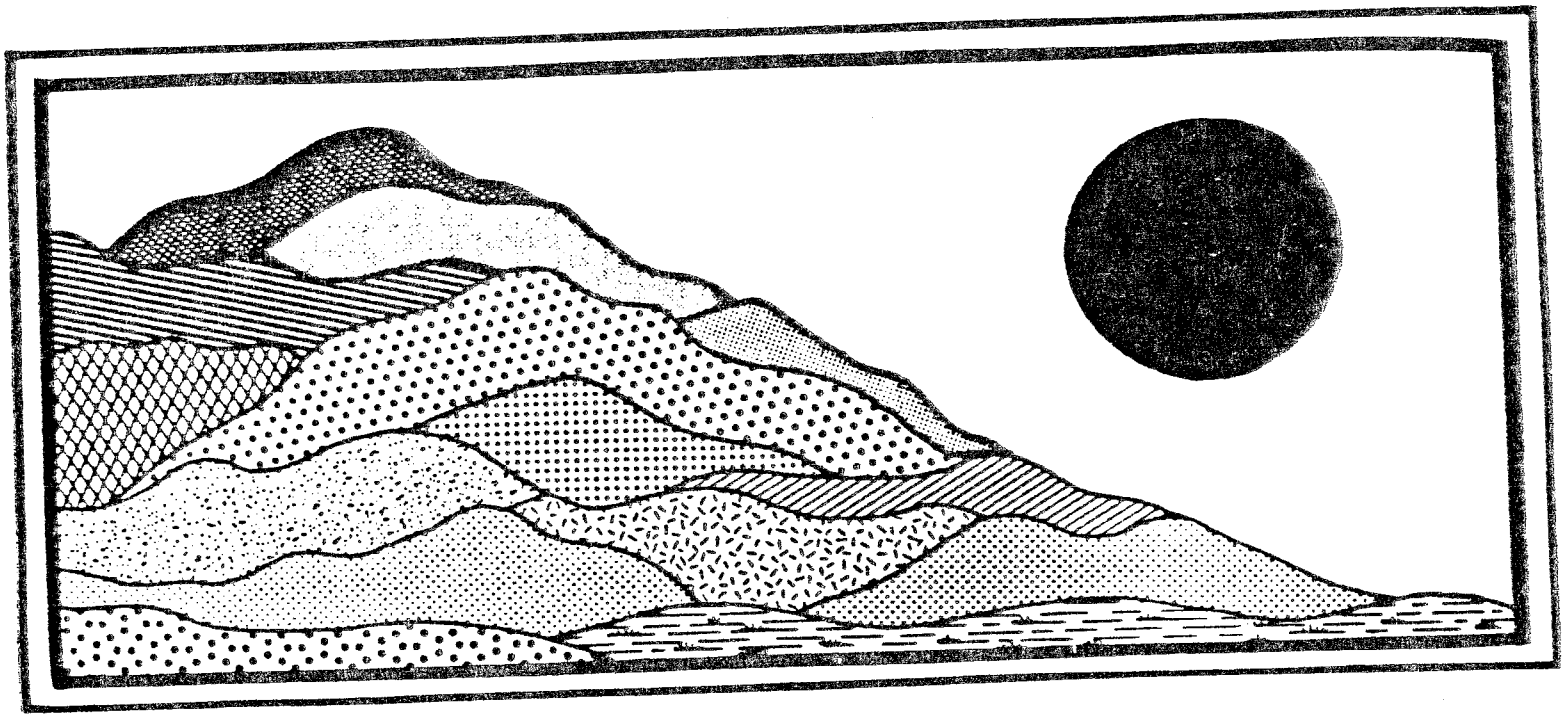
Secret Lake

Avon and Canton, Connecticut

November 1985



ENVIRONMENTAL REVIEW TEAM REPORT

EASTERN CONNECTICUT RESOURCE CONSERVATION AND DEVELOPMENT AREA, INC.

Secret Lake
Avon and Canton
Connecticut

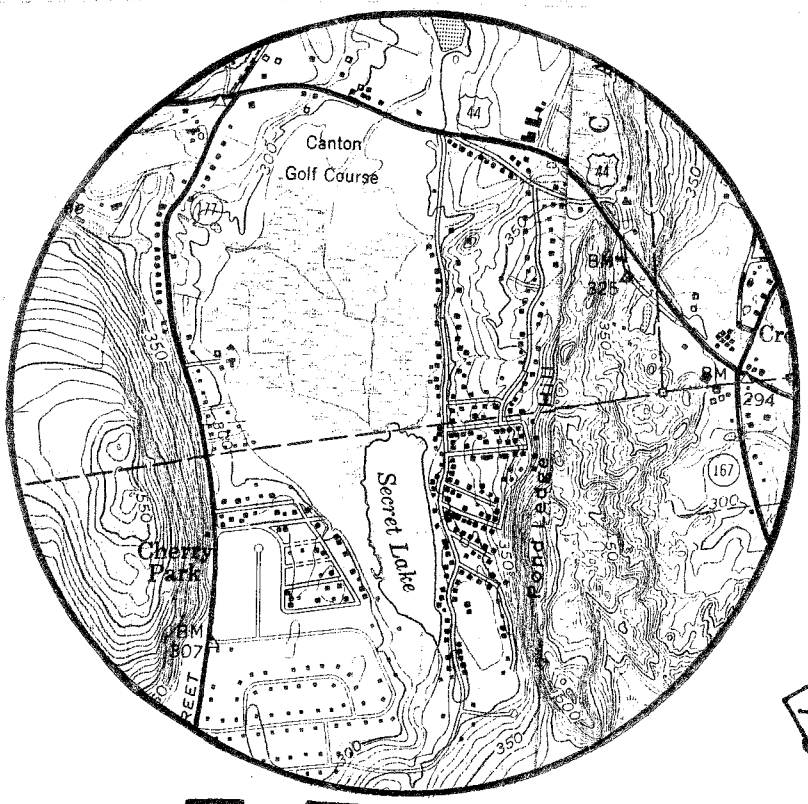
Review Date: 8·6·85

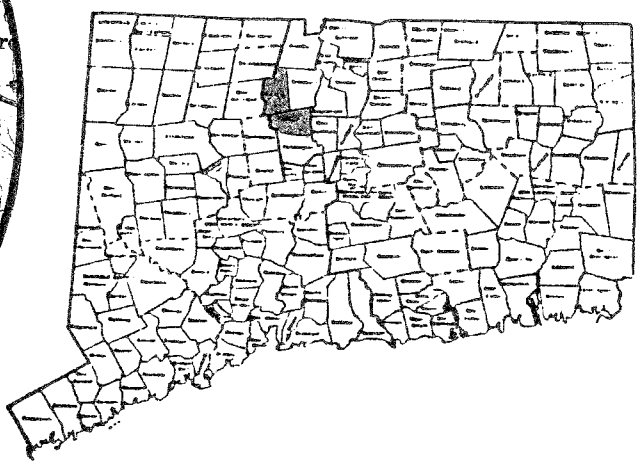
Report Date: 11 - 85

ENVIRONMENTAL REVIEW TEAM
PO BOX 198
BROOKLYN, CONNECTICUT 06234

Site Location

SECRET LAKE & ITS WATERSHED
AVON & CANTON, CONNECTICUT





EASTERN CONNECTICUT

RESOURCE CONSERVATION

& DEVELOPMENT AREA

ENVIRONMENTAL REVIEW TEAM REPORT
ON
THE SECRET LAKE WATERSHED
AVON & CANTON, CONNECTICUT

This report is an outgrowth from the Town Planner of Avon and the Town Engineer of Canton to the Hartford County Soil and Water Conservation District (S&WCD). The S&WCD referred this request to the Eastern Connecticut Resource Conservation and Development (RC&D) Area Executive Council for their consideration and approval. The request was approved and measure reviewed by the Eastern Connecticut Environmental Review Team (ERT).

The ERT met and field checked the site on Tuesday, August 6, 1985. Team members participating on this review included:

Steve Cashman	- Soil Conservationist - USDA Soil Conservation Service
Bill Hyatt	- Fisheries Biologist - Department of Environmental Protection
Amy Parker	- District Manager - Hartford County S&WCD
Paula Pendleton	- Sr. Environmental Sanitarian - CT Department of Health
Nancy Marin	- Lake Ecologist - DEP, Lakes Management Unit
Paul Rothbart	- Wildlife Biologist - Department of Environmental Protection
Larry Rousseau	- Forester - Department of Environmental Protection
Elaine Sych	- Coordinator - Eastern CT Environmental Review Team
Bill Warzecha	- Geologist - DEP, Natural Resources Center

Prior to the review day, each team member received a summary of background information concerning the lake and watershed, a list of concerns, a soils map and a topographic map showing the boundaries of the review area. The Team met with, and were accompanied by the town engineer of Avon and the president of the Secret Lake Association. Following the review, reports from each team member were submitted to the ERT Coordinator for compilation and editing into this final report.

This report represents the Team's findings. It is not meant to compete with private consultants by providing site designs or detailed solutions to development problems. The Team does not recommend what final action should be taken on a proposed project--all final decisions and conclusions rest with the Town and landowner. This report identifies the existing resource base and evaluates its significance to future development and changes, and also suggests considerations that should be of concern to the Town and the lake association. The results of this Team action are oriented toward the development of better environmental quality and the long-term economics of land use.

The Eastern Connecticut Resource Conservation and Development Area hopes you will find this report of value and assistance in making your decisions concerning Secret Lake and its watershed.

If you require any additional information, please contact:

Elaine A. Sych
ERT Coordinator
Eastern Connecticut RC&D Area
P.O. Box 198
Brooklyn, CT 06234
(203) 774-1253

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF MAPS AND CHARTS

I. INTRODUCTION

The Eastern Connecticut Environmental Review Team was asked to prepare a natural resource inventory and evaluation of Secret Lake and its watershed. The Towns of Avon and Canton are interested in the management of the watershed for future planning, and to improve and insure the quality of the environment of the Lake and the surrounding area.

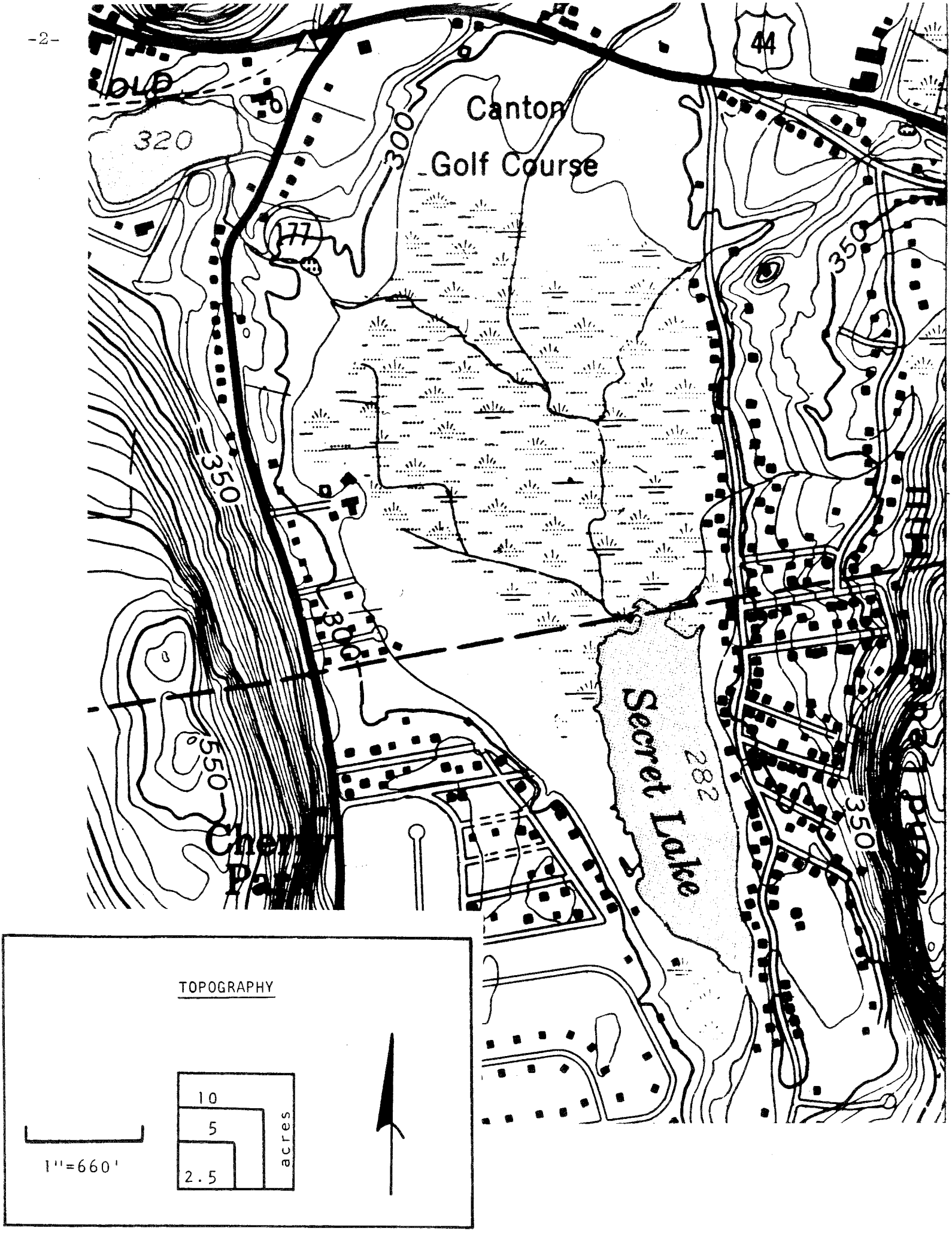
The following sections of this report cover the natural resource base of the watershed and lake area in detail. Management techniques are included in their appropriate sections. The summary highlights very briefly the major concerns and recommendations of the Team members. The appendix contains some soils information, and also copies of information on aquatic weed control published by the New York State Department of Environmental Conservation, and information on wildlife habitat from the National Wildlife Federation.

II. LAKE FEATURES

The approximate morphological characteristics of Secret Lake are as follows:

Surface Areas	- 25 acres
Maximum Depth	- 15 feet
Mean Depth	- 8 feet
Volume	- 8,712,000 cubic feet
Watershed Area*	- 2,067 acres = 3.23 mi^{2}**
	- 1,950 acres***
Retention Time	- 0.05 years (18 days)

* Discrepancy between watershed area acreage (117 acres) should not affect the reliability of this report to be used for planning purposes.
** Source - Gazetteer of Natural Drainage Areas.
*** Source - Area digitized by Team Geologist based on topographic features.


44
Canton
Golf Course
320
300
350
350
350
550
282
Secret Lake
TOPOGRAPHY
1"=660'
10
5
2.5
acres

III. SETTING AND TOPOGRAPHY

Although Secret Lake is located almost entirely in Avon, about 92 percent of its watershed lies in the Town of Canton. A very small piece of the watershed in the eastern limits lies within the Town of Simsbury. The watershed or drainage area of Secret Lake may be defined as that land area from which all of the natural input to the Lake is derived. The watershed of Secret Lake is about 1,950 acres in size and encompasses a relatively linear tract of land. Secret Lake, which is about 25 acres in size, is natural in origin.

Secret Lake and its feeding stream (Jim Brook) occupy a pronounced valley which bisects the watershed lengthwise. The valley probably resulted from a combination of the following: (1) the erosion of a belt of relatively weak rocks; (2) glaciation; and/or (3) the breakup of the rock by faulting (break in the earth's crust along which movement has occurred). The maximum elevation in the watershed is about 910 feet above mean sea level at the top of Onion Mountain in the northern parts. The minimum elevation is the same as the existing lake level (usually 282 feet).

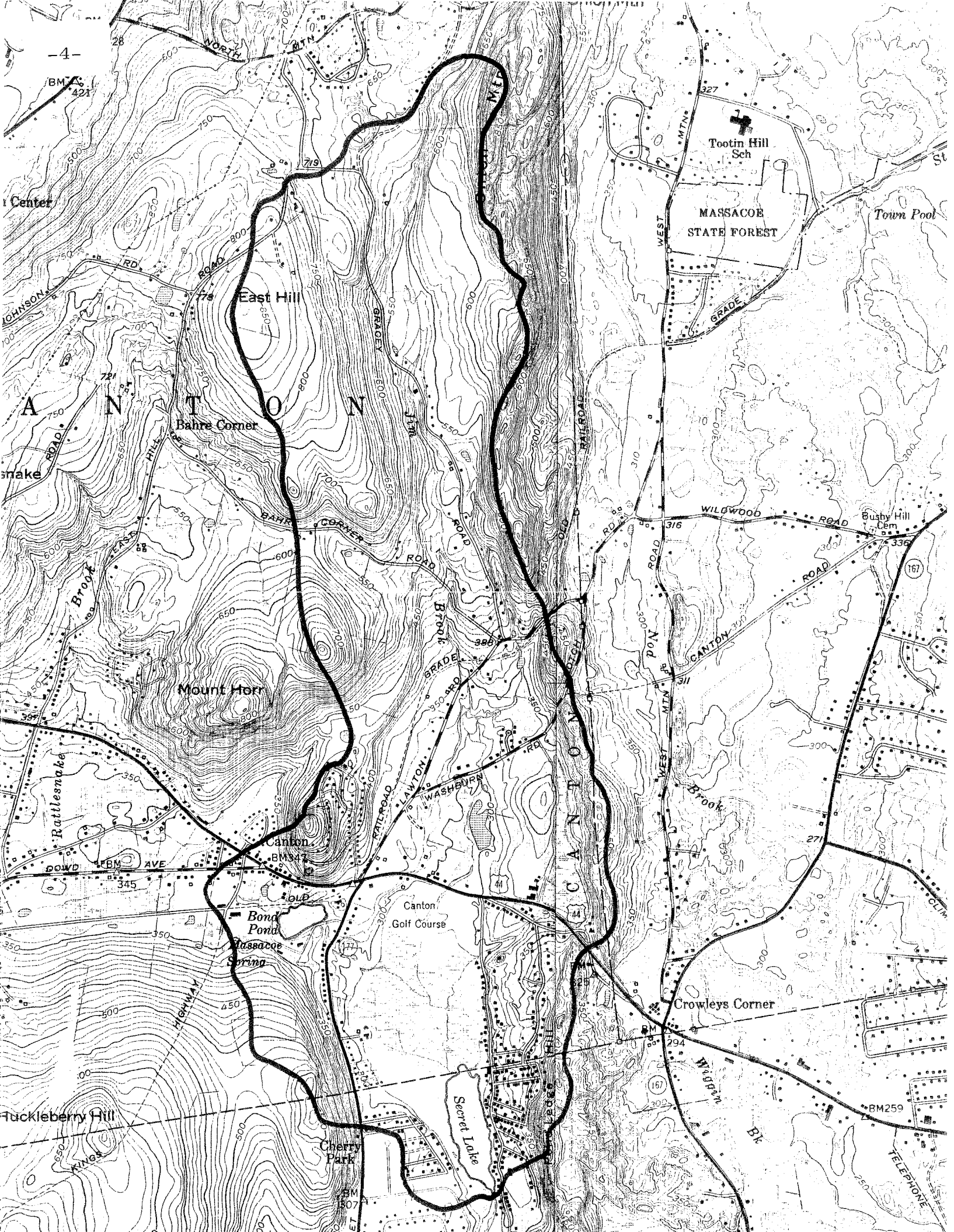
Of the hills and mountains surrounding the watershed, most appear to have bedrock controlled topography. The terrain throughout the watershed ranges from flat to precipitous. The precipitous and steep slopes are associated with rock outcrop areas and cliffs mainly along the eastern border of the watershed. Flat and gently sloping areas are found mainly in the valley and on tableland of some upland areas.

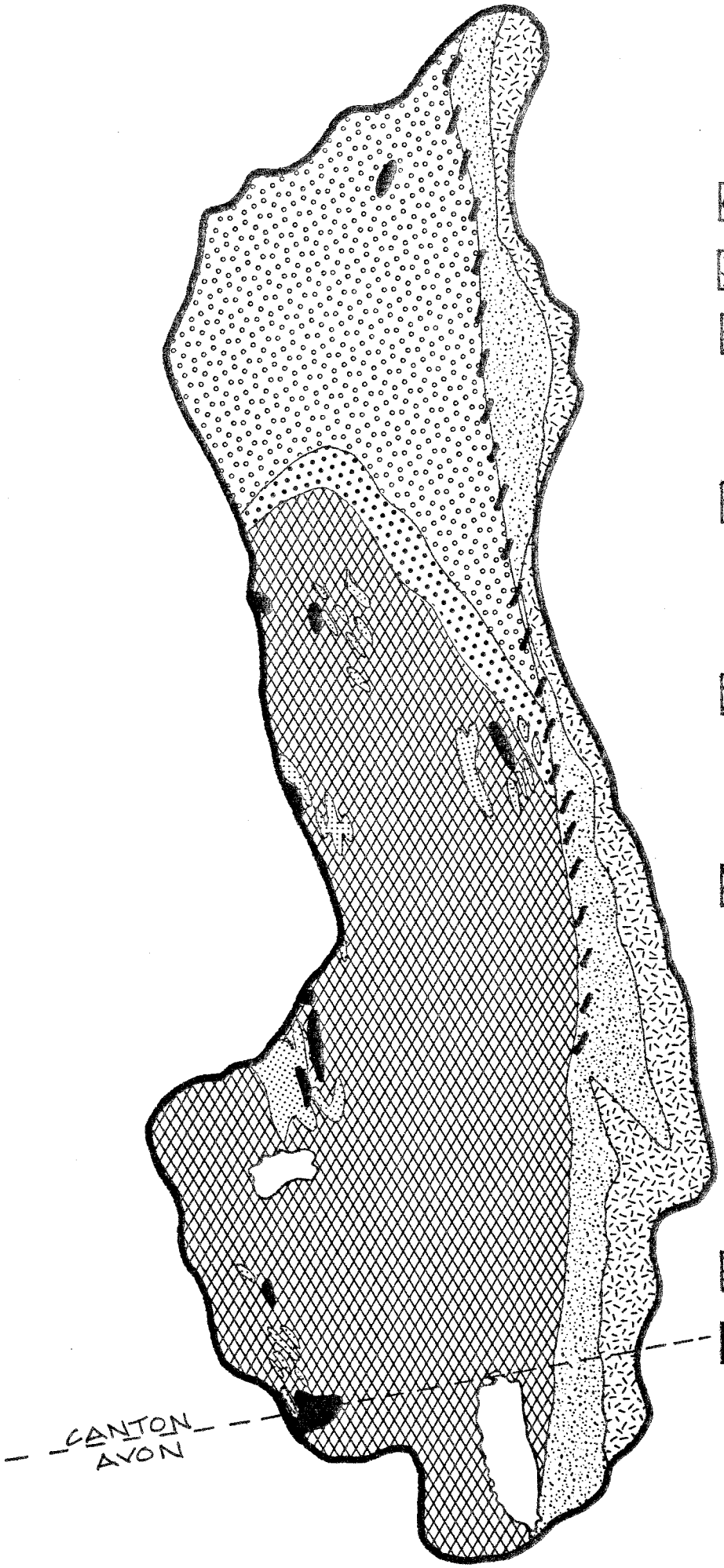
IV. GEOLOGY

BEDROCK GEOLOGY

With the exception of about 90 acres in the eastern parts of the watershed, the Secret Lake watershed lies within the Collinsville topographic quadrangle. The remaining land in the eastern part of the watershed lies within the Avon topographic quadrangle. The bedrock geology of the Collinsville quadrangle (QR-16, by Rolfe S. Stanley) and the Avon quadrangle (GQ-134, by R. W. Schnabel) have been published by the U.S. Geological Survey and Connecticut Geological and Natural History Survey, respectively.

A major geologic feature found in the Secret Lake watershed is a fault, which is referred to by some geologists as the Western Border Fault. The major fault line trends in a north-south direction in the eastern parts of the watershed. It separates two physiographic regions in the State; the Western Uplands and the Central Valley. It also separates distinct rock types. Rock types


CANTON
East Hill
Bahre Corner
Mount Horr
Canton
Canton Golf Course
Bond Pond
Massacoe Spring
Tootin Hill Sch
MASSACOE STATE FOREST
Town Pool
Bushy Hill Cem
Crowleys Corner
Cherry Park
Secret Lake
Huckleberry Hill
Rattlesnake
Jim Brook
East Brook
West Brook
Pond Brook
Waggon Bk
North Mtn
West Mtn
Pond Mtn
Old Mtn
Bahre Corner Road
Wildwood Road
Canton Road
Dowd Ave
Lawton Road
Washburn Rd
Grade Rd
Old Colony Railroad
Kings Highway
Telephone
BM 421
BM 345
BM 347
BM 294
BM 259
BM 1507



BEDROCK GEOLOGY

WESTERN BORDER FAULT

DIABASE

NEW HAVEN ARKOSE-Light to dark red arkose and arkose silts tone with some arkose conglomerate especially near the fault.

THE STRAITS SCHIST-Rusty weathering, medium to coarse-grained graphito - kyanite - garnet - plagioclase - biotite - muscovite - - quartz schist.

COLLINSVILLE FORMATION (Sweetheart Mountain Member) Non-rusty weathering, medium to coarse-grained kyanite - garnet - muscovite - biotite - plagioclase - quartz schist

COLLINSVILLE FORMATION (Bristol Member), Medium grained, garnet - biotite quartz - plagioclase gneiss, garnet - biotite - muscovite - plagioclase - quartz gneiss and schist, and amphibolite with lesser amounts of amphibolite - biotite - quartz - plagioclase gneiss. All the rocks are non-rusty weathering and range in color from white through shades of gray and greenish-gray.

AMPHIBOLITES

GRANITIC PEGMATITES

SCALE 1" = 2000'

underlying the watershed west of the fault are comprised mainly of crystalline, metamorphic rocks. The term metamorphic refers to a group of rocks which have been geologically altered by great heat and pressure within the earth's crust. They consist of very old rocks, 360-505 million years old, which were deposited during the Paleozoic geologic era and which have a very complex history. Various rock types comprising this group of rocks include schists, amphibolite and gneisses. Some of the major minerals found in the gneisses and schists include quartz, feldspar, micas (biotite and muscovite) and garnet, while amphibole is the mjor mineral comprising amphibolites.

Another type of rock found west of the fault line in the watershed are granitic pegmatites. Pegmatites are rocks which have an igneous origin, that are formed from molten magma. The granitic pegmatites are composed mainly of quartz, white feldspar and muscovite. In addition to these minerals, some of the pegmatites in the watershed may contain pink feldspar. Pegmatities are ounger in age than the surrounding metamorphic rocks. They are believed to be Late Devonian (360 million years old or younger). They intruded weak zones, i.e., fractures, fault zones, foliation zones, etc., as a molten liquid in the surrounding metamorphic rocks. Pegmatite rocks have a mineralogic composition which is more resistant to erosion than the surrounding metamorphic rocks and, therefore, form numerous outcrop areas in the western part of the watershed.

Rocks underlying the watershed east of the fualt consist of Mesozoic aged (145-245 million years ago) sedimentary and igneous rocks. Schnabel classified the sedimentary rocks (rocks formed from the accumulation of water-laid sediments), as New Haven arkose. These rocks consist of reddish-brown feldspathic and micaceous sandstones and siltstones and possibly conglomerates near to the Western Border Fault. Because these rocks are relatively soft and generally easily eroded, they do not outcrop in the watershed. However, these rocks do outcrop in the other parts of the Avon quadrangle.

Another rock type found east of the western border fault is an igneous rock referred to as diabase. "Diabase" is a dense, medium to dark-gray rock typically composed of the mineral plagioclase feldspar (typically labradorite). They intruded weak zones in the New Haven Formation in a molten state. Being an igneous rock like the pegmatites discussed earlier, diabases are more resistant to weathering than the surrounding sedimentary rocks. As a result, they also form prominent west facing ledges and scarps on Pond Ledge Hill and Onion Mountain in the eastern part of the watershed.

The presence of these scarps lies in their origin. The New Haven arkose and the diabase in the study area are part of the Newark sequence of rocks which underlie the Central Valley. Following the formation of these sedimentary and igneous rocks in the Central Valley basin, the basin dropped along the east side of the valley causing these rocks to tilt gently eastward about 15-20 degrees. This movement resulted in the west facing scarps and ledges and more gently dipping eastern slopes.

Depth to bedrock in the study area ranges from zero in areas where bedrock is exposed, to perhaps more than 80 feet in the Jim Brook Valley north of the Lake. A bedrock geologic map showing the approximate distribution of rock types in the watershed which was adapted from QR-16 and GQ-154 is included with this report.

SURFICIAL GEOLOGY

Surficial geologic materials consist of those unconsolidated rock particles or other debris that overlie bedrock. The surficial geology of the Avon quadrangle (QR-147, by Robert W. Schnabel) has been published by the United States Geological Survey. The surficial geologic map for the Collinsville quadrangle has not been published to date, but there is preliminary information available at the Department of Environmental Protection's Natural Resource Center in Hartford.

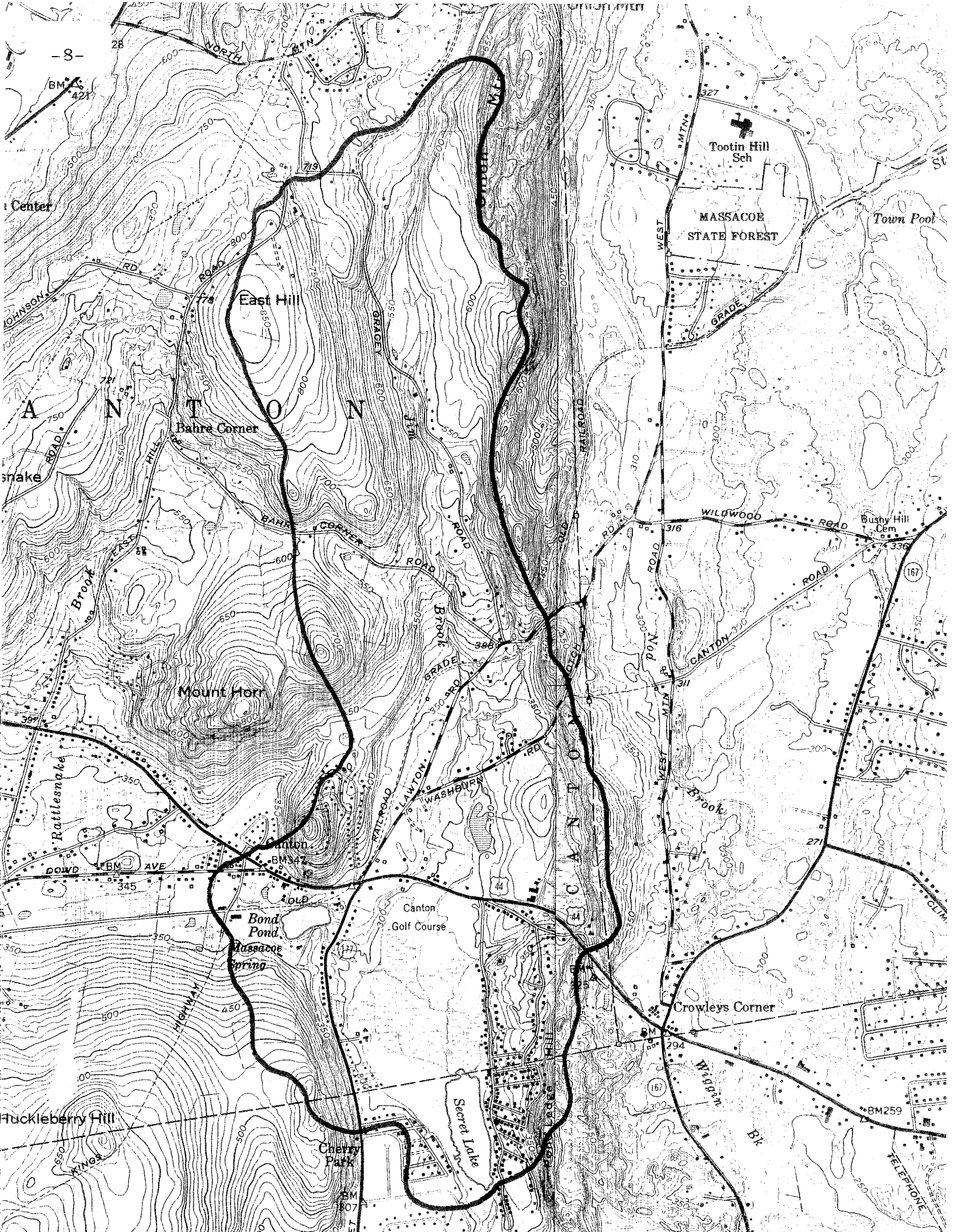
The surficial geologic materials comprising the watershed include the following: (1) till; (2) stratified drift; (3) swamp sediments; (4) alluvium; and (5) talus. The first two types of sediments are products of glaciation, while the final three are more recent deposits formed post-glacially. A brief description of each follows.

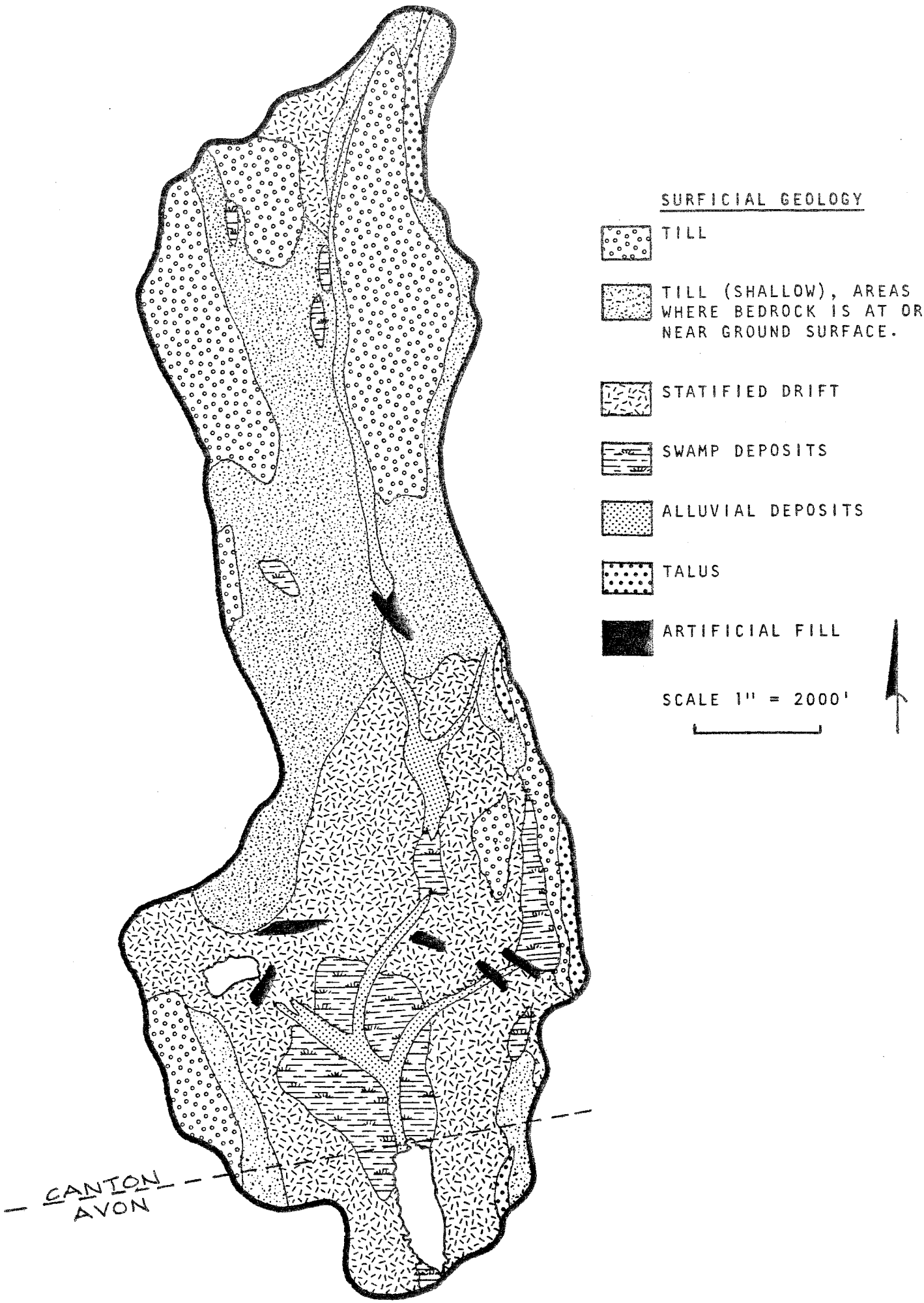
Till is a nonsorted, nonstratified deposit of glacial debris that is composed largely of rock particles that vary greatly in shape and size. The debris that was accumulated on, within, or beneath an ice sheet as it moved across pre-existing soils and rock outcrops were later deposited directly from the ice without substantial reworking by meltwater. The upper few feet of a till deposit is commonly sandy, loose and stony with the lower portions being less stony, siltier and more compact. Thickness of the till probably does not exceed much more than 10 feet in most places in the watershed. In some areas in the watershed, deeper pockets of till (perhaps 40 feet or more) may be encountered. One example would be East Hill in the northern parts. This hill appears to have been molded by ice into an oval-shape. These hills are commonly referred to by geologists as drumlin hills.

Stratified drift comprise those materials that were deposited by meltwater streams, either in contact with wasting ice, or as finer-grained sediment deposited away from the ice. Both of these varieties can be found in the Secret Lake watershed. Stratified drift deposits are composed primarily of sand and gravel. These deposits are found mainly in the southern parts of the watershed, but also cover areas at the northern tip.

Scattered throughout the watershed are swamp deposits. Swamp sediments consist of sand, silt, clay, and organic remains that were deposited post-glacially in stagnant or slow moving, well-vegetated bodies of water. Most of these areas are delineated by the symbol for swamps on the accompanying topographic map. According to the "Soils Survey for Hartford County" the large wetland area north of Secret Lake is comprised of peats and mucks, which are soils very high in organic matter and which are fairly deep (ranging from one and a half feet to more than 20 feet in thickness). Most of the swamp sediments in the watershed have water tables which are at or near ground surface throughout most of the year.

Seasonally wet areas which are also regulated inland-wetland soils parallel many of the streamcourses in the watershed. These soils commonly contain little or no organic material.


Canton Mt.
East Hill
Bahre Corner
Mount Horr
Tootin Hill Sch
MASSACOE STATE FOREST
Town Pool
Bushy Hill Cem
Canton Golf Course
Bond Pond
Massacoe Spring
Crowleys Corner
Secret Lake
Cherry Park
Huckleberry Hill
Rattlesnake
Brook
CANTON
WILDWOOD ROAD
CANTON ROAD
WASHBURN RD
BAHRE CORNER ROAD
GRADE RD
WEST MTN
NORTH MTN
RAILROAD
HIGHWAY
DOWD AVE
KINGS
TELEPHONE
BM 421
BM 345
BM 294
BM 259
BM 807


SURFICIAL GEOLOGY
TILL
TILL (SHALLOW), AREAS WHERE BEDROCK IS AT OR NEAR GROUND SURFACE.
STATIFIED DRIFT
SWAMP DEPOSITS
ALLUVIAL DEPOSITS
TALUS
ARTIFICIAL FILL
SCALE 1" = 2000'
CANTON
AVON

"Alluvium" consists of sand, gravel and silt that were deposited by modern streams on floodplains or in channels.

"Talus" refers to rock blocks of diabase rocks that have fallen from the west facing scarps in the eastern parts of the watershed. These deposits are a result of weathering and gravity effects and build-up from the toe of the scarp.

A final type of surficial deposit found in the watershed are man-made deposits. They consist of fill material, i.e., gravel, till, demolition wastes, etc., and cover areas of substantial thickness (5 feet or more) and areal extent. An accompanying surficial geologic map, adapted from Map GQ-147 by Robert W. Schanbel, as well as unpublished information on file at the Natural Resources Center, shows the approximate distribution of various surficial geologic units in the watershed.

V. HYDROLOGY

By definition, the watershed of Secret Lake comprises all land areas from which ground or surface water may ultimately enter the lake. A raindrop falling on the watershed boundary would have a 50 percent chance of passing into or out of the watershed. As shown on the topographic map, the watershed boundary tends to follow the crests of local hills and ridges; for example, Onion Mountain, Pond Ledge Hill, East Hill, Mount Horr, etc. It is to be expected that the true physical boundary may deviate to some extent from the boundary as mapped. The contours shown on the map are not completely accurate and small topographic details do not appear because of the 10 foot contour interval. Nevertheless, the boundary as mapped should be substantially correct and may be used as a reliable indicator of the general area of concern. It should be recognized, however, that any variations of true boundary from mapped boundary would be particularly important where the boundary is closest to the lake. Any planning for these areas should allow for a reasonable buffer strip outside the mapped boundary to provide a safety margin.

Secret Lake, which has a surface area of about 25 acres, is natural in origin. It's outlet is not constricted by any type of structure such as a dam. The watershed or drainage area of Secret Lake is about 1,950 acres or about 3 square miles. There appears to be no published bathymetric information on the Lake. According to a town official, the Lake probably has a maximum depth of 15 feet and an average depth of about 8 feet. Maximum volume of the Lake, based on the figures mentioned above, is estimated to be 65 million gallons.

Perhaps consideration by the Secret Lake Association should be given to conducting a bathymetric survey of the Lake. Also, in conjunction with the bathymetric survey, perhaps a survey of the Lake bottom deposits could also be conducted. According to a town official, the northern parts of the lake contain thick peat deposits.

Another surface water body found in the Secret Lake watershed is Bond Pond. It is located northwest of Secret Lake and is about seven acres in size. In addition, there are several small ponds located in Jim Brook Valley throughout the watershed.

Because Bond Pond is hydraulically connected to Secret Lake, a possible source of contamination that may affect Bond Pond may also affect Secret Lake. For example, most of the residences surrounding Secret Lake are presently connected to the municipal sewer line or are planned to be connected in the future with the sewage being piped out of the watershed. On the other hand, residences surrounding Bond Pond are not sewered. Septic system effluent is a common pollutant of real estate lakes in Connecticut. The Team has no reason, at this time, to believe that Bond Pond is presently threatened by such effluent or other type of pollutants; the point of the example is merely to show that if a pollution problem was to occur in Bond Pond or any of the other smaller surface water bodies in the watershed, the problem could be transmitted to Secret Lake. Hence, sewering Secret Lake residences may only be a partial solution.

It should be pointed out that potential sources of pollution in the upper parts of the watershed (i.e., closer to the headwater area) are less likely to damage the Lake to a noticeable degree than those sources that are near the Lake.

First, contaminants become more diluted as they travel, due to the increasing volume of water supplied by the watershed. Contaminants produced near the Lake may be concentrated in the Lake around their point of entry. Second, natural processes act to eliminate pollutants on their journey. These processes include chemical reactions, soil or biological uptake, sedimentation, evaporation, and others. In this context, it is important to recognize the differing abilities of the various soil types to absorb potential contaminants. Soils that are poorly drained, shallow to bedrock, or excessively permeable may have little beneficial effect. Well-drained soils with moderate amounts of fine particles may eliminate most pollutants discharged into them, thereby protecting groundwater.

The large wetland north of the Lake is an excellent hydrologic position for protecting the Lake of sediment accumulation and certain pollutants for the remaining parts of the watershed.

Although there is no gaging station at the outlet of Secret Lake, it is possible to estimate the flow duration characteristic of the outlet stream using a method described in Connecticut DEP Bulletin No. 35, "Streamflow Information for Connecticut with the Applications. Land-Use Planning," by Michael A. Cervione, Jr. The estimates are tabulated below in units of both cubic feet per second (CFS) and million gallons per day (MGD).

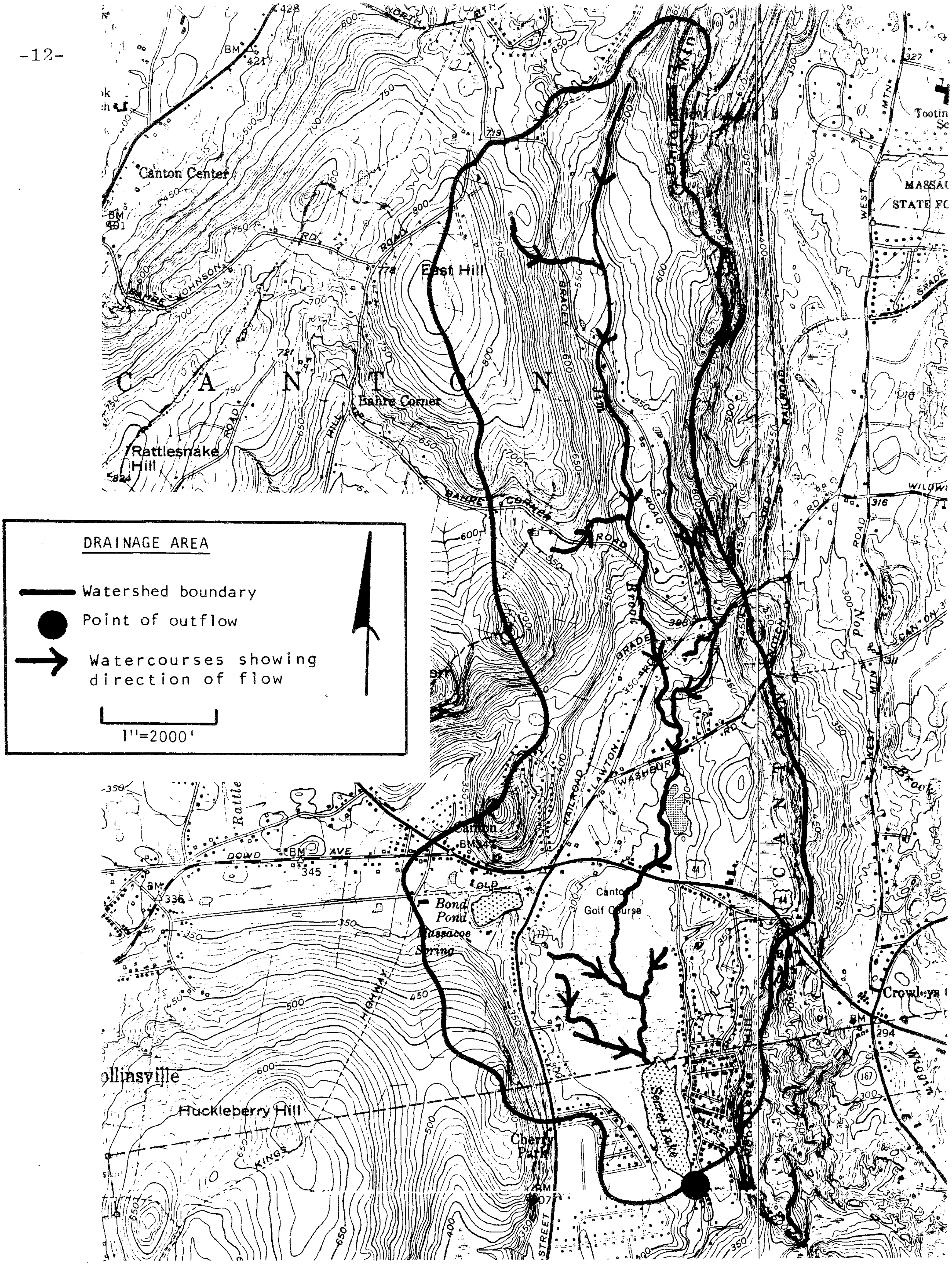

DRAINAGE AREA
Watershed boundary
Point of outflow
Watercourses showing direction of flow
1''=2000'
Canton Center
East Hill
C A N T O N
Bahre Corner
Rattlesnake Hill
Bond Pond
Massacoe Spring
Canton Golf Course
Secret Lake
Huckleberry Hill
Cherry Park
Crowleys
DOWD AVE
WASHBURN RD
LAWTON RD
BAHRE CORNER ROAD
GRACEY ROAD
JOHNSON RD
STREET

TABLE 1. Estimated flow duration characteristics of Roaring Brook at the outlet of Secret Lake.

Percent of time flow equalled or exceeded	1	5	10	30	50	70	90	99
Flow equalled or exceeded in million gallons per day	20.7	10.0	6.65	3.5	2.6	1.7	1.03	.58
Flow equalled or exceeded, in CFS	32.0	15.4	10.3	5.5	4.0	2.6	1.6	.9

The mean annual outflow from Secret Lake is estimated to be 5.0 cubic feet per second or about 3.2 million gallons per day.

The natural water quality in a watershed can be adversely affected by various sources of pollution such as septic systems, sedimentation, agricultural practices, fertilizers used on lawns, golf courses, etc., and stormwater runoff from roads near the surface water body. These sources of pollution, either singularly or in combination, can severely impact the environmental health of a lake.

As mentioned earlier, most of the homes on the east side of the Lake are connected or in the process of being connected to the municipal sewer system. This should help eliminate the potential for the addition of phosphorous, nitrates and other nutrients commonly found in sewage effluent from entering the Lake. It should be pointed out that sewage effluent from a leaking transmission could find its way into the Lake. Based on a copy of a water quality report submitted to Team members on the review day, bacteriological quality of samples taken from the bathing area during summer months between 1975 and 1984 indicated satisfactory levels for bathing except during 1975 and 1981 when samples revealed very high levels of bacteria. This may have been attributed to septic effluent discharging directly to the Lake.

It is most important that strict enforcement of the Public Health Code requirements regarding septic system design and installation for new construction in the Secret Lake watershed be adhered to.

Another non-point source of pollution which may threaten the environmental health of Secret Lake is erosion and siltation. Eroded soils which are transported directly or via streams into Secret Lake contribute to the physical "filling in" of the Lake and can also accelerate Lake eutrophication by enriching the water with nutrients. This nutrient loading of the Lake can accelerate the nuisance growth of aquatic weeds or algae.

The major source of sediment to the Lake is generated mainly by the road system; i.e., paved roads and driveways, gravel driveways, and road shoulders. Another major source of sediment to the Lake can be generated by stream bed and streambank erosion. Increased runoff from developed parts on the watershed can lead to streambank erosion. The wetland area north of the Lake provides protection since peak flows in Jim Brook are slowed down during periods of high runoff thereby allowing sediments a chance to settle out before they reach Secret Lake. A comprehensive erosion and sediment control plan should be developed for new construction in the watershed pursuant to P.A. No. 83-388 "An Act Concerning Soil Eorsion and Sediment Control." This should hopefully minimize new problems. In this regard, the publication "Guideline for Soil Erosion and Sediment Control" should be referenced.

It should be pointed out that during a cursory inspection of Roaring Brook on the review day near its outlet from Secret Lake, an accumulation of sediment has built up the brook. It appears that these sediments are from road sanding operation on Secret Lake Road. Consideration should be given to constructing a sediment basin before the brook. A sediment basin would provide a body of water into which heavy sediments would settle out before reaching the brook. Such a basin would need to be cleaned regularly to ensure proper operation.

If there are direct outlets for stormwater drainage system serving Secret Lake Road into the Lake, it is recommended that these discharge points be checked to see if sediment has accumulated in these areas. If so, there may be a need for sediment basins to trap the sediments before they reach the Lake. These basins, as mentioned above, will need to be inspected and maintained at least annually.

According to a Secret Lake Association member, the installation of road curbing near the bathing area has reduced the build up of road sand in this area.

VI. LAKE EUTROPHICATION AND MANAGEMENT

EUTROPHICATION

Eutrophication is a natural aging process through which a waterbody gradually increases in fertility and biological productivity, and fills in with accumulations of organic deposits. As eutrophication proceeds, algae blooms increase in both intensity and duration, and aquatic plant growth becomes more prolific. The lake becomes shallower and the deep, cold waters are lost. During the latter stages of this process, the waterbody becomes a boggy or marshy wetland.

Under natural conditions the eutrophication process usually advances very slowly over thousands of years. The process can be accelerated by activities of man which increase nutrient and sediment inputs to a waterbody.

In general, there are three accepted stages of eutrophication which are defined as follows:

1. Oligotrophic = early stages of the process, very infertile, low giological productivity, high transparency, usually highly oxygenated and relatively deep with little accumulation of organic sediments on the bottom.

2. Mesotrophic = a mid-range between the two extremes of oligotrophic and eutrophic.

3. Eutrophic = late stages of the process, very fertile (high in plant nutrients such as nitrogen and phosphorous), high in biological productivity, low in transparency, bottom waters usually show reduced levels of dissolved oxygen with an abundance of organic matter on the bottom.

Phosphorous has been identified as the growth limiting nutrient in the majority of Connecticut lakes. The term "limiting nutrient" refers to the nutrient which is in the shortest supply relative to growth requirements. In general, algae and macrophytes will grow until the supply of some basic nutrient is depleted. Then any increase in that nutrient will result in a corresponding increase in biological productivity. Enrichment of a lake with plant nutrients is the fundamental cause of eutrophication.

Undisturbed woodland contributes lower nutrient loads to a lake than other land uses. The nutrient loading from agricultural land is generally about five times greater than woodland. Residential and commercial land typically contribute more than ten times the nutrient loading that results from woodlands. Thus, as woodland is converted to other uses, or as agricultural land is converted to residential land, the nutrient contribution to the lake increases, advancing the eutrophication process. Although much of this increase in nutrient export from the watershed is inevitable and unavoidable, best management practices can provide for some degree of mitigation.

It should be noted that the Connecticut DEP has recently revised (1984) a report entitled "A Watershed Management Guide for Connecticut Lakes." The DEP report discusses in detail the process of eutrophication and methods of control. According to the DEP's report, the following factors may contribute nutrients to a waterbody and therefore accelerate the eutrophication process: erosion and sedimentation, septic systems, lawn and garden fertilizers, yard and garden vegetation disposal, agricultural land, timber harvesting, stormwater runoff, waterfowl, atmosphere, lake sediments. The key to controlling the eutrophication process is controlling the nutrient enrichment from these sources. The DEP's "Watershed Management Guide" is recommended reading and is available from the Department at 566-2588.

MANAGEMENT

Secret Lake is presently experiencing conditions typical of eutrophic lakes. Additional residential development or agricultural activities which do not employ best management practices will serve to worsen these conditions. Local agencies should consider developing and implementing watershed management practices to mitigate the effects of land-use changes in the watershed. The nutrient sources believed to be the most significant at Secret Lake are discussed in the next section of this report.

It is recommended that the Secret Lake Association develop a watershed management plan as outlined in the DEP Watershed Management Guide for Connecticut Lakes.

Potential Nutrient Sources

Erosion and Sedimentation - Erosion and sedimentation within a lake watershed is a natural process, the rate of which can be greatly increased by human acitivites that disturb the land.

Eroded soil contributes to eutrophication in several ways. Nutrients associated with the soil particles are introduced to lake waters. Sedimentation reduces water depths creating conditions conducive to the growth of aquatic weeds. Organic matter, associated with the soil particles, is decomposed by the soil bacteria which depletes oxygen overlying the lake sediments.

In 1983, the Connecticut General Assembly enacted legislation entitled "An Act Concerning Soil and Sediment Control" which amends local zoning pursuant to Section 2-8 of the Connecticut General Statutes. This legislation requires the Connecticut Council on Soil and Water Conservation to develop erosion and sediment guidelines and model regulations for municipalities. The legislation also mandates the adoption of municipal erosion and sediment control programs by July 1, 1985.

Lakeside residents and lake users should urge their town to adopt and utilize erosion and sedimentation ordinances in their zoning regulations.

Local officials should see to the correction of any existing sources of erosion, sedimentation and runoff within the Secret Lake watershed.

Roadway runoff can be a significant source of sediment in a lake watershed. The lake organization should establish cooperative working relationships with the appropriate town maintenance officials in order to implement a sound management program for lake watershed roads.

Lawn and Garden Fertilizers - Lawns and gardens are generally very efficient at utilizing soil nutrients and preventing their loss through runoff and leaching. However, runoff and leaching of nutrients can occur if fertilizer applications exceed nutrient requirements, or if fertilizers are applied prior to storm events which cause runoff. These situations can be avoided if fertilizers are matched to soil requirements, and if applications are timed to avoid periods

of runoff. Soil test kits can be purchased at a nominal charge from The University of Connecticut Cooperative Extension Service county offices. The samples are analyzed at the Extension Service Laboratory, and the results identify soil nutrient deficiencies.

Yard and Garden Vegetation Disposal - Leaves, grass clippings, and other vegetative material from yard and garden maintenance should not be deposited in a location where the material may be washed into the lake. Vegetative material will add to the sediment in the lake and will provide plant nutrients upon decomposition. Each property owner should select a suitable site away from the lake and its watercourses for the composting of vegetative material.

Waterfowl

Ducks and geese are generally considered attractive wildlife assets which enhance the aesthetic appeal of a lake. However, large numbers of migratory waterfowl which spend considerable periods of time on a lake can contribute appreciable loadings of phosphorus and nitrogen to lake waters. In a study of one Connecticut lake, it was estimated that the phosphorus in the excrement of four geese in one month was equivalent to the total annual loading of phosphorus from 2.5 acres of watershed land. In order to quantify the impace of waterfowl on a lake, it is necessary to develop accurate information on waterfowl population numbers, feeding habits, resting areas, and periods of occupancy. In the absence of detailed information, it should be recognized that large flocks of migratory waterfowl which stop at a lake for many weeks can be an important factor in the eutrophication process.

Lake Management Alternatives

At the present time, Secret Lake is experiencing moderate growths of aquatic macrophytes and algae which interfere with recreation.

Aquatic Weed Control

There are disadvantages to any weed control method. A few of the problems which may be encountered are:

1. Those macrophytes which are resistant to the control method employed may multiply due to a reduction in competitive pressures from other species.

2. If the weeds are removed, the loss of habitat, spawning areas and a food source for fish and other aquatic organisms may be incurred.

3. After the weeds are removed, nutrients could be made available to algae and subsequently, "blooms" may occur.

The most common means of aquatic weed control are: winter drawdown, weed harvesting, chemical treatments, drawdown and excavation, and hydraulic dredging. Each of these control methods is discussed below. Included in the Appendix for further information is a guide prepared by the USDA Soil Conservation Service, the New York State Department of Environmental Conservation and the New York State College of Agriculture and Life Sciences entitled "Mechanical Control of Aquatic Weeds."

1. Winter Drawdown

If the spillway has the capacity of effectively lower the water level, the lake may be drawdown in the fall to expose the sediments. Over the winter, the bottom freezes and destroys roots, vegetative parts and susceptible seeds. Winter drawdown will not kill algae. Winter drawdown should be coordinated with fisheries experts to prevent impacts on fish populations. Secret Lake does not possess a water level control structure, therefore, winter drawdown is not an alternative.

2. Weed Harvesting

Weed harvesting entails the mechanical cutting of the weeds. Although the method provides immediate relief, it may have to be repeated at periodic intervals.

3. Chemical Treatment

The use of any algicide or herbicide within the waters of the State is governed by statute (Sec. 430 of Public Act 872) and permits are required from the Pesticide Compliance Unit of D.E.P.

Chemical treatments are generally only "cosmetic" and repeated applications may be necessary.

4. Drawdown and Excavation

Drawdown and excavation is sometimes employed to remove the substrate utilized by the plants for growth. The process increases water depth to levels where plants growing on the bottom will not receive enough light to survivie. The effects of this method are generally long-termed.

The drawdown and excavation process requires the use of heavy equipment and it must be determined whether the pond bottom could support this weight.

This method has a relatively high capital outlay; however, the restorative effects are long termed.

If this method is given further consideration, a feasibility study should be conducted to "map" lake sediments according to depth, composition, and underlying substances. Final disposal of excavated sediments should also be explored during the feasibility study. Hydraulic dredging (see discussion below) accomplishes the same goal as drawdown and excavation, but is more costly due to increased specialization and complexity.

It is recommended that the lake association, when developing a plan for improving the area of the lake off the organization's beach, consult with the DEP Water Compliance Unit, the Soil Conservation Service District Office, DEP Fisheries, and local inland/wetlands agencies to ensure that best management practices are employed and that all possible impacts are explored.

5. Hydraulic Dredging

Under this method, specialized sediment dredges are employed to remove underwater sediments by suction as a slurry. The slurry must be dewatered prior to final disposal, and the decant water usually must be treated to remove solids and nutrients prior to disposal. The development of dewatering containment basins of suitable size and location is a major and expensive undertaking. However, where enviornmentally and financially feasible, this method can provide improvement if other methods are unsatisfactory.

VII. SOILS AND RELATED CONCERNS

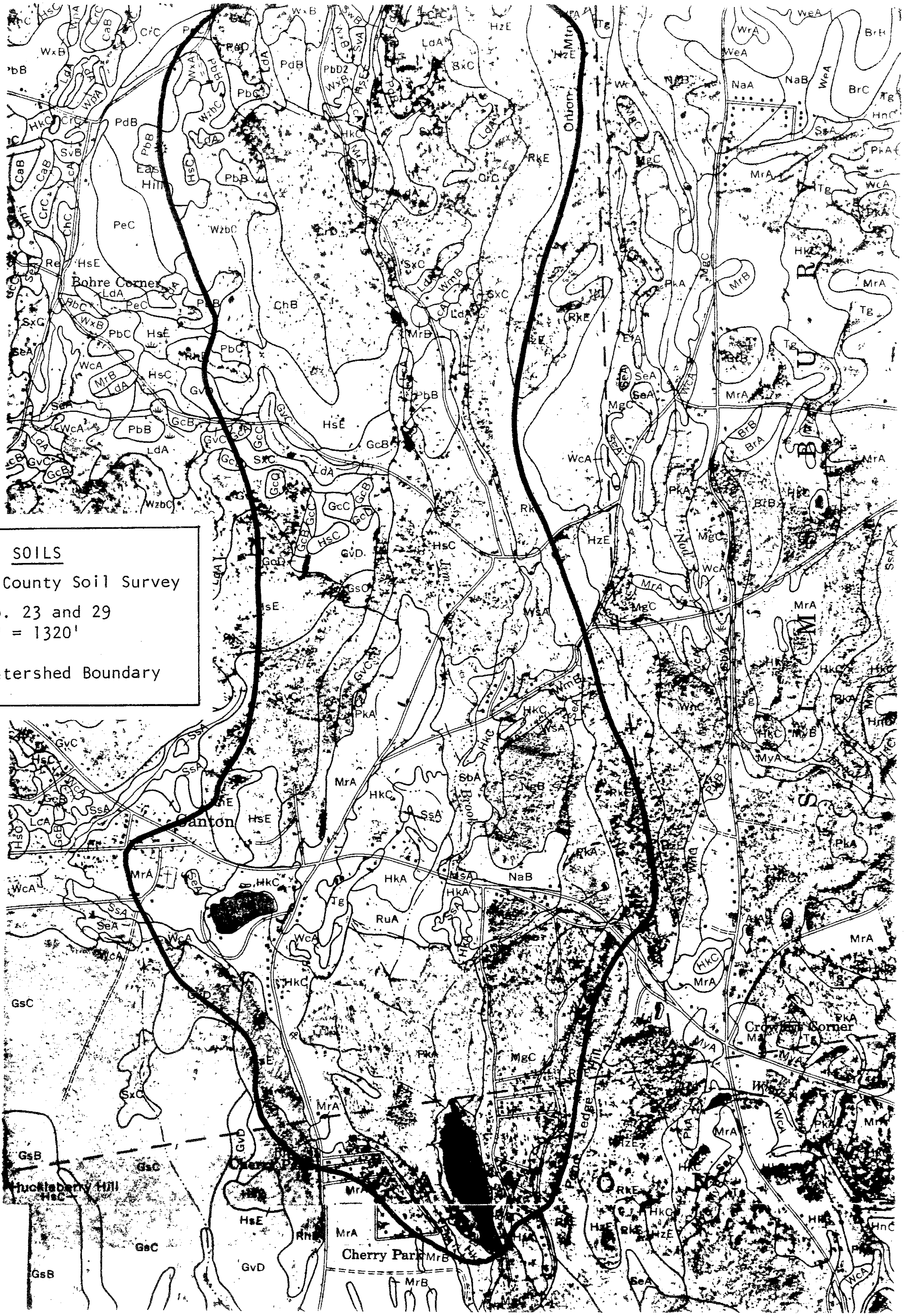
The soils of the Secret Lake watershed vary from very poorly drained peats and mucks to excessively drain sand and gravel. A detailed soils map and chart have been included for reference. Limitations for developments such as rockiness, steep slopes and wetness are also delineated. Many of the soils in the watershed have additional limitations due to poor filtering capacity for on-site septic systems. Where municipal sewer systems are not available, potential for groundwater pollution would exist. Many soils also have limitations for development due to high erosivity. This problem is more prevalent in areas of steep slopes.

Land uses in the watershed consist of a golf course, woodland, light industrial and commercial establishments and residential development. In general, the watershed is not heavily developed. As increased growth and development occur, proper erosion and sediment control measures as well as stormwater management plans should be designed and implemented.

It was noted during the field investigation of the area that a storm sewer outlet discharging runoff from Secret Lake Road south of the lake had accumulated sediments in the outlet area. Periodic removal of sediments and installation of plunge pools at outlet areas will reduce sediment pollution problems in the watershed areas. The "CT Guidelines for Soil Erosion and Sediment Control" are a good reference source in developing erosion and sediment plans and measures.

An additional concern of the towns and the homeowners association was the recreational swimming area opposite Fire House #2 on Secret Lake Road. There is an existing problem of water weeds in the swimming area. Dredging and deepening the immediate swimming area would have the greatest beneficial effect. The best time of the year to dredge is in the autumn prior to the pond's natural fall turnover. All material dredged from the pond should be

N

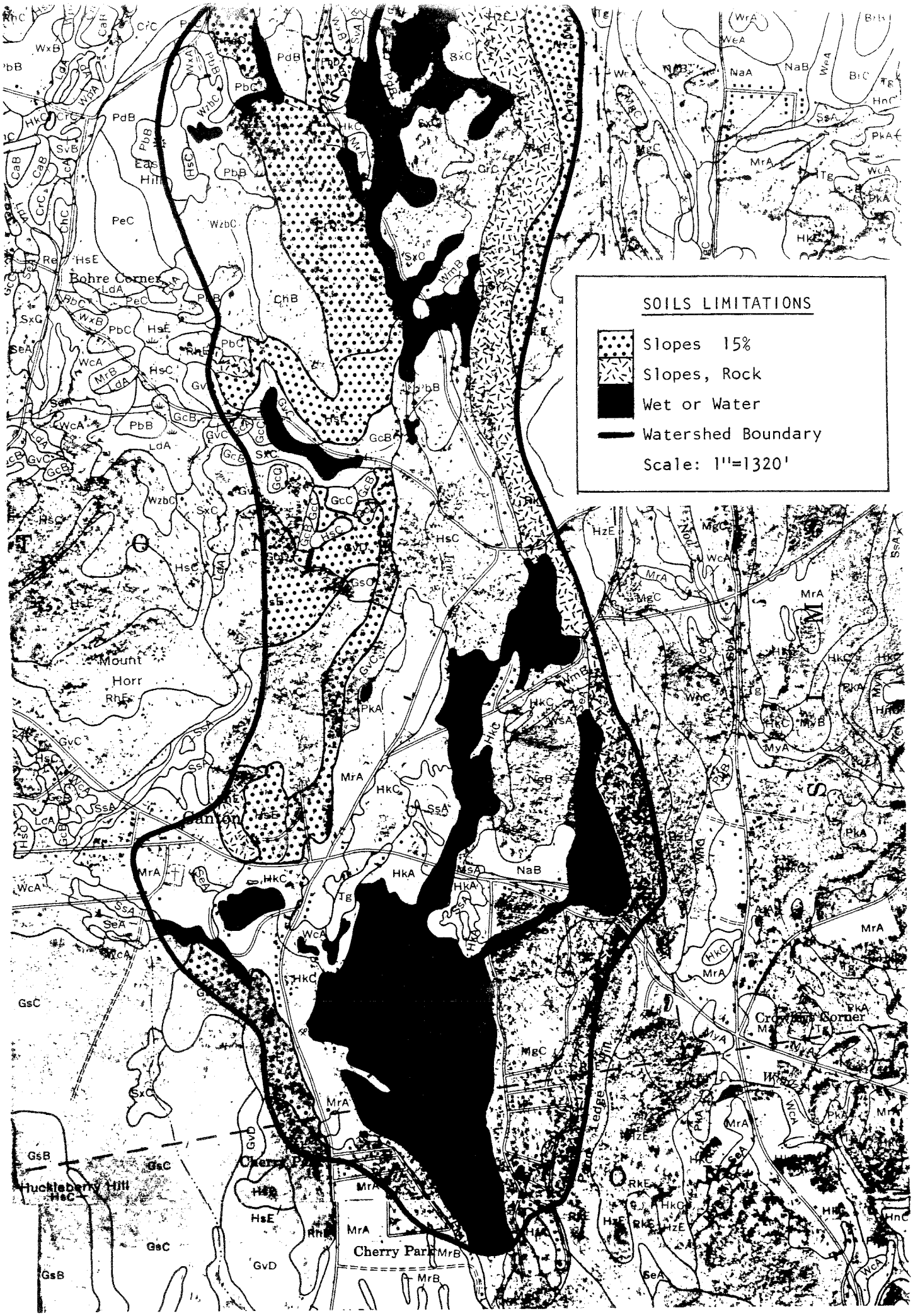


SOILS

Hartford County Soil Survey

Sheets No. 23 and 29
Scale: 1" = 1320'

Watershed Boundary


N
SOILS LIMITATIONS
Slopes 15%
Slopes, Rock
Wet or Water
Watershed Boundary
Scale: 1"=1320'
Bohre Corner
Mount Horr
Canton
Cherry Park
Huckleberry Hill
Crowley Corner
Pond Ridge

trucked away to a suitable non-wetland area for disposal. Additional sand and gravel could be brought in and properly graded to enhance the beach area.

If you need additional information, please contact the District office, 688-7725.

VIII. VEGETATION

The vegetation description for the Secret Lake watershed is divided into six broad cover types. These are described in more detail in the Vegetation Type Description section. The northern portion of the watershed is more heavily wooded and steeply sloped than the southern portion. The majority of the southern portion is heavily developed for commercial and residential use.

VEGETATION TYPE DESCRIPTION

Mixed Hardwoods (MH) - This type is composed of primarily hardwood species with a small portion of softwood present. The species composition is dependent on the soils and site conditions present. On the steeply sloping ridge tops and poorer growing sites, chestnut oak, red oak, hemlock, and red cedar are found. The hieght and diameter growth are usually very slow. The trees have little or no commercial value.

On areas with better growing conditions the species diversity increases to include red oak, black oak, white oak, red maple, sugar maple, black birch, yellow birch, white birch, hickory, ash, and aspen. The softwood present are white pine, hemlock and red cedar. Tree heights and diameters are larger and have greater commercial value than the poorer sites.

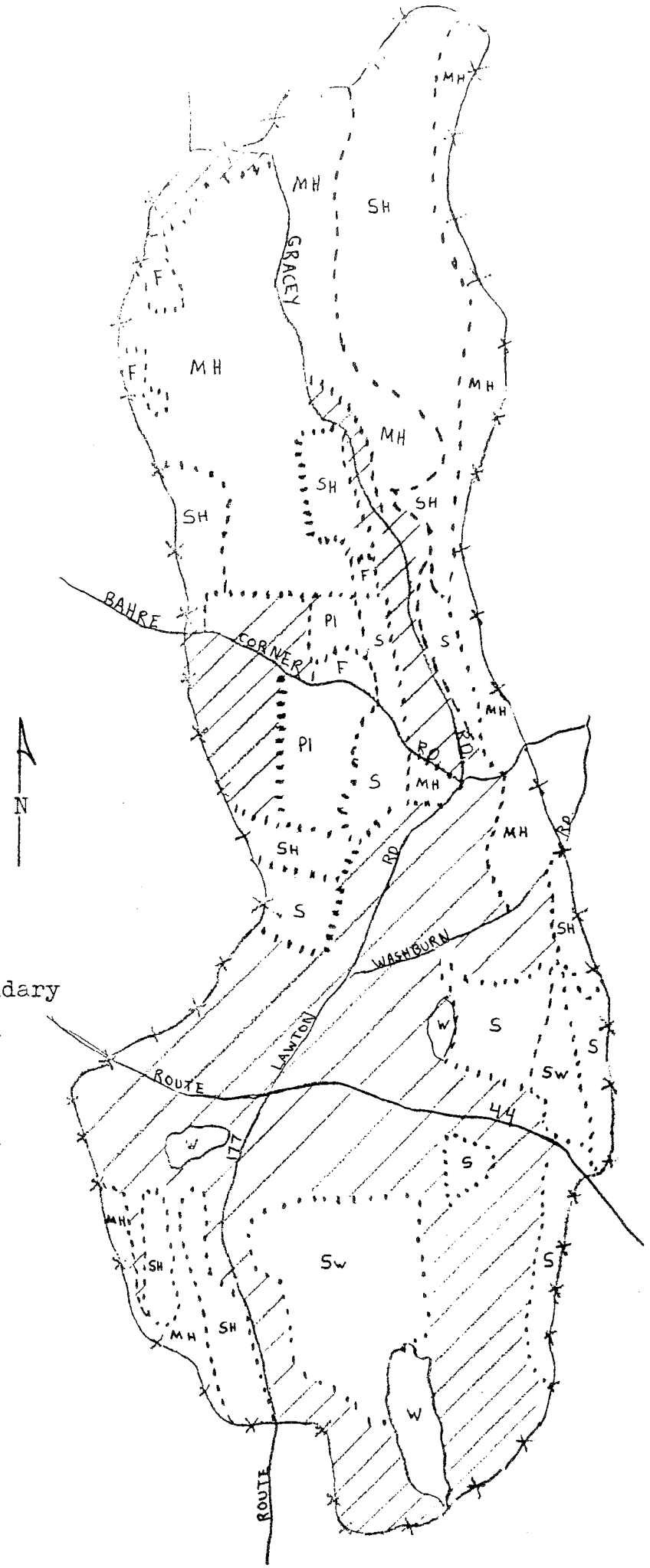
Softwood Hardwood (SH) - This type has softwood as the predominant component with a smaller portion of hardwood present. Again, site and soil conditions will dictate the species composition. Steep rocky areas and streamsides tend to have hemlock present with chestnut oak on the drier sites and black birch and red maple found on the wetter sites. The areas with more sandy, gravelly soil types will have white pine as the dominant softwood species. A small percentage of black cherry, aspen, white birch, white oak and black oak may be found. Along with the white pine, pitch pine and red cedar will occur. The commercial value of the stands depends on the size and quality of the trees. Generally white pine stands tend to be more valuable than hemlock stands. Though it would be the condition of the hardwood component that would influence the stands value.

FOREST STAND MAP

SECRET LAKE WATERSHED

AVON, CANTON, CT

Scale: 1"= 2,000 ft.



Legend

-x-x- watershed boundary

..... stand boundary

MH forest type

//// developed area

W water

Softwood (S) - These are natural stands having a composition of nearly pure white pine, hemlock or a mixture. White pine may also occur with pitch pine and red cedar. These stands occur on dry, sandy, gravelly soils. Hemlock stands tend to occur in areas of poor drainage and shallow soils.

Plantations (PL) - These are conifer stands that have been planted with one or more species. Species include white pine, red pine, larch and Norway spruce.

Hardwood Swamp (SW) - Areas of poor drainage with high water tables. Species occuring in such areas are red maple, ash, elm, willow, black adler and aspen.

Pasture/Old Field (F) - These areas are used for agricultural purposes or are abandoned fields reverting back to woodland. The reverting fields are occupied by red cedar, juniper, white pine, sumac, honey suckle, barberry and grey birch.

POTENTIAL FOR MANAGEMENT

The obvious diversity of ownership in such a large area limits the scope of forest management.

The impact that forest management could have on the watershed is limited to harvest activities and the possibility that erosion and sedimentation could occur. The location and distribution of the forested land in the watershed would make that possibility seem remote. As noted in the publication, "A Watershed Management Guide for Connecticut Lakes," Connecticut Department of Environmental Protection, Water Compliance Unit, 1984, timber harvesting operations do not affect nutrient export levels, but could cause site specific problems with sedimentation.

This can be avoided by following the Best Management Practices outlined in the Connecticut 208 Forest Advisory Committee's handbook entitled, "Logging and Water Quality - A Practical Guide for Protecting Water Quality While Harvesting Forest Products." The handbook describes effective and practical erosion and sedimentation controls related to haul roads, skid trails, stream crossings, harvesting practices, and job termination practices.

Proper forest management on the better growing sites would increase not only the commercial value of the woodland, but the recreational, wildlife habitat, and the watershed values of the area.

IX. WILDLIFE HABITAT

This wildlife review and evaluation is limited to Secret Lake and the immediate surroundings. The wildlife habitats involved are open water and hardwood swamp.

OPEN WATER

This type consists of Secret Lake, a water body averaging eight feet deep with a maximum depth of fifteen feet. Vegetation consists of pond lillies, duckweeds, pickerelweed, cattails, grasses and sedges. The southern half of the lake has approximately fifth percent cover with more open surface progressing northerly. Shoreline vegetation consists of dogwood, spicebush, grasses and sedges, and numerous residences with typical backyard habitat.

Wildlife utilizing such open water habitat include ducks, geese, herons, kingfishes, swallows, turtles, snakes, frogs, raccoon, muskrat and numerous non-game species.

HARDWOOD SWAMP

This habitat type has poor drainage with high water tables. Vegetation consists of red maple, ash, elm, willow, black alder, spicebush and dogwoods.

Wildlife frequenting such sites include woodcock, woodpeckers, raccoon, deer, songbirds and numerous amphibians and reptiles.

RECOMMENDATIONS

In a small but heavily developed and highly populated state like Connecticut where available habitat continues to decline on a daily basis, it is critical to maintain and enhance existing wildlife habitat. The following practices will help to improve conditions:

OPEN WATER GUIDELINES

1. Placement of four wood duck boxes on pond--two at southern end and two along northern edge adjacent to hardwood swamp. If boxes are utilized, increase number of boxes to 6-8.

2. Public awareness program to discourage feeding of geese which worsens nuisance goose problem.

3. Encourage backyard landscaping with natural concepts. Avoiding lawns and chemical applications will lessen acreages of lost habitat and additional lake weed problems.

Due to the abundance of residential development along the Lake, best wildlife management recommendations apply to backyard habitat improvements. Such activities include providing food, water, cover and breeding areas (see Appendix for flyer sheet from the National Wildlife Federation).

HARDWOOD SWAMP GUIDELINES

1. Leave buffer strips (100 feet) of natural vegetation along swamp areas to help filter and trap silt and sediments which might otherwise reach the site.

2. Development of potholes by mechanical means. This would create excellent waterfowl habitat and benefit numerous non-game species.

3. Placement of 4 wood duck boxes. If utilized, expand to 6-8 boxes.

If a timber harvest is planned within the watershed, the following guidelines should be followed to insure quality wildlife habitat:

a. Encourage mast producing species (oak, hickory, beech).

b. Leave 5 to 7 snags per acre.

c. Exceptionally tall trees are utilized by raptors for nesting and perching and should be encouraged.

d. Trees with vines (berry producers) should be encouraged.

e. Create small openings with feathered edges.

f. Construct small brush piles.

For further assistance, contact the Western District Headquarters of DEP, 485-0226.

X. FISHERIES HABITAT

RESOURCES

Secret Lake is a 25 acre body of water with a maximum depth of 15 feet and an average depth of 8 feet. The pond has a bottom consisting mostly of mud and swampy ooze. Much of the shoreline is gradually sloping with approximately 40% of the pond's area having a depth of 3 feet or less. This shallow littoral area supports luxuriant weed growth (primarily water lilly, spatterdock, watershield and pickerel weed). Secret Lake is reportedly inhabited by brown

bullhead, largemouth bass, chain pickerel, golden shinner, common sunfish, yellow perch, calico bass, and American eel (surveys conducted on 7/10/41 and 8/11/53). Additionally, it is likely that bluegill sunfish are also present. It appears that Secret Lake currently provides local residents with a warm water fishery (primarily for sunfish, largemouth bass and pickerel) which is of moderate quality.

Weed growth appears to cover roughly 50-60% of the surface area of the Lake's southern half. In the northern half of the Lake, weeds are limited to the immediate shoreline area. Weed growth becomes detrimental to the fisheries of a lake at a density where efficient predation by bass and pickerel on forage species is inhibited. When this density is reached, overcrowded and stunted populations of sunfish, bullheads and perch, and depressed growth rates in bass often result. Additionally, large numbers of stunted sunfish tend to prey heavily on bass eggs and fry, drastically reducing spawning success and the subsequent recruitment of bass into the fishery. A population made up of a few old bass, unable to produce a large successful spawn and insufficient in number to support truly good fishing, often results. Moderate weed growth, however, should be considered beneficial in that it provides escape cover for all fish species, and spawning habitat for pickerel, largemouth bass and yellow perch. Recent research has shown that the total biomass of largemouth bass, and the numbers of legal sized bass, increase with corresponding increases in the amount of macrophyte cover until vegetation covers roughly 20% of the entire lake surface. Once weed cover exceeds 20% of the total lake acreage, decreases in the capture rate of prey are likely to lead to prey species over-abundance and to a decrease in bass biomass.

A second means by which weed growth may become detrimental to the fisheries of a lake or pond is via the inducement of "winterkill" in bodies of water having marginal depth. Winterkill occurs when light penetration into the water is reduced under the cover of ice and snow. This results in conditions where life supporting oxygen is being removed from the water by bacterial decay of abundant plant matter, while it is not being added by photosynthesis. A fish kill results when oxygen concentrations drop to critical levels. A bass fishery can be severely impacted by winterkill as the larger fish present are particularly sensitive to low oxygen concentrations.

RECOMMENDATIONS

It is the opinion of the Team's fishery biologist that the excessive proliferation of aquatic vegetation throughout the southern end of Secret Lake is detrimental to the lake's warmwater fisheries. (A survey conducted in 1941 indicated below average fishing quality despite abundant small fish being present--possibly indicating that prey species were overabundant in the lake due to weed growth inhibiting effective predation.) It would benefit the lakes fisheries if some means of weed control were undertaken which would reduce the amount of vegetation in the southern end of the lake to between 20 and 30% of the surface area. It is also recommended that the vegetation be divided up rather than confined to one dense area. Doing this will provide a "patchy" environment and thus increase the amount of "edge" habitat. This will most likely increase the number of bass the pond is capable of supporting and will allow anglers access to some of the best bass cover.

The most economical means by which the weed growth in Secret Lake can be controlled is by treatment with aquatic herbicides (Granular 2,4-D Ester--a systemic herbicide--may be applied in the spring to control water lillies in specific areas of the lake). Still, it should be noted that the application of herbicides may result in a quick release of nutrients into the water as dead plant matter decays. This is usually accompanied by an increase in phosphorous levels and may result in greater plankton productivity. Additionally, in a lake or pond ecosystem macrophytes act as buffers of exogenous nutrients and may thus repress phytoplankton producitivity by limiting nutrient availability. If the biomass of plants and the corresponding foliar uptake of nutrients is reduced, runoff will proceed to enrich the water column. Phytoplankton may increase due to the greater availability of limiting nutrients. Algae blooms and trubidity may then serve to reduce both the fishing quality and aesthetic value of the pond, particularly if blue-green blooms occur. The use of copper sulfate is most often recommended for the control of algae in lakes and ponds not containing trout. Some aluminum compounds may be used to precipitate phosphorous (usually the limiting nutrient) from the water, thus limiting algae growth. However, aluminum is highly toxic to fish and is thus not recommended. The DEP has available a publication entitled "Control of Water Weeds and Algae" which provides information on the chemicals which may be used in the control of different types of nuisance vegetation, instructions for determining the proper dosage, and the procedures to follow to apply for a permit.

Alternatives to chemical treatment are more effective in the long term and often preferable from a fisheries standpoint. Unfortunately, the expense necessary to employ alternative methods is initially much greater; however, chemical treatment must be repeated yearly so the long term cost difference is not as great. Some of the advantages are (1) that chemicals foreign to the ecosystem are not being introduced to the water, and (2) the removal of harvested or killed plant material prevents the quick release of nutrients into the water as dead plant matter decays (thus preventing the often associated increase in phosphorous levels and phytoplankton productivity). Dredging the pond bottom offers the most permanent method of weed control available. A depth of 10 feet or more is best for preventing the development of nuisance vegetation as sunlight penetration is usually insufficient for the stimulation of plant growth. Additionally, dredging removes nutrients from the pond ecosystem which have built up in the sediments through years of decay.

Commercial weed harvesters may also be used to remove weeds from selected areas of the Lake. Harvesters allow the greatest control over where and when the weeds are to be removed. As previously mentioned, increasing the "patchiness" of the habitat is best from a fisheries standpoint. Plant material should be transported far enough from the pond so as to prevent the re-entry of nutrient rich leechate. Done correctly, this will prevent the quick release of nutrients into the water from decay; however, an increase in the concentration of nutrients from runoff would still occur and some increase in turbidity may result.

Some new methods of weed control are being developed. Information on the relative success and effects on fish productivity of "Dartec" (semi-permiable plastic) and "Aquashade" (photosynthesis retarding dye) have been requested by the Fisheries Bureau and may soon be available.

NOTE: The introduction of weed eating fish species is prohibited by law as the effects of such introductions on the complex biology of lakes, ponds and rivers has not yet been adequately quantified. Contrary to what has been published in much of the popular literature, there is substantial evidence that the weed eating white amur, also called grass carp (members of the minnow/carp family), does effect the food chain in lakes and ponds. Some of the negative impacts observed during scientific studies are: (1) a reduction in crayfish production, (2) an increase in the populations of some plant species due to preferential feeding on others, (3) the inducement of algal blooms due to the concurrent elimination of macrophytes and influx of nutrients via grass carp feces, (4) interference with the reproduction of game fishes requiring vegetation for spawning, (5) reduced production of fishes requiring weed beds for refuge, and (6) the creation of unbalanced ecosystems where species diversity was reduced and fish populations became unstable. These negative effects do not occur in all cases. However, we do not yet have the knowledge to predict what will happen in a specific pond or lake and, therefore, cannot allow grass cap introductions to be made. The danger that introduced fish may be caught and subsequently transported to other bodies of water must also be considered.

XI. WATER QUALITY AND RECREATION CONCERNS

WATER QUALITY

In regard to the water quality of Secret Lake, it appears from sample results over the recent past few years that the quality is adequate for bathing purposes (see Appendix E). The elevated count of 20,000 coliform per 100 ml sampled 7/21/81 resulted from a sewage pipe break during installation according to town officials. It was stated that six houses have not hooked up to sewers.

If the Lake is approximately twenty-five acres and the average depth is eight feet, the volume is approximately 65,165,760 gallons of water. Based on these figures, there are approximately 362,032 gallons of dilution water available from storage per day from natural circulation, which means the Lake can theoretically support 362 bathers from natural circulation of the Lake.

The desirable minimum figure of dilution water per bather per day is 1,000 gallons based on an average number of bathers. Peak numbers of bathers above this may be accommodated providing the peak usage does not exceed two or three days. Amount of dilution water will vary throughout the course of the season. Since most bather utilization will occur during drier times when flow is lower, using a flow rate than can be expected to be equaled or exceeded 90% of the time will be conservative viewpoint. Based on a flow through of 1.30 million gallons per day with a ninety percent duration flow, the Lake can theoretically support 1,300 bathers from flow through the Lake. Using those figures of water volume and flow through the theoretical total bather load that could be supported would be 1,662 bathers.

The beach area appeared to be approximately one hundred feet long. To provide for adequate dilution water where bathers will crowd into a small area, one thousand gallons of water within the immediate bathing area per bather per day is necessary. Since most activity in bathing areas is confined to water depths of seven feet or less, an average depth at the bathing area would be somewhere between three and four feet. At this depth, approximately fifty square feet of surface area would contain one thousand gallons of water. Most bathing activity occurs within fifty feet of shore. Thus, one running foot of beachfront per bather would be adequate in determining bather load at the beach. It is recommended that the bather load be restricted to one hundred bathers per day to prevent the possibility of bacterial deterioration and to allow for swimming activity.

Bottom contours of the bathing area should be a smooth moderate slope with sufficient shallow area. Hazardous projections or rocks should be removed. If unable to be removed, they should be prominently marked to avoid injuries. Any object one can become entangled in must also be removed.

In speaking with the President of Secret Lake Association, there are approximately two hundred-twenty lots, one hundred-ninety of them with houses on them. Ninety-six percent of all houses are occupied year round with the rest being summer cottages. Even with a conservative estimate of two and one-half persons per household, all households occupied, that totals four hundred seventy-five people. It is anticipated that once the beach is developed, it will be much more heavily utilized than at present. No parking is anticipated in the immediate beach area. Erosion is controlled to a large extent by roadside curbing and catch basins.

RECREATION

Presently it is believed that there is no bathing activity and very little picnicking. Recreation is limited to row boating, canoeing and motor boating with motors under five horsepower. After development, boat launching should be restricted to one side of the beach, preferably to the side where vehicles can back down to the water. Depending upon utilization, the possibility of overcrowding may have to be considered in the future. However, increased utilization by lake front owners on their own property will alleviate the magnitude of possible overcrowding and some may not bathe in the water but prefer picnicking, suntanning, and playing in the sand. It appeared that the depth of the beach from water's edge on the day of the review to the stone wall was approximately fifty feet.

The area has good potential for becoming a bathing area. The local director of health approves the locations of public bathing areas. It should be determined if this is a public bathing area open to a portion of the general public with the local health official conducting routine sampling or if Secret Lake bathing area is a private bathing area with sampling handled by the Association through an approved private laboratory. Although it may be private, the Association is responsible for adequate refuse control with covered rufuse barrels to prevent vermin from becoming a public health nuisance or hazard. Rubbish should be collected frequently as needed.

Public bathing areas must provide bathhouses and toilets in adequate number and be in good repair. Although many private bathing areas do not provide such facilities, it is recommended that flush or chemical toilets be provided to enhance utilization of the area and maintain water quality. Toilets should be adequately maintained and serviced regularly. A recommended minimum number of fixtures for a swimming area based on maximum load is: one toilet per seventy-five males, one toilet per fifty females, one urinal per seventy-five males, one sink per one hundred males and one sink per one hundred females. Shower ratios are one per fifty males and one per fifty females.

Swimming areas should be roped off with a lemon-line, floats and rope barrier, including an area for non-swimmers. A lemon-line should run at the five foot depth level. Depth markers are also recommended.

Although no lifeguard is required by law at the bathing area, the Association may choose to employ one for specific time periods. If a lifeguard is provided, it is recommended that a raised lifeguard chair be available. Not only does the raised chair give an unobstructed view of the swimming area, but it maintains a sense of authority and responsibility for the individual to be watching the swimming area at all times instead of chatting with the residents. If no lifeguard is on duty, there should be a warning sign placed in plain view with clear legible letters at least four inches high that states "Warning - No Lifeguard on Duty." Other beach front rules should also be listed such as "Children Not Allowed in Beach Area Without an Adult in Attendance," "No Horseplay," "No Glass on the Beach," "Do Not Swim Alone," etc.

Rescue equipment should be available. The minimum unit of rescue equipment recommended per one hundred running feet o beach is one reach pole or shepherd's crook with blunted end plus two ring buoys with a maximum inside diameter of fifteen inches that have a fifty foot, one quarter inch diameter throw line attached to each ring buoy.

It is strongly recommended that an emergency plan be adopted by the Association. This plan would include knowing where the nearest available telephone is, whether at the beach or at the fire department across the street. A first aid kit should also be available. There should be a clearly legible sign that indicates where the closet telephone is and emergency telephone numbers, at least one-quarter inch high.

XII. SUMMARY

NOTE: This is a very brief summary of the major concerns and recommendations of the Team. You are strongly urged to read the entire report, and to refer back to the specific sections in order to obtain all the information about a certain topic.

HYDROLOGY - SECTION V

1. The true physical boundary of the watershed may deviate to some extent from the boundary as mapped, therefore, any planning for these areas should allow for a reasonable buffer strip outside the mapped boundary to provide a safety margin.
2. Consideration should be given to conducting a bathymetric survey of the Lake, along with a survey of the Lake bottom deposits.
3. Other waterbodies in the watershed are hydraulically connected to Secret Lake, and pollution of these may affect Secret Lake.
4. It is important that there be strict enforcement of the Public Health Code requirements regarding septic system design and installation for new construction in the watershed.
5. There is an accumulation of sediment at the outlet from Secret Lake into Roaring Brook. Consideration should be given to constructing a sediment basin before the brook.
6. Direct outlets for stormwater drainage systems serving Secret Lake Road should be checked to see if sediment has collected in these areas. They may need sediment basins to trap sediments before they reach the Lake.

LAKE EUTROPHICATION AND MANAGEMENT - SECTION VI

1. Secret Lake is presently experiencing conditions typical of eutrophic lakes. Additional residential development which do not employ best management practices will serve to worsen these conditions.
2. It is recommended that the Secret Lake Association develop a watershed management plan as outlined in the DEP "Watershed Management Guide for Connecticut Lakes."
3. At the present time, the Lake is experiencing moderate growths of aquatic macrophytes and algae which interfere with recreation.
4. The most common methods of weed control are: weed harvesting, chemical treatments, drawdown and excavation, and hydraulic dredging.

SOILS AND RELATED CONCERNS - SECTION VII

1. In general, the watershed is not heavily developed, but as increased growth and development occur, erosion and sediment control measures and stormwater management plans should be developed and utilized.
2. Limitations for development do exist because of rockiness, steep slopes, wetness and poor filtering capacity for on-site septic systems.
3. Dredging and deepening the immediate swimming area would have the greatest beneficial effect on the existing problem of aquatic weeds.

VEGETATION - SECTION VIII

1. The great diversity of ownership in the area of the watershed limits the scope of forest management.
2. Timber harvesting could cause site specific problems with sedimentation.

WILDLIFE HABITAT - SECTION IX

1. It is recommended that certain steps be taken to maintain and enhance existing wildlife habitat.
2. Backyard habitat improvements are recommended, such as providing food, water, cover and breeding areas.
3. Specific guidelines for Open Water and Hardwood Swamps should be followed. These are found in Section IX.

FISHERIES HABITAT - SECTION X

1. Secret Lake currently provides the local residents with a warm water fishery (primarily sunfish, largemouth bass and pickerel) which is of moderate quality.
2. The excessive aquatic vegetation throughout the southern end of the Lake is detrimental to the Lake's warmwater fisheries. It would benefit the Lake's fisheries if some kind of weed control were undertaken.
3. It is also recommended that the vegetation be divided rather than confined to one dense area.

WATER QUALITY AND RECREATION - SECTION XI

1. The water quality is adequate for bathing purposes.
2. It is recommended that the bather load be restricted to one hundred bathers per day to prevent the possibility of bacterial deterioration and to allow for swimming activity.
3. The beach area has good potential for becoming a bathing area.
4. The Lake Association is responsible for refuse control and routine sampling of the water.
5. Swimming areas should be roped off, and depth markers are recommended.
6. Rescue equipment should be available, and it is strongly recommended that an emergency plan be adopted by the Association.

Appendix

SOILS IN SECRET LAKE WATERSHED

ChB	Charlton stony fine sandy loam 3-8% slopes
CrD	Charlton very stony fine sandy loam 15 - 35 percent slopes
GcB	Gloucester fine sandy loam 3-8% slopes
GcC	Gloucester fine sandy loam 8-15% slopes
GcD	Gloucester fine sandy loam 15 - 25 % slopes
GsC	Gloucester stony fine sandy loam 8-15% slopes
GvC	Gloucester and Brookfield very stony fine sandy loam 3-15% slopes
GvD	Gloucester and Brookfield very stony fine snayd loam 15-35% slopes
HkA	Hinckley gravelly sandy loam 0-3% slopes
HsC	Hollis very rocky loam 3-15% slopes
LcA	Leicester loam 0-3% slopes
MgC	Manchester gravelly sandy loam 3-15% slopes
MsA	Merrimac fine sandy loam 0-3% slopes
NaB	Narragansett silt loam 3-8% slopes
NgB	Narragansett stony silt loam 3-8% slopes
PbB	Paxton loam 3-8% slopes
PbC	Paxton loam 8-15% slopes
PbD2	Paxton loam 15 - 25% slopes, eroded
PkA	Peats and Mucks
RhE	Rocky land, Hollis materials 15 - 35% slopes
RkE	Rocky land, Holyoke materials 15 - 35% slopes
RuA	Rumney sandy loam 0-3% slopes
SeA	Scarboro loam 0-3% slopes
SvA	Sutton loam 0-3% slopes
SwB	Sutton stony loam 3-8% slopes
WmB	Wethersfield stony loam 3-8% slopes
WsA	Wilbraham stony silt loam 0-3% slopes
WxB	Woodbridge loam 3-8% slopes
WzbC	Woodbridge very stony soils 3-15% slopes

MAJOR LIMITATIONS FOR DEVELOPMENT

SOIL SYMBOLS	High Water Table			Erosion Factor (K)	Septic Tank Absorption Field	Shallow Excavations	Dwellings Without Basements	Dwellings With Basements	Small Commercial Buildings	Local Roads & Streets
	Depth	Kind	Months							
ChB	6.0			.20	SL	SL	SL	SL	SL	SL
CrD	6.0			.20	SE SLO	SE SLO	SE SLO	SE SLO	SE SLO	SE SLO
GcB	6.0			.24	SE PF	SE CB	MO STONES	MO STONES	MO STONES	MO STONES
GcC	6.0			.24	SE PF	SE CB	MO,SLO STONES	MO,SLO STONES	MO,SLO STONES	MO,SLO STONES
GcD	6.0			.24	SE SLO,PF	SE SLO,CB	SE SLO	SE SLO	SE SLO	SE SLO
GsC	6.0			.17	SE PF	SE CB	MO,SLO STONES	MO,SLO STONES	SE SLO	MO,SLO STONES
GvC	6.0			.24	SE SLO,PF	MO SLO	MO SLO	MO SLO	SE SLO	MO SLO,FA
GvD	6.0			.24	SE SLO,PF	SE SLO	SE SLO	SE SLO	SE SLO	SE SLO
HkA	6.0			.20	SE PF	SE CB	SL	SL	SL	SL
HSC	6.0			.17	SE DB	SE DB	SE DB	SE DB	SE DB	SE DB

(1) Apparent Water Table
(2) Perched Water Table

Erosion Factor

0.49 ↓ 0.17 — More erosive ↓ Less erosive

Degree of Limitations

SL - Slight Limitations: Soil properties and site features are generally favorable for indicated use and limitations are minor and easily overcome.

MO - Moderate Limations: Soil properties and site features are not favorable for indicated use and special planning, design or maintenance is needed to overcome or minimize the limitations.

SE - Severe Limitations: Soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs and possibly increased maintenance are required.

Types of Limitations

(SEP) Seepage (W) Wetness (PF) Poor Filter (PO) Ponding (CB) Cut bank-caving
(LS) Low Strength (FA) Frost Action (SLO) Slope (FL) Flooding (DB) Depth to Bedrock
(PS) Percs Slowly (DS) Dense Layer

MAJOR LIMITATIONS FOR DEVELOPMENT

SOIL SYMBOLS	High Water Table			Erosion Factor (K)	Septic Tank Absorption Field	Shallow Excavations	Dwellings Without Basements	Dwellings With Basements	Small Commercial Buildings	Local Roads & Streets
	Depth	Kind	Months							
LcA	*0-1.5*	*1*	*NOV.-MAY*	*.28*	*SE W*	*SE W*	*SE W*	*SE W*	*SE W*	*SE W,FA*
MgC	*6.0*			*.17*	*SE PF*	*SE CB*	*MO SLO*	*MO,SLO STONES*	*SE SLO*	*MO SLO*
MsA	*6.0*			*.24*	*SE PF*	*SE CB*	*SL*	*SL*	*SL*	*SL*
NaB	*6.0*			*.43*	*MO PF*	*SE CB*	*SL*	*SL*	*SL*	*MO FA*
NgB	*6.0*			*.43*	*MO PF*	*SE CB*	*SL*	*SL*	*MO SLO*	*MO FA*
PbB	*1.5-2.5*	*2*	*FEB.-APR.*	*.24*	*SE PS*	*MO DS,W*	*MO W*	*MO W*	*MO W*	*MP S,FA*
PbC	*1.5-2.5*	*2*	*FEB.-APR.*	*.24*	*SE PS*	*MO,DS W,SLO*	*MO W,SLO*	*MO W,SLO*	*MO W,SLO*	*MO,W FA,SLO*
PbD2	*1.5-2.5*	*2*	*FEB.-APR.*	*.24*	*SE PS,SLO*	*SE W*	*SE W*	*SE W*	*SE W*	*SE W*
PkA	*.5-1.0*	*1*	*SEPT.-JUNE*	*--*	*SE PD,PS*	*SE PD,LS*	*SE PD,LS*	*SE PD,LS*	*SE PD,LS*	*SE PD,FA*
RhE	*6.0*			*.17*	*SE DB*	*SE DB,DLO*	*SE DB,SLO*	*SE DB,SLO*	*SE DB,SLO*	*SE DB,SLO*

(1) Apparent Water Table
(2) Perched Water Table

Erosion Factor
0.49 More erosive ↓
↓ 0.17 Less erosive

Degree of Limitations

SL - Slight Limitations: Soil properties and site features are generally favorable for indicated use and limitations are minor and easily overcome.

MO - Moderate Limations: Soil properties and site features are not favorable for indicated use and special planning, design or maintenance is needed to overcome or minimize the limitations.

SE - Severe Limitations: Soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs and possibly increased maintenance are required.

Types of Limitations

(SEP) Seepage (W) Wetness (PF) Poor Filter (PO) Ponding (CB) Cut bank-caving
(LS) Low Strength (FA) Frost Action (SLO) Slope (FL) Flooding (DB) Depth to Bedrock
(PS) Percs Slowly (DS) Dense Layer

MAJOR LIMITATIONS FOR DEVELOPMENT

SOIL SYMBOLS	High Water Table			Erosion Factor (K)	Septic Tank Absorption Field	Shallow Excavations	Dwellings Without Basements	Dwellings With Basements	Small Commercial Buildings	Local Roads & Streets
	Depth	Kind	Months							
RkE	*6.0*			*.20*	*SE DB*	*SE DB*	*SE DB*	*SE DB*	*SE DB*	*SE DB*
RuA	*0-1.5*	*1*	*SEPT.-JUNE*	*.20*	*SE FL,W,PF*	*SE CB,W*	*SE FL,W*	*SE FL,W*	*SE FL,W*	*SE FL,W,FA*
SeA	*+1-1.0*	*1*	*JAN.-DEC.*	*.17*	*SE PD,PF*	*SE CB,HUMUS,PD*	*SE PD*	*SE PD*	*SE PD*	*SE PD,FA*
SvA	*1.5-2.5*	*1*	*NOV.-APR.*	*.24*	*SE W*	*SE W*	*MO W*	*SE W*	*MO W*	*SE FA*
SwB	*1.5-2.5*	*1*	*NOV.-APR.*	*.20*	*SE W*	*SE W*	*MO W*	*SE W*	*MO W,SLO*	*SE FA*
WmB	*1.5-2.5*	*2*	*FEB.-APR.*	*.20*	*SE PS*	*MO DS,W*	*MO W*	*MO W*	*MO W,SLO*	*MO W,SLO,FA*
WsA	*0-1.5*	*2*	*NOV.-APR.*	*.20*	*SE W,PS*	*SE W*	*SE W*	*SE W*	*SE W*	*SE W,FA*
WxB	*1.5-2.5*	*2*	*NOV.-MAY*	*.24*	*SE W,PS*	*SE W*	*MO W*	*SE W*	*MO W,SLO*	*SE FA*
WzbC	*1.5-2.5*	*2*	*NOV.-MAY*	*.20*	*SE W,PS*	*SE W*	*MO W*	*SE W*	*MO W,SLO*	*SE FA*

(1) Apparent Water Table
(2) Perched Water Table

Erosion Factor
0.49 More erosive ↓
↓ Less erosive
0.17

Degree of Limitations

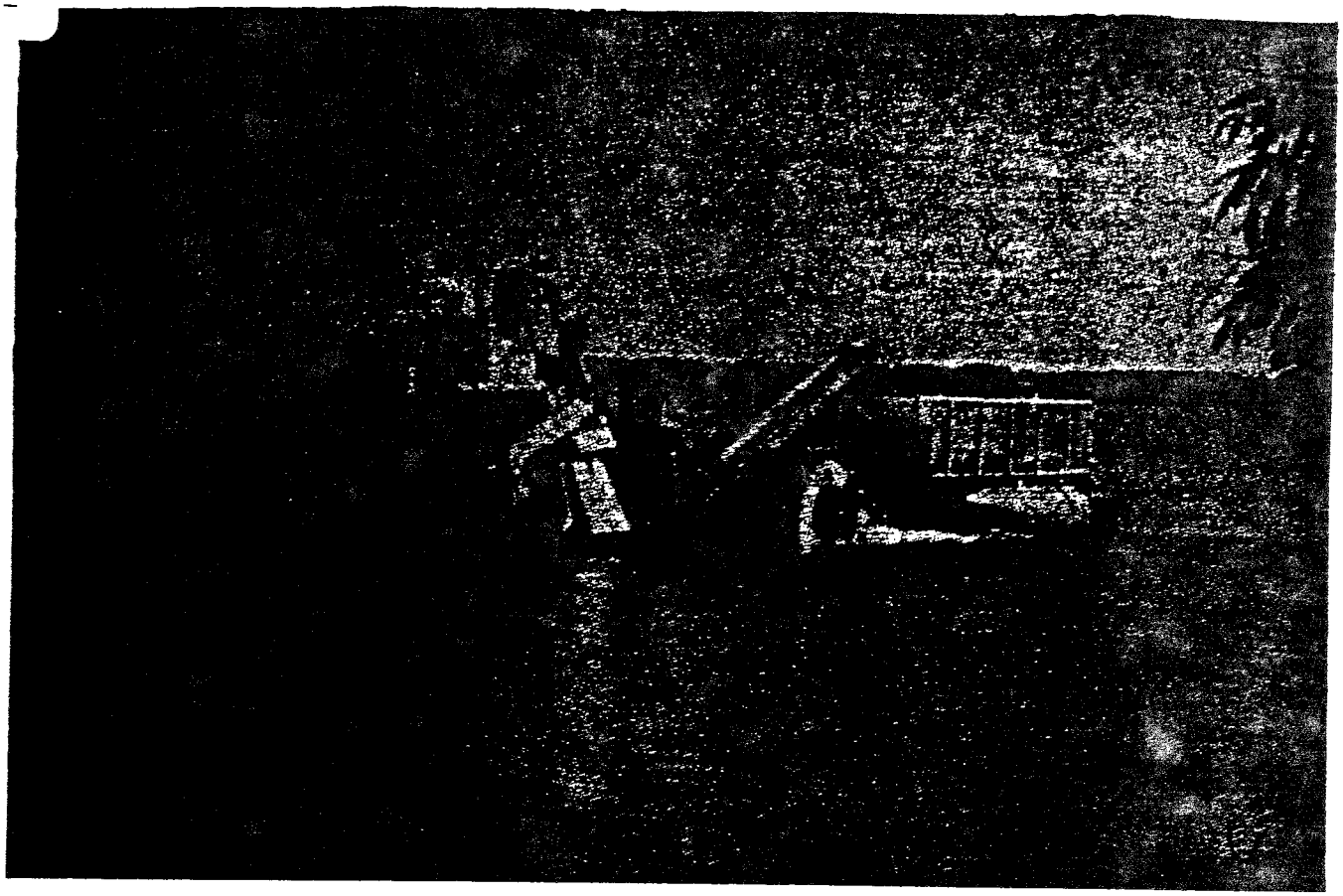
SL - Slight Limitations: Soil properties and site features are generally favorable for indicated use and limitations are minor and easily overcome.

MO - Moderate Limations: Soil properties and site features are not favorable for indicated use and special planning, design or maintenance is needed to overcome or minimize the limitations.

SE - Severe Limitations: Soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs and possibly increased maintenance are required.

Types of Limitations

(SEP) Seepage (W) Wetness (PF) Poor Filter (PO) Ponding (CB) Cut bank-caving
(LS) Low Strength (FA) Frost Action (SLO) Slope (FL) Flooding (DB) Depth to Bedrock
(PS) Percs Slowly (DS) Dense Layer



Mechanical Control of Aquatic Weeds

A Guide for Lakeshore Owners, Lake Associations, Municipalities and Individual Pond Owners

PREPARED BY:
USDA Soil Conservation Service
New York State Department of Environmental Conservation
New York State College of Agriculture and Life Sciences

PUBLISHED BY:
New York State Department of Environmental Conservation

WM-P52 (12/83)

Acknowledgments

This booklet was prepared and published by the USDA Soil Conservation Service, Syracuse, New York, the New York State Department of Environmental Conservation, Albany, New York, and the Agronomy Department, College of Agriculture and Life Sciences at Cornell University, Ithaca, New York.

It was written by Robert E. Myers, Wildlife Biologist, Soil Conservation Service, Syracuse, New York, with assistance from:

Gerald F. Mikol, Research Scientist II, Department of Environmental Conservation, Bureau of Water Research, Albany, New York.

Dr. John H. Peverly, Associate Professor of Eutrophication, Department of Agronomy, New York State College of Agriculture and Life Sciences, Cornell University, Ithaca, New York.

Michael W. Duttweiler, Program Coordinator, Sea Grant Extension Program, Cornell University, Ithaca, New York.

Dr. Gary L. Miller, Professor of Biology and Environmental Studies, Eisenhower College, Seneca Falls, New York.

Special thanks to Jake Warnken and Kay Day, Department of Environmental Conservation, Bureau of Publications, for the layout and typesetting of this publication.

May 1983

Table of Contents

Introduction

Lakes, ponds, and reservoirs are dynamic bodies of water, full of living plants and animals. Fish and aquatic plants are the most visible biological elements.

Aquatic plants are a vital part of the biological community of a lake, pond or reservoir. When aquatic plants grow where they are not wanted, or interfere with planned recreational uses, they become weeds.

The purpose of this publication is to explain the value of aquatic plants and describe mechanical control techniques. The control techniques can be used in swimming areas, around docks, boat moorings and other intensely used areas, and to provide access lanes to deeper weed-free waters.

Too many aquatic plants = WEEDS

Understanding Your Lake and Reasons for Weed Problems

Every lake, reservoir, and pond has a natural life cycle which starts when it is created and ends only when it ultimately fills in and becomes dry land. Nutrients in the water and bottom soil stimulate the growth of plants in the water body. In turn, plant-eating animals make use of the plants.

Over many years, lakes and ponds gradually fill in as organic matter and sediment accumulate. Organic matter comes from the partial decomposition of aquatic plants and leaves and other debris from terrestrial plants. Sediment is the result of soil erosion in the watershed and along the shore. This aging process is called "eutrophication." Activities that accelerate this process are termed "cultural" eutrophication.

Some lakes age faster than others because of more aquatic plant growth. Factors accounting for dense aquatic plant growth and rapid aging are shallow depth, gently sloping shoreline, good rooting material, warm water, clear water, and high fertility. A lack of wave or current action also contributes to plant growth. Aquatic plant growth is usually inhibited in soft water with low fertility, deep water, steep shorelines, unstable bottoms, cold water, and colored muddy water where light penetration is inhibited.

Not all areas of a lake will age at the same rate. Coves, the windward side of lakes, inlets, and outlet areas normally age faster. These areas receive the heaviest amount of organic matter and sediment deposition. Leaves, broken pieces of weeds and suspended sediment are blown or are deposited in these areas creating suitable conditions for aquatic plant growth. This in turn accelerates the aging process. Some areas of a lake may remain weed-free for years because of a rocky bottom or relatively sterile bottom soil conditions.

Types of Aquatic Plants

Several types of aquatic plants occur in New York waters. Three types of algae occur: microscopic, filamentous, and "rooted" algae. There are three general types of flowering vascular plants that are found in most waters: submergents, emergents and floating plants. The value of and control techniques for plants of the different groups vary and will be described later.

Algae

Microscopic algae occurs in suspension in all natural waters. Depending on its density, the water may appear almost clear or have a slight greenish tint. On occasion, it may look like "pea soup," in response to higher temperatures and nutrient content. Microscopic algae is beneficial in ponds, as will be discussed later, and is only a problem when it looks like "pea soup." There are no mechanical control techniques for microscopic algae.

Filamentous algae is generally thread or hair-like. It occurs as floating mats, often called "pond scum," or may be attached to rocks, plants, and other objects.

"Rooted" algae—*Chara*, often called muskgrass, and *Nitella*, stonewort, grow attached to the bottom like other submerged flowering plants but have no true roots. These plants have a main stem with whorled leaf-like branches. *Chara* commonly occurs in hard water and is often encrusted with lime. *Nitella* species commonly occur in soft-water.

Flowering Vascular Plants

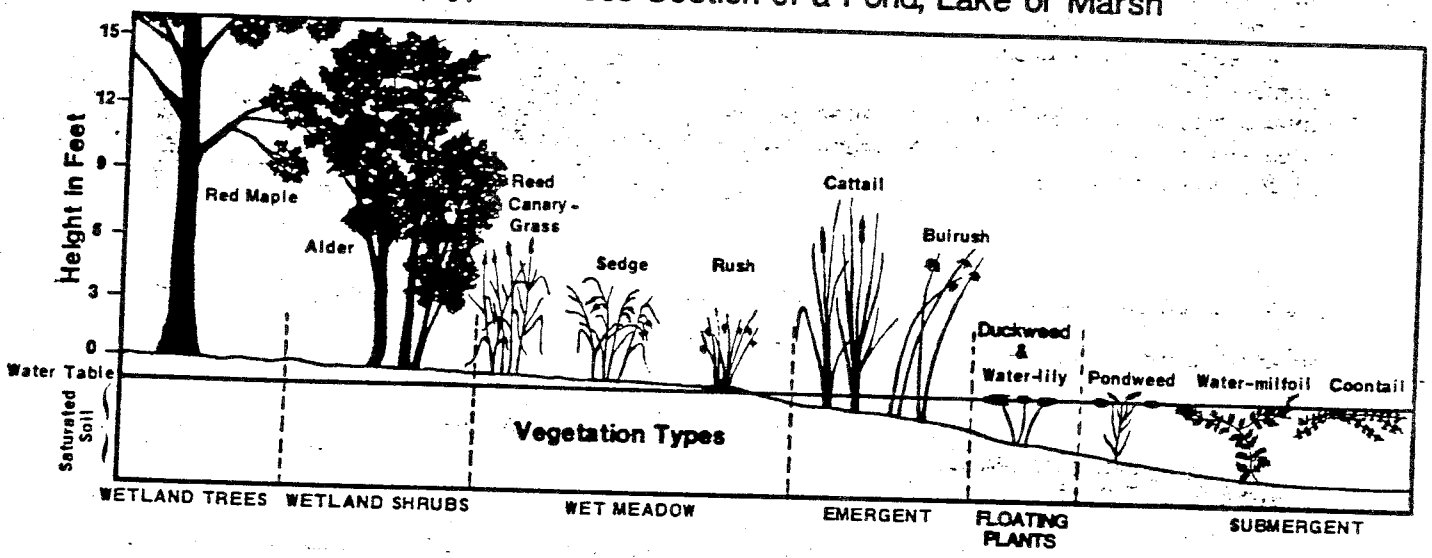
Submergents grow in both shallow and deep waters generally to depths of 15 feet. Except during flowering they grow entirely underwater. Examples of these are *Elodea*, pondweeds, milfoil, and coontail.

Emergents grow in shallow water of marshes and swamps, and along the shore of lakes and ponds, rooted to the bottom with stems and leaves extending above the water. They generally do not grow in water over two feet deep. Examples include cattails, rushes, reeds, arrowheads, and sedges.

Floating plants include the free floating duckweeds, and the waterlilies, watershield, water chestnut, and spatterdock that have floating leaves attached to the bottom by long stems. The duckweeds are 1/8 to 1/2 inch in size, are lobed, and have short roots hanging from the leaves. These plants may drift or be blown from one area to another. In very shallow water spatterdock appears like an emergent.

Figure 1 shows the general proximity of aquatic plants as they occur in a "Typical Cross Section of a Pond, Lake or Marsh."

Figure 1 Typical Cross Section of a Pond, Lake or Marsh



Value of Aquatic Plants

Aquatic plants are commonly referred to as weeds when they grow where they are not wanted, or are in excessive amounts that impair recreational use. With information about the value of aquatic plants, those once considered weeds may be looked upon as valuable plants to be managed instead of eliminated.

Plants have positive value to man and the environment. All green plants produce oxygen in the presence of sunlight. The oxygen is in turn used by other living organisms of the aquatic community including fish and by the plants themselves for respiration.

Microscopic algae and microscopic animals are collectively called plankton and are the base of the aquatic food chain (Figure 2). They give water its greenish color. The microscopic plants, called phytoplankton (algae), utilize nutrients from the water and energy from the sun for growth. Plankton provides food for aquatic insects which in turn are eaten by forage fish. Predatory fish eat the forage fish. Wildlife and man are the consumers at the top end of the food chain utilizing both predatory and forage fish.

Some species of fish and amphibians deposit their eggs on submerged vegetation including the underwater parts of emergent plants.

The stems and leaves of submerged plants harbor aquatic insects, crustaceans and snails which are food for fish. These same plants also provide hiding places that help protect the smaller fish from the larger predatory fish.

Ducks feed on floating duckweed and watermeal; on the seeds, tubers, winter buds, and finer leaves of the submerged aquatics; and on aquatic insects that live in association with the aquatic vegetation.

Emergent plants growing along the shore help break the force of waves and reduce shoreline erosion. They also help trap sediment.

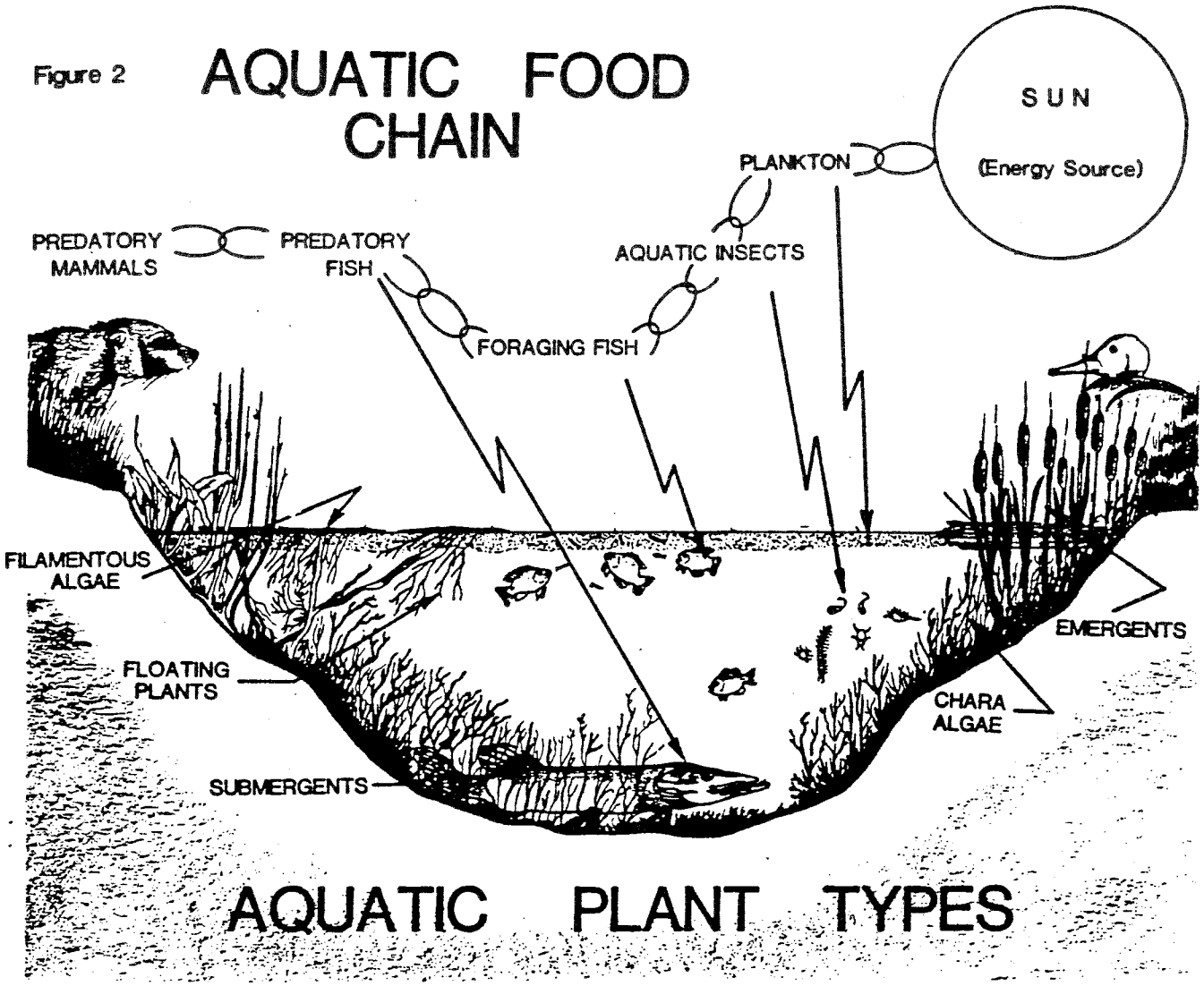
Ducks, geese, muskrats, and beavers use emergent plants for food and material to build their nests and homes. Many species of songbirds, marsh birds, frogs, and other animals nest, and seek food and cover in emergents.

On the negative side, submerged and floating leaved plants hinder swimmers, foul motorboat propellers, snag fishing lines, and are often unsightly. Emergents too, are often unsightly, hinder access to the water and provide quiet water in which mosquitos can hatch and develop. Filamentous algae and floating duckweed are unsightly and degrade swimming areas. Several species of algae give water a disagreeable taste and odor and make it unfit to drink without special treatment.

Microscopic algae "blooms," which turn the water to a "pea soup" appearance, are a result of excessive nutrients in the water.

During long periods of cloudy weather during the sum-

Figure 2



mer, or under ice with a deep snow covering, plants consume more oxygen than they produce because of a lack of sunlight. This reduces the amount of oxygen in the water and fish kills may occur either during the summer or winter. The decay of excessive vegetation may cause a foul odor in the summer.

There needs to be a balance between the amount of open water and aquatic plants. The proportions depend on the intended use of the lake or pond.

Table 1 summarizes some positive environmental values provided by groups of aquatic plants, and some typical problems associated with them.

Factors Which Accelerate Weed Problems

Aquatic plants need water, sunlight, and nutrients, and rooted plants additionally need suitable bottom material for growth. Of the nutrients, phosphorus has the greatest influence on eutrophication. It is considered a limiting factor. Forest runoff and atmospheric nutrient fallout, which are natural processes, account for about 21 percent of the dissolved phosphorus from an average watershed in central New York. Human activities are responsible for 75 to 85 percent of the dissolved phosphorus reaching lakes and ponds.

Sewage from both septic tanks and municipal sources is the largest contributor of phosphorus with 55 percent; agricultural runoff is second with 18 percent; followed by residential runoff with 6 percent. Human activities, therefore, have the greatest effect on accelerating eutrophication (cultural eutrophication, Figure 3).

Because nutrients are tied to soil and organic matter, churning of mucky bottom sediments in shallow areas by motorboats permits more nutrients to be released.

Most aquatic plants reproduce by means of seeds, root stocks and plant fragments. Submerged plants broken off by motorboats, water skiers, anglers, etc., may start new plants. Therefore, control of floating segments is very important, particularly during harvesting, cutting, raking, and other control techniques where plants may be fragmented.

TABLE 1. Aquatic Plants—Their Value and Some Typical Problems

Plant Groups	Value	Problems
Algae		
1. Phytoplankton—microscopic plants	Primary producers of the aquatic food chain; food for zooplankton which is critical to survival of fry stages of many fish; food for some species of fish and mollusks.	Creates "blooms," making the water become soupy green, brown or reddish-brown depending on the type of algae; creates problems for fish and swimmers. May cause off-flavor of drinking water.
2. Filamentous—floating or clinging thread or hairlike plants: (ex.—*Spirogyra sp.)*	Harbors aquatic insects which are important fish foods.	Free floating and those clinging to rocks and plants are unsightly, foul docks, piling and boat surfaces; messy for swimmers and slippery underfoot. May have foul odor.
3. "Rooted" Species—attached to the bottom with no true roots; low growing, not generally over 2' tall: (ex.—*Chara* and *Nitella)*	Harbors aquatic insects, provides cover for small fish; solid stands keep other taller aquatic plants from invading; is a waterfowl food.	Strong smelling odor when crushed; frees fine black organic matter when detached.
Flowering Vascular Plants		
4. Emergents—attached to the bottom with leaves extending above water. (ex.—cattails, burreed, rushes)	Protects shoreline from erosion; is muskrat and waterfowl food; provides cover for nesting songbirds; vegetation is spawning area for some amphibians and fish.	Makes access to water more difficult; blocks view of water; usually restricted to water less than 2 feet deep; creates still water for mosquitoes.
5. Submerged—attached to bottom, entire plant underwater. (ex. milfoil, pondweeds, *Elodea).*	Harbors aquatic insects; provides hiding and nursery place for fish; vegetation is spawning area for amphibians and fish; provides some food for waterfowl.	Interferes with swimming and fishing; fouls motorboat propellers; commonly don't exceed 20 feet in depth, but can be found in about 30 feet of water. (See Table 2, page 6.) Fouls domestic and municipal water intakes.
6. Floating—free floating on water surface (ex. duckweed); submerged plants with large floating leaves like water lilies are often included.	Harbors aquatic insects; duckweed is food for waterfowl.	Interferes with swimming, water skiing, and fishing; unsightly; floats from area to area.

Rooted living aquatic plants absorb nutrients primarily from sediments. When these plants die, the nutrients are released back into the water or bottom sediments, and may stimulate new growth.

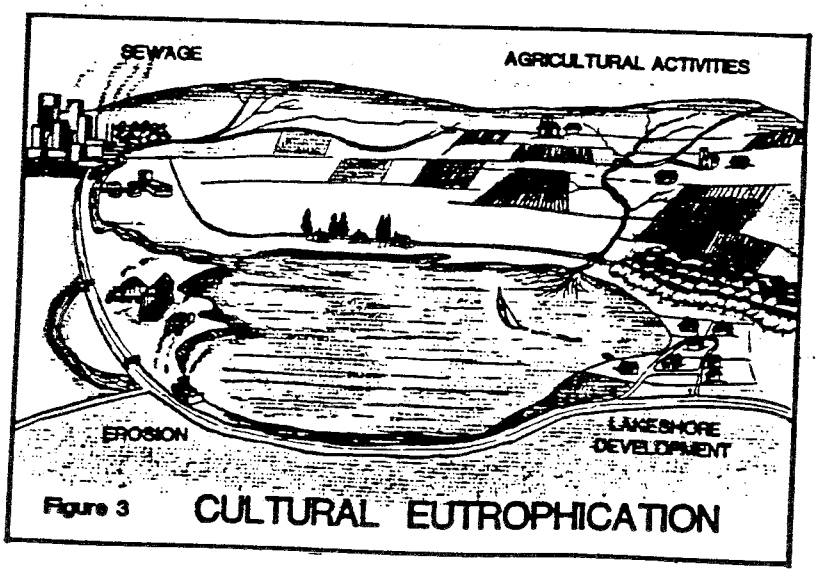


Figure 3 CULTURAL EUTROPHICATION

Reducing Cultural Eutrophication

An effective weed control program on a lake with multiple landowners requires the cooperation of all surrounding property owners and those in the lake's watershed.

In many cases, a lake association, or a lake management district[1], should coordinate and help guide lake management activities. If there is no lake association or district, consideration should be given to forming one. Town and county governments, Department of Environmental Conservation (DEC), Cooperative Extension personnel, and New York State Department of Health personnel may be able to provide assistance.

The North American Lake Management Society, (NALMS), is an international non-profit organization of scientists, students, and lay persons from government, academia, industry and the public who share

[1]In 1981, the New York State Legislature amended the county law to provide for creation of special lake management districts. While no appropriations are associated with the bill, it allows an established district to collect funds for lake management purposes, including restoration.

common interests in lake management. Members are provided technical as well as administrative information through newsletters and annual meetings. For information contact: NALMS, P. O. Box 217, Merrifield, VA 22116.

Since sewage is the greatest contributor of phosphorus, all lakeshore homes and business septic systems should be functioning properly. A sanitary survey should be conducted under the guidance of the county or district health department to determine those that are malfunctioning or overloaded and contributing to lake pollution.

A dye test can be performed to determine if a septic system is functioning properly. This is accomplished by flushing dye into a system. The dye will appear in the lake if the system is not working properly.

To insure that all systems around a lake are dye tested, it has been found to be most efficient for one person, or a team, to do the testing, rather than to rely on property owners to test their own system.

Some properly functioning septic systems with leach beds or filter fields that are located near the water may still contribute some nutrients to the water as effluent percolates through the soil.

A sewage treatment plant for all cottages with the discharge downstream of the lake is an alternative where large numbers of systems are malfunctioning and cannot be corrected because of site conditions. Such a treatment plant may need special treatment to reduce nutrient discharge. This would be particularly important where lakes and ponds are in series.

Nutrients may be entering lakes, reservoirs, etc., from the general watershed area, from the natural decay process, agricultural sources, or point sources such as industry. Efforts should be made to identify and control these sources of nutrients. As an example, the use of lawn fertilizer around the body of water should be minimal.

The presence of deciduous trees close to the water's edge can add substantial amounts of organic matter and nutrients to a lake or pond through the deposition and decomposition of their leaves. Planting of deciduous trees close to the water should be discouraged. Coniferous trees are not as detrimental as needle loss is very gradual and needle decomposition does not yield large quantities of nutrients or organic material.

Planning Aquatic Weed Control

The first step toward control of aquatic weeds is to identify them correctly. Successful control very often is species specific. A sketch map, showing location, species, extent, and relative density, may be helpful.

Next, evaluate their value in relation to your objectives and the overall lake or pond community and its conditions. Property owners' weed control practices should conform with the overall lake management plan of a lake association.

After determining which plants are truly problem weeds and need to be "managed," select the most appropriate control techniques and the extent of control suited for your resources. Plant location, type and density will also enter into the decision on the appropriate control techniques.

If help is needed, contact the appropriate resource agency listed on page 10, under "Agencies to Contact for Assistance."

Once a weed problem is under control, diligent treatment of regrowth is necessary to maintain control.

Aquatic Weed Control Techniques

There are three general types of aquatic weed control techniques: chemical, biological, and mechanical. Of these, mechanical control techniques are currently the most environmentally acceptable and are generally quite practical in the northeast.

Chemical Control Techniques

Chemicals are relatively easy to apply, but are expensive and have many drawbacks.

A PERMIT FROM THE DEPARTMENT OF ENVIRONMENTAL CONSERVATION IS REQUIRED TO APPLY ANY HERBICIDE INTO OR ON ANY LAKE, POND, OR RESERVOIR HAVING A REGULARLY FLOWING OUTLET, AND THE APPLICATOR MUST BE CERTIFIED BY THE DEPARTMENT OF ENVIRONMENTAL CONSERVATION (New York State Conservation Law).

Local, county, or district health departments should be consulted as they may have additional restrictions on the use of aquatic herbicides.

There may be a restricted use period after each application and chemicals may adversely affect aquatic organisms.

Decaying weeds release their locked up nutrients back into the water or to bottom sediments to stimulate other plants to grow. Algae blooms are often stimulated by the released nutrients. There is no guarantee that chemicals will work under all conditions. Some chemicals kill, and some only "knock down" or reduce weed growth for the season. However, generally there is no long lasting effect or carry over to the next season. Seeds not affected by herbicides will germinate and roots not killed will sprout.

In small volume lakes and ponds, decomposition of dead plants may consume sufficient dissolved oxygen from the water to cause fish kills.

The use of chemicals can change the species of weeds which are dominant with other less desirable plants often becoming dominant.

Biological control through the use of exotic plant-eating fish such as the white amur or grass carp is not a recommended technique. The possession or release of white amur, or their hybrids into New York waters is currently illegal, as per New York State Environmental Conservation Law. In addition to aquatic plants, grass carp also eat aquatic insects and other invertebrates, and can be detrimental to other fish and water quality.

Domestic waterfowl feed on certain aquatic plants, but the fertility added to the water from their fecal material helps to create algae blooms and stimulate the growth of rooted aquatic vegetation.

Fertilizing water to enhance a plankton population, and thus increase shading of rooting aquatics, is not recommended in New York as the fertilizer generally stimulates the rooted aquatic plants rather than reducing them in the long run.

Because of unpredictable and unacceptable results, biological controls are not recommended.

Mechanical control techniques can be used immediately, in most protected waters, in localized areas and with no technical supervision. There are no restrictions on the use of the water following treatment. These techniques produce the most immediate effects and environmentally, the most acceptable.

On the other hand, they are time consuming, energy intensive, and may pose a problem of weed disposal.

The removal of the weeds with their nutrient load helps to a minor extent reduce the nutrient content of the water. The weeds which are high in nitrogen and phosphorus make excellent garden mulch. Some have also been successfully fed to sheep, goats, and pigs.

Harvesting is also not a one-time operation but must be done several times in a season to remove new root and stem sprouts and missed plants. Seeds do remain in the soil to germinate later. Over several years of consistent harvesting of the same areas, the harvesting schedule may be reduced to a maintenance program. Remember, removal of plant fragments is advised due to the ability of plant segments to develop new shoots and roots, especially milfoil, *Naiads*, fanwort and waterweed *(Elodea)*.

TABLE 2—Aquatic "Weeds"—Type—Species—Typical Water Depth and Mechanical Control Techniques

Plant Groups	Typical Water Depth Feet	Mechanical Control Techniques								
		Skimming	Pulling	Raking	Dragging	Cutting	Shading	Smothering	Winter Drawdown	Deepening
Algae										
Microscopic	Throughout Water	None Practical								
Filamentous	0-3		X							
Chara (Muskgrass) & *Nitella* (Stonewort)	.5-4			X	X			X		
Flowering Vascular Plants										
Floating										
Duckweed	Surface	X					X			
Waterchestnut	1-15		X			X	X			
Waterlilies	1.6-6.6*		X				X	X		
Emergents										
Arrowhead	0-1		X			X	X	X		X
Bulrush	0-1		X			X	X	X		X
Burreed	0-1		X			X	X	X		X
Cattail	0-2		X			X	X	X		X
Rice-cutgrass	0-.5		X				X	X		X
Rushes	0-.5		X				X	X		X
Sedges	0-.5		X				X	X		X
Smartweed	0-.5		X				X	X		X
Spike rushes	0-.5		X				X	X		X
Water Plantain	0-.5		X				X	X		X
Submergents										
Bladderwort	.7-6.6*			X	X		X	X		
Coontail	2-32*		X				X	X	X	
Elodea	.7-18*		X			X	X	X		
Naiads	1.6-32*		X	X			X	X		
Pondweeds (*Potamogeton sp.*)	1-20*		X				X	X	X**	
Water Milfoil	1-20*		X				X	X	X	
Waterweed (see *Elodea*)										
Wild Celery	1-15*		X				X	X		

*From: *Ecological Inventory of Aquatic Vegetation in the Major Lakes of Cayuga County, New York and Recommendations for their Management*, Gary L. Miller. September 1, 1978.

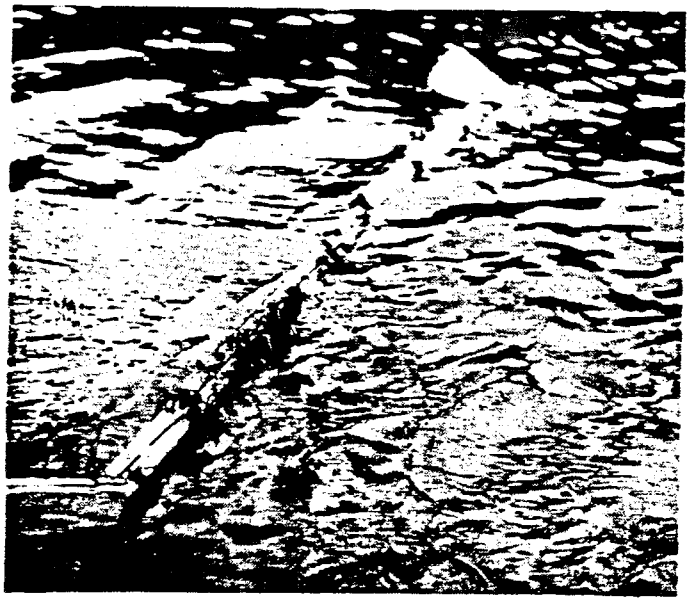
**_Potamogeton robbinsii_ and _amplifolius_ species only.

Mechanical Weed Control

Mechanical weed control techniques are described below, along with information on the type of weeds that are controllable. Table 2 is a summary of this information and includes typical water depth in which the plants may grow. Hand techniques are most effective for small scale operations and when plants first appear before dense beds become established.

A. SKIMMING—Duckweed, floating algae and plant fragments can be removed by skimming. A seine, dip net or a floating boom is effective.

A floating boom can be made of short pieces of wood fastened together with rope or screw eyes. Nails driven into the bottom of the boards, approximately one inch apart, or 3 to 4 inches of hardware cloth fastened to the boards is needed to catch and hold plant fragments. The boom can be drawn in a circle by boat or a swimmer to draw duckweed, floating algae mats, etc., to shore where they can be raked or dipped out. The boom can also be anchored downwind to catch fragments from other mechanical control operations.



Anchored floating boom catches aquatic plant fragments.

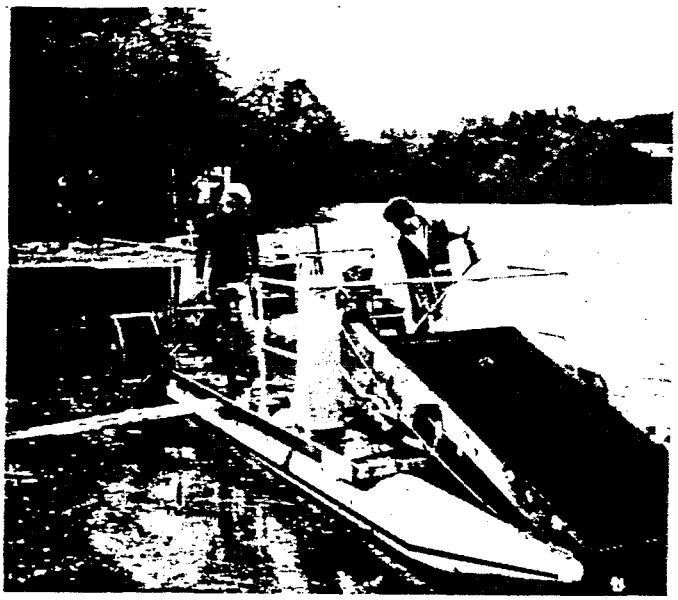
B. HAND PULLING—Emergent plants such as cattails, rushes, sedges, water chestnut, etc., are effectively controlled by hand pulling. Always start at the deep water side of the weed patch so as to remove the rhizomes that are starting to sprout and spread. The operation is much like pulling up a rug. Rhizome fragments left in the bottom may sprout, thus requiring more than one operation.

C. RAKING—The use of a long handled steel garden rake is effective to remove submerged plants in water less than 5 or 6 feet deep. This removes roots as well. Be sure to skim up all plant fragments. An extension can be attached to the handle for use in deeper water.

D. DRAGGING—In water deeper than 5 or 6 feet, it will be necessary to use a drag of some type. Many individuals have fabricated their own drags which are lowered into the water from a boat or rolled into the water and then pulled onto shore by ropes or chains.

Barbed wire, angle iron or chains with bolts 2 to 4 inches extending through them pulled by manpower or one or two vehicles have been used. Some devices may cut off the plants near the bottom and not get all of the roots which will regrow. Try to get as many roots as possible. Don't bite off too much at a time as it will be hard to pull. A lot of plant fragments will surface. Be sure to skim all plant fragments.

E. HARVESTING—Power weed cutters or harvesters (Figure 4) can be employed to cut submerged weeds to a depth of 5 to 8 feet. Most of these machines cut the weeds and gather them from the water by a conveyor. Cutting machines that do not gather, or "harvest" the weeds from the water, are not recommended as cut plants floating on the surface are problems for recreationists. Also, weed problems may be transmitted to other areas of a lake.

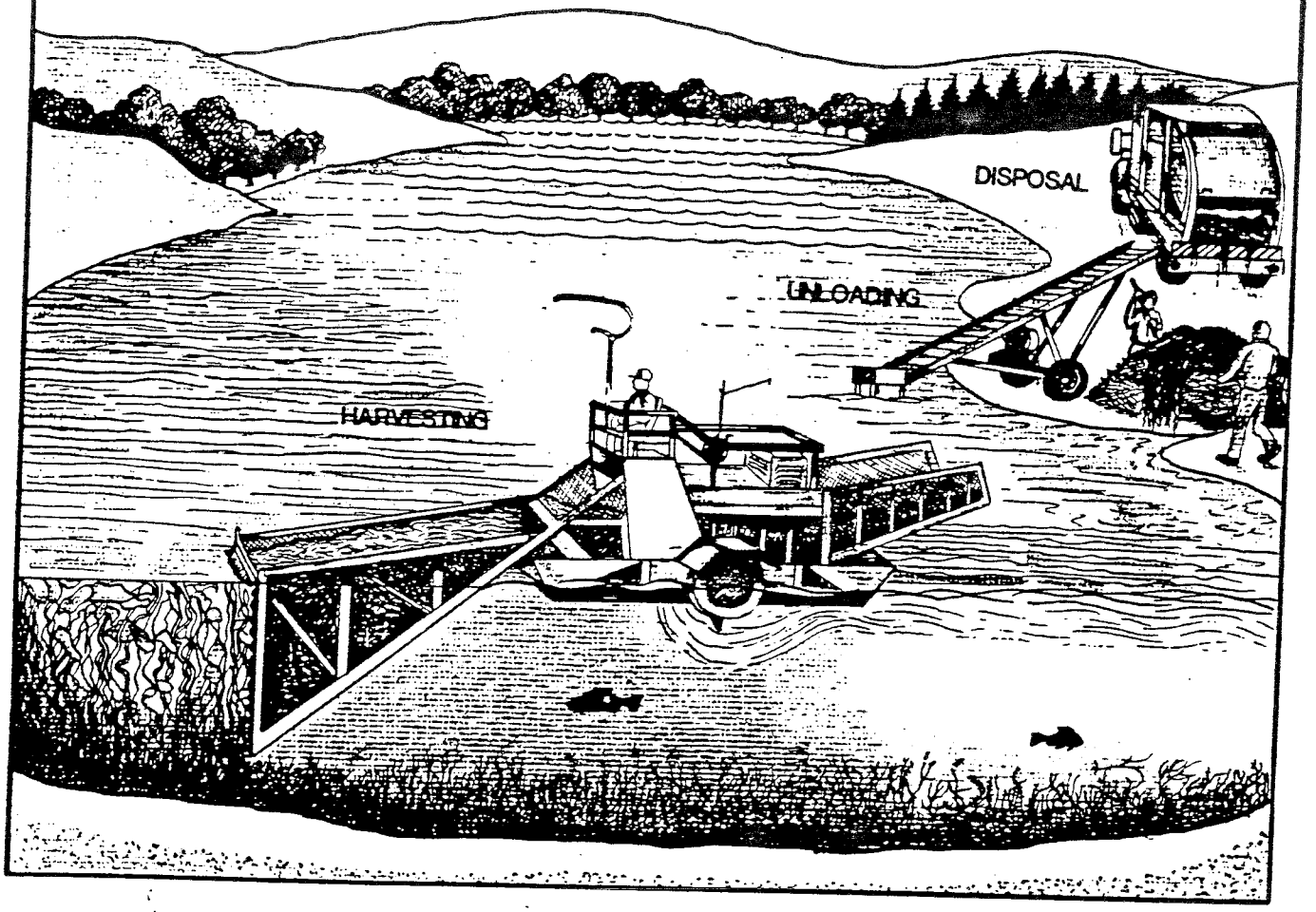


Conveyor transports cut plants to the deck of the harvester which carries the plants to an unloading site.

Regardless of the harvester, skimming is recommended to gather any plant fragments that may drop from the harvester.

Harvesting equipment is expensive and the results are temporary, sometimes requiring frequent cutting to maintain control. Generally, two harvests in the same area during the summer are recommended for most weed species. The first cutting should preferably be about mid-June, with the second cutting in mid-July. This does not imply that cutting at other times is not effective. Cutting from May 1 to the end of November can be effective.

Figure 4 AQUATIC WEED HARVESTING



If harvesting is not thorough in an area, weed growth can actually be stimulated rather than retarded. Frequent cutting can also promote bushy growth of less valuable weed species such as water milfoil.

Harvesting machines need room in which to maneuver to be most efficient. The harvester must be emptied of cut weeds frequently. The disposal of the large volume of weeds can be a problem. Depending on the density of the weeds, size of machine, and travel distance to a dumping site on shore, machines can harvest, on the average, about 1-1/2 to 2 acres per day.

F. CUTTING—Emergent plants, like cattails, can be controlled by repeated cutting. This can be done by hand or with a tractor and cutter bar. Repeated elimination of the food producing leaves in early summer, while a plant is actively growing, gradually starves the root system and the plant will eventually die over a period of years. Results are most effective when emergents are cut off under water as the direct air supply network to the roots is severed.

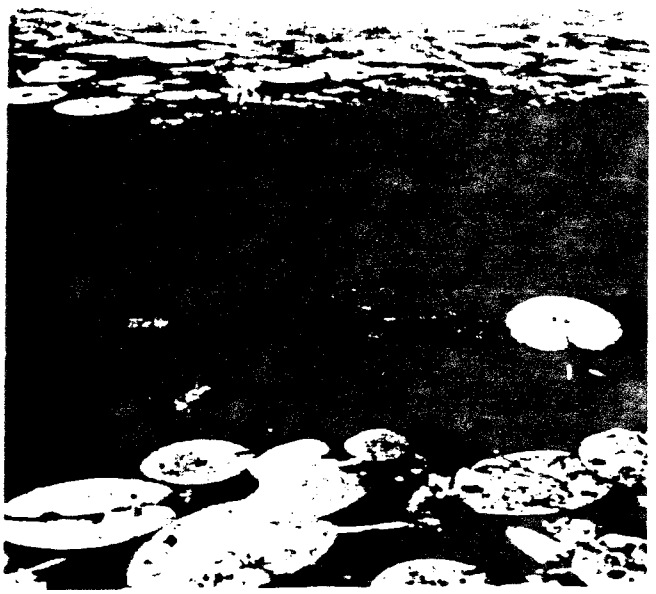
Cutting submergents has been discussed under "Harvesting."

G. SHADING

1. Floating shades made of black polyethylene plastic film, mounted on a braced 2" x 4" frame, can be used to control aquatic plants. These shades, when anchored in place from May through June, will control rooted growth for most plants. The shades interfere with water use but at a time when use is not heavy.

2. A commercial coloring agent, such as "Aquashade"™ can be added to small bodies of water to shade and inhibit the growth of submerged aquatic plants. It is not a chemically active substance; is not harmful to fish, wildlife or livestock; it is safe to use treated water for swimming and irrigation, and will not stain tissue or clothing after dispersal in the water. Depending on the water flow, fertility, etc., several treatments per season may be needed.

Smothering material is "walked down" and smoothed out prior to anchoring with pins, rocks or bricks.



An open area is created in dense growth of water lilies and milfoil by smothering with black vinyl plastic, Aquascreen ™ or commercial construction filter cloth.

H. SMOTHERING—Submerged weeds can be smothered with 10 mil or heavier black or gray vinyl plastic[1], or a commercial window screen-like material called "Aquascreen"™.

These materials can be laid down over dense weed growth, but it is most desirable to install the material when plants are young (May to June), or after summer harvesting.

The vinyl comes in 5 feet wide rolls; Aquascreen™ in 7 feet wide rolls. Strips can be bonded together with a commercially available bonding agent, like glue, to cover large areas. It has been found that 14-15 feet wide strips are most efficient to apply.

Carefully, clear away sharp debris as plants will grow through any cut or tear in the material. Weight or pin down one end of the vinyl or screening then unroll the remainder, adding weights along its length. Walk the material down, smooth it out and anchor it securely along the edges. It should be left in place at least 30 days to kill the weeds.

The material can be moved to a new location, used another season, or left in place. If left in place, and sufficient silt is deposited on the material, new plants may start to grow in the silt, however, they can easily be pulled out.

Some small weeds may sprout through the screening but these will normally remain stunted.

Gases from decomposition of the weeds may form large bubbles under the impervious vinyl and cause portions to rise. Gas bubbles can be expelled by puncturing the material with a pitch fork.

Emergent plants in shallow water can be controlled by smothering with black or gray vinyl plastic or black polyethylene. It should be applied early in the growing season before plants get tall or they should be flattened to facilitate laying the material. The material must be well anchored in the water so waves do not wash the material towards shore. Most plants should be killed in about 30 days.

I. WINTER DRAWDOWN—If a lake, pond, or reservoir can be drawn down in winter to expose the roots of aquatic plants to freezing and frost heaving, some species can be controlled. The plants must be exposed for at least four weeks with bottom mud frozen to a 4 inch depth between December and the first of April. Deep snow or heavy ice formation after drawdown, may result in inefficient weed control due to inadequate frost penetration.

Waterlilies, muskgrass (*Chara* algae), coontail (*Ceratophyllum demersum*), water milfoil (*Myriophyllum spp.*), and two species of pondweed (large-leaf pondweed and fern pondweed)which are illustrated on pages 11-13 can be controlled with winter drawdown. While *Chara* is susceptible to drawdown it recovers quickly.

Waterweed (*Elodea spp.*), and curly-leaf pondweed (*Potamogeton crispus*), have been controlled in some cases, and remain unaffected in others.

Other *Potamogeton* species, particularly the thin leaf pondweeds and *Najas* (bushy pondweed) are resistant to freezing and cannot be controlled by winter drawdown.

Adjacent shallow wells may be affected by the drawdown.

Fish kills from oxygen depletion may occur if fish and organic matter are concentrated in a small volume of water unless there is a substantial flow through the pond or lake.

There can be significant consolidation of sediments by drawdown, especially when the soils are high in organic matter. Such compaction can retard plant growth. It should be remembered that this will happen around the entire lake, including major fish spawning and feeding

[1]Black or gray vinyl is denser than water and sinks easily, while black polyethylene plastic is less dense than water and very difficult to sink.

areas. Compaction is the most irreversible of all effects of drawdown.

-54-

The influence of drawdown on plant nutrient availability is not straightforward. Sediment oxidation and stabilization can work to decrease nutrient availability. At the same time, increased aeration can stimulate microbial action which can release nutrients. The result could be a shift from rooted plants to algal "blooms."

It is impossible to predict the effects of drawdown on nutrient availability in any particular body of water without careful study.

Damage to surrounding wetlands also should be considered. Freezing and soil compaction of these areas can seriously effect their plant growth resulting in decreased fish and wildlife habitat.

A DEPARTMENT OF ENVIRONMENTAL CONSERVATION PERMIT MAY BE NEEDED.

J. DEEPENING—Emergent and some shallow submerged plants can be controlled by deepening the water with dredges, drag lines, or backhoes. This technique may be extremely expensive but does not have to be repeated annually and results last generally longer than other techniques.

Emergent vegetation can be restricted to a narrow area by steepening sloping shorelines to a three to one[1] or steeper slope to at least a depth of three feet.

Shallow offshore areas can also be deepened, ideally to a depth to which the problem weeds do not normally grow. (See Table 2 for typical water depth of plants.) This removal of the lake bottom sediments down to the subsoil essentially eliminates the stored nutrients for plant growth. It will be several years at least, until bottom sediments accumulate again to sufficient depth to support weed growths.

The disposal of dredged material may be a problem and the dredging may not be compatible with other uses of the lake waters.

A PERMIT FROM THE DEPARTMENT OF ENVIRONMENTAL CONSERVATION AND A PERMIT FROM THE ARMY CORPS OF ENGINEERS MAY BE NEEDED FOR MOST DEEPENING OR DREDGING OPERATIONS.

[1]Three feet horizontally to one foot vertical drop.

Agencies to Contact for Assistance

A. County Soil and Water Conservation District.
   1. Some provide aquatic plant management services.
   2. Land treatment application assistance.
   3. Assistance from Soil Conservation Service.
B. Soil Conservation Service, local county office.
   1. Conservation planning for all types of land and water management, including fishponds, aquatic plants, etc.
   2. Land treatment planning and application assistance.
   3. Sources of materials.
C. Department of Environmental Conservation Regional offices.
   1. Permits.
   2. Fisheries/aquatic plant management relationship information.
   3. Assistance with point source pollution control.
D. Cooperative Extension County office including Sea Grant.
   1. Information bulletins.
   2. Sources of materials.
E. County or District Health Department office.
   1. Guidance on sanitary surveys.
   2. Information on health regulations.

References for Additional Information

Lakes and Phosphorus Inputs—A Focus on Management, D. R. Bouldin et al. 1977. Cooperative Extension Plant Sciences Information Bulletin 127. Fee charged.

Aquatic Plant Management and Control, John H. Peverly. 1976. Cooperative Extension Plant Sciences. Agronomy 4, Information Bulletin 107. Fee charged.

A Guide to Plants Commonly Found in the Freshwater Wetlands of New York State, Thomas Rawinski et al. Department of Natural Resources, Community Environment Program, Cornell University. Fernow Hall, Ithaca, New York 14853.

A Manual of Aquatic Plants, N. C. Fassett. 1969. The University of Wisconsin Press, Madison, Wisconsin 405 pp.

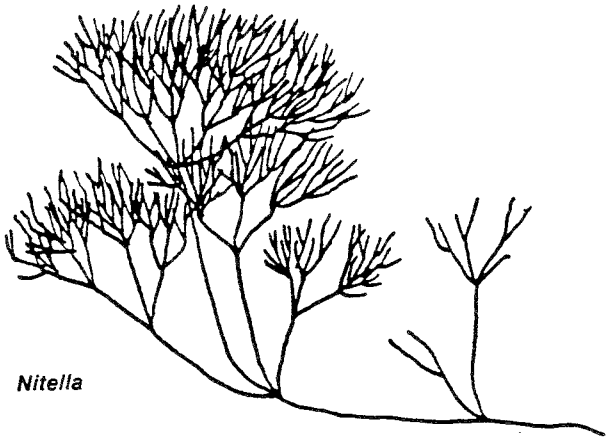
Potamogeton in New York, Eugene C. Ogden. 1974. New York State Museum Bull 423. 20 pp. Fee charged.

Field Guide to the Aquatic Plants of Lake George, Eugene C. Ogden. 1976. New York State Museum Bull 426. 65 pp. Fee charged. This publication is generally applicable to the entire state.

Lake Management Handbook. 1981. Central New York Regional Planning and Development Board, Midtown Plaza, Syracuse, New York 79 pp.

Common Marsh, Underwater and Floating Leaved Plants of the United States and Canada, N. Hotchkiss, 1972, Dover Publications Inc., New York, N.Y. 124 pp.

Illustrations of Some Common Aquatic Plants



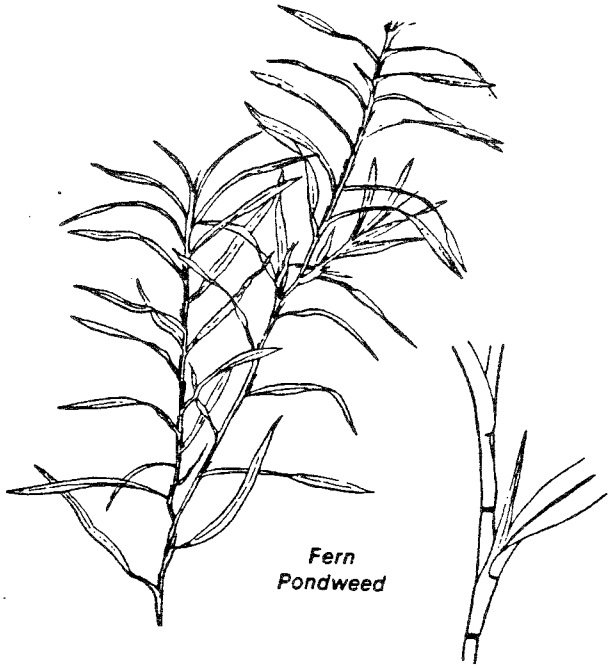
Nitella

Chara

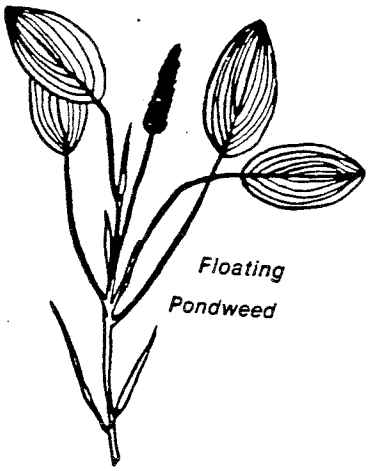
Naiads

Coontail

Large-leaf Pondweed



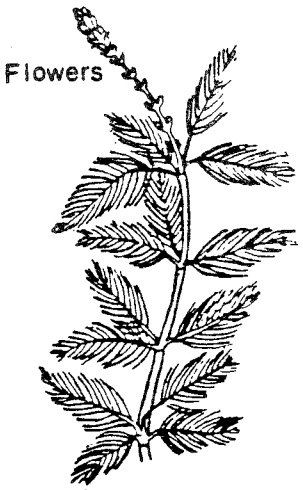
Fern Pondweed



Floating Pondweed

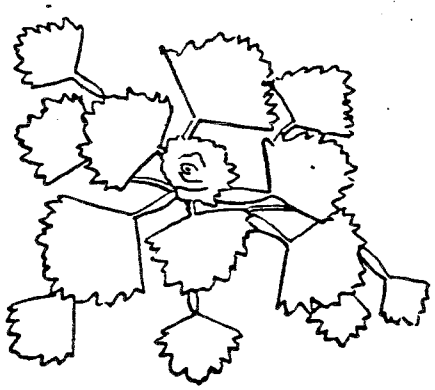
Sago Pondweed

Curly Leaf Pondweed

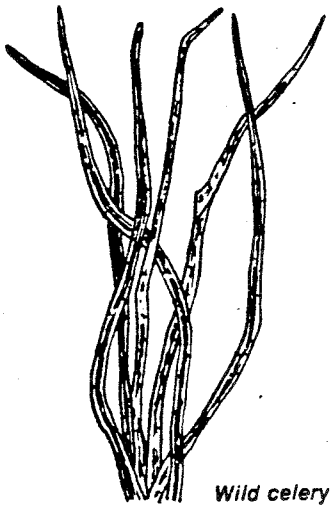


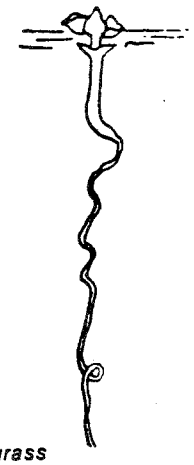
Water-milfoil

Waterweed* or *Elodea

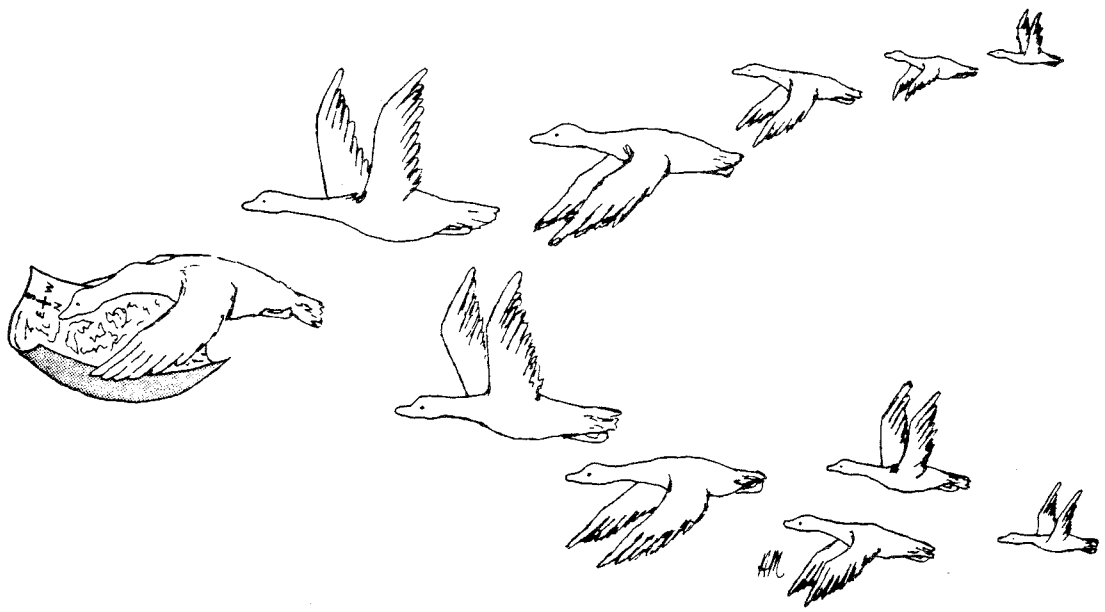


Water Chestnut





Wild celery* or *Eelgrass



Invite wildlife to your backyard

BY JACK WARD THOMAS, ROBERT O. BRUSH AND RICHARD M. DeGRAAF

GO OUT IN YOUR BACKYARD and look around. Watch the fish weaving among the water lilies, the dragonflies moving in glittering arcs above the little pool. Don't move — the robins are busy feeding their youngsters in that nest above your head; squirrels are edging down the beech trunks behind you and darting into the shrubbery. The wisteria on your stone wall is almost irresistible to the hummingbird that just appeared, and song sparrows are adding their notes to a tangle of birdsong sifting down from the oaks and maples. If you're really patient, that timid cottontail might bring her brood onto the grass for one last taste of the dew-silvered grass.

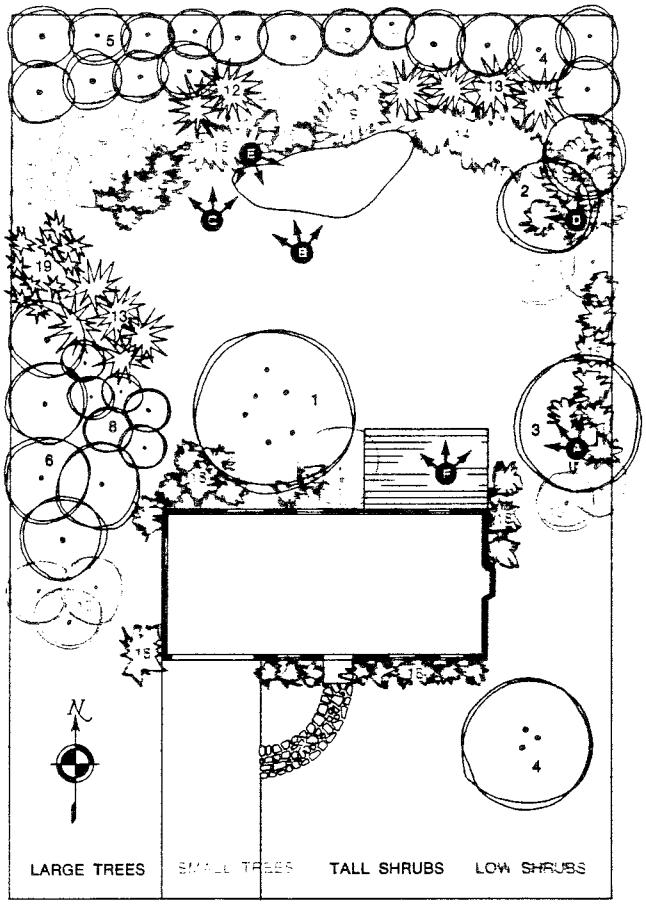
This isn't your yard, you say? It could be. If you have even a quarter-acre of crabgrass right now, you can turn it into a wildlife habitat as beautiful and gratifying as the one above. A few square yards — yes, even a window box

Your backyard can look like this — for as little as $200 and a plan like ours. This lot, viewed from the rear, has the mature plantings that attract a maximum variety of wildlife. On page 7, you can see this idealized wildlife habitat as viewed from the house patio.

Reprinted from April-May 1973 National Wildlife Magazine, a membership publication of the National Wildlife Federation, 1412 16th St. N.W., Washington, D.C. 20036

The logo in the upper right corner of this page symbolizes recognition of the National Wildlife Federation's Backyard Wildlife Habitat Program as an official Bicentennial activity. Participants enhance the quality of life in America's third century.

After the initial planting of trees, shrubs, flowers and herbs the first year, robins and other birds will feed on the lawn, and ground-feeding sparrows and finches will forage among the shrubs and flowers. Bird nesting will be limited, but many species will be attracted by the feeders and water.



The overhead view of this ideal backyard plan keys plantings to table on pages 4-5, and gives artist's viewing position in illustrations for food (A), water (B), cover (C), and reproductive area (D) on pages 8-11. Page 1 view is from backyard (E); Stages I, II, and III are viewed from terrace (F). Backyard area is 100 by 120 feet (about one-quarter acre).

— can become a wildlife refuge-in-miniature. You start with a dream — but then you need a plan. Want to have your own wildlife haven? Well, here is the plan . . .

Where do you start? This backyard habitat plan is divided into three model stages. No matter what your backyard looks like now, it will fit into one of them, give or take a few years' growth. But, before you do anything, put your plan on paper, no matter how crudely. Because the planning you do at the outset will determine the whole course of your backyard wildlife program.

No matter how large or small your backyard is, you use the same basic principles to attract wildlife

Stage I

FIRST YEAR PLANTING; SHRUBS LOW; TREES SCATTERED

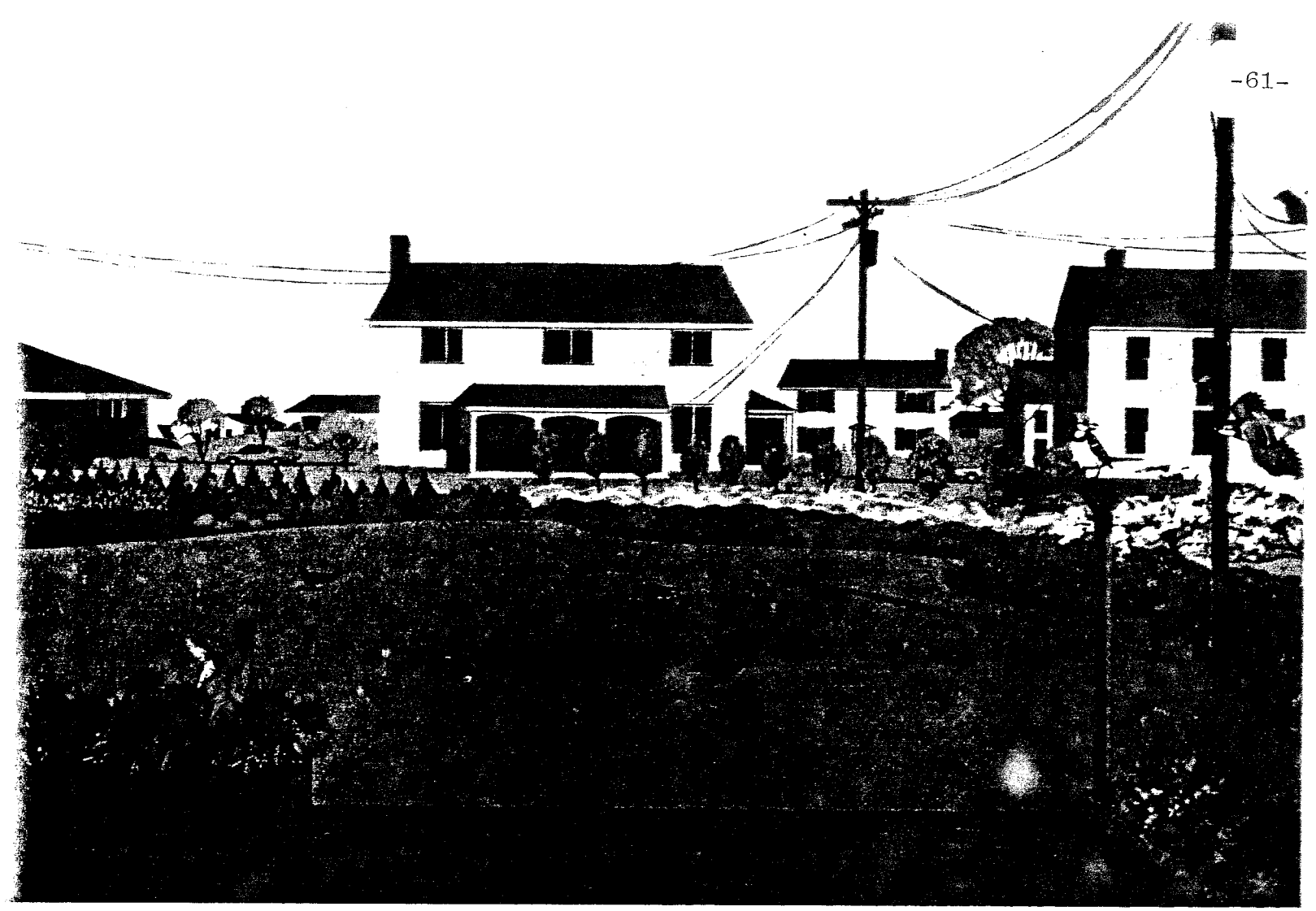
Stage I. If you start with only a sodded yard, and plant the trees, shrubs and herbs suggested on pages 4-5, your yard will be in Stage I. At this point you will already have some sparse, but usable wildlife habitat. In the early years, you really need to augment food and water resources with artificial feeders and birdbaths. Bird nesting will be limited, but here you can help with nesting boxes. Robins will feed on the lawn and ground-feeding sparrows and finches may forage among the shrubs and flowers. Cottontails may also come occasionally.

If you already have trees and shrubs in your yard but the kind, numbers and placement don't fit the total backyard habitat program outlined here, work out your own version of this plan. Use what you have to best advantage. Take out undesirable plants and relocate others.

Leave enough open space so you can observe wildlife without disturbing it. Consider the eventual heights of your plantings so the taller ones will be in the rear. Vary the heights of masses for a visually pleasing growth.

Stage II. It takes a yard about 5 to 10 years to progress from the initial plantings of Stage I to the fairly mature shrub condition of Stage II. The trees will be about 25 feet tall. If your yard is in this stage now, but is a dense wooded area of young trees and shrubs, make a plan to thin vegetation to achieve a balanced habitat.

In Stage II there will be enough flowers and fruits to



attract a variety of birds and insects, which will in turn attract reptiles and amphibians. A small pond will replace the birdbath. Robins will raise broods in the trees. Catbirds, cardinals and song sparrows will nest in the denser shrubbery. Dusk will bring rabbits to browse in the security of your yard. Mornings will find chipmunks emerging from holes in your stone wall to scurrry up trees.

Stage III. Starting from scratch, you can expect Stage III 30 to 40 years after initial planting. This means a yard with varied mature trees, with hardwoods in full fruit production, plus mature shrubs and sufficient open areas.

If, however, your yard has little shrubbery, but already has a reasonable number of these trees producing fruits and nuts, you can plant shrubbery and low vegetation to achieve Stage III in 5 to 10 years.

NATIONAL WILDLIFE *worked over a period of months with Ralph Winter, noted architectural artist, and a research team to develop this backyard wildlife feature. The authors are U.S. Forest Service specialists researching urban habitat needs for wildlife at the Environmental Forestry Research Unit, Amherst, Mass. Jack Ward Thomas, Unit Leader, and Richard M. DeGraaf are wildlife biologists; Robert O. Brush is a landscape architect experienced in wildlife management.*

This stage attracts the maximum number of wildlife species. Orioles and tanagers will nest in the higher branches; foliage-gleaning warblers will feed in the treetops. Rabbits will feed on the lawn and low shrubs and may even raise their young in well-hidden nests. Squirrels will live in tree hollows or nest boxes, if available. Chipmunks, field mice, garter snakes, toads, butterflies and other insects may make your backyard home.

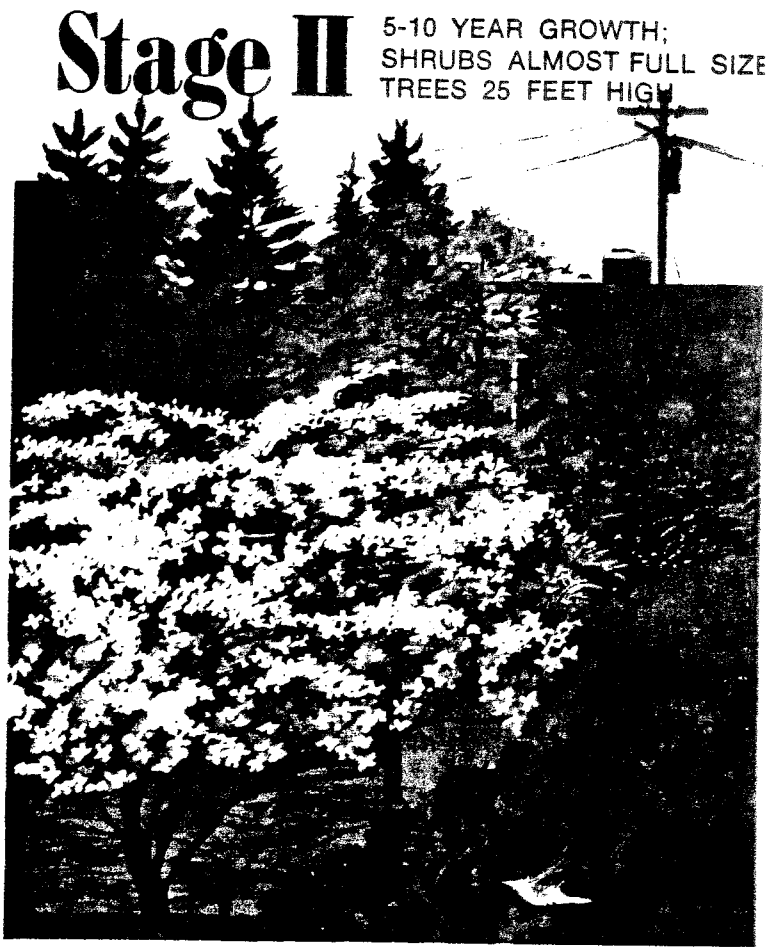
As darkness falls, bats and nighthawks may swing through the sky on feeding flights. Deeper into the night, whip-poor-wills and owls will mingle their calls with croaks of frogs and the chirps and trills of katydids.

Four wildlife needs. All wildlife, indeed all life, requires four basic elements to survive: food; water; cover as protection from natural enemies and the elements; and areas where they can reproduce and bear their young in safety. Combinations of these four elements are unique for each species, but you can plan a habitat that offers enough combinations to attract the greatest number and variety of wildlife your area will support.

Working with the natural resources at your disposal, your aim should be to plan the vegetation, supply water and natural, as well as artificial food, so that you provide the maximum number of homes for wild creatures.

Be sure to select your plants carefully to provide the maximum overlap of flowering and fruiting times. Food

Shrubs are almost full-grown and trees are about 25 feet high with 5-10 years' growth. Enough flowers and fruits are present to attract birds and insects, which will in turn attract reptiles and amphibians. Rabbits and chipmunks should appear at this stage. Many birds can nest in the shrubbery.



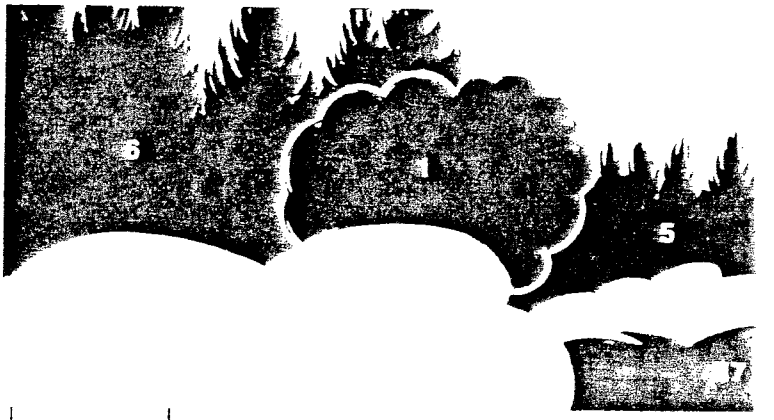
should be available as needed. For birds, this means a year-round supply. If you have bird feeders, continue to fill them through the spring until new growth takes over.

Trees. Trees are the key element in progressing to Stage III because they take the longest to reach maturity. They're essential to most backyard wildlife, providing food, cover, and nesting sites for many songbirds as well as squirrels and raccoons.

Get advice locally on species best suited to your lot, considering soil, moisture, nutrients and sunlight. It is possible to overcome some natural limitations through watering, landscaping and fertilizing.

Shrubs. They are really more important than trees in your wildlife program. Shrubs are less fussy, grow faster and provide food, cover and reproduction areas for a great variety of wildlife which lives on or near the ground. Don't prune the lower branches.

Blend your plantings. How you arrange your trees and shrubs is important. This suggested plan uses all of the basic principles of wildlife management to best advantage. For example, wildlife researchers have found



Key to Backyard Plantings

This list contains the plant materials suggested in our backyard wildlife plan for the Northeast. You may substitute others (see list on pages 6 - 7), but remember to select a variety of species that produce a year-round supply of food. Also, be sure that moisture and light requirements match your yard's conditions.

All the plants are available at commercial nurseries; many can also be transplanted from the wild.

An excellent guide to wildlife food habits is *American Wildlife and Plants* by Alexander C. Martin, Herbert S. Zim and Arnold L. Nelson (McGraw-Hill).

SPECIES	MATURE HEIGHT	FLOWERS	FRUITS	SUN/ SHADE	WET/DRY	WILDLIFE SERVED
Trees						
1. Beech	50-100′		Sept-Oct	Lt shd/sun	Moist	Nuts, seeds, acorns: fall and winter food for squirrels, large songbirds. Spring, summer foliage: cover and reproductive areas for songbirds, tree-dwelling mammals, insects. Leafless branches: winter roosting for birds.
2. Red oak	50-100′		Sept-Oct	Lt shd/sun	Moist	
3. White oak	40-100′		Sept-Nov	Lt shd/sun	Moist/dry	
4. Red maple	40-100′			Shd/sun	Moist/ well-drained	
5. White pine	40-100′		Aug-Sept	Sun	Dry	Cones: fall, winter food for pine squirrels, songbirds. Boughs: year-round cover, reproductive areas for songbirds, tree-dwelling mammals, insects.
6. White spruce	40-100′		Aug-Sept	Sun	Dry	
7. Hemlock	50-80′			Shd/sun	Moist	
8. Red cedar	30-80′		Sept-May	Sun	Moist/dry	
Small Trees						
9. Winterberry	10′	May	Oct	Lt shd	Wet/moist	Flowers: food for butterflies, other insects. Berries, fruit: fall, winter food for songbirds. Spring, summer foliage: cover, reproductive areas for songbirds. Leafless branches: winter cover, roosting for songbirds.
10. Flowering dogwood	10-40′	Mar-June	Aug-Nov	Sun	Well-drained/ dry	
Shrubs						
11. Hawthorne	10-20′	June	Oct-Mar	Sun	Dry	
12. Crabapple	15-30′	Mar-May	Sept-Nov	Sun	Moist/dry	
13. Autumn olive	10′	May-July	Sept-Feb	Sun/lt shd	Moist/dry	
14. Silky dogwood	6-8′	May-July	Aug-Sept	Sun/lt shd	Wet to dry	
15. Red osier dogwood	to 10′	May-Aug	July-Oct	Sun	Moist/wet	

SPECIES	MATURE HEIGHT	FLOWERS	FRUITS	SUN/ SHADE	WET/DRY	WILDLIFE SERVED
16. Elderberry	3-13′	June-July	Aug-Sept	Sun	Moist/wet	Spring, early summer flowers: food for butterflies, other insects. Berries: food for songbirds. Foliage: cover, reproductive areas for songbirds, mammals, reptiles, amphibians, insects. Dead branches: winter cover for ground-dwelling mammals and birds.
17. Blackberry	to 10′	May-July	July-Sept	Sun	Moist	
18. Rhododendron	10-15′	May-July	Aug-Dec	Shd	Moist	Spring flowers: food for butterflies, other insects, hummingbirds. Foliage: dense cover, reproductive areas for songbirds, mammals. Rhododendron foliage: winter cover for songbirds, mammals.
19. Honeysuckle	to 10′	June-July	July-Sept	Sun/shd	Well-drained/ dry	
Annual Flowers						
20. Sunflowers	to 5′	Aug-Oct	Sept-Nov	Sun	Moist/dry	Flowers: food for butterflies, other insects. Seeds: late-summer, fall, winter food for many seed-eating birds, especially sparrows.
21. Asters	to 4′	Aug-Oct	Sept-Nov	Sun	Moist	
22. Daisies	to 2′	June-Aug	July-Sept	Sun	Dry	
23. Marigolds	to 2′	Aug-Oct	Sept-Nov	Sun	Moist/dry	
24. Black-eyed Susans	to 2′	June-Sept	July-Sept	Sun	Dry	

Mature trees, more than 50 feet tall, characterize a yard in Stage III, 30-40 years after initial planting. Hardwoods in full fruit production will provide food for squirrels and jays. Orioles and tanagers might rear young in higher branches. This stage will attract the maximum number of wildlife species.

that different plant growth forms – grasses, shrubs, trees – planted around open areas create the "edge effect." These edges attract the greatest variety and numbers of wildlife to the smallest piece of land.

When do you start? Today. Of course, the best time to plant trees and shrubs is spring or early fall. But you can make your all-important plan, clear out unproductive growth, and prepare your soil almost any time. Maybe you'll build a bird feeder the first rainy weekend.

What's the cost? The answer to that is how much do you want to spend? You can make your own plans, provide your own muscle power and, if you don't mind waiting a little while for concrete results, you can start with quite small plant materials.

Retail nursery and garden centers are equipped to give you advice and supply the needed plants. Mail order nursery catalogs carry a wealth of information.

If cost is not a concern, you can hire a landscape architect to design your own backyard and a landscape firm to do the installation. This way you will see the fastest results in the shortest time.

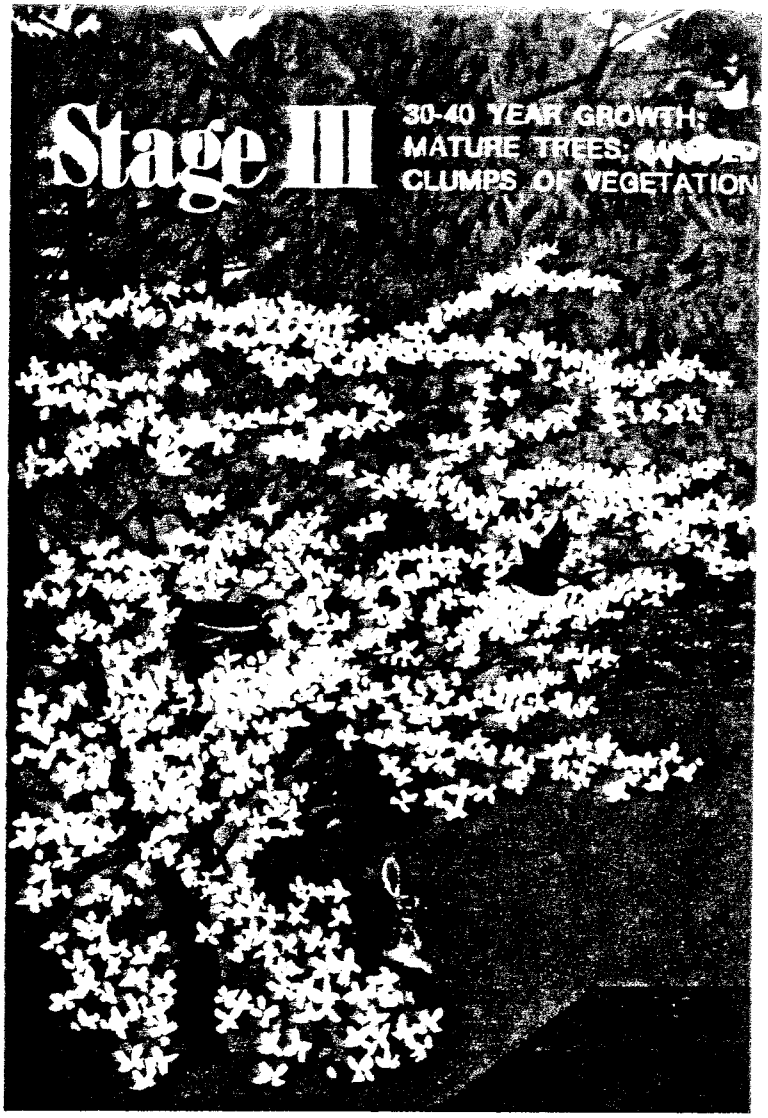
You will have additional cost for periodic maintenance. But expenditures for fertilizer, water and labor are no more for this kind of wildlife backyard than for a lawn.

How big a backyard? The backyard brought to life on these pages is about 100 feet by 120 feet (about one-fourth acre). If your yard is smaller, it may be difficult to provide food, water, cover and breeding areas for many species. But it *is* possible to provide one or more of them and attract *some* wildlife.

If you have no yard at all, you can still provide food and water in window box planters (see page 12). These can bring a little piece of nature into the lives of even apartment dwellers – provided, of course, that some bird life is already present, your apartment is not too high above the ground, and you can open your windows. Your window box can support the same basic processes as any natural area – soil, water, sunlight and plants combining to produce life in a microcosm. With a little luck, birds will make your window box a part of their lives.

If your yard is larger than our model, you're lucky. You can use the same basic principles to create a wildlife habitat which is vastly more effective because it can be more complete, diverse and stable (see page 12). It takes an acre or more to attract animals higher in the food chain – those that live on other animal life. These would include hawks and owls, as well as raccoons, skunks and foxes, which eat both plants and small animals.

Cooperation with neighbors to provide a larger area of suitable habitat will multiply the effects of your efforts



Regional Equivalents for Plantings

The plant materials listed on pages 4-5 and illustrated on these pages grow best in the Northeast. Use this list to select those best suited to other areas.

HERBACEOUS GROWTH

Northeast
Panicgrass
Timothy
Sunflower

Southeast
Lespedeya spp.
Panicgrass
Sunflower

Northwest
Turkeymullein
Timothy
Sunflower
Filaree
Lupine
Fiddlenecks
Tarweed

Southwest
Turkeymullein
Sunflower
Filaree
Lupine
Fiddlenecks

LOW SHRUBS

Northeast
Blackberry
Blueberry
Huckleberry
Snowberry

Southeast
Blackberry
Blueberry
Bayberry
Spicebush
Huckleberry

Northwest
Blackberry
Blueberry
Snowberry
Oregon grape

Southwest
Utah juniper
Blackberry
Spicebush
Prickly pear
Algerita

TALL SHRUBS

Northeast
Sumac
Dogwood
Elderberry
Winterberry
Autumn olive
Wisteria

Southeast
Sumac
Dogwood
Elderberry

Northwest
Sumac
Bitterbrush
Russian olive
Elderberry
Buckthorn
Madrone

Southwest
Mulberry
Lote bush
Sumac
Manzanita
Madrone

SMALL TREES

Northeast
Flowering dogwood
Crabapple
Hawthorn
Cherry
Serviceberry
Red cedar

Southeast
Holly
Dogwood
Serviceberry
Cherry
Persimmon
Red cedar
Palmetto
Hawthorn
Crabapple

Northwest
Serviceberry
Dogwood
Hawthorn

Southwest
Serviceberry
Dogwood
Mesquite
Crabapple

TALL TREES

Northeast
Coniferous
White pine
Hemlock
Colorado spruce
Deciduous
Sugar maple
White oak
Red oak
Beech
Birch

Southeast
Coniferous
Longleaf pine
Loblolly pine
Shortleaf pine
Deciduous
Ash
Beech
Walnut
Live oak
Southern red oak
Black gum
Pecan
Hackberry

Northwest
Coniferous
Douglas fir
Ponderosa pine
Western white pine
Lodgepole pine
Colorado spruce
Deciduous
Oregon white oak
California black oak
Bigleaf maple

Southwest
Coniferous
Arizona cypress
Pinon pine
Deciduous
Live oak
Pine oak
Bitter cherry

Wildlife has the same needs in your yard as in National Forests... food, water, cover and suitable sites for reproduction

It works anywhere. While this backyard plan is designed for the Northeast, you can apply these same principles wherever you live. In Miami, fill your yard with night-blooming jasmine and lemon trees and listen to the mockingbirds. In Tucson, plant flowering cactus and enjoy the white-winged doves. In Seattle, grow lupine and attract western bluebirds. In a window box or a national forest, the same principles apply. So, no matter where your yard is, or how big it is, you can refer to the substitution chart on pages 6-7 for suitable plant materials.

Where to get help. Your county agricultural agent or state university landscape specialist has free advice on a wide variety of problems you may encounter. So does your local nurseryman. If you live in a Soil Conservation District, you can get help on water and soil problems from that office. Some state game departments have staff biologists that can help you. Your local zoo, natural history museum or nature center can tell you the specific needs of wildlife in your area. And some commercial nursery catalogs are gold mines of information.

Don't expect too much. The illustrations on these pages show the variety of wildlife that might visit your backyard over a 24-hour period. However, it will be impossible for you to attract every kind of animal you would like to see in your backyard. The combinations and amounts of food, water, shelter and breeding sites for each species are too complex and varied.

Only a limited number of animals can use a single yard as home, particularly during the breeding season when a bird may require a larger territory and will defend it against others. Once the breeding season ends, however, territorial defense stops and additional individuals and species may use your backyard.

Include your neighbors. Your small island of good habitat will be a happy haven for some wildlife. But you'll be more successful if you can persuade your neighbors to cooperate in a backyard habitat program. And as the trend toward urbanization continues, green space for people and plantings for wildlife will become increasingly important. By cooperating with your neighbors, you can create "wildlife neighborhoods" that will aid wildlife and make life more fun for you and your family.

Informally, you can share plant materials and ideas. Formally, you can plan together. For example, if your yard is in Stage I, with only grass and shrubs, and is next to a neighbor's yard with 25-foot trees, the combined habitat would be close to Stage II in completeness. If you are lucky enough to have a neighbor with a stream or pond, or with a fairly wild woodlot or field, your total

Food

Food for wildlife is easy to furnish. You can supplement natural growth with a variety of products, especially for seed-eating birds. In fact, many people who don't have enough land to provide water, cover and reproductive areas can enjoy some wildlife through feeding alone.

The ideal wildlife management plan, however, supplies as much food as possible through vegetation, and variety — from berries to nuts — is necessary to meet the year-round needs of many species.

But don't make the mistake of considering food provision the beginning and end of wildlife management. Food must be accompanied by the other three habitat elements to enable wildlife to live in your yard.

Mallard ducks [illegible] of aquatic plants.

Male towhee scratches in dead leaves for an insect meal.

Water

You can fulfill wildlife's critical water needs — drinking and bathing — with a simple bird bath or ground watering device. Most desirable, however, is a small pool with an area large enough to support plants that grow in water, as well as around the edge. It will become the scene for a broad range of wildlife activity.

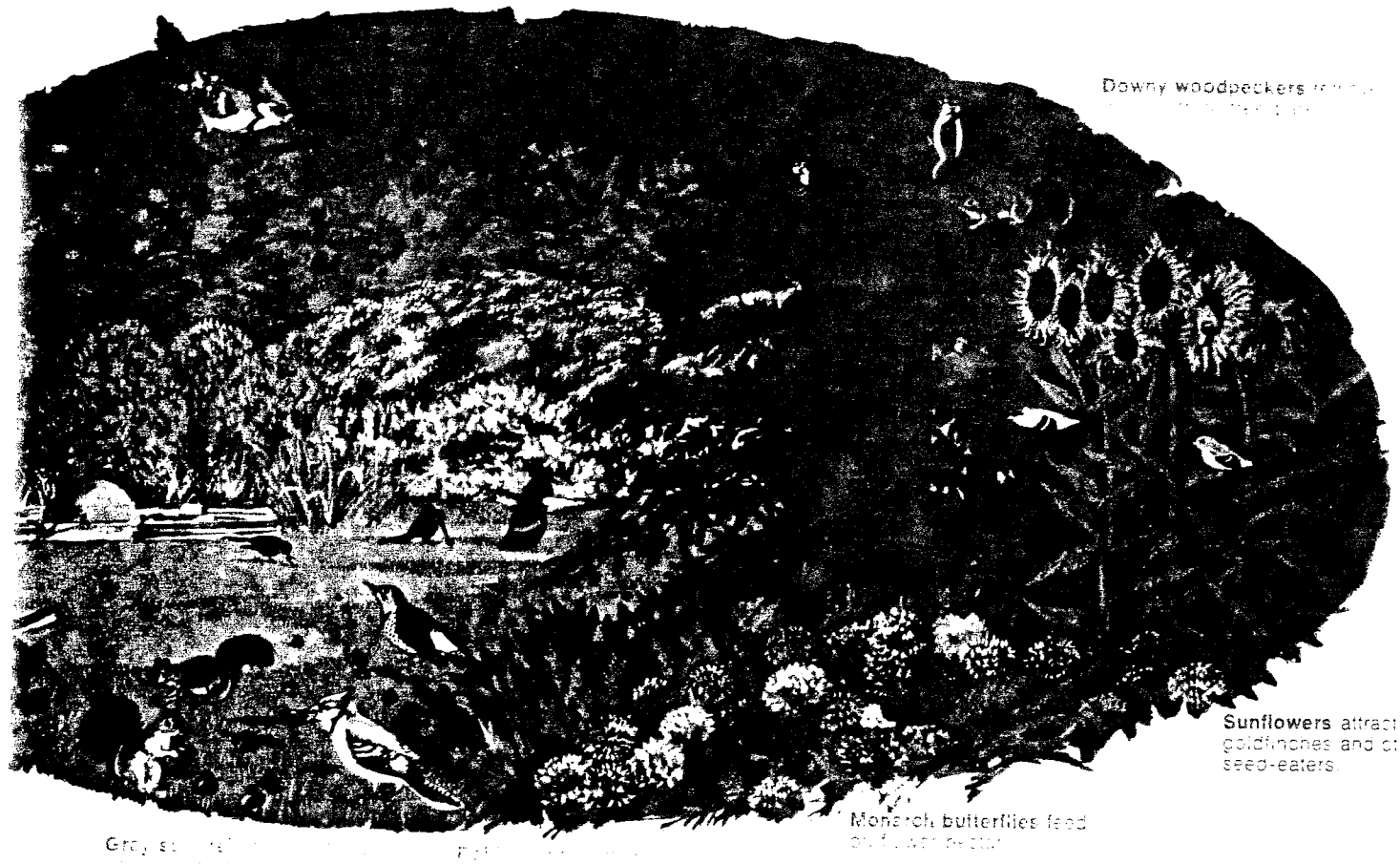
During the night, raccoons might make feeding forays while bats sweep the air above the pool for insects. In very early morning and late evening, rabbits will feed on the succulent growths around the edge, to the accompaniment of a nighthawk's plaintive "peent" as it, too, hunts insects overhead. Activity will drop during the day, but birds will still use the area for watering and bathing, turtles and frogs for sunning.

You can encourage winter activity by keeping a section of the pool ice-free; use a livestock trough warmer.

In addition to its wildlife value, the water area will provide a key focal point in the landscape design. Locate it to provide maximum visibility from the terrace or windows of the house.

Raccoons, chiefly nocturnal, feed on frogs, crayfish and other small creatures.

Painted turtles need rocks and logs for sunning.



Downy woodpeckers

Sunflowers attract goldfinches and other seed-eaters.

Monarch butterflies feed

Tree swallows keep insect

Red-winged blackbirds build their nests among cattails.

Killdeer.

Dragonflies brighten the air above a pool

Leopard frogs. American toad prey on insects and fill the night with a country chorus.

Avoid uniformity; the greatest variety of wildlife species is found where one habitat type blends into another

habitat will attract wildlife much more successfully than your yard could alone. And if your neighbor likes wildlife too, he's not as likely to complain if rabbits wander into his cabbage patch.

Unwelcome wildlife. Let's face it, some wildlife tenants are unwelcome. Rabbits may girdle shrubs. Squirrels may rob bird feeders or get into attics. Snakes repel some people, and bees and wasps may sting if disturbed. You have two choices when faced with undesirable species. You can accept the situation, or you can control it.

If you decide on control, you can either alter the habitat to eliminate the life requirements of the unwanted animals, or directly remove the offending individuals. You can discourage squirrels by using bird feeders that are squirrel-proof, taking down winter nest boxes, sealing the attic and covering tree holes with tin. Or you may want to live-trap the squirrels and transplant them.

While the actions of dogs and cats, whether pets or strays, are natural and part of the drama of nature, you can do this: increase the cover, move the bird feeder out of reach of cats, or move it closer to protective cover. Or, chain the dog, bell the cat, build a fence.

What's the pay-off? As your habitat develops and grows, it will become an increasingly exciting and intimate part of your family's life. Your backyard can become a stage where wild animals are the stars and people the audience. Inviting wildlife to your backyard is probably the best way for children to learn a simple tenet of the complex science of ecology: life operates in one large system and everything in that system is interconnected; any change in one part affects the rest of the system.

The case presented here is simple. Man's habitat can be wildlife habitat, too. If we are to maintain any contact between urban and suburban man and nature, we must share our living space. Also, studies show that property values rise from three to ten percent with the addition of vegetation and good tree cover.

What's really important. Anthropologist Rhoda Metraux has said that only when man has incorporated into the urban setting all that he once gained through living in nature will he be "fully and faithfully . . . urbanized."

Our society has been alerted to the deterioration of our environment, and we have heard the call to great crusades, both public and private. Yet there is a question in many minds: what can one person do?

You can improve your own environment with plans like these and, in doing so, exhibit a concern for, and a faith in, the solution of environmental problems. And you can do it where it means most to you — in your own backyard.

Cover

Cover is any place that protects animals from predators and the weather. Different species have different cover requirements: rock piles or stone walls for chipmunks and lizards . . . brush piles or dense shrubs for cottontails and towhees . . . evergreens for chickadees and pine squirrels . . . water for frogs and turtles.

Cover also serves as a home base — the farther an animal must venture from cover, the more vulnerable it is to predators. So try to provide cover close to food and water. Many cover plants can also be food plants.

You can also arrange cover to please the eye. Define your yard's open spaces with trees, shrubs and stone walls, grading their heights so tall trees and shrubs won't block open areas and low growth from view.

Hooded warbler

Reproductive areas

All wildlife needs a specific kind of cover where it can produce young, and, in most cases, raise them. Each reproductive area must offer protection from the elements and be relatively safe — either inaccessible to predators or well hidden.

The diversity of cover you need for a complete habitat requires mature trees. These provide den sites for squirrels and nesting places for both high- and low-nesting birds.

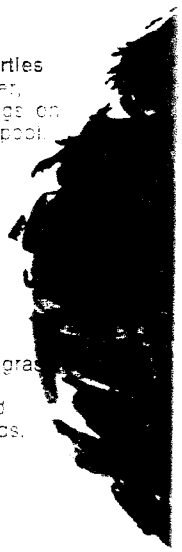
Until your habitat is complete, you can compensate for a lack of big trees with nest boxes for squirrels and some birds — English sparrows, house wrens and tree swallows will probably use them.

Unmowed lawn edges and low shrubs are perfect sites for song sparrows and cottontails; the moistness will attract katydids, crickets and grasshoppers.

Frogs, toads, salamanders and fish may deposit their egg masses in the pool and its vegetation, and water insects such as dragonflies, waterstriders and back-swimmers will breed there.

Cardinals, dense shrubbery for nesting

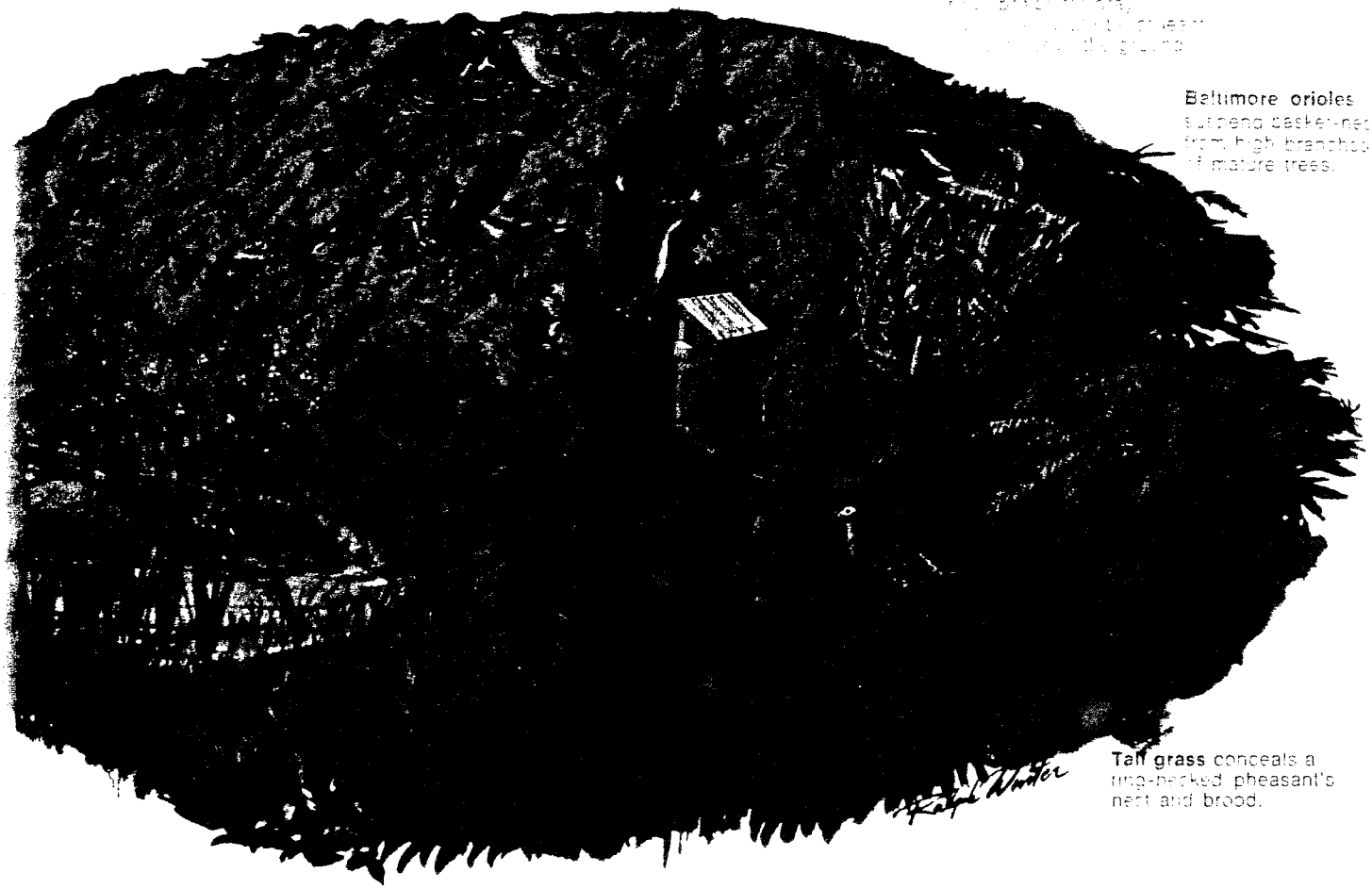
Painted turtles live in water, but lay eggs on land near pool



Mallards need high grass near water to nest and raise broods.

Rabbits make their hair-blanketed nests in tall grass.

Painted turtles and
leopard frogs find refuge
in water.



Baltimore orioles
suspend basket-nests
from high branches
of mature trees.

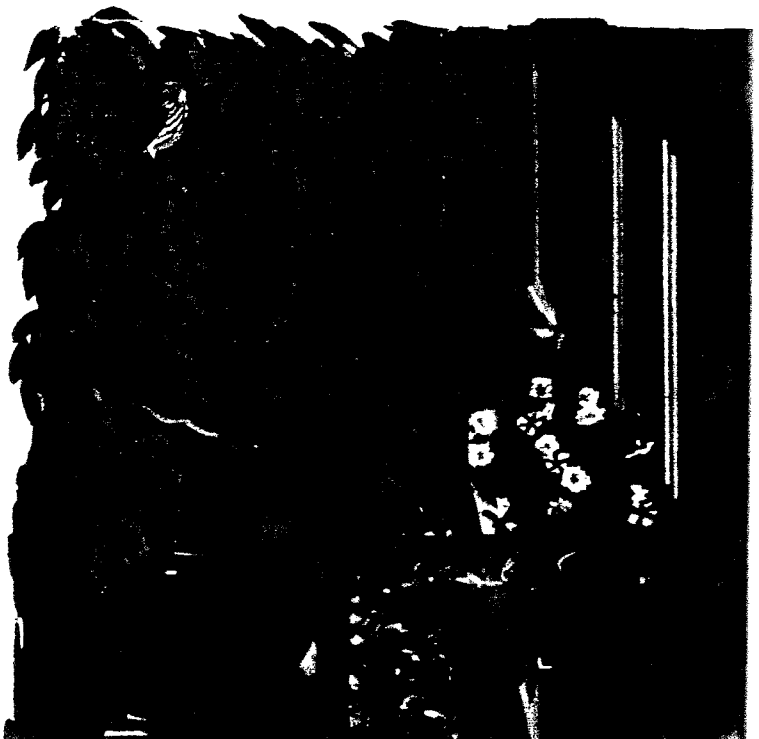
Tall grass conceals a
ring-necked pheasant's
nest and brood.

...Three acre lot

Increased size allows you to expand all the requirements of wildlife to support more species, including bigger animals and those higher on the food chain.

...Window box

If you don't have a yard, you can use a window box planter to provide three basic elements — food, water and cover — to support a microcosm of life.



MAKE YOUR BACKYARD OFFICIAL:

Realizing the tremendous value of wildlife which is so rare in urban and suburban communities, the National Wildlife Federation has launched a program to establish a nationwide network of mini-refuges in the backyards of Federation members.

"We're proud of the way many of our members are already providing for wildlife," says Thomas L. Kimball, Executive Vice President of the Federation, "and we want to applaud them. If thousands of others would follow their example, vast amounts of land in residential neighborhoods could be turned into a tremendous asset to wildlife—and people."

Everyone who has a backyard is eligible to participate in this Backyard Wildlife Program. Anyone whose application shows evidence of good wildlife habitat may receive a Backyard Wildlife Registration Certificate.

For details on the Backyard Wildlife Program, or reprints of this article at 25 cents each, write to: Backyard Wildlife Program, National Wildlife Federation, 1412 Sixteenth Street, N.W., Washington, D.C. 20036.

ABOUT THE NATIONAL WILDLIFE FEDERATION

The National Wildlife Federation is a private, nonprofit conservation education organization, publicly but not governmentally supported. It aims to inform our citizens concerning the wise management of our natural resources and the importance of a clean environment for man and the other inhabitants of Earth.

One way to do this is by circulating, free in single copies, the many conservation education publications which we produce. People often respond by asking, "What can I do to help?"

One of the best things you can do is to keep an eye on local, state, and federal government actions that might affect the environment. Learn the facts and make your views known in every forum available. You will be doing the environment—*your* environment—a favor.

Something else you can do: join an organization such as the National Wildlife Federation. As a conservation education organization, the Federation is working for a better environment for man and wildlife. If you would like information on becoming a member, please write to us.

TOWN *AVON* STREET ADDRESS *SECRET LAKE ROAD*

BEACH *SECRET LAKE BEACH* BODY OF WATER *SECRET LAKE*

DATE	SAMPLING SITE	MF	MPN	FECAL	REMARKS
8-5-75		1500			
8-13-76		210			
8-5-77		220			
8-21-78		30			
7-15-81		3300			
7-27-81		90	93	91	
8-19-81		80			
8-6-81		40			
7-21-81		20000	230	93	
6-3-82		600			
7-13-82		30			
6-9-83		110			
7-14-83		30			
8-10-83	Beach	10			
8-31-83	Bathing Area	30			
7-9-84	Bathing Area	70			H. Birden
8-8-84	Bathing Area	30			H. Birden