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Deer Wintering Area & Vernal Pool Assessment of the Greater Goose Pond Forest, Keene, NH

Part II
of a "Biologically Significant Interest Area" Analysis

Submitted to:

City of Keene, Department of Parks and Recreation
and
The Keene Conservation Commission

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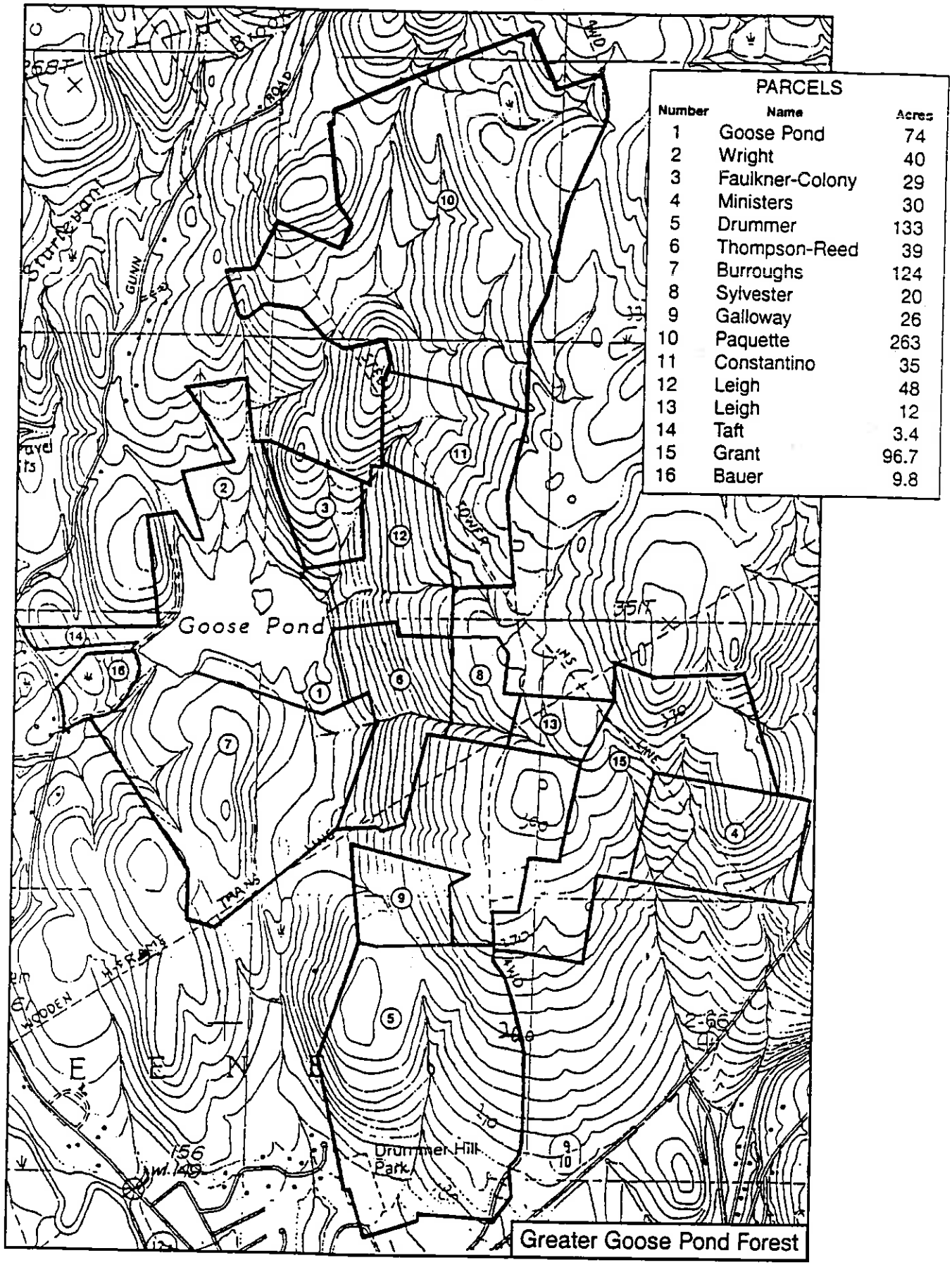

MAP 1. PARCEL MAP of the Greater Goose Pond Forest

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ABSTRACT

During the winter-spring months of January - May, 1996, an assessment was completed of the deer wintering areas and vernal pools within the Greater Goose Pond Forest (GGPF) of Keene, NH. The primary purpose of this assessment was to complete the analysis of "Biologically Significant Interest Areas," as outlined in the 1992 management plan for the GGPF, and preliminarily investigated by a team of Antioch students during the fall of 1994. Two site visits were completed during the deepest snow period of the 1995-6 winter in order to monitor deer track patterns into and out of the Paquette lot deer yard. At least 15 regularly used deer trails and over 394 deer track sets were identified during this part of the reconnaissance study. In addition, use by deer was documented by sightings, beds, browse, scat and repeated scarring of hemlock seedling bark. Immediately following snow melt, several non-random searches were conducted in areas of shallow topography for the purpose of locating and identifying vernal pools. At least 9 pools showed positive evidence of at least 3 species of breeding amphibians. The latter was determined by the presence of wood frog, spotted salamander, and/or jefferson's complex salamander egg masses. These ranged in number from 0 - 115 for wood frog, 0 - 308 for spotted salamander, and 0 - 5 for jefferson's complex salamander throughout the study area. Several other open water bodies were observed; however, these were determined to be either too shallow, or too deep to support regular and successful populations of obligate vernal pool species. This report summarizes both the quanitative and qualitative findings of this investigation by the prinicpal researcher in the project.

I. INTRODUCTION

This report is the second in a two part assessment[1] of the "Biologically Significant Interest Areas," or BSIA's on the 1046 acre Goose Pond property owned by the City of Keene. This report follows Part I, the vegetation analysis of these areas, which was submitted on October 9, 1995 to the Keene Parks & Recreation Department and the Keene Conservation Commission. The first report looked at two seasonally flooded / saturated wetlands in the Paquette Lot, as well as two natural community areas that were deemed less significant than originally designated in the preliminary assessment of Fall 1994.

The following analysis focuses on two areas of biological concern in the Greater Goose Pond Forest or GGPF: deer wintering habitat and vernal pools. Both of these wildlife areas were selected from the variety of habitats in the GGPF because of their potential sensitivity to human disturbance. Given the recreational, educational, and possible silvicultural potential that the GGPF holds, these two types of areas met at least one of the five criteria established for potential BSIA designation:

> *1) any unusual or rare natural community whose basic nature could be dramatically and or permanently altered by direct human activity.
>
> 2) any natural community that is exemplary relative to the surrounding Monadnock Region and whose basic nature could be dramatically and/or permanently altered by direct human activity.
>
> *3) any habitat that supports or has the documented potential to support state or federally listed rare and endangered species.
>
> 4) any area of exceptionally high species richness relative to the surrounding area (such as an existing wetland).
>
> *5) any area by virtue of its uniqueness would provide valuable scientific and or educational benefits.

Deer wintering areas have been identified by the NH State Fish & Game

1 In the October 1995 report, this study was referred to as as a "three-tiered assessment project." The second and third "tiers" represent the deer wintering area and vernal pool studies, respectively.

Department as regionally sensitive habitat areas that serve as critical shelter and food requirements for the state's deer population. Motorized and non-motorized vehicle use within a deer wintering area (sometimes called a "deer yard"), as well as extensive timbering could disrupt a local herd's ability to survive cold and/or snowy winters (Halls 1984).

Vernal pools are also known as critical habitat areas for selected species of vertebrates, in this case, breeding frogs and amphibians. Concentrating their breeding cycle into a few short weeks in early spring, these organisms provide tremendous food chain support for forested ecosystems, and can be excellent indicators of environmental conditions in a region (Colburn 1991). In southern New Hampshire, there is an additional benefit of monitoring vernal pools in that they contain potential habitat for two rare salamanders, the jefferson's complex salamander (*Abystoma jeffersonianum-caerulescens*) and the marbled salamander (*Abystoma opaca*). Greater detail is provided on both of these species within the report below.

Both deer wintering areas and vernal pools have high value as potential educational sites for local schools. They both represent an evolutionarily complex set of abiotic and biotic factors coming together in a distinct wildlife community. Indicator organisms for both areas tend to depart from these habitats at non-critical times of year, and both areas tend to be highly sensitive to significant human disturbance. As will be discussed below, the findings of this report suggest that the GGPF has the potential to serve as an excellent laboratory for students who are interested in monitoring local wildlife populations through the study of these critical habitat areas.

This report contains a description of the reconnaissance methods used in studying the above-mentioned resource areas, the qualitative and quantitative data generated by the survey, as well as a general statement of findings. In regards to the latter, it should be noted that both the deer wintering area and vernal pools were only studied over a single season. It is well known that population fluctuations regularly occur among both deer and vernal pool species, and that a single season's survey can only yield a preliminary assessment of

condition (Taylor 1956; Tyning 1990). While the 1996 winter and spring seasons happened to have been conducive for the study of these ecological areas (ie. deep winter snows and ample meltwater and rains for long-lasting vernal pools), the findings presented herein should be regarded with its preliminary nature in mind. A more in-depth discussion of the implications of this is given in the final section of the report.

II. METHODS & MATERIALS

Four field days were spent investigating the deer wintering area of the Paquette Lot and the vernal pools of the GGPF in general. Additional data was gathered both during the preliminary assessment phase in the fall of 1994 and during the vegetational analysis phase in the summer and fall of 1995. Both of the latter time periods involved the generation of qualitative data on habitat. For deer wintering areas, this entailed the remote observation of areas with ample softwood cover, fresh running water, positive solar gain (ie. south or west facing slopes). In the field, it involved the recording of heavily browsed areas, most notably, those sites that contained seedling hemlocks under 4 inches dbh (diameter at breast height). Other favored browse species were looked for in these areas, especially hobblebush (*Viburnum alnifolium*) and maple-leaved viburnum (*Viburnum acerifolium*). The presence of an overstory of hard mast trees such as red oak (*Quercus rubra*) and American beech (*Fagus grandifolia*) was also noted. Finally, the presence of abundant scat piles, deer trails, and/or bedding sites also yielded evidence of potential yarding conditions.

During the winter, a more careful reconnaissance of these preliminarily identified high use areas was conducted. As shown in the October 1995 report, a map of the potential deer yard was generated. This was used as a guide for a more in-depth exploration of habitat use. During the first field day on February 11th, the outer edge of this deer wintering area was walked, and careful notes were taken on the number, direction and location of deer trails entering or leaving the area. Some non-random deviations from the apparent boundary were made in order to investigate outlying habitat areas that also had potential for wintering deer. During the 2nd field day on March 13th, these outlying areas were traversed more carefully, and track data were recorded as on February 11th. In addition, a straight line transect was run north to south through the middle of the observed deer wintering area, and tracks and other sign were quantified. These transects as well as the revised deer wintering area habitat map are shown in Appendix A-1.1

During these field days, weather conditions, snow depth and condition, and signs of other mammal species were recorded as well. In addition, several random sampling points were established within the deer wintering area in order to estimate the basal area per acre of trees. Weather and snow conditions are described in the results section below; track intercept data for other species are summarized on a chart on page 12; and basal area of the tree cover is included in the study area description below.

Vernal pools were also preliminarily identified during the reconnaissance work in the fall of 1994 and summer and fall of 1995. In both cases, the water table was lower than in the spring of 1996, and so positive indicators were not very abundant for vernal pool obligates. Low-lying, shallow basins were taken note of nonetheless, and recorded on maps for future analysis. All four of the so-called vernal pool areas identified on Map 3 of the October 1995 reports were checked carefully during the optimal spring time period of April - May. In addition, all depressional areas within the GGPF were checked again to make sure they weren't missed during the initial BSIA assessment of Fall 1994. Locational areas for observed vernal pools are summarized on map A-1.2.

Once the vernal pools were located and identified, a comprehensive search was conducted at each pool for evidence of obligate vertebrate species. Target species primarily included wood frog (*Rana sylvatica*), spotted salamander (*Abystoma maculatum*), and the jefferson's complex salamander (*Abystoma jeffersonianum - caerulescens*). Positive evidence was comprised of egg masses, spermatophores, sightings of larvae or adults, as well as signs of predation of any of these indicators. Total counts were kept on each type of observation, as well as statistics on pool size, maximum depth, average depth, percent cover, and dominant vegetation. These are summarized in the results and discussion section below. Notes were also kept on obvious vernal pool invertebrate species, although no careful or quantitative accounting was made of this group of organisms.

During all reconnaissance days of this investigation, observations were also made on other significant cover types of the GGPF. These included an assessment of the small impoundment on Drummer Hill, the beech - oak community

surrounding vernal pool #5, the oak - ash community east of Goose Pond, and the beaver wetland as studied under Part I. Upland areas were looked at in terms of recreational, educational, and timber potential; open water areas were looked at in terms of their more marginal role as breeding areas for vernal pool amphibians. Finally, since plans have been expressed to secure some public conservation control over the large, private lot inclusion north of Drummer Hill, a cursory study of the 4 vernal pools on this property was made as well.

III. DESCRIPTION OF STUDY AREA

A more complete description of the Greater Goose Pond Forest was included in the vegetation report, Part I. The following provides a more in-depth assessment of those areas that were particularly studied for Part II.

A. Deer Wintering Area - Paquette Lot

As the accompanying map indicates, the deer wintering area on the Paquette lot was determined to be larger than originally identified. An additional @ 25.5 acres was added to the original 45 acres that were observed to hold deer yarding potential. This additional area was identified by direct observation of sign as described above. Furthermore, it contained the proper slope, aspect and cover types that are favorable to wintering deer herds. The following characteristics were noted about this area:

Approximate Size within GGPF: 70.5 acres
Cover Types: Mixed, Softwood Dominant (@ 53 ac), Mixed, Hardwood Dominant (@17.5 ac)
Dominant Canopy Species: red oak, red maple, white pine
Dominant Understory Species: eastern hemlock
Soil Types: ablational till, shallow to moderately deep to bedrock, including hydric phases
Average Slope: 8 - 12%
Max. distance to winter running stream: @ 715 ft.
General Aspect: south and west
Dominant Mast Species: red oak
Dominant Winter Browse Species: eastern hemlock, hobblebush, maple-leaved viburnum, yellow birch, red oak

The primary deer wintering in 1996 was observed to be near or along the permanent stream that flows southerly into the aforementioned beaver wetland just north of the transmission lines (see photo next page). This area was characterized by a fairly dense understory of seedling hemlock and yellow birch, and contained a mix of yellow birch, red maple and some red oak in the canopy. The terrain was fairly bouldery and steep in places, although moderately to poorly drained level areas were seen farther up the drainage.

The higher ground portion of the deer wintering area was slightly more mature, and large diameter red oaks dominated the overstory, especially on the well drained west-facing slopes. Eastern hemlock (*Tsuga canadensis*) was intermixed on the more level, central portions of this area, especially where shallow soils prevented adequate drainage for root systems. Hemlock and red maple were absolute dominants in all of the wetland areas, both in the northeastern fen-swamp and the major stream drainageways that fed into the beaver pond wetland. The following chart summarizes the results of the basal area plot work:

Basal Area Sampling (BAF 10 prism) within deer wintering area

Species:	BB	AB	RO	WP	EH	RM	WA	YB	WBTOTAL
Tally:	1	5	36	4	2	18	10	3	3 82

 # random points = 6; @ 136 ft sq of BA per acre
dominant overstory species: red oak
dominant understory species: eastern hemlock

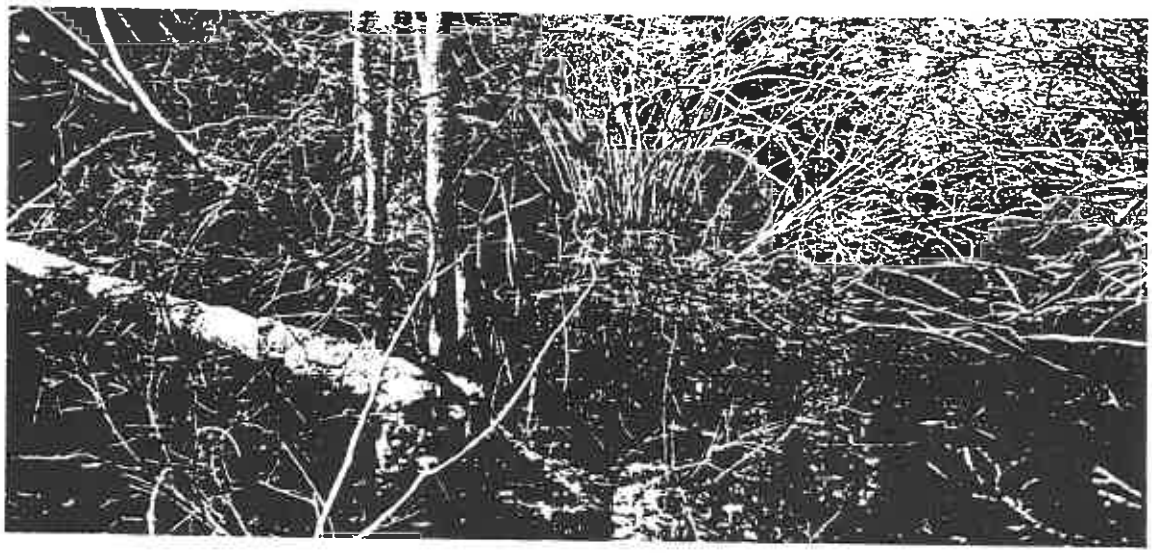
[BB = black birch; AB = American beech; RO = red oak; WP = white pine; EH = eastern hemlock; RM = red maple; WA = white ash; YB = yellow birch; WB = white birch]

As shown above, red oak was the dominant tree species and made up nearly half of the basal area total. Average dbh was approximated at 15 inches, in contrast with the white pine which averaged over 18 inches. Red maple was more numerous than white pine, but had a much small average dbh of @ 8 inches.

All of the observed deer wintering area within the GGPF was contained within the Paquette Lot. However, a significant additional area appeared to reside north of the City property's boundaries. This included a pocket red maple (*Acer rubrum*) and scrub shrub swamp and additional hemlock understory areas. The size of the latter was undetermined.

B. Vernal Pool Areas

Vernal pools #1 - 4 were within the Paquette Lot and were in the midst or on the border of the deer wintering area as described above. Vernal pool #1 was within a hemlock dominated canopy on a flat bench just west of the northeastern fen swamp. Its primary canopy edge species was hemlock and red maple, while the central portion was dominated by winterberry holly (*Ilex verticillata*) (see below). Water depth, size and biotic characteristics are summarized in the results and discussion section.



Vernal Pool #2 was a small pocket of inundated water within the northeastern fen swamp itself. Its small size and location within a sphagnum-dominated wetland made it the least typical of all of the vernal pools. Vernal pools #3 and #4 were both larger, isolated in upland areas, and had a typical coverage of shrub species. Both winterberry holly and highbush blueberry made up the latter, while adjacent tree dominants were red maple and red oak. Both of these pools were located directly west of the Old Gilsum Road, and could be seen from the roadway.

The remaining five vernal pools were all located in the southern section of the GGPF. The Ministers Lot contained the largest and most productive pool (#5), which sat on a small bench above a steep southeast facing slope next to the transmission lines that traverse the GGPF from NW to SE. Only a few hemlocks bordered the pool, while most of the adjacent tree species were red oak and red maple. Very little shrub cover was found within the pool proper, although an extensive sphagnum moss mat (*Sphagnum cuspidatum*) occupied the central portion.

Vernal pools #6 and #7 were located immediately to the north, on the same shoulder of the ridge in the eastern portion of the Grant Lot. Both were quite hummocky from old windthrow mounds, and supported red maple as the canopy dominant. Some white pine and eastern hemlock could be found in their vicinity as well. In areas where windthrows had opened up the canopy, winterberry holly and highbush blueberry dominated the understory. In pool #7, enough open water allowed fowl manna grass (*Glyceria striata*) and some sedges to grow as well. Both of these pools were uniquely clear-watered, and gave evidence of extensive upwelling of groundwater in the area.

Vernal pools #8 and #9 were located at the summit of Drummer Hill. Neither of these pools were very deep nor highly productive in terms of breeding amphibians. Their predominantly white pine canopies likely made them quite acidic as well, although no pH tests were taken. The bouldery, hard pan nature of the soils probably created sufficient conditions for periodic breeding success by wood frogs, although it was doubtful whether or not these pools would be occupied

in drier years. Some winterberry holly and highbush blueberry was found in the understory, however, thus indicating sufficient water table moisture to create inundated conditions in most years.

Several other inundated water bodies were investigated during this survey; these are more fully described in the report below.

IV. RESULTS & DISCUSSION

A. Deer Wintering Areas

Quantitative data on deer wintering areas in the GGPF was recorded on two separate field days during the 1996 winter season. Data collection locales are summarized on map A-1.1 in the Appendix. A total of 8.01 km of meandering transect and .96 km of straight line transect was completed within or at the edge of the identified deer wintering area of the Paquette Lot. A total of 15 regularly used deer trails were identified going into or out of the deer wintering area, and a total of 394 deer track intercepts were recorded. Deer track sets were recorded along with those of other medium to large sized mammals in order to provide a sense of relative track abundance. These data are summarized in the table below:

Medium to Large Mammal Track Intercepts - GGPF, Keene, NH

Date	Dist	Location	Ov	Mp	Lc	La	Aa	Ts	Mf	Cl	Vv	Ed	Lr	Pl
2/11/96	4950 m	Paquette lot	235	9	14	1	3	1	1		1	1	1	
3/13/96	4020 m	Paquette lot	159	5	2	6				6				1
Totals:	8970 m		394	14	16	7	3	1	1	6	1	1	1	1

Total track intercepts: 446; @ 1 set per 20 m of travel

[Abbreviations in Appendix A-1]

Deer track sets averaged one per 22.7 m overall, with a differential of 24.7 m per track set along the edge of the deer yard versus 13.7 m per track set within it. Track sets were usually found singly. The highest number of track sets found in one locale was four; this was corroborated by a visual sighting of four individuals within the wintering area.

A total of 12 regularly used deer trails were found entering or leaving the deer wintering area. Almost all of them were in a north-south orientation, and followed the contours of the ridgeline. An additional 3 trails were observed in adjacent habitats that were deemed unsuitable for winter cover protection. These additional trails were observed during the second field day on March 13th, when

snow pack levels were well below the estimated depth requirements for yarding activity (Halls 1984).[2] Most of the trails observed contained between 2 and 6 fresh track sets by deer. A few (notably trail #5 and #13) distinguishably contained more than 10 track sets. Pre and post-snowmelt surveys indicated that many of these trails serve as pathways for the local herd year-round.

Eleven deer beds in snow were found along the transects. Nine of these were located near an area of extensive winter use at the southeast corner of the mapped deer wintering area. The remaining two beds were within the deer yard proper along the straightline transect. Given the nature of the areas traversed, it is suspected that more beds would have been discovered had the central portions been reconnoitered more intensively. These areas were purposefully avoided, however, so as not to disturb the resident herd during the deepest snow portion of winter.

Snow conditions during the survey were optimal for detection of sign. The February 11th site visit had nearly 14 days of track accumulation that could be observed in 8 - 18 inches of icy, soft snow. March 13th conditions contained 6 days of track accumulation on somewhat of a crustier, shallower snowpack of 4 - 8 inches depth. At least a 2 - 4 inches of snow depth difference was recorded for hardwood vs softwood stands. On south-facing slopes this differential was as great as 1 foot.

Qualitative observations were made throughout the study time period. These included records of high concentrations of browse and/or scat, the presence of predator sign within or adjacent to the deer wintering areas, and the presence of human disturbance. Three areas of browse/scat concentration were noted in the survey area. The first was located at the southern tip of a lobe of hemlock understory in the southeast portion of the mapped wintering area. Several snow beds, heavy browse on hobblebush and a high concentration of scat and track indicated that this site was perhaps the most heavily used area in the northern part of the GGPF.

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2 Literature states that yarding activity tends to occur when snow depths within the yard reach a depth that is ≥75% the length of the average foreleg, or roughly 16 - 18 inches.

A second area of extensive use was located along the inflow stream to the beaver pond. This hemlock dominated understory and mixed overstory contained an abundance of scat piles in late summer and early fall, and a high frequency of track sets in early winter. Hemlock seedling browse was also extensive, as shown in the photo below. The presence of good cover, extensive sheltering from winter snow loads, and running water no doubt contributed to this area being heavily used.

The third area of extensive use was observed in the eastern part of the northeastern fen swamp. A large (.5 acre) hobblebush stand was very heavily browsed down, along with most of the other shrubs in the vicinity. Acorns and beech nuts were dug out from underneath the snow, and woodfern roots were actively grubbed out from rocky hummocks. With a hardwood overstory and a

southwesterly aspect, the solar gain in this sight was optimal. An adjacent hemlock and pine overstory provided snow shelter as well. This part of the GGPF is perhaps the most remote, although the Old Gilsum Road passes within a thousand feet to the east.

Coyotes and bobcat were the only predator species observed in the vicinity of the deer wintering area. Several coyote trails of one to three individuals were seen entering the deer yard from the north and passing to the southwest. Many of the coyote trails were directly overlying the observed deer trails, notably trails #9 and #10. The only bobcat track was seen on the small unnamed hill adjacent to the transmission lines below the beaver pond. While this was outside of the designated wintering area, this trail appeared to be following a group of three deer which were feeding on acorns on top of the hill in early March. No active signs of deer predation were observed, although some domestic dog scat near the beaver pond contained deer hair, ostensibly from a poached deer that was found nearby in the late fall of 1994.

Human disturbance in the deer wintering area was minimal. One set of cross-country ski tracks were observed off of the Old Gilsum Road, although these did not traverse the heart of the deer yard area. One other set of human tracks were seen in the talus woodland community area in February. Again, these did not enter the deer wintering habitat as designated on map A-1.1. Some logging had recently taken place in the private lot adjacent and to the west of the Paquette Lot, although no evidence of disruption (ie. avoidance) was noted when following deer tracks in that area. It is likely that the increased browse that will result will probably attract the resident herd into this area from the east.

B. Vernal Pools

Colburn (1991) describes a vernal pool as an area where an ephemeral water body sits for at least two months of the year and supports vertebrate and invertebrate wildlife species that are typically adapted to life in temporary waters. In central New England, the classic vernal pool species is the wood frog, *Rana*

sylvatica, since it is so widespread and well known. In early spring, choruses of these duck-like sounding frogs can be heard from nearly every small isolated water body in our upland woods. Defined as "explosive breeders," congregations of over ten thousand individuals are not unknown in a single shallow pond (T. Tyning, p.c.). Hundreds of egg clusters containing over 200-300 eggs per cluster are attached to surface and underwater sticks and stems, whereupon thousands of tiny black tadpoles emerge after 14 - 24 days, depending on weather conditions.

With this kind of productivity, it is not surprising that wood frogs provide an essential food chain ingredient to the success of vertebrate and invertebrate wildlife species. Being restricted to vernal ponds in spring, their numbers are easily accounted for, relative to the widespread non-breeding distribution they throughout our upland areas (DeGraaf and Rudis 1983).

In the ponds and pools they are joined by our second most common, obligate vernal pool amphibian, the spotted salamander, *Abystoma maculatum*.

These vertebrates are far more secretive in their non-breeding habits, where they tend to seek dark, moist hibernacula underground or inside of old rotten logs. Waves of breeding Abystomids can be observed during warm rainy nights in early spring, as the males move first into the breeding ponds and deposit spermatophores in a "congress" of up to several hundred individuals. Females follow within a few days or weeks (again, depending on weather), and fertilize their extruding egg masses by clutching on to the pre-deposited spermatophores (Tyning 1990).

During conducive weather years such as 1996, both wood frog and spotted salamander eggs can be found in most temporary water bodies with a maximum depth of over 10 - 14 inches (R. Van de Poll, pers. obs.). Frogs will tend to be less exact in their breeding requirements, and will often lay eggs in shallower depths, only to have these pools dry up and subject the eggs to desiccation. Salamanders will rarely lay their eggs in pools shallower than 14 inches, although this was observed in vernal pool #2 in the GGPF.

During the study time period of April - May, 1996, a total of 16 temporary pools and/or ponds were observed. Nine of these were within the GGPF and contained positive breeding evidence of obligate vernal pool species. Only 1 of the 4 originally designated pools in the Paquette Lot was confirmed as a vernal pool. The chart below summarizes the abiotic and biotic data collected on these pools.

VERNAL POOL CHARACTERISTICS - GGPF, Keene, NH

			Water Depth			Egg clusters			
Pool #	Lot Name	Size (ft)	Max (in)	Ave (in)	% cvr	# R.s.	# A.m.	# Aj-c	Sprm?
VP #1	Paquette	40 x 115	28	18	65	115	18	2	yes
VP #2	Paquette	6 x 8	14	10	100			5	no
VP #3	Paquette	32 x 45	18	8	90	12	3	2	yes
VP #4	Paquette	25 x 110	18	10	95	16	2	2	yes
VP #5	Ministers	26 x 62	48	32	25	64	308	1	yes
VP #6	Grant	20 x 35	15	6	95	6	2		no
VP #7	Grant	72 x 105	21	15	75	27	44		yes
VP #8	Drummer	35 x 45	17	8	100	2			yes
VP #9	Drummer	35 x 40	18	7	100	3			no

Notes: size is approximate, and includes internal hummocks above water level
% cover includes shrub cover (> 3 ft high)
egg cluster counts are approximate for wood frog, esp. in VP #5

Pool sizes ranged from 48 sq. ft. to 7560 sq. ft. Size, however, did not indicate productivity in terms of amphibian egg masses. Pool #5 (as pictured on the front cover) had the greatest depth and consequent volume of water, and contained a personal record of 308 spotted salamander egg masses! It also contained the second highest number of wood frog egg clusters, although these were mostly hatched and disintegrated by the time the observations were made. The highest number of wood frog egg masses occurred in pool #1, where higher elevations and cooler temperatures allowed for an accurate count of intact egg masses. It also had the largest continuous area of open water of any of the pools.

The smallest pool was located in the northeastern fen swamp, and was accidentally discovered since it was not within an upland depressional area. With a surface water basin of @ 48 sq. ft., it contained the highest count of jefferson's complex salamander egg masses found on the GGPF. Jeffersons salamanders (*Abystoma jeffersonianum*) are considered rare in the state and are on the state threatened list of amphibians. However, they are known to actively hybridize with a slightly more common species, the blue-spotted salamander (*Abystoma caerulescens*) , and cannot easily be told apart except through DNA analysis. The author has confirmed the presence of the "j-c complex" in the Keene area, through both red blood cell analysis and the presence of confirmed breeding males. (The females are the polyploid and occasionally parthenogenetic individuals in a population). The presence of several breeding ponds that contained jeffersons egg masses was the most significant find of the vernal pool survey.

Second in significance was the relative productivity of the nine confirmed breeding pools. Size and depth were not the only factors that created optimal conditions for breeding amphibians. As stated above, pool #5 had the highest count of salamander eggs yet was not the largest pool. While it was the deepest, it had relatively few attachment sites for egg clusters and was largely cloaked by sphagnum and other aquatic mosses. Moreover, it was obviously disturbed by a former logging operation that had cut out some pool-side trees and dragged the logs out across its outflow. The following photo indicates the area of disturbance by the lush growth of sun-loving sedges.

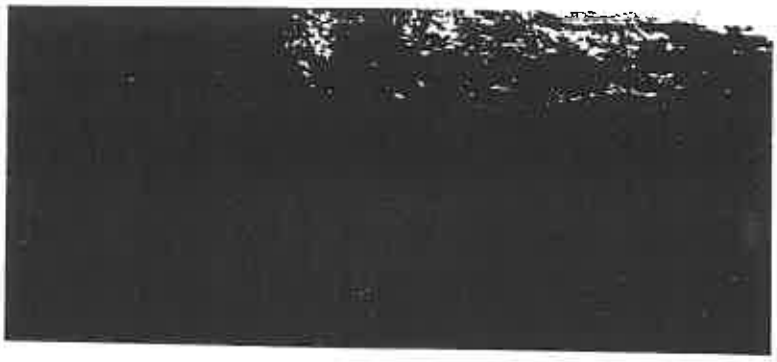
The above pool #5 contained at least three successive egg deposition dates for the Abystomids, as evidenced by the successive growth of algae on each set of egg clusters. Critical to the development and egg-laying capabilities of the salamanders this year was the rate at which the snow and ice retreated from the ponds. This pool was south-facing, and was in a warm pocket, primarily among hardwood trees. It was suggested that solar gain played a significant role in allowing earlier movements into this pool as a result (T. Tyning, p.c.). Being fairly isolated from other water bodies to the east, south and west, it was also suggested that proximity likely also played a significant role in its observed relative productivity.

Productivity was also fairly high in pool #7, just to the north of pool #5. While having the same open water size and depth as pool #4 in the Paquette Lot, it contained considerably more egg masses of both common species. The high water clarity and mineral content of this groundwater-fed pool may have played a role in its productivity. In contrast, the shallow, acidic and tannin-rich pools of the Drummer Hill Lot (#8 & #9) were quite sparse in their egg mass numbers,

wherein salamander eggs were not observed at all. Low pH may have played a part in this, as spotted salamander larvae cannot generally withstand a pH level of less than 4.5 (Tyning 1990; Colburn 1991).

In addition to the 9 pools observed within the GGPF, 4 pools with obligate vernal pool breeders were seen immediately adjacent to the GGPF. These were concentrated in the 36.4 acre Albert Fontaine Lot just north of Drummer Hill and west of the Grant Lot, and all contained breeding wood frogs, spotted salamanders, and in the case of pool #O-1 and O-2, jeffersons complex salamanders as well. A fifth pool that was located outside of GGPF boundary was found at the edge of the wooden frame transmission lines just north of the Grant Lot. In spite of its large size (45 ft x 60 ft), adequate depth (to 24 inches), and abundance of attachment sites, it only contained 6 spotted salamander egg clusters and no wood frog eggs. Its position of being > 50% within the powerline right-of-way may have had an influence on amphibian survival in the area.

Additionally, two water bodies were observed that were considered as potential breeding areas. One was the temporary impoundment on Drummer Hill, which contained tadpoles of overwintering bullfrogs but no other amphibian species. While it contained sufficient water depth for vernal pool species, several fish species (redbelly dace, slimy sculpin, and pumpkinseed sunfish) were quite prevalent. The second open water body was the beaver impoundment area studied during Part I of this investigation. It contained several spotted salamander egg masses, as well as red-spotted newts and redbelly dace, which are known consumers of salamander eggs. The picture below depicts several red-spotted newt larvae along its shallow rocky shore.



These additional open water areas may occasionally produce vernal pool species, especially spotted salamanders, however they will likely not be very productive on account of the presence of vertebrate predators. The regularity and relative success rate of these species would be an interesting study to undertake.

V. SUMMARY & CONCLUSION

The Greater Goose Pond Forest was found to contain an least one active deer wintering area during the 1995 - 1996 winter season. This area was primarily concentrated in the 263 acre Paquette Lot in the northern portion of the GGPF. Definitive evidence of wintering deer in a @ 70.5 acre section of this lot was determined through direct sightings and observations of scat, browse, snow beds, and bark scarring of seedling hemlocks. Regular winter and summer use trails were observed throughout the wintering area; most of these followed the north - south running contours of the ridgeline. The most heavily used trails corresponded with the most recent sign of extensive browse. A maximum of four individuals were observed at any given spot, although a total population for the area was not discernible given the scope of the study.

Wintering deer yards in the Monadnock Region are becoming more and more scarce as development, increased human disturbance, and increasing populations of predators (primarily coyote and bear) expand through the region. The Greater Goose Pond Forest wintering deer area provides a potential long-term zone free from the effects of at least the first two of these concerns. By maintaining a deer conservation area that is free from trails that may bring more motorized and non-motorized traffic into it, at least one sub-population of white-tailed deer in the area will be assured adequate natural protection from the elements during the winter time period.

In terms of the second type of BSIA studied during this investigation, it is clear that the GGPF holds a representative amount of temporary vernal ponds for breeding amphibians. Nearly all open water areas of sufficient depth and size within this city property contained positive evidence of obligate vernal pool breeders (9 out of 11). While no rigorous study of breeding invertebrates was conducted, at least three species of obligate breeding amphibians were identified through the presence of egg clusters. Wood frogs were the most widespread breeders with egg masses found at all but one site. Spotted salamanders were the most productive breeders with at least 377 egg clusters found across six different pools. Jeffersons complex salamander were the least common, with only 12 egg

clusters observed across five separate pools.

The sparsity of egg clusters for the latter species was consistent with the observations of the principal researcher in the Monadnock Region. Several plausible reasons exist for this observation, namely:

1) jeffersons salamanders are at the northern limit of their range in southern New Hampshire;
2) jeffersons salamanders are earlier breeders than the other two documented species, and winter was late this year;
3) jeffersons salamander eggs often suffer greater predation by raccoons and other vertebrate predators due to their early egg dates;
4) polyploid females are estimated to outnumber diploid males by 10:1; this and parthenogenetic reproduction may have reduced the number of successfully reproducing adults over time.

At least one vernal pool was observed to have been impacted by logging activities in the central portion of the Ministers Lot. While this pool happened to have been the most productive in terms of numbers of egg clusters per unit volume of water, it was unclear what if any long-term effects may have been incurred by the reduction in canopy cover and lowering of the water table. It is hypothesized that at least during the 1996 season the greater solar gain may have contributed to an earlier ice free date and a consequent increase in the number of egg laying opportunities by spotted salamanders. This pool should be studied for long-term trends in this regard.

Overall, the Greater Goose Pond Forest contained a number of sensitive ecological sites that could be severely impacted by increased human activity. Part I summarized the two most critical wetland habitats on the property in the Paquette Lot. Both contained rare species that represent a significant degree of niche specialization over time. Both also served as areas of high biological diversity relative to the surrounding forest. The vernal pool areas as identified in this report also served the same function, and in 5 out of 9 cases also contained regionally rare species. All of these biologically significant areas should remain

untouched by direct human activities. The latter would include timbering as well as trail building activities that would increase motorized and non-motorized use. Moreover, adequate buffer zones should be established surrounding each of these areas in order to preserve the integrity of the ecological conditions that have created the sites.

Part I of this investigation outlined the preliminary recommendations relative to the four BSIA's studied at that time. The following section will outline the suggested management recommendations for the remaining two types of areas, as well as general recommendations for appropriate conservation activities of the GGPF as a whole.

VI. RECOMMENDATIONS

As stated in Part I of this study, the following recommendations should not be viewed as a static output of this single investigation. It reflects the opinions of the principal researcher only, and is based upon approximately two years of field work and a fairly sound familiarity with the management processes of city-owned land. It also reflects the growing need for properly managed forested tracts that are being increasingly scrutinized for their contribution to biodiversity. Given the shift in public opinion about the use and management of public lands, as well as the increasing pressure on our timber resources, these recommendations attempt to strike a balance between active management and no management, and between conservation and preservation. Necessarily, it is suggested that ideas be put to a public test and formalized in a committee that is representative of the public interest.

1) **Maintain and retain the northernmost section of the GGPF *inclusive of Goose Pond and its immediate watershed* as a nature preserve in perpetuity.** The appropriate lots for inclusion are: Paquette (263 acres), Constantino (35 acres), Leigh (48 acres), Faulkner-Colony (29 acres), Wright (40 acres), Thompson-Reed (39 acres), Burroughs (124 acres), Bauer (9.8 acres), Taft (3.4 acres), and Goose Pond (74 acres). These represent the most visible and actively used recreational areas of the GGPF. They also include the most ecologically rich site, the 263 acre Paquette Lot.

2) **Maintain and retain the southern and easternmost portions of the GGPF as active timber management areas, taking into account the necessary buffer zones as itemized below.** The appropriate lots for inclusion in this zone are: Sylvester (20 acres), Leigh (12 acres), Galloway (26 acres), Drummer Hill (133 acres), Grant (96.7 acres), and Ministers (30 acres). Most of this area is comprised of second growth hardwoods and white pine that have been actively managed for timber prior to their acquisition by the city. These areas also receive less foot traffic than the lots surrounding Goose Pond, with the exception of the Old Gilsum Road and other trails in the Drummer Hill area. Sensitive selection cut management of these areas should have as its primary fiscal objective the generation of revenue

dedicated to the improvement of the trail system within the GGPF.

3. **Maintain a minimum logging buffer of 100 feet from all perennial streams, open water bodies and vernal pools.** This follows the recommendations of the state relative to disturbance setbacks from wetlands, streams and shorelands, and represents a minimalist approach. As stated in Part I, cutting should be restricted at least two tree lengths away from sensitive wet areas such as vernal pools. The latter should be increased if the slope and hydrology in the immediate vicinity of the vernal pool suggests significant potential impact from tree fall or skidder ruts.

4. **Refrain from building any trails or pathways in the Paquette Lot.** For the reasons described above under the deer wintering area assessment, this area should be remain open only to random foot travel. The diversity of wildlife observations was higher here than anywhere else in the GGPF. This alone should suggest caution when promoting recreational use of the park.

5. **Consistently and regularly mark and post the boundaries of the GGPF.** No Hunting' signs should conform to legal standards and should be placed at a minimum of 100 ft apart. Tree blazes should be installed and/or maintained, and questionable survey bounds resolved.

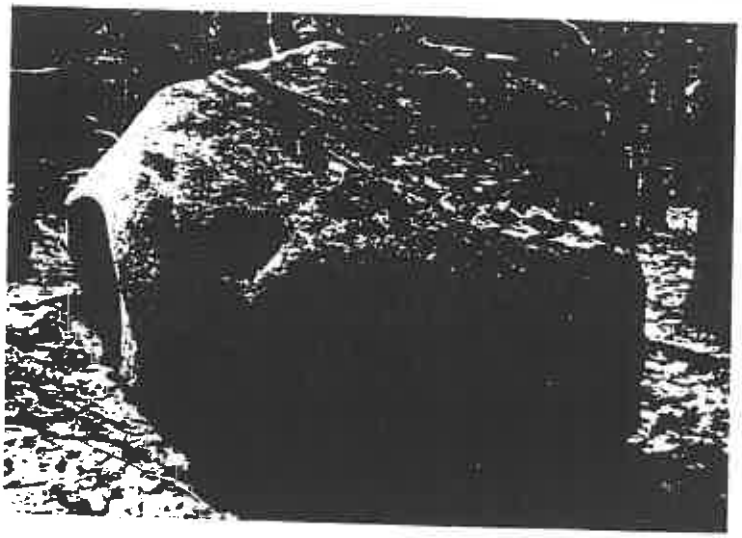
6. **Secure conservation easements, development rights, and/or fee title to all lands within the watershed of Goose Pond.** By priority, these should include the Albert Fontaine lot just west of the Grant Lot, the 'out' lot downstream of the beaver pond in the Paquette Lot, the Leigh lot surrounding the transmission lines in the east central portion of the GGPF, and the scrub shrub wetland area west of Drummer Hill. Landowners should be actively courted for such conservation initiatives in the public interest.

7. **Map and mark all trails leading into, within or out of the GGPF.** This recommendation has appeared before, but has apparently not been completed in its entirety. An appropriate trail guide and dispenser should be installed in the primary parking lot on the East Surry Road and at the base of Drummer Hill.

8. Consider establishing or actively seeking a long-term endowment fund for research and educational use of the GGPF. While potential funds from timber harvests may not be permanently established or applied, an endowment fund that can be managed for the purposes of environmental education within the GGPF would greatly enhance the visibility, appreciation and public understanding of this largest public holding in the City of Keene.

9. Regularly monitor the vernal pools in the GGPF for the presence and population fluctuation of the regionally rare jeffersons complex salamander. As stated in the above report, this species is perhaps the most sensitive amphibian species in the GGPF and could be critically imperiled by one to several severe weather years. In order to gain a better understanding of its occurrence in this permanently protected land, regular monitoring studies should be conducted by area schools. This can be accomplished through an "adopt-a-vernal-pool" program in secondary schools or through regular college or graduate level research.

10. Integrate the findings of the continuing research within the GGPF with efforts within the rest of the New England bioregion. Considering the active establishment of ecological reserves in northern New England and elsewhere, the GGPF should be viewed as a potential resource in the identification of significant natural communities. Some of these have been identified in these two reports; further research into the aquatic and the developing terrestrial natural communities should be undertaken as a part of the multi-state effort.



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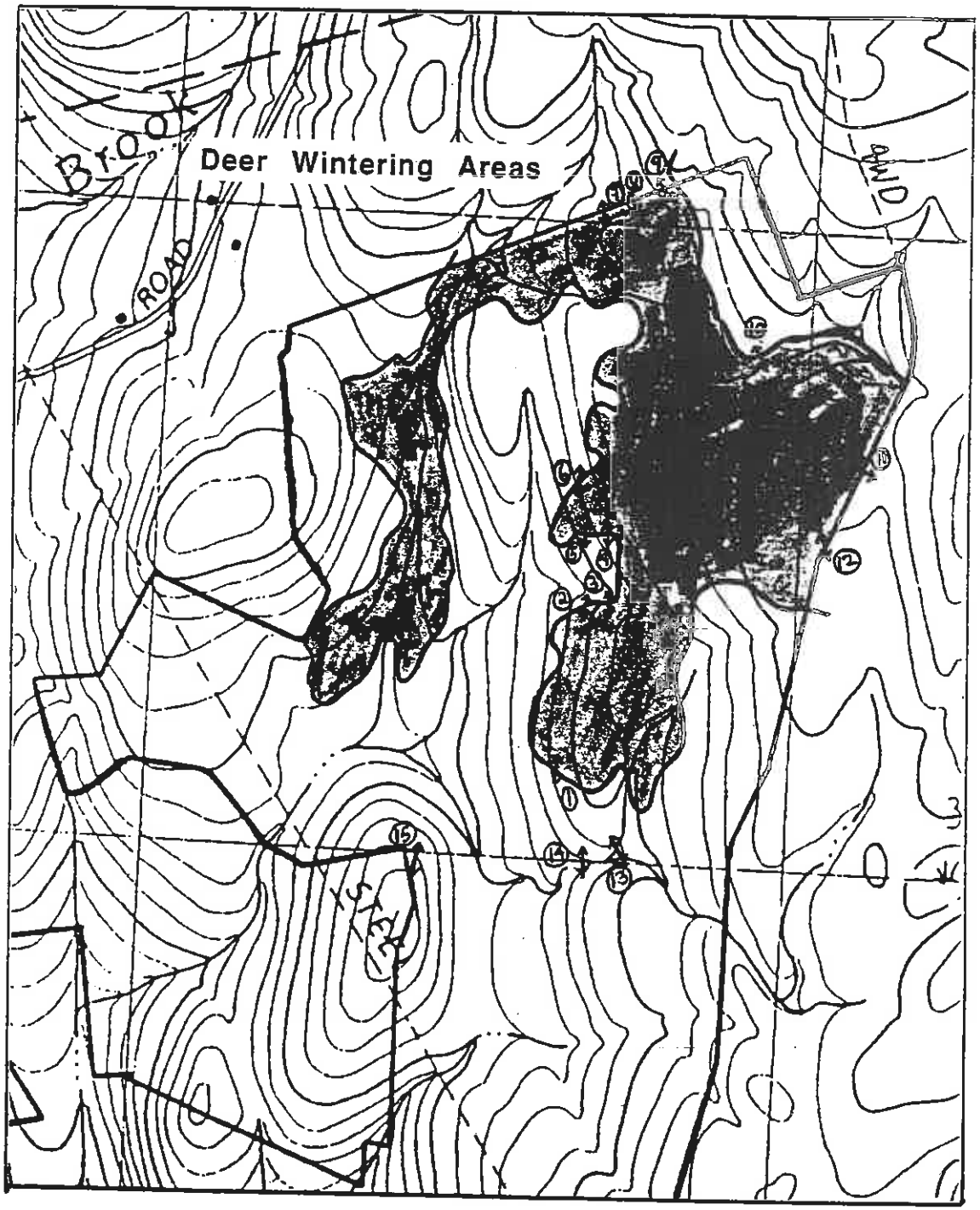
APPENDICES



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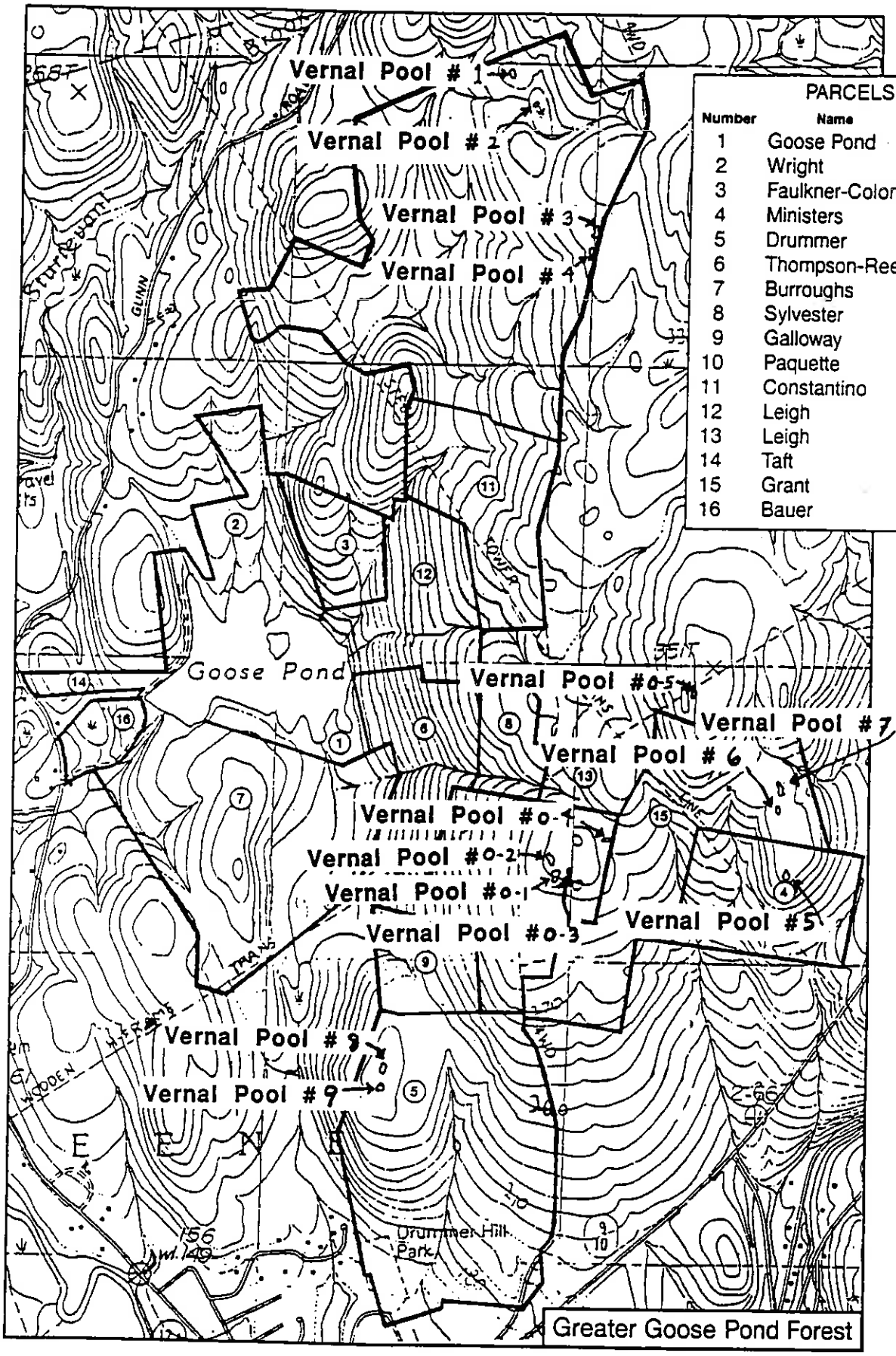
0 100 200 300 400 500m

One Centimeter represents 100 meters

Contour Interval 6 meters

MAP A-1.1 Deer Wintering Areas
Greater Goose Pond Forest



PARCELS

Number	Name	Acres
1	Goose Pond	74
2	Wright	40
3	Faulkner-Colony	29
4	Ministers	30
5	Drummer	133
6	Thompson-Reed	39
7	Burroughs	124
8	Sylvester	20
9	Galloway	26
10	Paquette	263
11	Constantino	35
12	Leigh	48
13	Leigh	12
14	Taft	3.4
15	Grant	96.7
16	Bauer	9.8

0 200 400 600 800 1000m

N

One Centimeter represents 200 meters

Contour Interval 6 meters

MAP A-1.2 VERNAL POOLS

Greater Goose Pond Forest

APPENDIX A-2.1

Mammal Species Found on the Intercept Transects - GGPF, Winter 1996

ABBREVIATION	SCIENTIFIC NAME	COMMON NAME
Ov	Odocoileus virginianus	White-tailed Deer
Mp	Mustela pennanti	Fisher
Lc	Lutra canadensis	River Otter
La	Lepus americanus	Snowshoe Hare
Aa	Alces alces	Moose
Ts	Tamias striatus	Chipmunk
Mf	Mustela frenata	Long-tailed Weasel
Cl	Canis latrans	Eastern Coyote
Vv	Vulpes vulpes	Red Fox
Ed	Porcupine	Porcupine
Lr	Lynx rufus	Bobcat
Pl	Procyon lotor	Raccoon

Medium to Large Mammal track intercepts - GGPF, Keene, NH

Date	Dist	Location	Ov	Mp	Lc	La	Aa	Ts	Mf	Cl	Vv	Ed	Lr	Pl
2/11/96	4950 m	Paquette lot	235	9	14	1	3	1	1		1	1	1	
3/13/96	4020 m	Paquette lot	159	5	2	6				6				1
Totals:	8970 m		394	14	16	7	3	1	1	6	1	1	1	1

Total track intercepts: 446; @ 1 set per 20 m of travel

Basal Area Sampling (BAF 10 prism) within deer wintering area

Species:	BB	AB	RO	WP	EH	RM	WA	YB	WB	TOTAL
Tally:	1	5	36	4	2	18	10	3	3	82

 # random points = 6; @ 136 ft sq of BA per acre

dominant overstory species: red oak

dominant understory species: eastern hemlock

VERNAL POOL CHARACTERISTICS - GGPF, Keene, NH									
			Water Depth			Egg clusters			
Pool #	Lot Name	Size (ft)	Max (in)	Ave (in)	% cvr	# R.s.	# A.m.	# Ai-c	Sprm?
VP #1	Paquette	40 x 115	28	18	65	115	18	2	yes
VP #2	Paquette	6 x 8	14	10	100			5	no
VP #3	Paquette	32 x 45	18	8	90	12	3	2	yes
VP #4	Paquette	25 x 110	18	10	95	16	2	2	yes
VP #5	Ministers	26 x 62	48	32	25	64	308	1	yes
VP #6	Grant	20 x 35	15	6	95	6	2		no
VP #7	Grant	72 x 105	21	15	75	27	44		yes
VP #8	Drummer	35 x 45	17	8	100	2			yes
VP #9	Drummer	35 x 40	18	7	100	3			no
Notes: size is approximate, and includes internal hummocks above water level									
% cover includes shrub cover (> 3 ft high)									
egg cluster counts are approximate for wood frog, esp. in VP #5									

Wildlife Species List - Greater Goose Pond Forest
Summer 1995
(UPDATED SPR. 96)

MAMMALS

Scientific Name	Common Name
Ursus americanus	Black bear
Procyon lotor	Raccoon
Mustela vison	Mink
Martes pennanti	Fisher
Lutra canadensis	River otter
Canis latrans sp.	Eastern coyote
Vulpes vulpes	Red fox
Castor canadensis	Beaver
Ondatra zibethicus	Muskrat
Erethizon dorsatum	Porcupine
Tamiasciurus hudsonicus	Red squirrel
Tamias striatus	Eastern chipmunk
Clethrionomys g. gapperi	Red-backed vole
Lepus americanus	Snowshoe hare
Odocoileus virginianus	White-tailed deer

Additions 1996:

Parascalops breweri	Hairy-tailed mole
Alces alces	Moose
Mustela frenata	Long-tailed weasel
Lynx rufus	Bobcat
Sciurus carolinensis	Grey squirrel

Totals: 1995: 15 spp
1996: 5 spp
Both years: 20 spp

BIRDS

(All but the heron, turkey, woodcock, and kingfisher likely nest in the vicinity of the study area based upon repeated vocalizations by males heard during site visits. Those species that were confirmed nesters based upon observations of nest material, eggs, or fledglings are indicated with a '*')

Scientific Name	Common Name
Ardea herodias	Great blue heron
Aix sponsa	Wood duck*
Anas platyrhynchos	Mallard*
Buteo platypterus	Broad-winged hawk*
Meleagris gallopavo	Wild turkey
Bonasa umbellus	Ruffed grouse
Scolopax minor	American woodcock
Zenaida macroura	Mourning dove
Bubo virginianus	Great horned owl
Archilochis colubris	Ruby-throated hummingbird
Ceryle alcyon	Belted kingfisher
Colaptes auratus	Common flicker
Dryocopus pileatus	Pileated woodpecker
Sphyrapicus varius	Yellow-bellied sapsucker
Picoides villosus	Hairy woodpecker
Picoides pubescens	Downy woodpecker
Myiarchus crinitus	Great-crested flycatcher
Tyrannus tyrannus	Eastern kingbird*
Sayornis phoebe	Eastern phoebe*
Contopus virens	Eastern wood pewee
Tachycineta bicolor	Tree swallow
Cyanocitta cristata	Blue jay
Corvus brachyrhynchos	American crow
Parus atricapillus	Black-capped chickadee
Sitta carolinensis	White-breasted nuthatch
Sitta canadensis	Red-breasted nuthatch
Certhia familiaris	Brown creeper
Catharus guttatus	Hermit thrush
Catharus fuscescens	Veery
Bombycilla cedrorum	Cedar waxwing
Vireo olivaceus	Red-eyed vireo
Mniotilta varia	Black-and-white warbler
Dendroica caerulescens	Black-throated blue warbler
Dendroica virens	Black-throated green wrabler
Dendroica coronata	Yellow-rumped warbler
Seiurus motacilla	Louisiana waterthrush
Geothlypis trichas	Common yellowthroat
Piranga ludovicianus	Scarlet tanager
Quiscalus quiscalus	Common grackle*
Ageliaeus phoeniceus	Red-winged blackbird*
Icterus galbula	Northern oriole
Pipilo erythrophthalmus	Rufous-sided towhee
Carduelis tristes	American goldfinch

Wildlife Species List - Greater Goose Pond Forest - Summer 1995 - Revised Sp 96

Birds (cont'd)

Additions 1996:

Pandion halietus	Osprey
Accipiter cooperi	Coopers hawk
Accipiter striatus	Sharp-shinned hawk
Buteo jamaicensis	Red-tailed hawk
Buteo lineatus	Red-shouldered hawk*
Cathartes aura	Turkey vulture
Chaetura pelagica	Chimney swift
Parus bicolor	Tufted titmouse*
Turdus migratorius	American robin*
Sturnus vulgaris	European starling
Regulus satrapa	Golden-crowned kinglet
Regulus calendula	Ruby-crowned kinglet
Vireo solitarius	Solitary vireo*
Seirus aurocapillus	Ovenbird*
Cardinalis cardinalis	Cardinal
Spizella passerina	Chipping sparrow
Melospiza melodia	Song sparrow*
Zonotrichia albicollis	White-throated sparrow*
Junco hyemalis hyemalis	Dark-eyed junco*
Pipilo erythropthalmus	Rufous-sided towhee
Carpodacus mexicanus	House finch
Coccothraustes vesperitinus	Evening grosbeak
Loxia curvirostra	Red crossbill

Totals: 1995: 43 spp
1996: 23 spp
Both years: 66 spp

AMPHIBIANS & REPTILES

Rana catesbeiana	Bullfrog
Rana palustris	Pickerel frog
Rana clamitans melanota	Green frog
Hyla versicolor	Gray tree frog
Bufo a. americanus	Eastern american toad
Notophthalmus v. viridescens	Red spotted newt

Additions 1996:

Rana sylvestris	Wood frog
Pseudacris crucifer	Spring peeper
Abystoma maculata	Spotted salamander
Abystoma jeffersonianum-caerulescens	complex Jefferson's complex salamander
Plethodon cinereus	Red-backed salamander
Chrysemmys picta picta	Eastern painted turtle
Thamnophis sirtalis sirtalis	Eastern garter snake

Totals: 1995: 6 spp
1996: 7 spp
Both years: 13 spp

FISHES

Cottus cognatus	Slimy sculpin
Lepomis gibbosus	Pumkinseed sunfish
Phoxinus eos	Northern redbelly dace

Total both years: 3 spp

ATHROPODS

Simuliidae	black flies
Anopheles spp.	mosquitos
Collembola sp.	springtails
Limnephilidae rhombicus	caddisfly
Libellulidae	water skimmers
Gerridae	water striders
Lycaenidae, subfamily Plebeiinae	common blue butterfly
Anisoptera sp.	white-banded dragonfly
Enallagma sp.	bluet
Aestinidae	blue darner
Trichoceridae	zebra cranefly

Additions 1996:

Lymantria dispar	Gypsy moth
	Predaceous diving beetle
	Water boatman
	Carpenter ants