

Ecological Inventory of the Ninevah Foundation Lands Mount Holly & Plymouth, VT

Final Report for the Ninevah Foundation

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30 April 2018

This report presents the results of our ecological inventory of the roughly 3400 acres of property owned by the Ninevah Foundation. These lands found around Lake Ninevah in the towns of Mount Holly and Plymouth, Vermont, are referred to in this report as the Ninevah Foundation Lands (NF Lands). I did most of the field work and analysis of the results, including writing the report, and Andy made all the maps, including the beautiful final maps which accompany this report in PDF format. Starting in the spring of 2016, the inventory took place over a two year period. The Ninevah Foundation is gratefully acknowledged for fully supporting our work.

In addition to Andy's final PDF maps, the products of this inventory include the primary digital spatial data files (shapefiles and geodatabase) we created during the inventory. The spatial data files include databases attributed with information describing the characteristics of the point or polygon natural features. After finishing entering metadata associated with these spatial data files, they will all be available upon request. Metadata is provided on all the final PDF maps.

Truly, it has been a privilege to be able to spend many days exploring this surprisingly diverse landscape tucked up in the elevated basins found at south the end of the Coolidge Range in the Green Mountains. At the outset I was expecting a fairly low diversity of natural communities and not a great number of wetlands given the geological and physiographic setting of NF Lands. After the first few days in the field on the project I realized how wrong my expectations were. Not only was there rich northern hardwood forest perched high in the mountains where I was least expecting it, but wetlands, including numerous vernal pools and seeps, appeared almost everywhere I went on the elevated flats north and south of Lake Ninevah. And Lake Ninevah - the crown jewel - and its large peatland occupying a bay at its south end, are one of Vermont's ecological treasures, both for their biodiversity, including many rare plants, and their sheer beauty.

The results divided into these sections: Uplands; Wetlands; Wildlife and Natural Features; Rare, Threatened, Endangered, and Uncommon Species; and Invasive Species. A Management

Recommendations sections follows the results' sections. Before diving into the results, a few explanations of key phrases and concepts needed to understand the results are given below.

- **Natural Community:** As defined in Elizabeth Thompson and Eric Sorenson's Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont (The Nature Conservancy and the Vermont Department of Fish and Wildlife, University Press of New England, Hanover, NH, 2000, p. 2) "A natural community is an interacting assemblage of organisms, their physical environment, and the natural processes that affect them." Habitat type, and plant community or association, are akin to natural community, though habitat is generally thought of as relating to a particular organism (e.g. bear habitat) and plant community relates to vegetation but leaves out the multitudes of animal world and the physical environment. Of recent origin, the natural community is an attempt to give a name to ecologically unique parts of the landscape which repeat across a landscape, though never exactly the same.
- **Element Occurrence (EO):** This is a term adopted by The Nature Conservancy many years ago as they developed Natural Heritage Programs throughout the United States. The Natural Heritage Programs use element occurrence to describe a particular colony or population of a rare, threatened, or endangered animal or plant species as it appears in the landscape, or a particular "significant" natural community as it appears in the landscape. The Rough Cotton-grass discovered in the peatland at the south end of the lake is an EO because it is a rare species in Vermont. Though observed in a couple different spots, this species' population is considered a single EO because the two colonies occur in same natural community in relatively close proximity to one another. Depending on the natural community type, discreet natural communities up to a half-mile apart can still be considered the same EO if the intervening land is in natural (versus cultural) condition. Wetland natural communities can have more restrictive conditions for defining a single EO, such as they must be in the same watershed.
- **State-significant:** The adjective state-significant, or significant at the state level, is given to natural community occurrences that are exemplary and of conservation importance. State-significant natural communities are ranked according to their condition, size, and landscape context, with the more common natural community types requiring occurrences to be relatively in better condition, larger, and in better landscape context than rarer natural community types. This ranking construct is based upon the conservation biology maxim that larger, better condition (e.g. more mature forest with fewer or no invasive species), and better landscape context (e.g. surrounding lands with less development, agriculture, roads) natural communities are of higher conservation value than smaller, poorer condition, and poorer landscape context natural communities. In Vermont, the Natural Heritage Program, now called the Natural Heritage Inventory (VNHI), considers all state-significant natural community occurrences as EOs. Additionally, all rare, threatened, and endangered species are state-significant.

Uplands

As shown in Table 1 and on the Rare, Threatened, Endangered & Uncommon Species and State-Significant Upland Natural Communities (RTE-SS Uplands) map, NF Lands support several state-significant examples of uncommon upland forests on the tops and upper slopes of both Salt Ash and Bear Mountains. These mountains have good examples of montane yellow birch-red spruce forest, the latter intermingled with montane spruce-fir forest. Their proximity to mapped EOs of the same forest communities on adjacent Coolidge State Forest (CSF) make them part of the CSF state-significant element occurrences.

Table 1. Summary of upland natural communities on the NF Lands.

Natural Community Type	State Rank	# of Polygons	Size in Acres*				# of Element Occurrences
			Max.	Min.	Median	Total	
montane spruce-fir forest	S3	2	3	2	3	5	1
montane yellow birch-red spruce forest	S3	6	22	<1	7	55	1
montane tall herb glade	NR	1				1	1
mixed hardwood-conifer forest**	NR	20	453	<1	7	1225	0
northern hardwood forest	S5	13	618	<1	22	1819	1
rich northern hardwood forest	S4	6	47	1	4	70	2

* Only within Ninevah Foundation Lands. EO acreages much larger since natural communities extend off NF Lands property.

** Catchall for all mixed hardwood-conifer forest not in northern hardwood forest EO

A high-elevation example of rich northern hardwood forest occurs in three areas on Salt Ash Mountain. Totalling 67 acres, this less common northern hardwood forest natural community is distinctive as its fertile soil produces a wealth of spring wildflowers and nutrient-demanding herbs, ferns, and sedges, such as blue cohosh, wild leek, maidenhair fern, and plantain-leaved sedge, not found in typical conifer-hardwood forests with acidic soils. These rich woods are also notable for being in what appears to be near pristine condition. Altogether the size, condition, and landscape context make this a state-significant element occurrence of the rich northern

hardwood forest natural community. Another much smaller rich northern hardwood forest EO is found in two high coves on the northeast end of Bear Mountain.

A 1.5 acre “montane tall herb glade” is mapped and described as an inclusion within the rich northern hardwood forest on Salt Ash Mountain. While smaller examples of these glades were mapped as wetland points further northeast on NF Lands, this exceptionally large example straddling the property boundary with Coolidge State Forest is ambiguously upland. This is an unusual natural community type which has only recently been described in Vermont from elsewhere on the Coolidge Range, particularly along the ridge between Killington and Pico peaks. These glades are highly diverse with a luxuriant growth of tall herbs associated with breaks in the forest canopy. Note that this natural community has not been ranked by VNHI, hence not included in the state natural community classification. Because of its unique ecological characteristics, this will be submitted to VNHI of the Vermont Fish & Wildlife Department as an EO.

Northern hardwood forest and a catchall “mixed hardwood-conifer forest” are the matrix forest communities mapped on the NF Lands. The northern hardwood forest is part of an enormous northern hardwood forest EO that extends for thousands of acres on the Coolidge Range in CSF as far north as Killington Peak. This EO also extends east on to Tiny Pond Wildlife Management Area. On the NF Lands the 1800+-acres of northern hardwood forest occupies most of the mountains excepting the summits, plus most of the lesser slopes elsewhere on the property. As with all the natural communities, its state-significance is predicated on its size, condition, and landscape context. In the case of the Coolidge Range northern hardwood forest, the EO is exceptionally large, the landscape context is very good, and the overall condition of its forest is mature and largely undisturbed by human activities. This gives it an EO rank of A.

The large remainder (1225 acres) of upland forest is mapped as mixed hardwood-conifer forest, which is a mix of red spruce-northern hardwood forest, hemlock-northern hardwood forest, and secondary forest (formerly pastures) that I was not able to clearly map as natural communities. At this point none of this forest is considered state-significant, hence not an EO. It occupies flats, benches, basins, and ground surrounding wetlands north of the lake, and most of the low-relief terrain south of the lake.

The last important upland forest shown on the RTE-SS Uplands Map is a four-acre beech forest. This important bear hard mast stand is described in the Wildlife and Natural Features section.

Wetlands

A total of 300 wetlands covering 220 acres are shown on the Wetlands maps. Broken out by natural community type, Table 2 summarizes the Inventory’s wetlands data. The total wetlands acreage includes 13 acres that extend off the NF Lands, but does not include 8 acres of potential wetlands. These potential wetlands were mapped in GIS using a combination of aerial

Table 2. Summary of Ninevah Foundation Lands' wetland natural communities.

Natural Community	State Rank	Wetland Group	# of Features		Size in Acres				# Element Occurrences
			Polygons	Points	Max.	Min.	Median	Total	
small stream bottomland forest	NR	Alluvial wetland	1	0				0.7	0
small stream alluvial zone	NR		0	1				<0.1	0
red spruce - cinnamon fern swamp	S3	Basin swamp	16	0	4.1	0.07	0.68	17.3	1
sphagnum swamp	NR		0	2	0.1	0.07	0.07	0.1	0
hemlock-balsam fir-black ash seepage swamp	S4	Forested seepage wetlands	20	0	8.0	0.17	1.10	29.1	7
northern hardwood seepage forest	S3		51	1	4.8	0.07	0.48	42.9	6
sedge meadow	S4	Marshes and wetland meadows	2	0	9.4	5.80	7.59	15.2	1
shallow emergent marsh	S4		9	1	23.7	0.03	1.59	38.2	3
sphagnous meadow-marsh	NR		3	0	0.9	0.07	0.24	1.2	0
tall fern-herb meadow	NR		0	1				0.2	0
wet meadow	NR		0	1				0.1	0
intermediate fen	S2		Open peatland	1	0				34.4
artificial pond	NR	Open water	3	0	0.5	0.06	0.10	0.7	0
beaver pond	NR		1	0				0.3	0
alder swamp	S4	Shrub swamps	8	0	3.5	0.50	1.00	11.6	1
basin shrub swamp	S2		2	1	0.3	0.05	0.24	0.6	2
sweetgale shoreline swamp	S3		5	0	3.4	0.55	0.76	7.6	1
tall lakeshore shrub swamp	NR		3	0	1.4	0.20	0.42	2.0	0
montane tall herb glade*	NR	Small open seepage wetlands	1	1	1.6	0.07	0.83	1.7	1
seep	S4		5	53	0.2	0.01	0.04	3.5	14
seepage glade	NR		5	0	0.2	0.06	0.13	0.7	0
semi-alluvial seep	NR		5	10	0.2	0.01	0.06	1.2	0
semi-alluvial seepage meadow	NR		9	0	1.5	0.04	0.17	3.5	0
sloping seepage shrubby woodland	NR		1	0				3.6	0
seepage meadow	NR		0	3	0.05	0.04	0.05	0.1	0
semi-alluvial seepage drainage	NR		0	3	0.1	0.02	0.04	0.1	0
temporary pools	NR	Temporary pool(s)	0	2	0.1	0.02	0.05	0.1	0
vernal pool	S3	Vernal pool	10	42	0.2	0.01	0.04	3.0	27
Potential wetlands seep, others	NR	Potential wetlands	10	7		0.01		[8]	0
Total			171	129				220	65

*Includes 1 polygon mapped as an upland

photos and fine-scale contour/slope layers, but were not visited to confirm. This new wetlands mapping represents a great expansion from the 25 wetlands covering 177 acres that appear on the Vermont Significant Wetland Inventory maps. The twelve-fold expansion of number of wetlands is particularly impressive. Wetlands less than 0.1 acre are mapped as points because of their small size.

While most of the newly mapped wetlands are small – one acre or less – they greatly add to the ecological diversity of the NF Lands, including important wildlife habitat for moose, deer, bear, breeding salamanders and frogs, and a plethora of invertebrates that are critical members of forest ecosystems. Additionally, small wetlands play are of inordinate importance for plant diversity. One study of an old-growth forest in Quebec* found that while wetlands occupied just 1% of the landscape, they contributed 45% of the vascular plant diversity. Though I have not done this analysis for NF Lands, I suspect the wetlands which occupy less than 1% of the lands would contribute more the 50% of the plant diversity.

The NF Lands wetlands are not only abundant and diverse, they contain many high quality examples that are significant at the state level. The 300 mapped wetlands contain a total of 65 element occurrences.

Many of the wetlands are seepage wetlands, forested or not, characterized by shallow muck soils situated on gentle slopes. While the tiny seeps and related small open seepage wetlands are the most numerous wetlands group (98 features), their total size adds up to less than 15 acres. Yet the forested seepage wetlands, including the newly classified northern hardwood seepage forest and its closely related hemlock-balsam fir-black ash seepage swamp, both are numerous (72 features) and combined have a total of 72 acres, which is by far the greatest acreage of any wetland group.

In addition to the numerous newly-mapped seepage wetlands, many new vernal pools were discovered during field surveys on May 15-16, 2017. A total of 52 vernal pools are now documented on NF Lands, of which 27 – over half – are confirmed as state-significant, i.e. natural pools present in the spring that are critical breeding habitat for vernal pool specialists, such as mole salamanders, wood frogs, and a few invertebrates. Prior to our ecological inventory, four confirmed vernal pools and one potential vernal pool had been identified by Arrowwood Environmental in the Mount Holly portion of NF Lands. During the spring 2017 surveys, several of these pools on NF Lands contained over 100 spotted salamander egg masses and over 50 wood frog egg masses. All those egg masses will potentially produce thousands of salamanders and frogs. The high concentrations of vernal pools found on the low flat ridge south of the lake and on the small plateau north of the lake is unprecedented in Vermont to my knowledge.

*Flynn, K., Lechowicz, M., and Waterway, M. 2008. Plant species diversity and composition of wetlands within an upland forest. *Am. J. Bot* 95: 1216-1224.

The single largest wetland natural community on NF Lands is the 34-acre intermediate fen that occupies the large cove at the south end of Lake Ninevah. Intermediate fen - a more nutrient rich type of bog - is a rare (S2) natural community in Vermont. I mapped this large peatland differently than Arrowwood Environmental and Kathy Doyle, who did a field survey of the site in 2008 and whose EO mapping is found in the VNHI database. This wetland is a mosaic of three wetland natural communities: intermediate fen, poor fen, and sweetgale shoreline swamp. I chose to map it as only intermediate fen and sweetgale shoreline swamp since I could not readily distinguish poor fen from intermediate fen out in the peatland. I consider my mapping provisional. More inventory work is needed to understand this outstanding wetland.

Ninevah Foundation Lands support a variety of other wetlands, beautiful and diverse, including red spruce-cinnamon fern swamp, alder swamp, shallow emergent marsh, sedge meadow, and basin shrub swamp. The latter is a newly-classified natural community ranked rare (S2) in Vermont. In addition to the classified natural communities, I mapped many unclassified natural communities, such as seepage meadow, sphagnous meadow-marsh, and montane tall herb glade, which are denoted in Table 2 as “not ranked” (NR) in the State Rank column. I assign these descriptive names to natural communities that do not fit into the state natural community classification. Of course artificial pond is not a natural community. It is an ecologically functional natural feature in the landscape, hence mapped as a natural community.

Wildlife and Natural Features

Observed wildlife, and wildlife sign, plus a multitude of other small natural features of the NF Lands that are best mapped as points, are shown on the Natural Features maps. These maps include other wildlife information such as game trail, potential den site, beaver dam, and coyote activity spot; forest features such as legacy tree, older and primary forest, plantation, hemlock grove, soft mast trees, and small upland forest natural communities; plant features other than rare and uncommon species, such as invasive and locally uncommon species; water features such as springs, cascades, and waterfalls; and geologic features such block, bluff, boulder, bedrock outcrop, cutbank, ravine, slope failure, and plunge pool. My attempt here is to show a sampling of the wealth of natural features which enrich the NF Lands. Unfortunately I did not have time to enter all the wildlife and other natural features data. So consider these preliminary maps upon which to expand.

Legacy trees, including the largest and sometimes oldest trees, were mapped not only because of their intrinsic value as large trees of a variety of species, but also because of their value for wildlife. With age, legacy trees often form large cavities as they rot internally. These cavities potentially are homes to a variety of wildlife, from flying squirrels to porcupine. And when they fall to the ground, if large enough, they can be den sites for bear.

Bear and NF Lands warrant special mention. Bear sign was found throughout the NF Lands with a concentration on Salt Ash Mountain and the wetlands at the base of the mountain along

upper Patch Brook. Of critical importance for bear, as well as other mammal and bird wildlife species, is a four-acre beech forest found at 2700-2850 feet on the southeast-facing slope of Salt Ash Mountain's south shoulder. It is shown on the RTE-SS Uplands central map. Beechnuts – the hard mast produced by beech trees – are a vitally important source of fat-rich food for bears to help them make it through Vermont's long winters. In September 2016, Silos, Andy, and I encountered over 20 bear-marked beech (claw marks on bark from climbing trees), including many freshly clawed trees and several piles of fresh bear scat at this site. This hard mast stand is yet another critical wildlife habitat found on NF Lands. As a side note: the beech stand I mapped might be the same as the one shown the Vermont Fish & Wildlife Department's "Bear Map" data layer which appears on the same side of Salt Ash Mountain but very close to the summit.

While our field data on bear sign and the hard mast stand shows the importance of NF Lands on a local level, it is important to step back and view NF Lands at a regional scale. As shown on the Green Mountain Bear Corridor map found in Ninevah Foundation's 2015 annual report, NF Lands are indeed a critical link in bear movement between the great forest blocks of Green Mountain National Forest to the north and south of Ninevah.

As described in the Wetlands section, high concentrations of vernal pools occur on flats perched both north and south of the lake. These are critical breeding sites for several salamander and frog species, including the large spotted salamander and wood frog. Additionally, some of the basin shrub swamps are functional vernal pools. A few of these vernal pools likely correspond to the vernal pools described by one person that responded to your request for natural features information at your 2016 Ninevah community gathering and meeting. The note from the same or perhaps another respondent of salamander crossings of Patch Brook Rd. between Lake Ninevah Rd. and Townsend Barn Rd. is worth pursuing.

Rare, Threatened, Endangered and Uncommon Species

The known and newly documented rare, threatened, endangered, and uncommon species found on NF Lands and in Lake Ninevah are shown in Table 3 and on the RTE-SS Uplands maps. All of the aquatics excepting the lesser bladderwort, plus the common loon, are associated with Lake Ninevah itself, and hence not technically part of NF Lands. They are included in this table because the Ninevah Foundation owns a large portion of both the lake shoreline and watershed.

Of the 9 rare and 9 uncommon species, all except two species (large roundleaf orchid and bristly crowfoot) are associated with wetlands or the lake. This highlights the biodiversity importance of the NF Lands wetlands and the lake. Of these species, the rusty blackbird and pod-grass receive statutory protection in Vermont as Endangered and Threatened species, respectively. Though ranked as an uncommon breeder, the rusty blackbird populations have plummeted in recent years leading to its listing as an endangered species. During the inventory

Table 3. Rare, threatened, endangered, and uncommon species known from Ninevah Foundation Lands and Lake Ninevah.

Common Name	Species	State Rank	Global Rank	VT Status	Other Status	First Observed	Last Observed	# EOs	Source	Species Category
Common Loon	<i>Gavia immer</i>	S3B: uncommon breeder in VT	1		RFSS, RSGCN, SGCN	1995	2017	1	VNHI	Bird
Rusty Blackbird	<i>Euphagus carolinus</i>	S3B: uncommon breeder in VT	G4	Endangered	RFSS, RSGCN, SGCN	2006	2006	1	VNHI	
Large Roundleaf Orchid	<i>Platanthera macrophylla</i>	S1: very rare in VT	G4		SGCN	2016	2016	2	FBE	Upland wildflower
Bristly Crowfoot	<i>Ranunculus pensylvanicus</i>	S3: uncommon in VT	G5		RFSS, SGCN	2011	2011	1	VNHI	
Pod-grass	<i>Scheuchzeria palustris</i>	S2: rare in VT	G5	State-Threatened	RFSS, SGCN	2008	2008	1	VNHI	Wetland plant
Wiegand's Sedge	<i>Carex wiegandii</i>	S1: very rare in VT	G4		SGCN	2011	2011	1	VNHI	
Rough Cotton-grass	<i>Eriophorum tenellum</i>	S1S2: very rare to rare in VT	G5		SGCN	2016	2017	1	FBE	
Ovate Spikerush	<i>Eleocharis ovata</i>	S3: uncommon in VT	G5			2017	2017	1	FBE	
Smaller Forget-me-not	<i>Myosotis laxa</i>	S2: rare in VT	G5		SGCN	2017	2017	1	FBE	
Rose Pogonia	<i>Pogonia ophioglossoides</i>	S3: uncommon in VT	G5			2008	2017	1	VNHI/FBE	
Northern Wild Licorice	<i>Galium kamtschaticum</i>	S3: uncommon in VT	G5			2016	2017	1	FBE	
Lesser Bladderwort	<i>Utricularia minor</i>	S3: uncommon in VT	G5			2012	2013	1	VNHI/DEC	
Slender Naiad	<i>Najas gracillima</i>	S2: rare in VT	G5?		SGCN	2012	2012	1	DEC/VNHI	
Tuckerman's Pondweed	<i>Potamogeton confervoides</i>	S2: rare in VT	G4		RFSS, SGCN	2012	2012	1	DEC/VNHI	
Farwell's Water-milfoil	<i>Myriophyllum farwellii</i>	S2S3: rare to uncommon in VT	G5		RFSS, SGCN	2013	2017	1	DEC/FBE	Aquatic plant
Low Water-milfoil	<i>Myriophyllum humile</i>	S1S2: very rare to rare in VT	G5		SGCN	2013	2013	1	DEC/VNHI	
Nuttall Waterweed	<i>Elodea nuttallii</i>	S3: uncommon in VT	G5		SGCN	2007	2017	1	VNHI/FBE	
Water Bulrush	<i>Schoenoplectus subterminalis</i>	S3: uncommon in VT	G5			2013	2017	1	DEC/FBE	

I searched a couple times for rusty blackbird in the large Patch Brook beaver wetland complex north of the lake where it was last observed in 2006, but did not find any birds.

Abbreviations shown in the Other Status column include RFSS for the Regional Forester Sensitive Species for the Green Mountain and Finger Lakes National Forests, and SCGN for the Species of Greatest Conservation Need as identified in the Vermont Wildlife Action Plan. Source abbreviations include DEC for Department of Environmental Conservation, FBE for Brett Engstrom, and VNHI for Vermont Natural Heritage Inventory of the Fish & Wildlife Department.

Invasive Species

Six invasive plants species are now documented on the NF Lands. Table 4 gives summary data on these invasives. Three of the species are listed by the Department of Agriculture as Class B Obnoxious Weeds, meaning that they are currently known from Vermont and pose a serious threat to the State. Though not currently listed as Noxious Weeds, the giant hogweed, wall-lettuce, and wild chervil are well-established invasives that have spread throughout Vermont. The locations of these invasives are shown on the south and central Natural Features maps. It is heartening to know that no invasives are known from the north map portion of NF Lands. The Natural Features south map, which has the great majority of invasive plants, clearly shows that the invasives are spreading along town roads, especially Sawyer Hill and Lake Ninevah Road.

Table 4. Invasive plants found on the Ninevah Foundation Lands.

Common Name	Species	VT Dept. Ag. Status	# points	Populations	Notes
common buckthorn	<i>Rhamnus cathartica</i>	Class B noxious weed	1	1	Single small individual in seepage wetland N. of Flying Cloud
garlic mustard	<i>Alliaria petiolata</i>	Class B noxious weed	6	2	Along Sawyer Hill above and below powerline ROW. Also on L. Ninevah Rd.
giant hogweed	<i>Heracleum mantegazzianum</i>		1	1	Handful of plants located near mouth of stream just before enters NW end of lake
Japanese knotweed	<i>Fallopia japonica</i>	Class B noxious weed	5	4	2 colonies on west lakeshore; small colony at cellar hole on Sawyer Hill Rd; large colony on Patch Bk. Rd
wall-lettuce	<i>Mycelis muralis</i>		3	2	One large colony W. of L. Ninevah Rd. and another small in wetland on upper Patch Brook
wild chervil	<i>Anthriscus sylvestris</i>		11	3	Along Sawyer Hill above and below powerline ROW. Also on L. Ninevah Rd. & Crown Pt. Trail

Management Recommendations

As an overarching vision, my recommendations for management of NF Lands lean towards a high-level of protection for the natural communities, both upland and wetland, and the conservation of native species and natural features that are integral parts of the natural communities. The great wealth of biodiversity found on these lands during the ecological inventory inspire this vision.

The following recommendations are for specific features of the lands.

Wetlands: While many of the wetlands on NF Lands support trees which could potentially be harvested, I recommend that all wetlands be excluded from timber harvest and that logging equipment avoid crossing wetlands. The rationale for this lies in the fact that the muck soils found in most of the wetlands are easily rutted, even in winter. Furthermore, disturbance of the wetland soils and increased sunlight reaching the ground due to logging increases the potential for non-native and invasive species encroachment. Since wetlands are so important for biodiversity, it is best to protect them from degradation of all types. It is also recommended that wetlands along streams, both intermittent and perennial, have the same 50' or larger buffer zones, or riparian management zones, as recommended in the Agency of Natural Resources' "Riparian Management Guidelines for Agency of Natural Resources Lands" found at http://fpr.vermont.gov/sites/fpr/files/About_the_Department/Rules_and_Regulations/Library/Riparian%20Final%20Guidelines%20%28signed%20copy%29_resized.pdf

Streams: Given what I saw on the land, I suspect that stream buffers are mostly in place in the current forest management plan. If not, I would recommend a 50' minimum stream buffer for both intermittent and perennial streams as outlined in the Agency of Natural Resources guidelines document cited above. While these buffers do not preclude logging, the vegetation goals for the buffers of basically intact, uneven-aged, forest natural communities suggest at most selective and very limited timber harvest in the buffer zones.

Vernal Pools: Management goals for forests surrounding vernal pools should focus on what conserves the vernal pools themselves as well as the surrounding habitat for adult vernal pool specialist salamanders and frogs. The Vermont Center for Ecostudies, based in Norwich, Vermont, did some of the important early research on amphibians that breed in vernal pools and live as adults in the forest around the pools. Based on this research, recommendations for timber harvest around vernal pools is provided in their handout found at <http://vtcostudies.org/wp-content/uploads/2017/04/VP-BMP-handout.pdf> Their recommendations are for a minimum of 400' buffer zone where timber harvest is selective so as to maintain at least 75% canopy cover within the first 100' from the pool and 55% cover from 100'-400' from the pool. They also note that 500' buffer would be better, and that the more canopy cover and less disturbance around the pools is better for the frogs and salamanders. My recommendations are for higher canopy covers (i.e. more restrictive logging) around the state significant vernal pools, and using the larger 500' buffer. Since many of the pools are

concentrated in a couple areas north and south of the lake, vernal pool buffers likely overlap, in which case vernal pool protection areas where no timber harvest takes place might be designated.

Invasive Species: While the small populations of common buckthorn and giant hogweed should be easily managed, the larger and wider spread populations of the other species is more problematic. Garlic mustard and wild chervil have spread along both sides of Sawyer Hill Rd. downhill from Tinney Rd junction. Both species will spread further up the road if not checked. I found several wild chervil plants washed down intermittent streambeds from Sawyer Hill Rd., exposing another vector of spread. Both species were discovered in a more restricted roadside location on upper Lake Ninevah Rd. In addition to the large colony of Japanese knotweed located along Patch Brook Rd. near the junction of Townsend Barn Rd., new colonies of knotweed were discovered along the west lakeshore, and at an old foundation on Sawyer Hill Rd. Though not as threatening as some invasives because of their small size, the hundreds of wall-lettuce plants found in the Norway spruce plantation west of Lake Ninevah Rd. present a control challenge because of their sheer numbers. While these invasives present management challenges, the good news is that I encountered no invasives over the great bulk of the 3,400 acres of NF Lands. As I have expressed previously to the Board, my recommendations for invasive plant species management are to do as much manual control as possible using methods that other groups, such as The Nature Conservancy, promote, and use herbicide as a last resort. I would not recommend herbicide use on any of the Japanese knotweed colonies on the lakeshore due to the risk of the herbicides getting into the lake water.

Rare and Uncommon Species: Since most of the rare and uncommon species on NF Lands and the lake are found either in wetlands or in the lake, protection of both wetlands and the lake should be a priority. Continuing the vigorous protection measures the Ninevah Foundation has promoted, funded, and acted upon to prevent invasive aquatic plants from getting into the lake should remain a high priority. Kudos for this sustained effort! Enacting wetland protection described above in the wetlands management recommendations section would go a long way towards protecting the wetland rare and uncommon species. Also, controlling the roadside invasive plants will help prevent invasives which might compete with these rare plants from entering wetlands in road runoff coming down drainages from the roads. Of the two upland rare/uncommon species, only the large roundleaf orchid colonies require avoidance. Though they can move over time, a 100' no-cut buffer at the two points where it was found should be adequate for the species protection. The bristly crowfoot is rather weedy in habit and grows in the powerline right-of-way, so needs no specific management consideration.

Upland Forest Element Occurrences: Though the boundaries of the upland natural community EOs need to be reconciled with those of adjacent CSF and Tiny Pond Wildlife Management Area, I recommend that the Ninevah Foundation consider these natural community EOs that cross property lines to be treated as the same EOs, regardless of ownership. In addition to the montane spruce-fir forest, montane yellow birch-red spruce forest, and montane tall herb glade

EOs that cross property boundaries on Salt Ash and Bear Mountain, this includes the enormous northern hardwood forest EO that extends north far along the Coolidge Range and east into the Tiny Pond WMA. On State lands, natural community EOs are managed so as to maintain, or enhance, the EO rank (A-ranked in the case of northern hardwood forest EO, and B-ranked for the montane yellow birch-red spruce forest) (Pers. Com. Robert Zaino, State Lands Ecologist, VT Dept. of Fish and Wildlife). Management of the montane spruce-fir and yellow birch-red spruce forest EOs would not be affected by their state-significant status on either NF Lands or the State Forest since both EOs are above 2500' and quite inaccessible. The northern hardwood forest EO, however, would limit timber harvest and other forest management in order to maintain its EO rank of A. In an email on the subject, Zaino goes on to say that "...for uneven aged forests that are already developing complex structures like old trees, large standing and downed dead trees, and a mix of size and age classes, it might be possible to maintain the ecological quality during very careful timber harvesting (using techniques like those suggested by Bill Keeton) but I don't think harvesting can improve overall ecological quality."

Further Inventory: Several more field surveys are recommended to complete documentation and our knowledge of some natural communities and to search for rare species in appropriate habitat.

- Do another spring vernal pool survey, visiting ones with an "E" EO rank, i.e. ones not visited during vernal pool specialist amphibian breeding season.
- Do a more intensive vegetation/natural community survey of the lake's south end peatland paying close attention to mosses in order to draw a more accurate natural community map. Also, search for the four-toed salamander in this peatland. I suspect this might be good habitat for the rare salamander.
- Do a 0.1 ha vegetation plot in the high elevation rich northern hardwood forest on Salt Ash Mountain, and smaller vegetation plots in the montane tall herb glades and montane seeps. The latter are important for developing descriptions of proposed new natural community types.