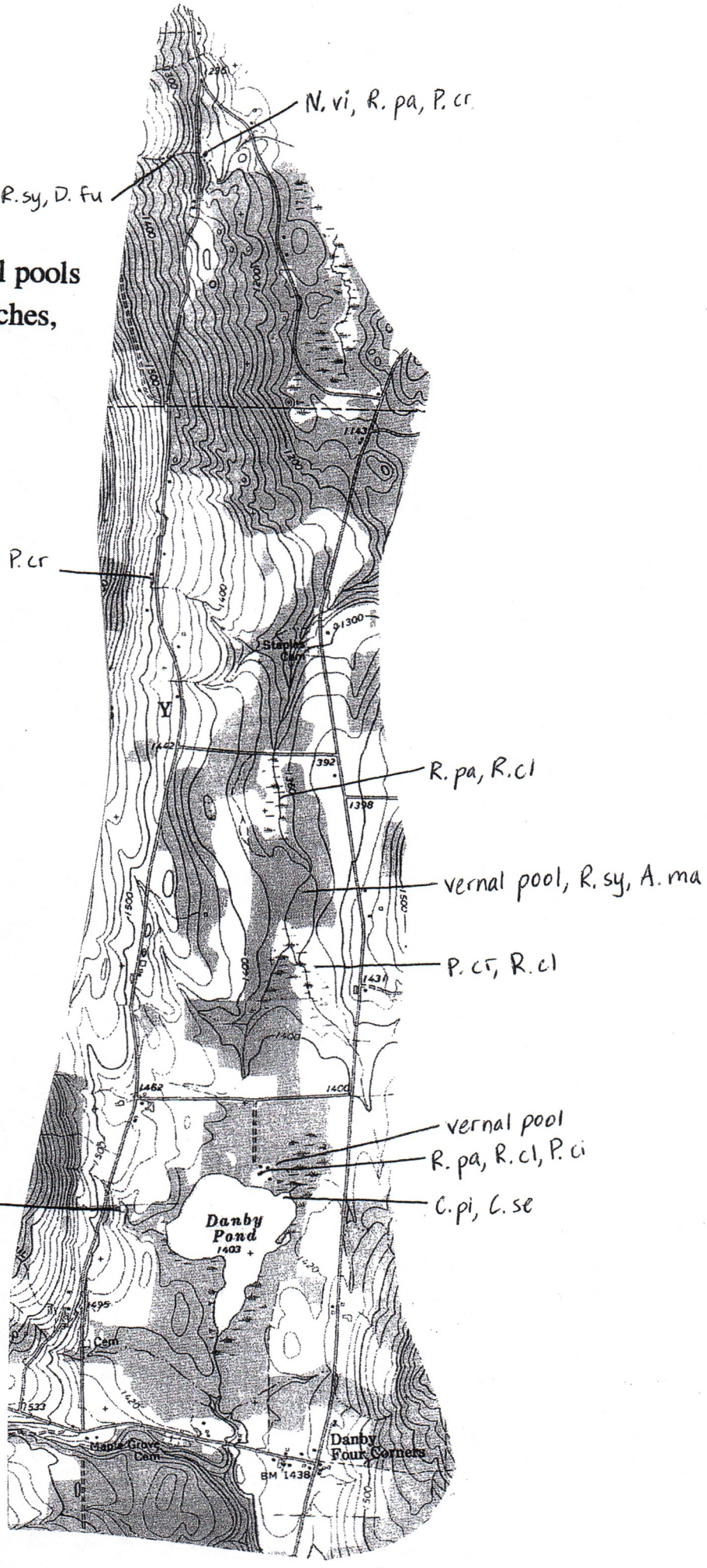
Spring Peepers (*Pseudacris crucifer*) and Wood Frogs (*Rana sylvatica*) seen or heard during night-time road searches, April 6-June 21, 2001



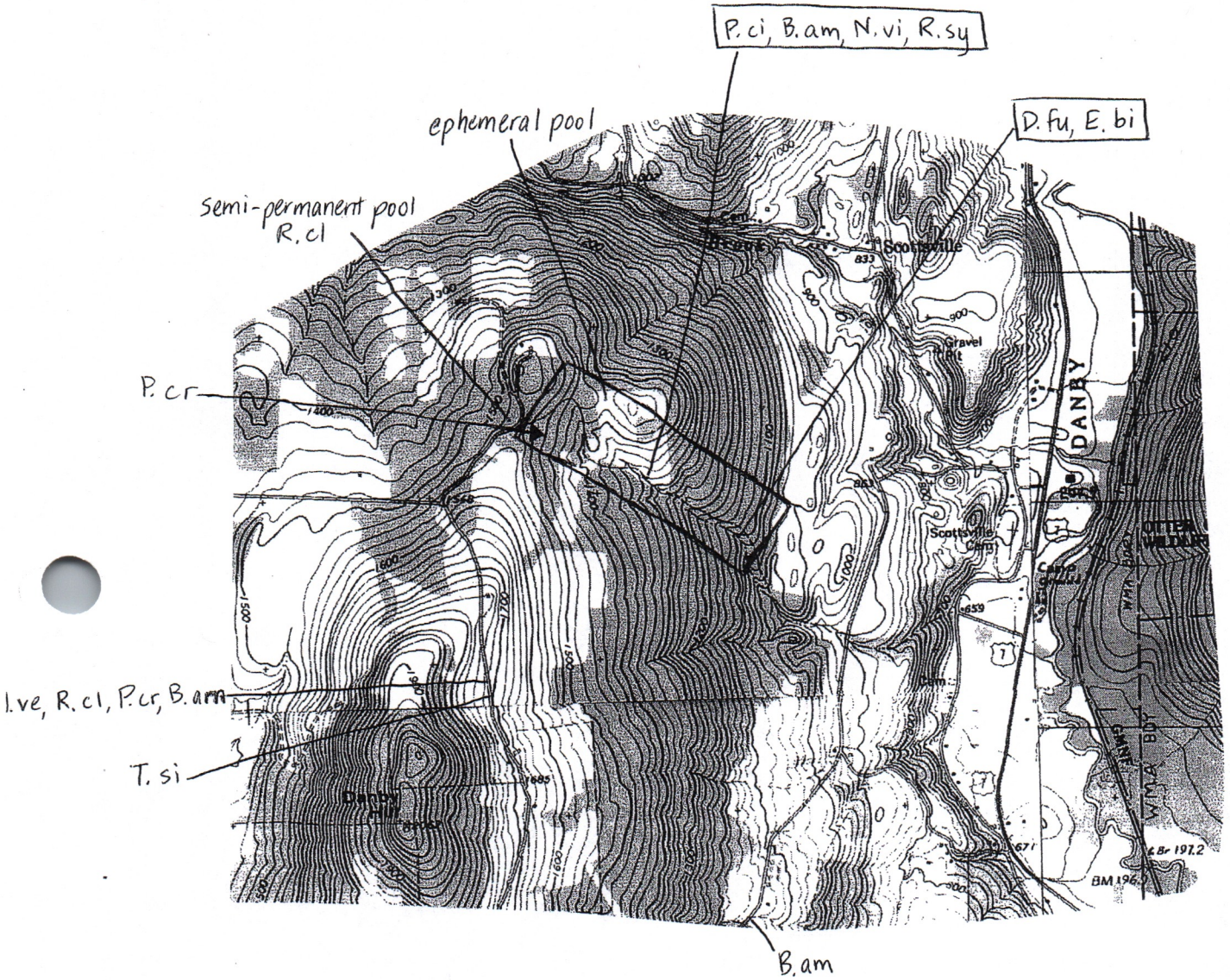
Amphibians and reptiles other than Spring Peepers (*Pseudacris crucifer*) and Wood Frogs *(Rana sylvatica*) seen or heard during night-time road searches, April 6-June 21, 2001



Amphibians, reptiles, and vernal pools seen or heard during active searches, April 6-June 21, 2001

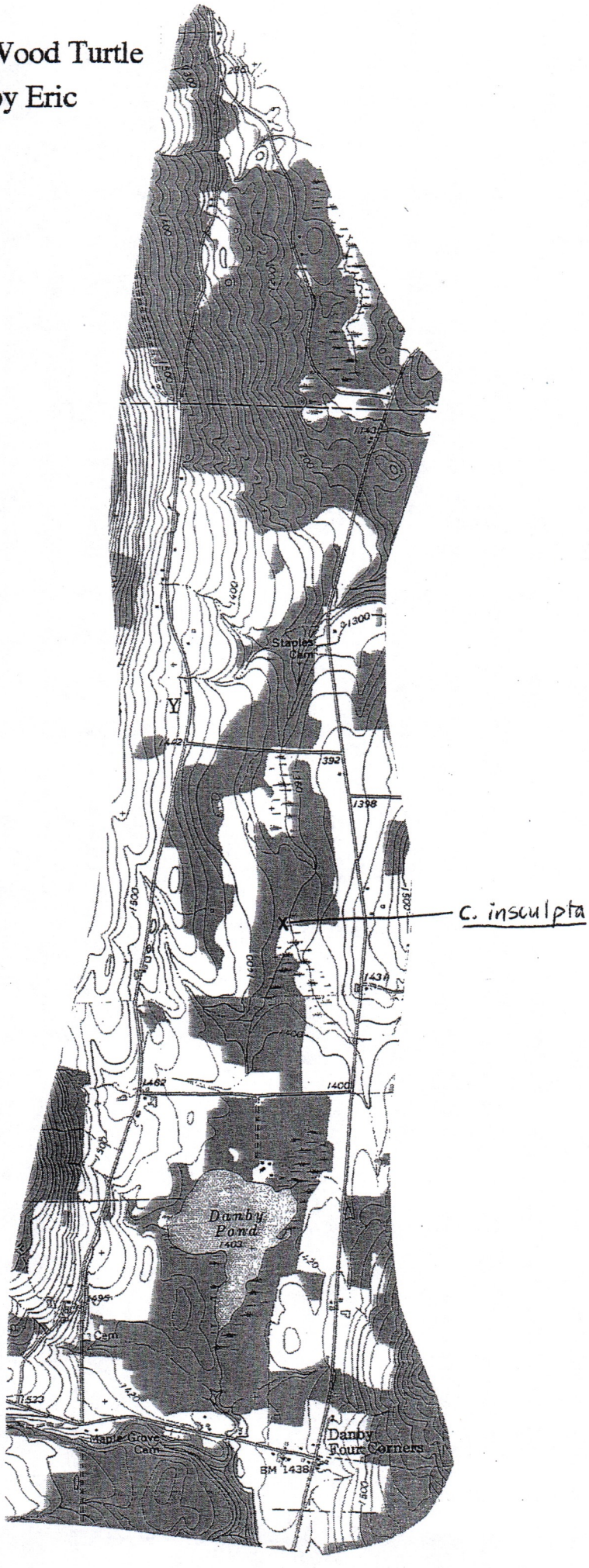


Amphibians, reptiles, and pools seen or heard in the North Hill Road area during night-time road searches and active searches, April 6-June 21, 2001



= active search area and species found during active search

Approximate location of the Wood Turtle (*Clemmys insculpta*) located by Eric Sorenson on June 26, 2001



Appendix B

Photographs Taken During the May 6, 2001 Flyover of the Baker Brook Region

Potential OMYA mining site in Danby, VT, on May 6, 2001.

Potential OMYA mine site in Danby, VT, on May 6, 2001.

North end of OMYA site in Danby, VT, on May 6, 2001.

Potential Jefferson salamander breeding sites at potential mine site in Danby, VT, on May 6, 2001.

Probable Jefferson salamander breeding pond at OMYA site on May 6, 2001.

Potential Jefferson salamander breeding site at potential OMYA mine site in Danby, VT, on May 6, 2001.

Probable Jefferson salamander breeding site at potential OMYA mining site in Danby, VT, on May 6, 2001.

Probable Jefferson salamander breeding sites at OMYA site in Danby, VT, on May 6, 2001.

Breton Farm and mining site looking north up valley in Danby and Tinmouth, VT, on May 6, 2001.

Breton Farm and mining site shows lack of breeding sites from ridge on west in Danby, VT, on May 6, 2001.

Breton Farm in Danby, VT, on May 6, 2001.

Breton Farm in Danby, VT, on May 6, 2001.

Jefferson salamander breeding site – small pond on left, west at road, Breton Farm in Danby, VT, on May 6, 2001.

Jefferson salamander breeding site – small pond on left, west side of road at the Breton Farm in Danby, VT, May 6, 2001.

Part of wood turtle area at Breton Farm looking southwest in Danby, VT, on May 6, 2001.

Breton and Fisk Farms from ridge on west in Danby, VT, on May 6, 2001.

Breeding site on Fisk Farm in Danby, VT, on May 6, 2001.

Fisk Farm in Danby, VT, on May 6, 2001.

Danby Pond on May 6, 2001.

Easton residence on Danby Pond.

Danby Pond and Pratt's land, closest connection between Danby Rd and ridge to west in Danby, VT, on May 6, 2001.

Pratt's land in Danby, VT, on May 6, 2001.

Pratt's land and Danby Pond on May 6, 2001.

Annette Smith residence.

Annette Smith residence.

Spring-fed pond on Old Otis Rd in Tinmouth, VT, on May 6, 2001.

Little Fen looking west at Old Otis Rd in Danby, VT, on May 6, 2001.

Probable breeding sites at Danby-Pawlet and Dutch Hill Rds in Danby, VT, on May 6, 2001.

Hoisington Cross Rd from western ridge, shows lack of breeding sites along ridge in Danby, VT, on May 6, 2001.

Wood turtle area at North Fen looking south from above Hoisington Cross Rd on May 6, 2001.

Tinmouth Channel looking southwest at Mountain View Rd in Tinmouth, VT, on May 6, 2001.

Tinmouth Channel and Mountain View Rd looking southwest in Tinmouth, VT, on May 6, 2001.

Mountain View Rd and Danby Tinmouth Rd looking west.

North Fen and Little Fen looking west.

Little Fen and North Fen looking southwest.

White Farm and wetland looking east.

White Farm and wetland looking east.

West of White Farm looking southwest.

South end of White Farm wetland.

No information provided.

Appendix C

Identification and Natural History Notes on the Amphibians of Vermont

The Salamanders of Vermont

Species that spend their adult lives in or near water

Name	Field Marks	Habitat	Occurrence	Notes
Mudpuppy *Necturus maculosus* 20-33 cm	very large, totally aquatic dark-brown salamander with the external gills of a larvae throughout its life; wide flat heads with squared snouts; young larvae have light longitudinal stripes	large permanent bodies of water	primarily in the major tributaries of both Lake Champlain and the Connecticut river, as well as larger lakes draining into them	very difficult to locate other than through methods used for fish; has been killed in lampricide treatments of Lewis creek
Eastern newt *Notophthalmus viridescens* 5.7-12.2 cm	a small to medium-sized salamander with rough relatively dry skin and no vertical grooves along its sides; red in its adolescent terrestrial stage (red eft), becoming green as it matures with yellow undersides; at all stages it has red spots and a line horizontally through its eye	primarily hardwood woodlands at all elevations; terrestrial when young and aquatic when adult; adults found in permanent and semipermanent water that is slow or standing	very abundant in appropriate habitat throughout the state	toxic to predators in the red eft stage
Dusky salamander *Desmognathus fuscus* 6.4-11.5 cm	a muddy-brown medium-sized salamander with a rounded body and partially keeled tail; look for a light line extending from the eye down and backwards to the corner of the mouth	very wet soils along slow streams and in small seepage areas in hardwood forests particularly where the soil is richly organic and deep with a heavy, dark overstory	locally common in appropriate habitat; found at a wide range of elevations; apparently intolerant of occasional drying	partially keeled tail, wet habitat, and dark-brown color separate it from the elusive Mt. Dusky
Spring salamander *Gyrinophilus porphyriticus* 12.1-19 cm	large size of adults and larvae; solid salmon-pink with dark reticulations; heavy rounded body with laterally flattened tail	springs and cool, clean, well-oxygenated, headwaters of streams	can be locally abundant in high-elevation, small, fishless, (?) streams; distributed wherever permanent cool headwaters can be found	turn large flat rocks in streams that are over a square foot in area to locate this impressive salamander
N. two-lined salamander *Eurycea bislineata* 6.4-12 cm	delicate slender body with a flattened yellow or brown back contrasting with darker sides; adults have tails with yellow-orange undersides	very wet soils, gravel, or in crevices between rocks; in or along permanent streams or ditches in wooded areas	throughout Vermont at all elevations; it can be locally abundant	during or after heavy rains it wanders up to 100 meters from the nearest stream or seep

Species which lay their eggs in still water, but spend most of their adult lives on land

Name	Field Marks	Habitat	Occurrence	Notes
Blue-spotted salamander *Ambystoma laterale* 9-12 cm	a small but solid bodied salamander with a black background heavily spotted with blue, a narrow head, and closely spaced nostrils	lowland oxbows and temporary pools; usually near rocky hillsides	can be fairly abundant in good habitat; apparently scattered throughout the state	usually found with its hybrid relatives; not as subterranean as Jefferson's; much easier to find outside the breeding season
Blue-spotted salamander hybrids *Ambystoma laterale X jeffersonianum* 9-16 cm	larger than the above species with slightly wider heads and more widely spaced nostrils	same as above	same as above	usually found with and outnumbering its non-hybrid relatives
Jefferson salamander *Ambystoma jeffersonianum* 15-18 cm	a large, gray-brown, solid-color, salamander with a few small light flecks restricted to the lower sides; look for the broad head and widely spaced nostrils	rocky wooded areas with upland vernal pools and semipermanent ponds	apparently restricted to low hills outside of the Green Mountains	usually associated with the hybrids listed below; very difficult to locate outside of its breeding period in April
Jefferson salamander hybrids *Ambystoma jeffersonianum X laterale* **10-18 cm**	more heavily spotted with blue than the Jefferson's with a narrower head and darker background color but still a large salamander	same as above	same as above	these hybrid complex salamanders often outnumber the non-hybrids with which they are found; they are almost entirely female and are genetically diverse
Spotted salamander *Ambystoma maculatum* 11.2-19.7 cm	a large heavy bodied salamander with a black background and yellow spots (the yellow of the spots is sometimes mixed with red or green)	found in greatest concentrations in woods around permanent or semipermanent, fishless, bodies of standing water with vegetation along the margins, but it also breeds in temporary pools	widespread throughout the state in wet wooded areas where appropriate breeding habitat can be found	easiest to find during its spring breeding season of April-May; at other times it remains underground
Four-toed salamander *Hemidactylium scutatum* 5.1-9 cm	a slightly rounded orange-brown body, an enamel-white belly with black spots and a constriction at the base of its tail	rocky oak-hickory hillsides including or adjacent to dark swamps or pools with sphagnum moss	probably restricted to the warmer areas of western and southern Vermont; it is never very abundant	only recently has it been discovered in the Lake Champlain Basin

The Frogs of Vermont

Name	Field Marks	Habitat	Occurrence	Notes
American toad *Bufo americanus* 5.1-9 cm	rough warty skin with small black spots; usually one or two large warts per spot; belly with black markings	widespread in many habitats, at all elevations, but most common in woodlands with small bodies of permanent and semipermanent water	rarely found in dense concentrations; often in yards and driveways under lights but seems to most abundant in scattered forested areas	glands on its head release toxins when it is eaten
Fowler's toad *Bufo woodhousii fowleri* 5.1-7.5 cm	rough warty skin with large black spots; usually many small warts per spot; plain white belly; other differences need to be studied carefully with text diagrams	sandy soils ?	very rare, two reports from southern Vermont; we are at the northern extreme of its range	the mating call is a very distinctive bleating cry; somewhat like the crying of a baby or bleating of a sheep
Gray treefrog *Hyla versicolor* 3.2-5.1 cm	rough, bumpy, skin similar to a small toad but with a small white patch under the eye and adhesive disks on its toes; usually grayish but it sometimes can be found in background colors from white to dark green	in the vicinity of slow moving or standing water with abundant vegetation	widespread if appropriate breeding habitat can be found; usually in trees when not breeding	can be located by its call during breeding season (May - July), very difficult to locate otherwise
Bullfrog *Rana catesbeiana* 9-15.2 cm	very large size, looks like large green frog except dorsolateral ridges do not extend down the edges of the back past the tympanum (ear)	standing or slow-moving permanent water, usually at lower elevations in or near large water bodies	locally common, but missing from large areas that do not contain the appropriate habitat	wanders from water only during heavy rains
Green frog *Rana clamitans* 5.7-9 cm	a medium-sized green frog with ridges extending well past the tympanum and with stripes on the hind legs oriented across the legs	permanent water of all kinds and sizes, (rivers, ponds, lakes)	very widespread at all elevations but most abundant on standing or slow moving well vegetated water bodies	this is the common pond frog; it wanders from water only during heavy rains; it's color and pattern vary tremendously from light to very dark-green and unspotted to heavily spotted
Mink frog *Rana septentrionalis* 4.8-7 cm	very much like a small green frog but the ridges usually don't extend past the tympanum (ear); it is heavily spotted with spots on, not bands crossing the legs; when agitated it releases a burst of garlic scent	slow-moving heavily vegetated bodies of water adjacent to larger bodies	locally common only in the far north and central part of the state	often reported to be associated with northern spruce-fir forests or at least the latitudes where these forests are found

Name	Field Marks	Habitat	Occurrence	Notes
Wood frog *Rana sylvatica* 3.5-7 cm	a medium-sized frog that has a plain-brown back with black patches below the eyes and around the tympanum, the upper lip is white in contrast	very widespread in woodlands of all elevations, where semipermanent or temporary pools can be found to breed in	very abundant in woodlands throughout the state	the color of the brown varies tremendously from very light to dark and reddish to brown
Northern leopard frog *Rana pipiens* 5.1-9 cm	a medium-sized frog that has oval spots on a green or gold background with white on the underside of the legs	often found in fields or woods near large lowland marshes and swamps	can be locally very abundant but missing from high elevations and other portions of the state	compare carefully with the Pickerel frog
Pickerel frog *Rana palustris* 4.4-7.5 cm	a medium-sized frog that has roughly rectangular spots on a brown background; look for the yellow undersurface of the legs on the adult frogs	beaver meadows and adjoining woods near clean, cool, permanent, water	never very abundant but compared to leopard frogs it is more widespread in woods and mountains throughout the sate	reported to release toxins capable of killing other amphibians when in a confined area
Spring peeper *Pseudacris crucifer* 1.9-3.2 cm	a very small brown frog with thin dark lines that often form a rough X on its back; small adhesive disks on its toes	in vegetation or woods near heavily vegetated swamps and marshes of all sizes; apparently missing from the immediate areas populated by bullfrogs	can be very abundant and is widespread at all elevations throughout Vermont	with the occasional exception of moist woods in late summer and early fall it can be difficult to locate other than by its call in the spring
Western chorus frog *Pseudacris triseriata* 1.9-3.9 cm	a peeper-sized frog with parallel stripes running the length of its back	apparently peeper-type habitat	one population was located in Grand Isle county in the 1980's, but it has not been found since	it has not been located at all in Vermont in recent years; state endangered; we are at the eastern limit of its range

Version 2, James S. Andrews, April 1996 most sizes and names are taken from Reptiles and Amphibians of Eastern/Central North America by Roger Conant and Joseph T. Collins, 1991

Species which are entirely terrestrial throughout their lives

Name	Field Marks	Habitat	Occurrence	Notes
Redback salamander *Plethodon cinereus* 5.7-10 cm	small slender and delicate with a flat red back; sometimes dark brown or gray morphs are found	mature hardwood forests that are not highly acidic in nature appear to be the best habitat but it is found in smaller numbers in any wet woods	widely distributed at all elevations throughout the state; often very abundant under ideal conditions	our only salamander that does not spend its larval stage in the water, hence it can be found far from the nearest standing water

Unconfirmed species found in nearby states

Marbled salamander *Ambystoma opaqum* 9-10.7 cm	short, heavy, rounded, body with a black background and strong pewter bars or blotches	dry hillsides with semipermanent or temporary pools	reported once in the 50's from the Inman Pond area of Fair Haven	not verified in the state; unlike other *Ambystoma* species it migrates to breeding sites in fall
Mountain dusky salamander *Desmognathus fuscus* 7-10 cm	look for a redback-like dusky with a rounded tail and a light line from the eye to the corner of its mouth	redback-type habitat under logs and rocks but along streams and ravines	one juvenile reported from within the state; no populations of adults have been located	this species is found across the border in New York State; the Taconics would be a good place to look for it
Slimy salamander *Plethodon glutinosis* 12.1-17.2 cm	a large slender black salamander with white spots and very sticky skin secretions	shaley stream-banks or road-cuts	limited amounts of this habitat occur in Vermont, if found, one would expect it to be in southern Vermont	isolated populations are reported from New Hampshire but the contiguous range begins further south in southern New York

Version 3, James S. Andrews, April 1996; most sizes and names are taken from Reptiles and Amphibians of Eastern/Central North America by Roger Conant and Joseph T. Collins, 1991

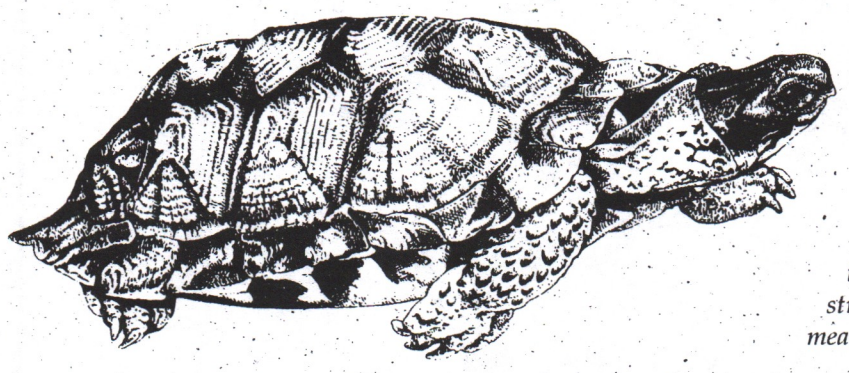
Appendix D

Wood Turtle (*Clemmys insculpta*) Fact Sheet

Vermont's Wildlife Heritage

Nongame and Natural Heritage Program

Species at Risk



Wood Turtle

Clemmys insculpta

The wood turtle is a moderately sized turtle with reddish-orange skin on portions of its neck and legs and a roughly textured, or sculpted shell. The adult's shell is about 7 to 8 inches long. It spends the winter on stream bottoms and most breeding occurs in streams. Although it regularly returns to streams throughout year, it may travel up to 1000 feet from the stream while foraging for food in hardwood forests or meadows.

Turtles are an ancient group of animals, originating many millions of years ago. Wood turtles have likely been in Vermont for the past 10,000 years, following the retreat of the last glacier. In spite of their long history of success, wood turtles have not fared well recently in the face of human development and use of the landscape. The wood turtle is a species of conservation concern in the northeastern states, including Vermont, due to its region-wide decline.

Human activities are the main cause of the turtles' decline. While it is rare that any person intentionally harms a wood turtle, the cumulative effect of our activities does have a negative impact. Although it is illegal to collect wood turtles in Vermont, people do remove them from the wild. Collection results in population decline and loss. A Connecticut wood turtle population was studied before and after a water supply area was opened to limited permit hiking. Wood turtle collection was the likely cause of this population disappearing after only ten years.

We also harm turtles by transforming their habitat into housing or commercial building lots, clearing away stream-bank vegetation, and inadvertently hitting them with mowing machines or cars.

Adult wood turtles may live 60 years, but egg and hatchling survival is extremely low. Survival of adult wood turtles is key to maintaining this species. Mature turtles are important because they manage to produce the few offspring that will carry the population into the future.

Turtle Time Table

Early April - First emergence from water to stream bank. Initially, turtles stay near stream, then gradually move farther away.

Early June - Initial movements to summer foraging areas which may be 1000 feet from stream. These areas consist of meadows, wetlands and woods.

Mid June - Females with eggs move to nesting area. Some females will travel over one mile to nest. Return to foraging area within a few weeks

June through mid September - Turtles spend up to a month at a time foraging well away from stream, but return to the stream for short periods.

Late August through mid November - Breeding occurs in the stream, and also occurs to a lesser extent in the spring months.

November through April - Turtles stay underwater at wintering sites in streams where they absorb oxygen through their skin. Some movement may occur during this time, but the turtles are generally confined to protected pools.

(continued on back)

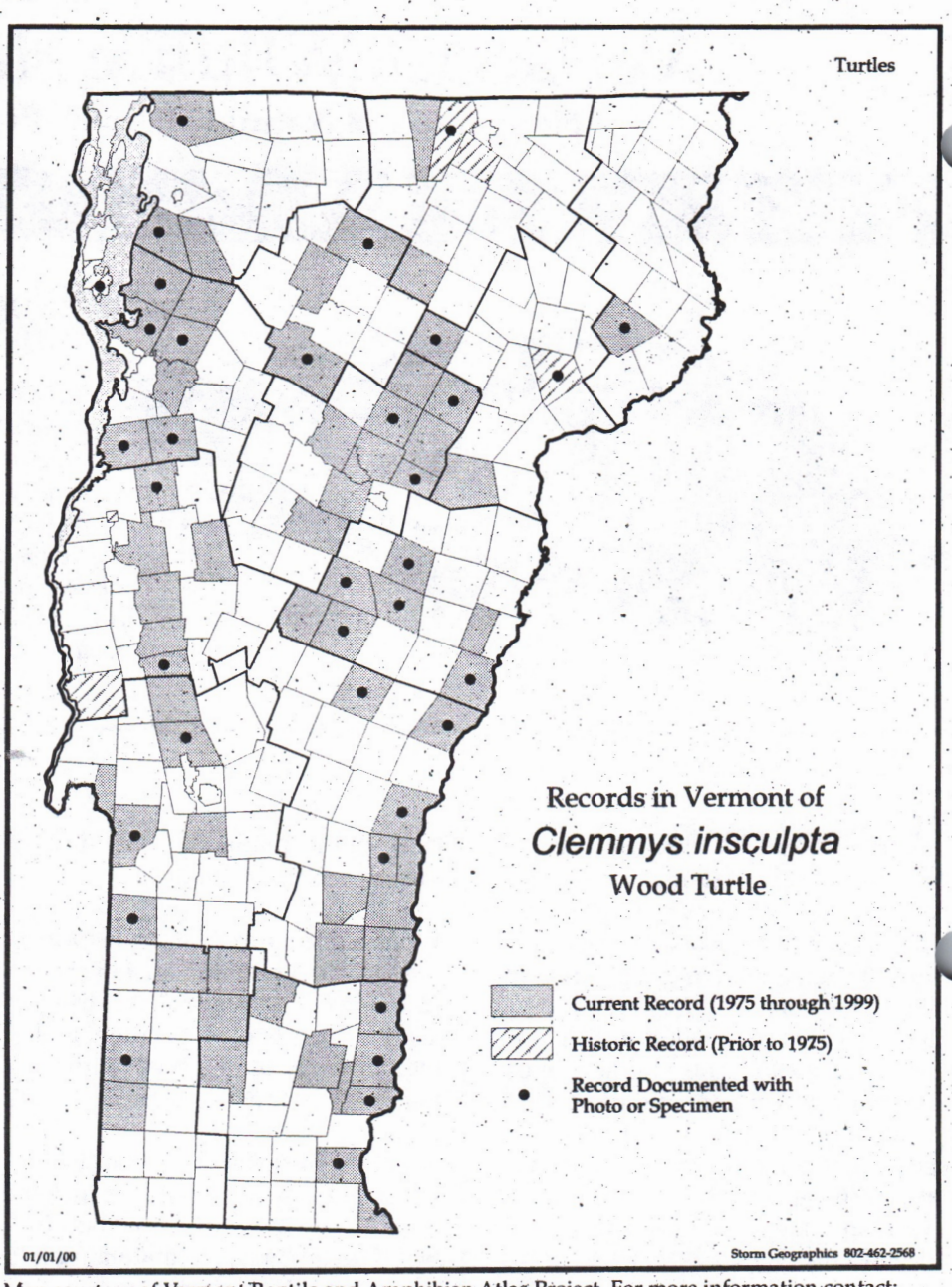
The Nongame and Natural Heritage Program (NNHP) is responsible for managing and enhancing Vermont's native plants, natural communities, and animals that are not hunted or fished (nongame species). A unit within the Vermont Department of Fish and Wildlife, the NNHP's mission includes the preservation of Vermont's rich and varied natural heritage for present and future generations.

Threats

- ✓ Habitat loss and alteration
- ✓ Road mortality
- ✓ Impacts from mowing machines
- ✓ Commercial collection for pet trade
- ✓ Casual collection when encountered
- ✓ Isolation of populations
- ✓ Turtle and egg predators such as raccoons and skunks

What You Can Do

- ✓ Locate roads more than 1000 feet from large streams and rivers.
- ✓ Locate housing and commercial development away from streams, rivers, and wetlands.
- ✓ Maintain natural vegetation along waterways.
- ✓ Route recreation paths away from streams, never along the channel.
- ✓ Teach children to respect wildlife. Leave wildlife in the wild.
- ✓ Encourage friends and neighbors to protect stream corridors.
- ✓ Promote town plans and ordinances that protect naturally vegetated stream corridors and discourage stream alterations.
- ✓ If possible, avoid mowing meadows until late September.
- ✓ If mowing May-September set mowing bar to 5 inches.
- ✓ Learn more about the natural world.
- ✓ Report collection of turtles to your local game warden.
- ✓ Report unauthorized stream alterations to the Agency of Natural Resources (Winooski River watershed and north: 751-0129; White River watershed and south: 786-5906).
- ✓ Contribute to the Nongame Wildlife Fund on your Vermont income tax form.
- ✓ Display a Vermont Conservation Plate on your car - and watch out for turtles crossing the road!



Map courtesy of Vermont Reptile and Amphibian Atlas Project. For more information contact: Jim Andrews, Biology Department, Middlebury College, Middlebury, VT 05753.

For more information contact:
Nongame and Natural Heritage Program
Vermont Fish and Wildlife Department
103 South Main Street, Waterbury, Vt 05671-0501
(802) 241-3716
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Wood Turtle recovery efforts in Vermont, including this fact sheet, are funded by contributions to the Nongame Wildlife Fund. Created by the legislature in 1986, the fund enables people to voluntarily contribute to programs on behalf of Vermont's nongame species. These tax-deductible gifts are used by the Nongame and Natural Heritage Program to inventory, monitor, and manage species and their habitats and to provide planning assistance and educational programs. Direct gifts are accepted, payable to:

Nongame Wildlife Fund
Vermont Fish and Wildlife Dept.
103 S. Main St., Waterbury, VT 05671-0501
(802) 241-3716

Appendix E

Vermont Nongame and Natural Heritage Program Rankings for Reptiles and Amphibians

2001 List

Reptiles and Amphibians of Vermont

Accepted Name, State Rank, and State Status, as of May 2001

Common Name	Scientific Name	State Rank	State Status
Reptiles	**Reptilia (Class)**		
Turtles	**Testudines (Order)**		
Spiny Softshell	*Apalone spinifera*	S 1	T
Snapping Turtle	*Chelydra serpentina*	S 5	
Painted Turtle	*Chrysemys picta*	S 5	
Spotted Turtle	*Clemmys guttata*	S 1	E
Wood Turtle	*Clemmys insculpta*	S 3	SC
Northern Map Turtle	*Graptemys geographica*	S 3	SC
Stinkpot	*Sternotherus odoratus*	S 2	SC
Lizards and Snakes	**Squamata (Order)**		
Lizards	**Lacertilia (Suborder)**		
Common Five-lined Skink	*Eumeces fasciatus*	S 1	E
Snakes	**Serpentes (Suborder)**		
Eastern Racer	*Coluber constrictor*	S 1	SC
Timber Rattlesnake	*Crotalus horridus*	S 1	E
Ring-necked Snake	*Diadophis punctatus*	S 4	
Eastern Ratsnake	*Elaphe obsoleta*	S 2	SC, PT
Milksnake	*Lampropeltis triangulum*	S 5	
Northern Watersnake	*Nerodia sipedon*	S 3	
Smooth Greensnake	*Opheodrys vernalis*	S 4	
Dekay's Brownsnake	*Storeria dekayi*	S 4	
Red-bellied Snake	*Storeria occipitomaculata*	S 5	
Eastern Ribbonsnake	*Thamnophis sauritus*	S 2	SC
Common Gartersnake	*Thamnophis sirtalis*	S 5	
Amphibians	**Amphibia (Class)**		
Salamanders	**Caudata (Order)**		
Jefferson Salamander	*Ambystoma jeffersonianum*	S 2	SC
Blue-spotted Salamander	*Ambystoma laterale*	S 3	SC
Spotted Salamander	*Ambystoma maculatum*	S 5	
Marbled Salamander	*Ambystoma opacum*	S R	
Northern Dusky Salamander	*Desmognathus fuscus*	S 4	
Allegheny Mt. Dusky Salamander	*Desmognathus ochrophaeus*	S R	
Northern Two-lined Salamander	*Eurycea bislineata*	S 5	
Spring Salamander	*Gyrinophilus porphyriticus*	S 4	
Four-toed Salamander	*Hemidactylium scutatum*	S 2	SC
Mudpuppy	*Necturus maculosus*	S 2	SC
Eastern Newt	*Notophthalmus viridescens*	S 5	
Eastern Red-backed Salamander	*Plethodon cinereus*	S 5	
Frogs (including toads)	**Anura (Order)**		
American Toad	*Bufo americanus*	S 5	
Fowler's Toad	*Bufo fowleri*	S 1	SC
Gray Treefrog	*Hyla versicolor*	S 5	
Spring Peeper	*Pseudacris crucifer*	S 5	
Western Chorus Frog	*Pseudacris triseriata*	S 1	E
American Bullfrog	*Rana catesbeiana*	S 5	
Green Frog	*Rana clamitans*	S 5	
Pickerel Frog	*Rana palustris*	S 4	
Northern Leopard Frog	*Rana pipiens*	S 4	
Mink Frog	*Rana septentrionalis*	S 4	
Wood Frog	*Rana sylvatica*	S 5	

J. Andrews, 2001

Vermont Nongame & Natural Heritage Program

Department of Fish & Wildlife

Explanation of Legal Status & Information Ranks

State Status: As per the Vermont Endangered Species Law

E:	Endangered--In immediate danger of becoming extirpated in the state.
T:	Threatened--High possibility of becoming endangered in the near future.

Information Categories: Not established by law

PE:	Proposed for endangered.
PT:	Proposed for threatened.
SC:	Special Concern--rare; status should be watched.

State Ranks of Plants, Animals, and Natural Communities

State ranks are assigned by the Nongame & Natural Heritage Program based on the best available information. They are not established by law. Ranks are reviewed annually.

S1:	Very rare, generally 1 to 5 occurrences believed to be extant and/or some factor(s) making it especially vulnerable to extirpation from the state.
S2:	Rare, generally 6 to 20 occurrences believed to be extant and/or some factor(s) making it vulnerable to extirpation in the state.
S3:	Uncommon, believed to be more than 20 occurrences and/or there is some threat to it in the state.
S4:	Apparently secure in the state, often with more than 100 occurrences.
S5:	Demonstrably secure in the state.

SA:	Accidental in the state.
SE:	An exotic established in the state.
SH:	Known from historical records only.
SR:	Reported from the state, but without persuasive documentation.
SRF:	Reported in error, but this error persisted in the literature.
SP:	Possible in the state but no reported or documented records.
SSYN:	No longer considered a taxon in the state.
SZ:	Not of practical conservation concern because there are no definable occurrences.
SX:	Extirpated from the state.
SU:	Status uncertain.
?:	Denotes provisional rank.

Appendix F

Forest Management Practices to Minimize Negative Impacts on Vermont Reptiles and Amphibians

Forest Management Practices to Minimize Negative Impacts on Vermont Reptiles and Amphibians

Most amphibians spend the majority of their lives away from water in the surrounding woods. The wetlands, vernal pools, and ponds are critical for breeding of most species but the forests are also critical for the foraging and wintering of those species. Some local amphibians migrate 300 meters or more from wintering and foraging areas to breeding ponds. Most snakes, some turtles, and Vermont's only lizard spend the majority of their lives away from water. Hence management of wetlands and the surrounding woods both have an impact on reptiles and amphibians. Some species of larger snakes and most land turtles require many years to reach breeding age. Direct mortality or removal of breeding adults can have a devastating impact on a population.

Specific management plans for rare, threatened, or endangered species

Learn to recognize Vermont's rare, threatened, and endangered species.

(habitat in which they are found should be managed specifically for them)

(contact the Vermont Non-game and Natural Heritage Program, they will be interested in the distribution information and may be able to make specific management suggestions)

General

Maintain large down trees (2 per acre, 7 per hectare), dead standing trees, and a future supply consisting of older standing trees.

Maintain standing trees with knotholes and dead branches.

Within areas that are heavily cut, patches of older trees should be left in addition to the scattered mature trees.

Maintain a thick layer of deciduous litter.

Softwood plantations limit the number and diversity of amphibians.

(decreased coarse woody debris, decreased structural diversity, decreased hardwood leaf litter, increased acidity)

(in these situations maintaining pockets of hardwoods and leaving large debris on the ground would help to minimize the impact)

Long rotations provide the old mature growth and dense forest cover amphibians prefer.

(as forests age they show increasing amphibian abundance up to an age of 60 to 70 years old in wet cool habitats and up to 120 years in warm, dry, lowland habitats)

Minimize compaction of the soil and direct mortality by keeping heavy equipment off the site when the ground is saturated.

(winter logging or logging in late summer and early fall conditions should help minimize this effect)

Protect and maintain shrub cover in the forest and on forest edges.

Openings

Maintain a natural pattern of forest cover with small forest breaks.

Large clear-cuts regularly show fewer amphibians than adjacent older growth.

(successive short rotation clear-cuts showed the lowest abundance of amphibians)

(natural disasters such as diseases and storms seem to have less of an effect on amphibian abundance as clear-cuts, probably because of the amount of coarse woody debris left behind)

(large clear-cuts seem to block the movements of some amphibian species)

Small upland meadows with nearby woods provide partial habitat requirements for some snake species.

In small upland meadows exposed rock piles, sawdust piles, and coarse woody debris can provide good habitat for snakes.

Wetland areas

Maintain the ability of swamps, vernal, and semipermanent pools to hold water.

Do not create ditches and ruts that will hold water only briefly. Amphibians often lay their eggs in these small patches of water which dry too soon to permit the larvae to transform and leave. They should either be prevented or they should be deep and shaded enough to hold water through July.

Streams, ponds, and vernal pools should be kept shaded and silt should be kept out.

(among other effects, silt fills the spaces in stream beds where the larval amphibians hide and feed)

(direct sun may speed the rate of evaporation in vernal pools)

Equipment and logs should be kept out of vernal pools and other wetlands.

(small amounts of coarse woody debris or single trees that fall into a wetland are not harmful but vernal pools should not be filled with debris)

Buffer strips should be maintained around all water bodies including streams, ponds, and vernal pools.

(these strips minimize siltation, maintain shade, maintain undisturbed soil and deep leaf litter, provide patches of older growth as sources for recolonization, and provide movement corridors)

(the width of uncut buffer strips should be a minimum of 30 meters, with a wider zone of up to 100 meters where cutting and its impacts are limited)

(deMaynadier and Hunter suggest no more than 25% of the basal area should be cut in this second tier buffer)

(buffer strips should be widest where streams are larger, where the intensity of harvest is greatest, where the surrounding terrain is steepest, or where rare, threatened, or endangered species are found)

Equipment should be kept out of forested seepage areas.

Forest cover over seepage areas should be maintained.

Chemicals

Amphibians absorb any chemicals which are in the water (dew, ground water, streams etc.) around them.

(minimize use of herbicides, pesticides, etc.)

(one study suggests that CaCl spread on roads to minimize dust may be a barrier to amphibian movement)

Roads

Minimize the number of roads, size of roads, and the amount of traffic on roads.

(a rural paved road in upstate New York killed between 50 and 100 percent of migrating amphibians breeding near it)

Permanent roads should be planned not to intercept the annual movements of reptiles and amphibians between breeding, foraging and wintering habitats.

Other Species

Allow only moderate grazing after the breeding season.

Keep livestock out of the riparian zone and away from vernal pools and ponds.

If livestock need access to a pond or a lake, limit it. Maintain as much naturally vegetated shoreline as possible.

Don't introduce fish in streams and ponds where they were not previously found.

(many fish feed on amphibian eggs and larvae, and absence of predacious fish is a primary requisite of vernal pool breeders)

Open areas with dense annual or shrubby growth near water bodies or on the edge of woods provide foraging areas for some species

open areas that are to be kept open should be cut high and either not raked or raked by hand, (direct mortality should be minimized)

these areas could be cut after the ground is frozen and before the first snows (reptiles and amphibians would no longer be active)

General amphibian microhabitat requirements include;

breeding locations that hold water at least through July,
coarse woody debris in adjacent forested areas,
foliage height diversity in adjacent forested areas,
canopy cover over breeding and foraging areas,
deep deciduous leaf litter for moisture retention and feeding,
cool and moist conditions.

General reptile microhabitat requirements include;

coarse woody debris (standing and down),
small open patches for basking, mixed with well shaded refugia for warm weather and feeding,
undisturbed areas in and around wetlands for feeding and breeding,
access to safe denning areas.

Many of the above ideas were taken from a recent review of the literature regarding amphibians and forest management. This review includes an extensive bibliography that might be of interest.

deMaynadier, P. and M. Hunter. 1995. The relationship between forest management and amphibian ecology: a review of the North American literature. Environmental Reviews 3: 230-261.

Additional suggestions for this list were provided by the author (J. Andrews), P. Bartelt, S. Droege, S. Jackson, L. Raw, and R. Waldick.

James Andrews, 7/96