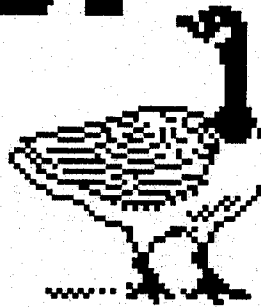
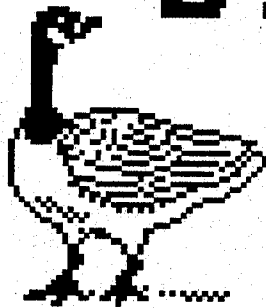


# WOODBURY LAKES and PONDS STUDY



Submitted by:

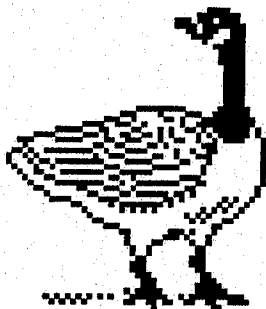
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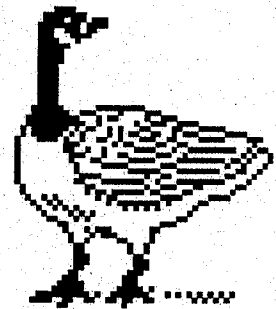
The Town of Woodbury  
May 2, 1991

Edited by:

Farley Brown



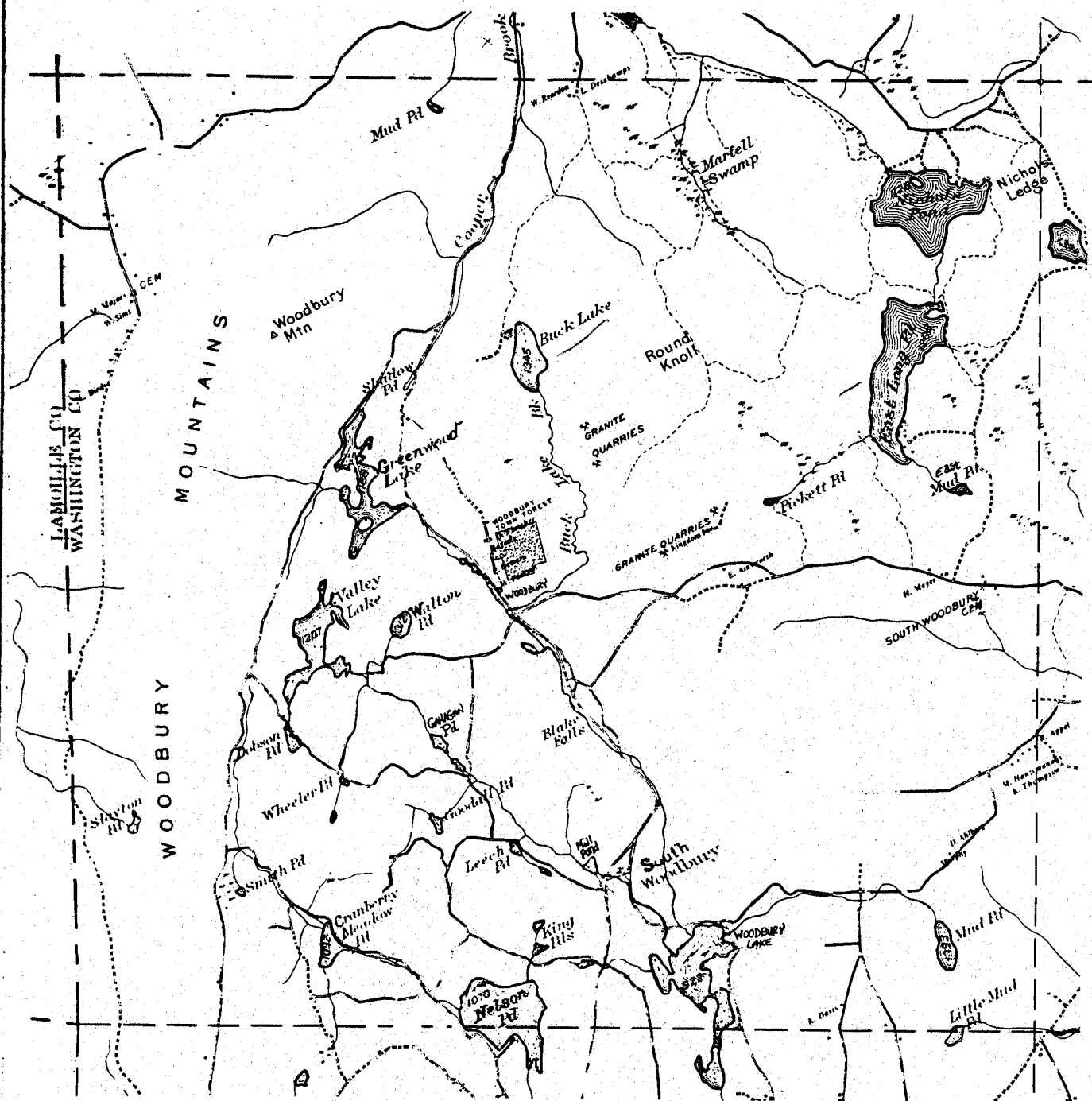
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Special Planning Grant



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# WOODBURY, VERMONT



1989

# WOODBURY LAKES AND PONDS STUDY

## 1.0 Introduction

The Town of Woodbury, with 23 lakes and ponds, has more lakes than any other Vermont town. These lakes and ponds represent a valuable resource worthy of special attention and protection. The people of Woodbury feel a special affection and responsibility for these waters. Water quality was the top concern expressed in a 1989 Town Meeting questionnaire. In response to this concern, and to a growing perception of threats to water quality from lake use, shoreline development, and watershed disturbance, the Conservation Commission of Woodbury applied for an Act 200 Special Planning Grant in 1989.

The consultant team of Jeffrey Parsons, Don Meals, and Deb Lester was hired to carry out the study. They submitted the Woodbury Lakes and Ponds Study to the Town of Woodbury in May, 1991.

This edited version of the study was completed by Farley Brown and provides the general public with an overall view of the elaborate process undertaken by the consultant team. The original version of the study is available at the Woodbury Town Clerk office.

## 1.1 Purpose of Study

The purpose of the study was to collect and evaluate water quality information necessary to assess current conditions in Woodbury's lakes and ponds and to develop an action plan for lake protection. The Conservation Commission expressed three goals for the management and preservation of the town's lakes and ponds:

- (1) Protect water quality
- (2) Allow for appropriate public use
- (3) Preserve and protect aquatic ecosystem and wildlife habitat

With these goals in mind, the team of consultants evaluated the current status, sensitivity to degradation, and potential future problems of individual lakes and ponds in Woodbury.

## 1.2 The Present Situation in Woodbury

Presently, Woodbury's lakes and ponds appear to be in reasonably good condition. The dominant land use in nearly all of the lake watersheds is forest. Some of the town's lakes and ponds have experienced little or no watershed or shoreline development.

Wildlife can be observed on many if not all of Woodbury's lakes and ponds. Otter, mink, beaver, waterfowl, herons, moose, deer are common sights on and near the town's lakes and ponds. Loons, rare in Vermont, nested on East Long Pond; herons and otters are commonly observed. Two endangered plant species are found around Woodbury's lakes.

Most of the large lakes in town continue to attract numerous residents and visitors for recreation. Many of the larger lakes, such as Greenwood, Valley, Nelson, and Woodbury are used extensively for fishing. The other lakes and ponds are used for swimming, pleasure boating, and jet skiing as well. Even smaller ponds such as Cranberry Meadow serve as local swimming holes. Sailing is common on Woodbury's larger lakes and canoeing is a favorite activity on lakes and ponds of all size. In the winter, snowmobiling is common on the lakes.

There do exist threats to the enjoyment and use of Woodbury's lakes and ponds. These threats include:

- Recently reported moderate algal blooms in Valley and Greenwood Lakes.
- Potential for Eurasian water milfoil, a nuisance aquatic plant known for "choking" lakes and ponds, to eventually find its way into one of the lakes or ponds.
- Increase in development pressure in the town, as evidenced by proposals for a 110 unit RV park on the shore of Woodbury Lake and a major subdivision near Greenwood Lake.
- Increase in the intensity of recreational use of some of the larger lakes, and notable conflicts between power boat use and more passive use and enjoyment of the lakes and ponds.

In summary, the importance of the town's lakes and ponds for recreation cannot be underestimated. While the annual influx of camp residents is economically important for local businesses, this influx also greatly increases the level of human activity and impact on the lakes and within the watersheds. The continued use and enjoyment of these lakes and ponds in almost all cases depends upon the maintenance of high water quality.

### 1.3 Introduction to the Geography, Geology and Soils of the Woodbury Area

The Woodbury Mountains line the western edge of town and Slayton Pond is the dominant surface water body in the mountains. The eastern side of town varies from rolling to hilly uplands. Most of the town and its many lakes drains to the south through the Kingsbury Branch of the Winooski River. However, Nichols and East Long Ponds, and the smaller ponds in their watersheds flow to the north and eventually empty into the Lamoille River drainage system. Both the Winooski and Lamoille Rivers eventually empty into Lake Champlain which drains through the St. Lawrence River to the Atlantic Ocean.

The area's bedrock is predominantly limestone, but occasional granite outcroppings occur throughout the town. The limestone bedrock in Woodbury has influenced the development of wetlands in town and also provides some buffering against the problems associated with "acid rain". This bedrock provides a natural source of neutralizing materials (such as calcium) which enter the waters and help prevent lakes and ponds from becoming acidic. Slayton Pond, located high in the Woodbury hills, is not situated in an area of bedrock which provides as much buffering capacity but has already been limed by its owners and may be influenced by acidic deposition.

The glaciers tore loose and transported much rock and soil materials resulting in the more gradual topography found in Vermont and Woodbury today. As the glaciers melted they dropped extensive soil and rock fragments. This material, referred to as till, covers much of the town of Woodbury and is generally thinner in the uplands and deeper on hillslopes and in lower elevations (when it is found there). The thickness, composition and relative permeability of till can vary widely and these variables can have a large influence on the land's suitability for farming, development and septic suitability, and other human uses.

Most of Woodbury's lakes and ponds are located in areas where the bedrock is covered with a relatively thin layer of this glacial till. Nelson, Nichols, and East Long Ponds as well as many of the smaller ponds are examples of ponds developed in till materials. Greenwood and Woodbury Lakes, and to a lesser extent, Valley Lake also have extensive outwash and deposits of sands and gravels in their immediate watersheds. More recent sandy soils are common in the immediate watersheds of Gahagan, Leech and Mill Ponds.

The most significant consequence of these different soils is the suitability of an area for construction, and the ability of these soils to support standard septic fields. Most of the till-derived soils are relatively shallow to bedrock and have severe limitations for septic field operation. The sand and gravel soils in Woodbury generally do not have a good filtering capability, making these soils unsuitable for standard septic systems.

## 2.0 Study Methods and Findings

The properties, distribution, and circulation of water (hydrology) as well as the ecology of the lakes and ponds were investigated in order to understand the status of Woodbury's surface waters. These factors were applied to each lake and pond and include sensitivity to pollution, oxygen status, trophic state, phosphorus level, surrounding land use, wetlands and aquatic plants. The information used was gathered from existing data provided by the Vermont Department of Environmental Conservation or from collecting data in the field. This information was then evaluated through a variety of scientific methods.

The following is a brief discussion of how each of these factors were studied and the results from each area.

### 2.1 Hydrology and Sensitivity

Evaluating the sensitivity of a lake or pond involved calculating several factors including size, depth, and watershed size. Other key factors include flushing rate and retention time of a body of water. (See Table 1, General Factors of Woodbury Lakes and Ponds, page x.).

Retention time is the amount of time it would take to completely fill a lake if it were empty. It is in part a function of watershed size relative to lake volume. For example, Woodbury Lake, with an extremely large watershed, has a relatively short retention time of 0.13 years (1.5 months) despite its large surface area. In contrast, North King Pond has a very small watershed, resulting in a relatively long retention time of 0.7 years (8 months). Calculated retention times ranged from 0.005 years for Mill Pond to 1.8 years for East Long Pond and Valley Lake. The larger, deeper lakes

such as Buck, East Long, Nelson, Nichols, and Valley tend to have long retention times - 1.1 to 1.8 years. This suggests that, on average, it would take one to two years to completely replace the water in these lakes with "new" water from their watersheds. The smaller, shallow lakes such as Mill, Dobson, Slayton, Leech, Gahagan, and the Mud Ponds tend to have short retention times of 0.003 years (1 day) to 0.14 years (1.5 months), suggesting that the water in these lakes is renewed very quickly.

Flushing rate is a key factor in lake sensitivity to pollution, since a pollutant's impact may be less in a lake which flushes quickly, compared to the impact in a lake where the water is renewed more slowly. Flushing rates varied among the lakes and ponds of Woodbury. For example, Mill Pond has the most rapid flushing rate of 333 times/year ( $1/0.003 = 333$ ), while East Long Pond has the slowest rate of 0.56 time/year. These numbers suggest that while the water in Mill Pond is "replaced" with new water almost daily, only about half of the water in East Long Pond is replaced in a year.

Lakes differ in their response to pollution stress. Although, for example, the amount of phosphorus in two lakes may be identical, the response of each lake will be different depending on the hydrologic and geological characteristics of each lake. Thus as a screening procedure, it is useful to rank the lakes and ponds of Woodbury by their sensitivity to pollution. Such a ranking may help begin to set priorities for protection of critical lake resources (see Table 2. Sensitivity of Woodbury Lakes and Ponds, page x).

A variety of ranking methods for lake sensitivity begins to suggest that lakes in Woodbury may need to be treated differently. A sensitive lake with high water quality may need more immediate attention in order to prevent degradation. On the other hand, an insensitive lake may be able to withstand greater pollution stress and therefore be placed somewhat lower on a priority list. Conversely, a sensitive lake with low water quality may respond more quickly to reductions in pollutant load, while an insensitive lake may be more resistant to improvement efforts.

Of the lakes and ponds in Woodbury, Buck Lake, the King Ponds, Valley Lake, Walton Pond, East Long Pond, Greenwood Lake, and Nichols Pond appear to be the most sensitive. The smaller ponds such as Leech, Pickett, Gahagan, and Mill are relatively insensitive to pollution, primarily due to their high flushing rates.

## 2.2 Oxygen Status

The oxygen status is measured in dissolved oxygen concentrations in lakes and is important for two major reasons. First, oxygen is required for fish and other animal life to survive. Second, oxygen levels in bottom waters indicate the amount of decomposition (which consumes oxygen) occurring, an indirect measure of the organic productivity of a lake. High oxygen levels indicate a healthy, clean lake with good support for fish.

The oxygen profiles of Woodbury lakes and ponds were conducted in mid-winter and mid-summer. Several of the large, deep lakes in Woodbury showed high oxygen levels as well as East Long Pond, Nelson Pond, and Nichols Pond. Other lakes, however, indicated some problems. North King Pond, Walton Pond, and the main and West basins of Woodbury Lake had very low dissolved oxygen concentrations in bottom waters in winter; the main and West basins of Woodbury Lake had oxygen levels approaching zero in bottom waters in mid-summer. Bottom waters in Buck

Lake, Cranberry Meadow Pond, Goodall Pond, Greenwood Lake, South King Pond, Valley Lake, and the south and central basins of Woodbury Lake were essentially without oxygen at both winter and summer sampling.

One possible conclusion from these data is that significant oxygen demand exists in these lakes, possibly from decomposition of algae or other organic material or from the sediments. The observed pattern suggests that cold water fish survival may be a problem in these lakes. Additionally, phosphorus released from sediments under low or no oxygen conditions may add significantly to the phosphorus load in some of these lakes.

### 2.3 Trophic State

Trophic state refers to the level of biological productivity of a lake. It is a natural process for a lake or pond to increase in biological productivity over thousands of years. The concern of the trophic state of a lake or pond is based on the fact that acceleration of this productivity can lead to algal growth. Algal growth can affect the recreational and aesthetic characteristics as well as the general health of a lake or pond.

The scale of algal productivity ranges from low productivity (oligotrophic), moderate productivity (mesotrophic), to high productivity (eutrophic). Lakes which have low productivity are usually deep, cold water lakes with little algae or other plant growth and high water clarity. Lakes that tend to be more shallow, warmer, and highly productive, often produce nuisance quantities of algae and plants. While lakes naturally vary in trophic state, people tend to prefer lakes of low productivity for recreation and for aesthetic reasons. Thus, management of lake trophic state is often a priority in lake protection.

Trophic status is measured by a variety of factors, including nutrient concentrations, algae production, and water clarity. In Woodbury, phosphorus concentrations and water clarity were collected then evaluated with the use of a standard scientific index.

The data revealed that Nelson Pond, Buck Lake, East Long Pond, and Nichols Pond are in the low productivity range. Of the other large lakes, Woodbury Lake and Greenwood Lake are in the moderate productivity category. Many of the smaller ponds such as Walton Pond, the King Ponds, and Goodall Pond, also appear to be in the moderate range. None of the lakes and ponds in Woodbury appear to be high into the eutrophic range, but Valley Lake was one point of concern. Of the large lakes in Woodbury, Valley appears to be most productive and this productivity may be beginning to approach problem levels.

### 2.4 Phosphorus Loading Evaluation

Human activity can greatly accelerate the natural process of biological productivity. Activities such as sewage disposal and agricultural runoff can increase the loading of nutrients like phosphorus and nitrogen to lakes. Just as fertilizing a garden stimulates plant growth, fertilizing a lake with additional nutrients may stimulate unwanted algae and aquatic plant growth. Phosphorus loading is one of the most important determinants of lake trophic state in our region.

In Vermont lakes, as in most of northern lakes in North America, phosphorus is the nutrient of most concern because it is in the shortest supply. Adding more phosphorus to a lake generally results in increased algal production and a shift toward higher trophic state. Increased algal production can lead to a decrease in water clarity and oxygen availability and ultimately can decrease a pond's value for swimming, boating, fishing, and even use by certain wildlife, such as fish eating mammals or birds. Understanding and management of lake phosphorus loading is often the key to the maintenance and restoration of lake water quality.

Several scientific approaches were taken to derive an estimation of phosphorus loading to Woodbury lakes and ponds. In the first approach, Woodbury Lake was estimated to have the highest phosphorus load - 228 kg/year (503 lb/yr), while North King Pond had the lowest - 0.8 kg/year (1.8 lb/yr) (see Table 1 for estimated annual lake phosphorus load).

Using another model for evaluation, phosphorus loading in the lakes and ponds was categorized as "Permissible" or "Dangerous". "Permissible" refers to the load below which low productivity conditions may be maintained and "Dangerous" refers to the load above which high productivity conditions are expected.

Several lakes were closer to the "Dangerous" category of this model. These lakes, based on their estimated phosphorus loads, may be closer to the critical transition to eutrophic condition: Greenwood Lake, Valley Lake, Wheeler Pond, Leech Lake, Gahagan Pond, and Mill Pond.

The estimated phosphorus loading to several of Woodbury's larger and more sensitive lakes is near or above the estimated critical loading: Buck Lake, Greenwood Lake, and Valley Lake fall into this category. These lakes are likely threatened with accelerated eutrophication. A few lakes - Dobson, Leech, and Wheeler-appear to have phosphorus loading approaching their critical loads, but these lakes are among the least sensitive in Woodbury. Estimated phosphorus loading to some other lakes appears to be well below critical level: Cranberry Meadow, East Long, Nelson, Nichols, and Woodbury. These lakes appear to be in less imminent danger of eutrophication, although East Long Pond, Nelson Pond, and Nichols Pond are somewhat sensitive to increased phosphorus loading.

## **2.5 Watershed Land Use Evaluation**

Since there are no known point sources discharging to Woodbury's lakes and ponds, the lakes' watersheds are the most important sources of phosphorus lakes. In this study the land use of each watershed was interpreted. The dominant land use in each of the watersheds is forest; in nearly all of the lake watersheds, forests cover 75%-90% of the land. Agricultural land use is nearly nonexistent in Woodbury; very small amounts of hay/pasture land are found in the watersheds of Mill Pond and Woodbury Lake. Generally, less than 10% of the land is in residential use.

Through analysis of information regarding sources of phosphorus, Woodbury lakes and ponds could be placed into 2 general groups. One group, including Cranberry Meadow Lake, Mill Pond, and Woodbury Lake have other lakes upstream in their watersheds; some of the phosphorus coming from the watershed may be settling out in these lakes, reducing the actual phosphorus load delivered downstream. These lakes as well as Gahagan, Goodall, and Pickett Ponds, also contain significant wetland area in their watersheds. Wetlands play an important role in

absorbing nutrients in the watershed and can absorb phosphorus before it can be delivered to a lake.

The other group of lakes are Buck, Greenwood, and Valley. According to the research these lakes do not have enough phosphorus coming from the watershed to account for the amount estimated to be in the lake. What is the source of this "unexplained" phosphorus?

There are two main possibilities. First, contributions from lakeshore septic systems around Greenwood and Valley Lakes could contribute significant quantities of phosphorus to the lake. The Green Mountain Conservation Camp on Buck Lake may make similar contributions to the total phosphorus loadings. The use of phosphorus in lawn fertilizer is another contributor.

The second possible explanation is internal phosphorus loading, in which the phosphorus stored in lake sediments is released. Another factor in shallow lakes such as Dobson Pond and Leech Pond might be the release of phosphorus stored in sediment. This release can be caused by wind action or other water turbulence, making phosphorus available for algal or larger aquatic plants growth.

Specific investigation of internal loading is very difficult and expensive; testing of lakeshore septic systems is considerably easier and cheaper. For the lakes where this may be an important source of phosphorus, especially the more sensitive Valley Lake, such testing might be an important next step in lake management. Certainly, the suggestion of unaccounted-for phosphorus load in Buck Lake, Greenwood Lake, and Valley Lake points to possible directions for future work in Woodbury.

## 2.6 Woodbury's Mud Ponds: Their Value as Wetlands

### 2.6.1 An Introduction to Woodbury's Wetlands: General Occurrence and Significance

The Town of Woodbury has 1,112 acres of mapped wetlands-more wetlands than any other town in the county. This 1,112 acres is over one-seventh of the entire Washington County total wetland acreage (7,113 acres). A more precise breakdown of wetlands by type is not available for the town of Woodbury.

Wetlands are areas which occur between upland and aquatic habitats. They are commonly known as marshes, swamps, bogs and fens. These areas are inundated by surface or ground water through out the year, supporting specific vegetation or aquatic life. Such areas also include river and lake overflows and mud flats.

Many wetlands are effective at storing flood waters and slowly releasing them later at a time when the flood peak has decreased. Wetlands can also be effective at reducing the erosive energy of swift currents and large waves. Many wetlands also serve as storage areas, sometimes temporarily, for nutrients such as phosphorus and nitrogen which if made available to surface waters might lead to a decrease in water clarity and overall quality. Some wetlands are even effective in retaining contaminants entering waters from a wide variety of sources.

Wetlands in Vermont are protected by the Vermont Wetland Act and the Rules which help implement that law. All wetlands which are found on the National Wetland Inventory map for the town are presently considered Class II wetlands. This classification of wetlands regulates and frequently prohibits most development activities in and within 50 feet of these wetlands.

#### 2.6.2 The Functions and Values of Woodbury's Mud Ponds

Several smaller ponds in Woodbury are actually more like wetlands than like the larger, deeper lakes and ponds in town. This category includes all of the mud ponds in town: Little Mud Pond, Big Mud Pond, and East Mud Pond. The other Mud Pond located in the northern section of Woodbury is largely inaccessible and was not visited as part of this study.

These ponds/wetlands generally have shallow (less than 5 feet) open water areas and have perimeters that are ringed with marshy vegetation. Because the mud ponds share characteristics of both ponds and wetlands these areas were chosen for detailed investigation in this study. The investigation primarily provides some insight into the value of the areas as wetlands.

Little Mud Pond is a shallow 14-16 acre wetland/pond located along the Woodbury-Calais border (and partially in Calais). The wetland is isolated with no development on its shoreline and no evidence of human activity. There are 3 distinct biological systems including an open water wetland, a fen-like tamarack swamp, and a sedgy bog-like wetland community. Peat moss is present throughout the area and orchids may be found at this site in spring and/or summer. There were extensive signs of wildlife use.

Big Mud Pond is a shallow wetland/pond located in the south-eastern corner of Woodbury. Big Mud Pond flows into Woodbury Lake through a small stream. The open water area is perhaps as large as 10 acres. The pond is relatively isolated. The larger contiguous wetland is comprised of the open water pond, a boggy mat surrounding the pond, and several small alder and coniferous swamps. Orchids may be found at this site in spring and/or summer.

East Mud Pond is 7-9 acre wetland/pond located to the southeast of East Long Pond. East Mud Pond drains into East Long Pond and is accessible by road and a short trail.

The 3 Mud Ponds are important natural areas. The wetland/ponds provide excellent wildlife habitat for a wide variety of animals and waterfowl. It is likely that furbearers use these areas extensively as do the town's moose populations. Big and Little Mud Ponds are very isolated and provide as close to a "wilderness" experience as one can find in Woodbury. In addition, all of the ponds probably fulfill hydrological and/or water quality enhancing functions which are worthy of protection.

The town's other major wetlands are either marshy wetlands such as those lining many of the smaller streams in town; or are forested wetlands often with a coniferous forest cover. Beaver activity in many areas has created large stands of drowned dead swamp forest.

Woodbury's wetlands play an important role in the overall lake water quality and ecology of the town. The marshes provide important furbearer habitat and support extensive waterfowl populations. Muskrat, mink and otter also utilize the marshlands in town. Many of these marshes are also associated with open water areas further increasing their value for waterfowl and other water-dependent birdlife. Woodbury's marshes also provide good feeding opportunities for moose. Forested wetlands are important areas for many species of wildlife such as bobcats, white-tailed deer, and black bear. The role that a specific wetland has on water quality is best determined on a wetland by wetland basis.

## 2.7 Aquatic Plants Surveys - Findings and Summary

Aquatic plants surveys were conducted during July and August 1990 on East Long Pond, Nichols Pond, Woodbury Lake/Sabin Pond, Nelson Pond, Cranberry Meadow Pond, Dobson Pond, Greenwood Lake, Valley Lake and Buck Lake. Because aquatic plants surveys are very time intensive to conduct, all of the lakes and ponds in the town could not be surveyed. These 9 lakes and ponds were chosen on the basis of size and access as initial criteria for vulnerability to invasion by Eurasian water milfoil. Larger lakes, and those lakes with some level of public access are likely to be much more vulnerable to invasion than a small, remote, lake or pond.

The purpose of these surveys was two-fold. The first was to determine if Eurasian water milfoil had taken hold in any of the lakes; second was to conduct a general survey of the species composition and density of aquatic plants. This information is a valuable complement to the other water quality data collected for these lakes and ponds.

### 2.7.1 Eurasian Water Milfoil

Eurasian water milfoil is an exotic invasive species, is native to Europe and Asia, and is thought to have found its way to the United States in the late 1800's. Eurasian water milfoil reproduces rapidly and can easily invade and push out native populations of plants. It invades communities of aquatic plants and within 2-3 years can competitively displace most other plants, forming large beds that may cover an area larger than what was originally present. Its luxuriant growth makes fishing difficult, snarls motors, is unpleasant to swim in, and has little value as waterfowl food. The spread and reintroduction into non-infested areas is insured by a highly mobile boating population and by the activities of carp and waterfowl.

While Eurasian water milfoil was not found in the lakes and ponds that were surveyed in 1990, it has been found in North Montpelier Pond just south of Woodbury, which makes its introduction via motorboat props and trailers into a lake or pond in the town of Woodbury *very likely unless precautions are taken*. The threat of invasion is higher in lakes that have a transient boating population and those lakes that have the greatest recreational uses. These lakes would include Greenwood Lake, Nelson Pond and Woodbury Lake.

The second purpose for the aquatic plants survey was to determine species composition and density. It should be noted that the growth of aquatic plants in a lake does not necessarily indicate that a lake is "polluted". Aquatic plants are ecologically very important to lakes. They serve a number of important functions such as food for waterfowl, shade, nesting and cover for fish, food for fish and habitat for invertebrates that are in turn food for fish. Different plants serve

different purposes ecologically. Therefore, diversity of species composition is important when accessing plant communities.

It is extremely difficult to draw conclusions about the results of the density and species composition data due to the fact that there is little historical data for comparison. The density and species composition information obtained from these surveys indicate that while species diversity in each of the surveyed lakes is high, there are areas of some lakes where dense growth of plants occurs. While species diversity alone cannot be used to assess the health of the ecosystem, a high species diversity is one indication of stability in an ecosystem. A plant community containing only two or three species of plant does not indicate high ecosystem health.

It cannot be concluded from this limited information that dense growth results from one specific cause. The natural aging of a lake or pond lends itself to "filling in" via sedimentation. This natural slow process involves a change in plant communities over time, an example being the natural succession of a pond to a marsh. These natural changes usually occur on a scale much greater than can be witnessed in a single life time. The exception to this is when human activities accelerate this natural aging process. When this occurs, sedimentation occurs much faster and change is much more dramatic. Land use practices play a major role in determining the rate of aging or "filling in" that occurs in lakes. In the case of aquatic plants, the rate of sedimentation has a direct impact on available habitat for growth.

### **3.0 Recommendations**

The recommendations which follow assume that the goal of lake management is to manage for a variety of uses, and that, in *most* cases, by maintaining the current water quality, these uses will not be impaired.

#### **Lakes and Ponds: Water Quality**

- #1. Consider most vulnerable lakes and ponds a high priority for protection, adopting appropriate measures to ensure maintenance of water quality.**

Buck Lake, East Long Lake, Nichols Pond, and Nelson Pond currently have the highest water quality *and* are the most sensitive of the larger lakes. The Town of Woodbury should consider these lakes a high priority for protection, and at a minimum, should adopt recommendations to improve septic system siting and set-backs, buffer strip standards, and other measures appropriate to the protection of these lakes and ponds (see recommendations 6 and 8). Other measures may include adoption of Erosion and Sediment Control Standards within the Shoreline Districts of these lakes and ponds (sample Provisions have been drafted by the Vermont Department of Environmental Conservation); and, along tributary streams.

- #2. Assess the status of lakeshore septic systems to protect Valley Lake.**

Valley Lake, because of its relative sensitivity and current trophic status is in danger of eutrophication. Our study suggests that the status of lakeshore septic systems should be assessed. This could be accomplished with either dye, the use of a septic sniffer, or the use of a Septik. The Town should consult the State Lakes and Ponds Division to discuss which method is appropriate. Septic systems which are found to be faulty should be repaired. Those systems which are faulty and are located in an area of inappropriate soils or steep slopes (generally greater than 15% slopes), should be re-located or septic holding tanks should be installed. At a minimum, the recommendations adopted for the Valley Lake watershed should address septic system siting and set-backs, and buffer strip standards for the maintenance of natural vegetation (see recommendations 6 and 8).

- #3. Assess the status of lakeshore septic systems to protect Greenwood Lake and adopt measures to protect its watershed.**

Greenwood Lake's current water quality status with a high phosphorus loading rate and oxygen depletion suggests that it is in danger of eutrophication. The lakeshore septic systems should be assessed, with either a septic sniffer or with the aid of a dye at Greenwood Lake. Septic systems which are found to be faulty should be repaired. Those systems which are faulty and are located in an area of inappropriate soils or steep slopes (generally greater than 15% slopes), should be re-located or septic holding tanks should be installed. At a minimum, the recommendations adopted for the Greenwood Lake watershed should address septic system siting and set-backs, and buffer strip standards for the maintenance of natural vegetation (see recommendations 6 and 8).

- #4. Assess facilities at Green Mountain Conservation Camp on Buck Lake to determine if any problems exist regarding septic disposal.** Buck Lake is showing danger signs as well. While Buck Lake is currently of high quality, the activities of the conservation camp should be reviewed to identify if there are significant phosphorus contributions. The Town of Woodbury should investigate the facilities at the Green Mountain Conservation Camp to determine if

there are problems present such as: overland flow of septic field contaminants to Buck Lake, inadequate below-ground septic field treatment of effluent at the camp (i.e. is there sufficient depth to seasonal high water tables and/or bedrock), and shoreline alteration and erosion problems. The Town of Woodbury should work with camp personnel to correct deficiencies/problems if they are found. If no problems are found in the camp area or broader shoreline-the Buck Lake watershed should be examined for possible problems. Significant contributing sources of sediment and/or nutrients should be identified and remedial actions implemented.

If no significant sources of sediment and/or nutrients are identified in the Buck Lake watershed the current water quality problem may be related to some past activity/activities which contributed large phosphorus loads to the lake. That is to say, the phosphorus in Buck Lake may be internally recycled from a pool of phosphorus which reached the lake at some time in the past. If water quality declines in Buck Lake-remedial measures to address and inactivate this pool of phosphorus might be considered. To assess possible changes in water quality at Buck Lake, monitoring should continue under the State's Lay Monitoring Program.

**#5. Monitor activities in watersheds of smaller lakes and ponds to maintain their insensitive status.**

The majority of the smaller lakes and ponds in Woodbury are relatively insensitive. In general, the smaller lakes and ponds have high flushing rates and polluted waters can be moved out of the lake system relatively quickly. If the watersheds of these lakes and ponds become developed in such a way as to contribute large loads of phosphorus to the surface waters-these high flushing rates may not be enough protection to stop water quality problems from appearing and persisting. If water quality problems develop on a small lake or pond, we recommend that the Town of Woodbury adopt a Shoreline District zoning class for these areas. The Town of Woodbury should consider adopting buffer strip standards and a septic system ordinance and set-back regulations for these Districts (see recommendation 6).

**#6. Adopt one or more measures to ensure that septic systems are properly sited, designed, and constructed throughout the Town.**

Because such a high percentage of Woodbury's soils have Severe Limitations (Soil Conservation Service [SCS] Advance Copy Soil Maps) for septic system operation, the Town should adopt one or more measures to ensure that systems are properly sited, designed, and constructed. The SCS soil mapping units for the Town of Woodbury are, in general, no finer in scale than 10 acres. While a high percentage of the soils mapped have Severe Limitations, there are many smaller soil inclusions within these mapping units which are more suitable for septic system construction and operation. The Town would benefit from knowing the location of these sites, and siting septic systems in these areas. Once these sites are located, the Town needs to ensure that the septic systems will provide adequate treatment of septic effluent.

We recommend the following:

(A) In order to ensure town review of septic system soils the Town should appoint a Town Sewage Officer. The Town Sewage Officer should review the design and construction of systems or at least ensure that the responsible engineer or certified technician certifies that the design and construction meet the standards adopted by the town.

(B) We strongly encourage the Town of Woodbury to adopt a Municipal Sewage Disposal Ordinance. By adopting a Municipal Sewage Disposal Ordinance the town can set standards for placement of septic systems which would ensure that these systems will not convey contaminants to its lakes and ponds. Assistance in drafting an ordinance can be obtained from the Vermont Association of Conservation Districts, Montpelier, VT., and the Agency of Natural Resources, Waterbury, VT.

(C) If a town-wide sewage ordinance is not adopted, a system of septic field set-backs in the Shoreline District (Town of Woodbury Zoning Ordinance) of Woodbury's larger lakes and ponds may be used. Set-backs in the Shoreline District should provide a minimum of 100 feet in soils well-suited for septic systems (those soils with percolation rates between 10-40 minutes per inch) and a minimum of a 200 foot set-back for those soils which are less-well suited for septic system operation (soils with percolation rates between 0-10 minutes per inch and 40-60 minutes per inch).

(D) The Town of Woodbury should adopt a system of septic system replacement (and repair) which calls for the installation of the best possible system for each site condition. In cases where phosphorus and/or nitrogen is likely to reach (or is already) reaching surface waters (through overland flow or ground water) a holding tank should be installed.

(E) The Town of Woodbury should adopt a program which mandates a High Intensity Soil Sampling process. The SCS soil maps (as mentioned above) are gross mapping units and smaller inclusions of soils which in some cases are more appropriate for septic system operation are included in these mapping units. In Woodbury much of the limitation for septic field operation is due to the presence of steep slopes and/or shallow bedrock. The soil types which have less severe limitations for septic system operation are those areas with less slope and also those soils which are deeper to bedrock. High Intensity Soil Sampling could locate these inclusions within a parcel of land. The Town of Woodbury could implement a process which mandates that within Shoreline Districts (or near/within 800 feet of all lakes and ponds regardless of size, or on a town-wide basis) applicant's proposing new developments either (1) finance High Intensity Soil Sampling on the land in question, or, (2) install septic holding tanks.

**#7. Consider adopting a growth management strategy which considers the interaction between land use, lake sensitivity, and water quality.** The Town of Woodbury should consider adopting a growth management strategy that considers the interaction between land use, lake sensitivity, and water quality. We would strongly encourage the Town of Woodbury to adopt such a program if it were determined that one or more lakes and ponds were experiencing negative impacts from declining water quality.

One such growth management program has been implemented by the Maine Department of Environmental Protection. This program adopts limits to watershed development based on the capacity of individual lakes to maintain a desired level of water quality. We have provided a copy of the Maine procedure to the Town of Woodbury (it is titled *Phosphorus Control in Lake Watersheds: A Technical Guide to Evaluating New Development*). Representatives from the Maine program may be willing to speak in Woodbury.

**#8. Encourage better continuing and long term management of shoreline and near-shore areas.**

The Town of Woodbury should encourage better continuing and long term management of shoreline and near-shore areas. This might include: limiting the use of fertilizers and pesticides near lakes and ponds; maintaining the integrity of shoreline vegetation; and controlling erosion.

The Town's current Shoreline District zoning is inadequate in preventing shoreline, and near-shoreline erosion from contributing sediment and nutrients to lakes and ponds. Current provisions only address removal of trees within the shoreline area. There are many options available for the Town to provide greater protection of lakes and ponds by maintaining shoreline vegetation. The publication "Planning For Lake Water Quality Protection: A Manual For Vermont Communities" available through the Vermont Department of Environmental Conservation (August 1990) provides 3 different possible Sample Provisions for Buffer Strip Standards (pages 86-87). We recommend that the Town of Woodbury adopt standards which consider and adjust buffer strip standards based on site specific conditions such as slope and soil erodibility. Standards should be adopted near all lakes and ponds regardless of size.

**Other Recommendations**

**#9. Maintain active participation in State's Lay Monitoring Program.** The townspeople should maintain active participation in the State's Lay Monitoring Program. All of Woodbury's larger lakes and ponds should be monitored in order to provide some continuity to the findings of this study. The information gained by participating in the Program is invaluable to efforts at gauging on-going lake water quality and the success of any measures implemented as a result of this study.

**#10. Promote the formation of lake associations on all lakes and ponds.** The Town of Woodbury should promote the formation of lake associations on all lakes and ponds. Lake associations should be involved in the implementation of this study's recommendations.

**#11. Protect the 3 Mud Ponds as significant wetlands and Town Natural Areas.**

The Town of Woodbury should protect the three Mud Ponds as significant wetlands and Town Natural Areas. While this study did not involve a thorough inventory of wetlands in Woodbury, the three Mud Ponds are significant natural resources. The Town of Woodbury should petition the Water Resources Board to reclassify these areas as Class I wetlands under the Vermont Wetland Rules. Such reclassification would provide greater protection to these areas by granting them a larger buffer (100 feet instead of a 50 foot buffer) and by signifying their importance in regulatory hearings. We believe wildlife and aesthetic values of the ponds would be better protected with a larger buffer. An alternative is to petition the Water Resources Board to increase the size of the buffer strip along these wetlands. The Town should consider a broader program for the identification and protection of all significant wetlands.

**#12. Inventory and protect significant undeveloped shoreline and develop criteria for defining such shorelines.**

The Town of Woodbury should inventory and protect significant undeveloped shoreline. Criteria for defining significant shorelines should be developed by the Town of Woodbury Conservation Commission in consultation with townspeople. Criteria which may be considered include: aesthetics, wildlife and fisheries value,

shoreline stabilization benefits, water quality benefits, wildness or uniqueness values, and naturalness.

**#13. Conduct educational programs for year-round and summer residents on lakes and water quality.**

The Town should conduct educational programs for year-round and summer residents on lakes and water quality. The Woodbury Conservation Commission should organize a series of presentations on lake ecology, pollution, and measures to protect lakes and ponds.

**#14. Provide some protection for loons known to nest on East Long Pond.**

As the Common Loon is a State Endangered Species the Town of Woodbury Conservation Commission may want to provide some protection for loons known to nest on East Long Pond. The Vermont Institute of Natural Science recommends that water level manipulations not occur during the period after a loon lays an egg and the chick has hatched (usually late May-July 4). The Town of Woodbury should negotiate terms for loon protection with an appropriate representative from the power company.

**#15. Protect ponds and lake tributaries which serve as spawning areas for trout.**

In order to maintain the existing coldwater fisheries in East Long Pond, Nichols Pond, Nelson Pond, and other water bodies, lake tributaries which serve as spawning areas for trout should be protected. The fisheries or wildlife biologist with the State Department of Fish and Wildlife, as well as local anglers, may be of help in identifying these areas in the field.

**#16. Important spawning areas such as lakeshore and tributary wetlands should be identified and protected.**

Where warmwater fisheries are important, as in Valley Lake, Greenwood Lake, Buck Lake, and Woodbury Lake, important spawning areas such as lakeshore and tributary wetlands should be identified and protected. Personnel from the State Department of Fish and Wildlife, as well as local anglers may be of help in locating these areas.

**Aquatic Plants**

**#17. Prevention of infestation of Eurasian water milfoil in the Woodbury lakes and ponds should become a high priority for the Town.** While Eurasian water milfoil was not found in the lakes that were surveyed, prevention of infestation of Eurasian water milfoil in the Woodbury lakes and ponds should become a high priority for the town.

**#18. A program should be developed to educate residents and visitors of the Town about Eurasian water milfoil.**

An educational program should be developed to educate residents and visitors of the town about Eurasian water milfoil. While the Vermont A.N.R. has posted signs at public fishing accesses, additional effort should be made to educate the public.

**#19. With assistance from the Vermont A.N.R. "Milfoil Watchers Program", create an educational pamphlet on Eurasian water milfoil that could be distributed at local businesses and the town clerks office.**

The Woodbury Conservation Commission with assistance from the Vermont A.N.R. "Milfoil watchers program" could create an educational pamphlet on Eurasian water milfoil that could be distributed at local businesses and the town clerks office. It could also be distributed with the purchase of a fishing license. The pamphlet could also be mailed to all lakeshore residents.

**#20. Create a program in which local residents are trained to identify Eurasian water milfoil and are responsible for the monitoring of specific lakes and ponds.**

The Woodbury Conservation Commission with assistance from the Vermont A.N.R. "Milfoil Watchers Program" could create a program similar to that of the "lay-monitoring" program where local residents are trained in the identification of Eurasian water milfoil. A volunteer would be responsible for monitoring a specific zone of shoreline. While this concept would require a larger number of volunteers per lake, it would not require the weekly commitment that the lay monitoring program does and would provide an inexpensive method for monitoring the lake.

**#21. Designate an individual to serve as a local contact regarding Eurasian water milfoil.**

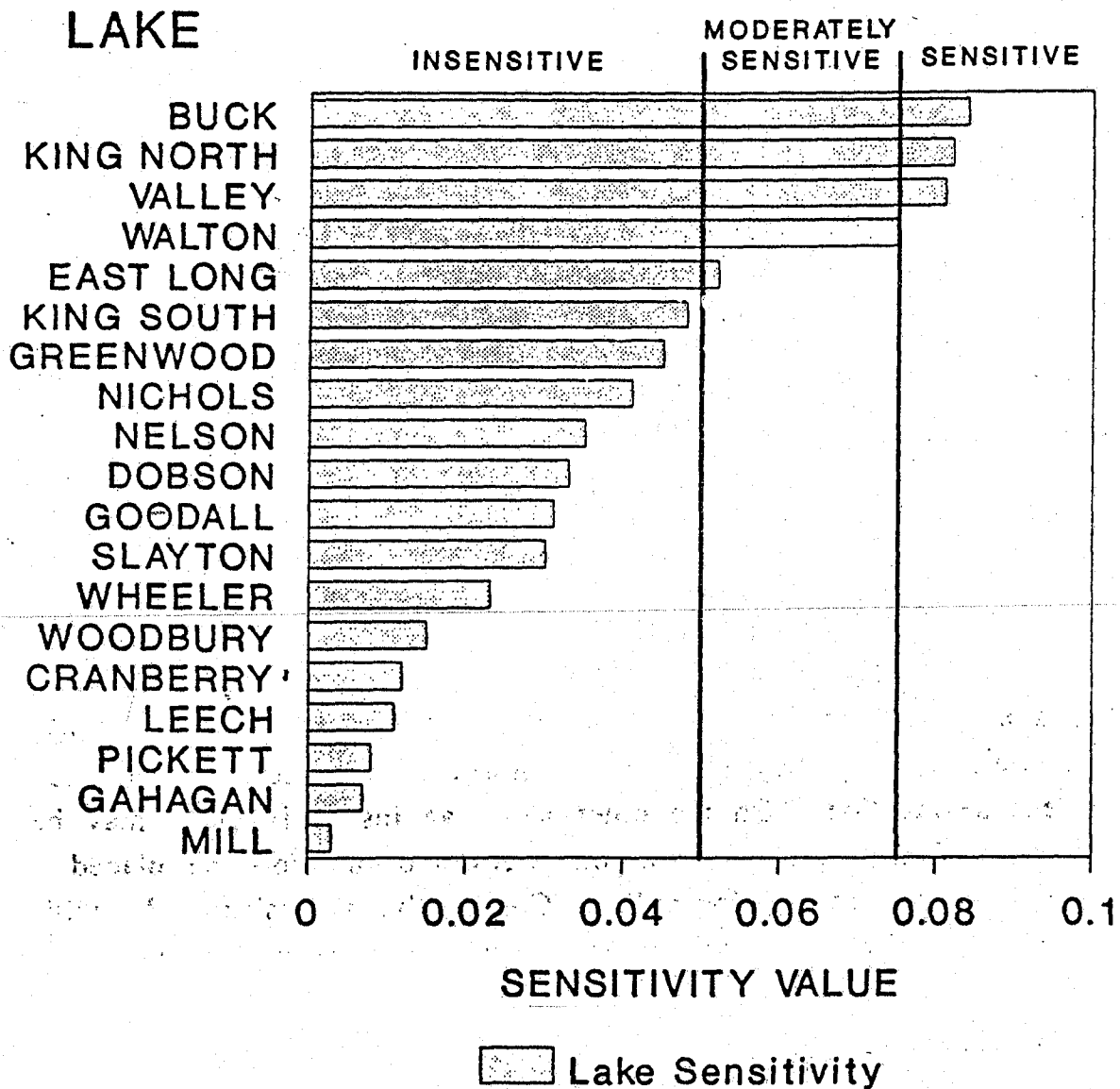
The Woodbury Conservation Commission should designate a person to serve as a local contact person regarding milfoil. This person would be contacted if it was thought that the plant was found. This person would be responsible for following up on any possible sighting of the plant and contacting the VT. Agency of Natural Resources. If the town begins implementing all of the recommendations regarding milfoil (18, 19, 20, 21), the chances of milfoil becoming established in the lakes and ponds will be greatly minimized. If milfoil is found, because of this effort, it will likely be found before a large population of the plant can establish itself and eradication should be relatively simple.

**#22. Work closely with planning commission and lake associations to limit impact of land use to the lakes and ponds with a concentration on protecting the aquatic plant ecology.**

In regard to species diversity and density of aquatic plant growth the following is recommended. The Woodbury Conservation Commission work closely with the local planning commission and lake associations to limit the impact of land use to the lakes and ponds in order to limit the impact of these activities on aquatic plant ecology. By preventing erosion and sedimentation in near-shore area's a more diverse and healthy aquatic plant community will persist. All lake users will benefit from a diverse and healthy aquatic plant community.

TABLE 2

# SENSITIVITY OF WOODBURY LAKES AND PONDS



Woodbury Lakes and Ponds Study

Table 1. General Parameters of Woodbury Lakes and Ponds

LAKE	Area (acres)	Mean Depth (meter)	Watershed (sq. meter)	Retention Time (yr)	Flushing Rate (#/yr)	Phosphorus (kg/yr)
Buck	46	4.3	890000	1.3	0.8	27.5
Cranberry	21	5	7126000	0.1	10	39.1
Dobson	7	0.4	600000	0.03	33.3	9.4
East Long	212	14.3	9243000	1.8	0.6	161.5
Gahagan	114	2	4670000	0.02	50	35
Goodall	6	3	560000	0.2	5	5.8
Greenwood	85	4.6	5380000	0.4	2.5	181.1
King North	3	2.5	60000	0.7	1.4	0.8
King South	4	3	203000	0.33	3	17.2
Leech	3	1.5	570000	0.04	25	8.4
Little Mud	14-16	0.8	1130000	0.04	25	***
Mill	129	1.8	8179000	0.005	200	49.4
Mud (N)	5	0.5	380000	0.04	25	***
Mud (SE)	10	0.5	650000	0.1	10	***
Mud (E)	7 - 9	0.5	800000	0.08	12.5	***
Nelson	132	14.9	10922000	1.1	0.9	118.4
Nichols	385	13.7	12160000	1.2	0.8	146.2
Pickett	3	2	1340000	0.02	50	7.8
Slayton	6	2.5	630000	0.14	7.1	6.3
Valley	92	7.3	2070000	0.8	0.6	168
Walton	11	4.9	323000	1	1	6.3
Wheeler	4	1.8	530000	0.07	14.3	8.3
Woodbury	423	5.5	36480000	0.13	7.7	228.3