THE IMPACT OF URBANIZATION ON NEW ENGLAND LAKES

An Experiment in Regional Interdisciplinary Research to Assist Lake Management Efforts

VOLUME I

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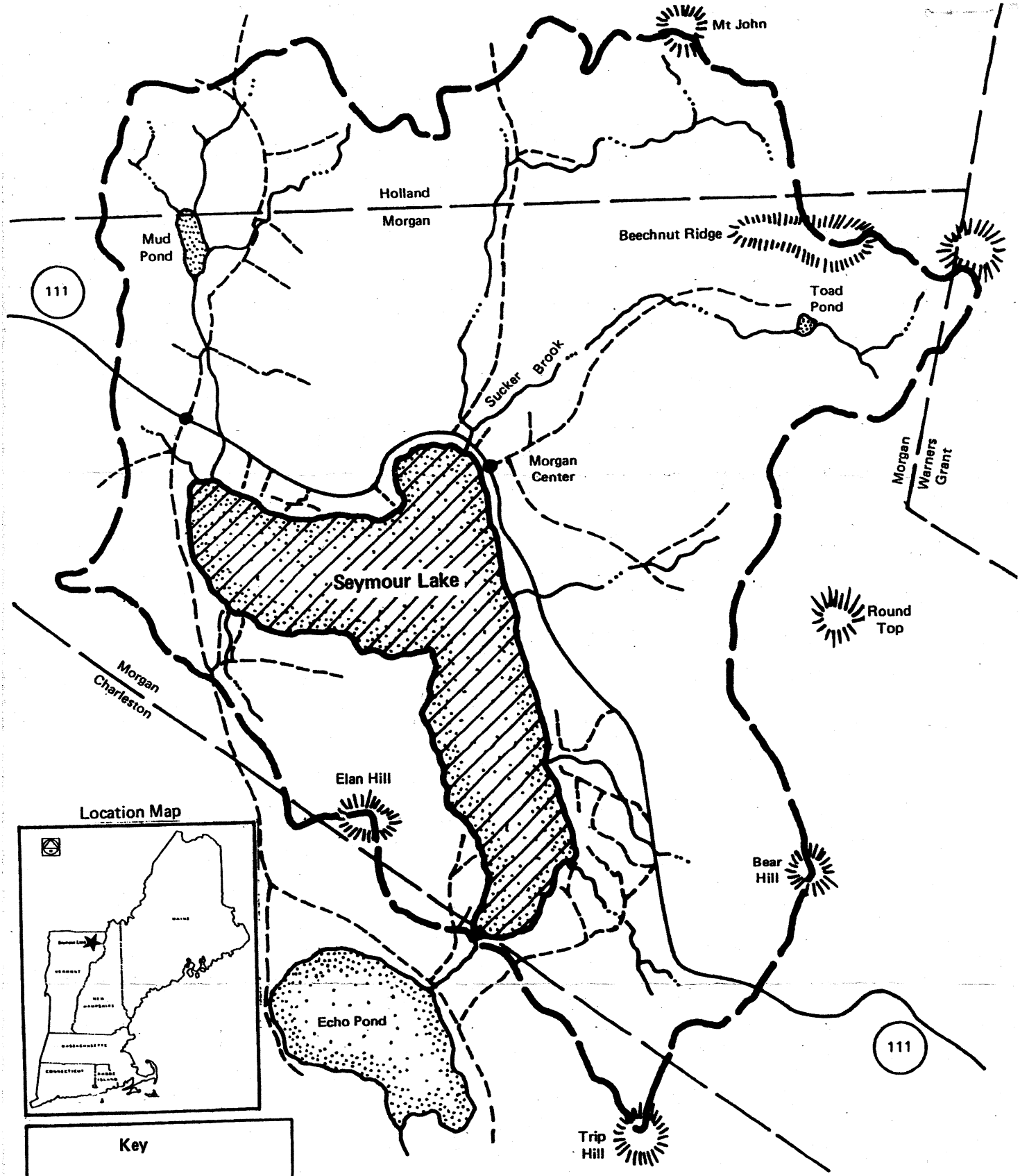

FIGURE 12.

SEYMOUR LAKE WATERSHED

Seymour Lake

1. The Physical Condition

Seymour Lake is the largest of the lakes in the survey, 542.0 ha. (1,732 acres), and has the greatest maximum depth, 50.9m (167 ft.). The average depth is 21.2m (70 ft.), and the volume of the lake is four times greater than the next largest lake in the survey, Long Pond. Impoundment (less than 1m) probably had little effect upon this lake.

Stratification and light penetration data are not presently in hand, so only general observations can be made at this time. Light and, therefore, photosynthetic oxygen production probably do not extend very deeply into the metalimnion (the zone of decreasing temperature and mixing that occurs at mid-depths). Consequently, productivity is probably confined to the epilimnion (the upper, circulating layer of warm water). Lower layers of the lake (hypolimnion) are isolated from all sources of oxygen throughout the period of summer stratification. Despite its vast size, this lake has at least one property that is a potentially ominous one relative to eutrophication, and its water turnover time is correspondingly long. Thus, it is by far the most stagnant lake in the survey, and, once polluted, will be the most difficult to manage.

Chemically, Seymour Lake may occupy an intermediate position on the oligotrophic-eutrophic spectrum due to the composition of bedrock in its watershed. Apparently, a modest amount of calcareous, sedimentary (although metamorphosed) rock is available in the watershed and along the western side of the lake. Thus, the lake water is probably slightly basic (pH 7.0+) at the surface and somewhat buffered. Further, nutrients, most importantly phosphorus, are being supplied naturally in the ground water and by runoff entering the lake. Pollutional load increases the supply of both carbonates and phosphorus to the watershed and the lake.

Further information is needed before a conclusion can be reached on the relative position of Seymour on the eutrophication spectrum as compared to other lakes in the survey. Basically, the size of Seymour favors its continued high quality. On the other hand, the size and composition of its watershed present some liabilities. A small watershed means less water is available to flow through and renew the water in the basin, and

the existence of basic rock in the watershed indicates an elevated nutrient load in that water already. (There is potential of an even higher load when and if weathering and nutrient transport rates in that part of the watershed are perturbed, by development, for example). In the short term, Seymour Lake will probably have no apparent problems, but in the long term, Seymour is potentially a "nonforgiving" lake.

Sedimentation following permanent settlement was marked at first by a decline in total phosphorus and organics, but recently this trend has reversed dramatically, and precultural levels have been substantially exceeded. This corroborates the hypothesis that Seymour is highly vulnerable compared to other lakes in the sample. Noteworthy is the rise in zinc levels. These levels are similar to those observed at Granite Lake and Beach Pond, which contained varying levels of cadmium and lead. Also, lead and manganese levels are twice as high as the precultural levels and are still on the increase. Though it is difficult to trace origin, these elements may enter the lake not only from the surrounding lakeshed, which is still sparsely settled, but also from atmospheric fallout (acid rain or dry precipitation). Only an endrin-like residue in the surficial sediment was found, and it appears to be of little significance.

2. The Human Community

History. Morgan and Holland townships were first settled in the early 1800's. Traditionally, the dominant economic activity in these towns has been agriculture. Only briefly, near the end of the nineteenth century, was agriculture of secondary economic importance.

Initially, farms around Lake Seymour were subsistence operations, small in size and characterized by a non-intensive use of land. Specialization came slowly, and intensive agricultural development was handicapped by less fertile land in the watershed, land rockier and steeper than that elsewhere in Morgan and Holland townships. During the mid-19th century, sheep grazing and grain production were briefly important. Toward the end of the 1880's, dairy farming replaced all other agriculture in the area. Throughout this century, dairy farming has continued as the only important agricultural activity around Seymour. Peak production and related land clearing occurred during the 1920's. Since World War II, the number of

farms in the watershed has been declining, although the average size has increased somewhat. Today there are less than ten dairy farms in the Seymour watershed. All are small.

Probably the most intensive period of economic development around Lake Seymour occurred during the last quarter of the 19th century. At that time, large-scale commercial forestry operations commenced, accompanied by a surge of industrialization. The local focus of this industrial development was the village of Morgan Center. During their heyday in the 1880's, the mills there and in the surrounding hills, employed 150 to 250 men (seasonally) and produced 15 to 20 million board-feet of various lumber products yearly.

This brief phase of industrialization ended by the turn of the century when most of the commercially valuable lumber had been cut. No other significant industrial activity has occurred in the watershed before or since. Also, since 1900, commercial forestry operations have been intermittent and relatively unimportant, and the area has been extensively reforested. However, three large paper and wood products companies retain large holdings in Morgan, and a resumption of intensive logging operations remains possible.

The recreational development of Lake Seymour dates from the early 1900's with construction of the first lakeshore cottages. The pace of development proceeded only very gradually through the early 1950's, and most of the lakeshore remained undeveloped at that time. In 1936, a boys' camp was opened along the southwest shore. It still operates today.

Population Trends. From their establishment, ca. 1800, until the 1880's, the populations of Morgan and Holland townships increased steadily. Peak population coincided with peak industrial activity (and peak employment). At that time the two village areas in the watershed, Morgan and Morgan Center, attained their greatest population levels, about 50 and 100 respectively.

From the 1880's through 1960, the populations of both towns declined steadily. Poor agricultural fortunes and the inability of the towns to support a stable industrial base were the major reasons for this decline. Since 1960, the populations of both Morgan and Holland have begun to increase again. In fact, the increase in Morgan since 1970 has been especially sig-

nificant, from 286 in 1970 to ca. 400 in 1975. This growth can largely be attributed to the immigration of families whose working members commute to other towns (Newport, Island Pond, Derby) for employment.

The Area Today. Although population levels have increased substantially on a percentage basis since 1960, Morgan township is still quite small. The local economy remains heavily dependent on the larger cities and towns of the area.

Most new residents of Morgan live in the hills overlooking the lake and commute to Newport for work. The natural beauty of the lake is a magnet for local families. Land prices for small lots in the surrounding hills have increased significantly in the last decade and have recently been selling for $1,000 to $1,500 and more per acre.

The lake community has also experienced growth in recent years. Since 1950, the number of lakeshore homes has more than doubled, from 100 to about 240. The vast majority of these homes are still used only seasonally, and most of the owners are not residents of Morgan.

Because the majority of lakeshore owners are not permanent residents, they have no formal voice in local government. However, the value of their property represents a significant percentage of the town's tax base. Thus, there exists a potential for conflict over issues of land use and policy and tax rates. The Lake Seymour Association has for a number of years acted as a mediator between town government and lakeshore residents.

3. The Relationship Between Human Activity and the Natural Processes in the Lakeshed

How the Condition of the Lake Affects the People. Seymour Lake is both large and deep by New England standards. It is a natural lake, although a dam was built at its outlet by the Citizen's Utility Company of Newport in 1920, and raised the water level slightly. The lake level is controlled by the Vermont Public Utilities Commission.

As described earlier, Seymour, like most deep lakes, separates, or stratifies, into three temperature layers each summer. The bottom layer (roughly between 40 feet and the bottom) stays cold all summer, is isolated from the rest of the lake waters during stratification periods, and lacks vegetation. Thus, oxygen levels in this bottom layer during

the summer are entirely dependent on oxygen supplied during the fall and spring turnovers. Trout, a great attraction for sportfishing on the lake, live in this layer and thrive on well-oxygenated waters. However, there are indications that oxygen levels in the bottom layer of Seymour are about 33 percent below maximum saturation during the critical late summer period.

There are two causes fol the somewhat depressed levels of oxygen in the bottom level of Seymour in the summer. The extreme depth of the lake probably prevents the complete mixing of lake waters during spring and fall turnover. This inhibits the renewal of oxygen in the bottom layer. Second, since settlement of the lake basin, Seymour has become a significantly more productive lake. More algae grow in its waters now than prior to 1880, even though, by most standards, Seymour has become a significantly more unproductive (oligotrophic) lake. The algae, when it dies, sinks through to the bottom layer of the lake. There it decays, using and depleting oxygen in the process. Increased algae growth, supported by the ever increasing nutrient levels in the lake, will likely continue to reduce the oxygen in the lake's bottom layer. Although the trout are in no present danger, a long-range deterioration of the cold-water fishery is possible.

How Human Activities Affect the Natural System of the Lake. Despite the fact that the relative intensity of man's activities has traditionally been low (except for the period of forestry and industrial operations), man's impact upon the lake has been significant. The lake has become more productive since settlement in the watershed. Furthermore, even though the intensity of man's development is lower now than at its peak 80 years ago, the lake's productivity continues to increase. This results from the cumulative effects of past disturbance of watershed lands, from the increased availability of nutrients to the lake, and from the continued heavy seasonal activity around Seymour, a lake with slow flushing characteristics and the resultant nutrient accumulation.

In sum, Seymour seems to be a relatively fragile lake. Disturbances of the watershed lands have increased the transport of nutrients from natural sources. These inputs are joined by others (septic system inputs,

runoff from developed shoreline areas, and precipitation), but they appear to be absorbed without effect on the lake. Nutrient loading is aggravated by the very slow flushing rate of the lake, which allows the nutrients to accumulate at the bottom. Again, there is no immediate visible effect. However, if trout population diminishes, then the ecological balance of the lake will be changed.

4. Major Issue Confronting People in the Lakeshed

To date, Seymour's two major problems -- the lake's slow flushing rate and increasing nutrient load -- have not seriously affected water quality. All indications, however, point to a significant increase in watershed development. The resultant increase in nutrients transported to the lake could have adverse consequences for the lake's recreational value. The problem of development is further complicated because, in many areas around the lake, the soils are unsuitable for proper septic tank operation.

The development of the lakeshore has already become an issue of some concern to residents of Morgan. The increase of lakeshore homes over the last 20 years has convinced many residents that land use regulations were necessary. However, zoning laws passed recently may complicate the problem, as present regulations allow one-fourth acre lots around the entire lake (including a full tier of large backlots). Tax revenue considerations apparently played a role in the zoning decisions. The high-value but small-lot properties of shoreland may induce rapid development and higher tax revenues in the short run. Heavy development, if it occurs, is likely to accelerate the trend of increasing productivity in Lake Seymour.

These six profiles may give the appearance that each lake was subject to a unique set of circumstances (variables). There are, however, recurrent themes, and it will be the object of the last two chapters to draw meaning from both differences and similarities.

Chapter III

A Comparative Analysis of the Six Study Lakes

In what respects are the six lakes alike, how do they differ, and which are the crucial impacts of urbanization? As before, we will begin with the natural system and follow it with the social system and an analysis of interactions.

Natural Systems

The table below presents salient limnological data for all the six lakes:

TABLE 3

Summary of Limnological Data

	Beach Pond	Columbia	Granite	Lashaway	Long Pond	Seymour	Mean (average)
Area	160.6	113.57	101.7	109.4	542.0	701.5	288.2 hectares
Max. Depth	19.8	7.8	33.9	6.1	18.2	50.9	22.8 meters
Ave. Depth[1]	6.1	5.1	13.0	2.6	6.1	21.2	9.0 meters
D_L[2]	2.0	1.70	1.6	1.5	3.0	1.7	2.2
Watershed[3]	10.7	7.43	11.1	14.8	310.5	45.8	66.7 Km^2
Vol./Wtrshd.	0.9	0.8	1.2	0.5	0.1	3.2	1.1
Impoundment	yes	yes	yes	yes	yes	yes	
Amt. raised	3.0	19.8	NA	ca. 6	ca. 1.0	NA	7.9 meters
Secchi disk	4.7	5.0	6.0	NA	6.3	NA	NA
Conductivity	42	57	47	54	31	NA	NA
Volume	9.9	5.8	13.2	2.8	31.6	148.6	35.3 x 10^6 m^3

[1] Average depth = Area/Volume

[2] D_L = shoreline development; the ratio of the actual shoreline length to the circumference of a circle having the same area as the lake.

[3] Watershed area excluding the area of the lake, itself.

approximation of urban impact, a number of general conclusions can be reached. First, population (permanent settlement) has grown steadily, though unevenly, in the areas of the southern three lakes since at least 1900. Second, this increase tended to accelerate in two of the three areas in the period 1950 to 1970. At Columbia, a relatively small town, population began to decelerate, though absolute growth continued to at least 1970.

TABLE 4

Population Change 1900-1970

	Resident Population				Net Changes			Percent Changes		
	1900	1950	1960	1970	1900-1950	1950-1960	1960-1970	1900-1950	1950-1960	1960-1970
Beach Pond	1713	2695	3326	4832	+982	+629	+1506	57	23	45
Columbia Lake	655	1327	2163	3172	+1317	+836	+1009	103	63	47
Granite Lake	662	431	368	464	-231	-63	+96	-35	-15	26
Lake Lashaway	NA	4687	5149	5939	NA	+462	+690	NA	10	15
Long Pond	2384	2172	2065	2169	-212	-93	+104	-9	-5	5
Lake Seymour	510	296	260	279	-214	-36	+19	-42	-12	7

SOURCE: Adopted from James Novak, Judy Pickering, Richard Andrews
The Economic Profile: A Method of Analysis for Six Study Lakes, p. 29.

TABLE 5

Median Family Income

Lake	Town	Median Income
Beach	Exeter	$ 9,064
	Voluntown	10,850
Columbia	Columbia	12,530
Granite	Stoddard	9,741
	Nelson	7,928
Lashaway	East Brookfield	10,131
	North Brookfield	10,600
Long	Rome	7,314
	Mt. Vernon	7,363
	Belgrade	7,625
Seymour	Morgan	6,138

SOURCE: Adapted from James Novak, Judy Pickering, Richard Andrews The Economic Profile: A Method of Analysis for Six Study Lakes, p. 32.

However, the income and population data is more significant where several tiers of private permanent residences surround the lake. Income levels and distribution can then be compared, for example, with education and attitudes, or population can be compared with lake usage.

3. Accessibility

The degree of urban influence may also be, in part, a function of accessibility and distance. Three factors are involved: the quality of the road network in and close to the town; the degree of public access in relation to private access; and the distance from major metropolitan centers and sizeable urban areas. Seymour, Lashaway, Granite and Columbia are completely surrounded by improved paved roads with easy access to the lake front. The shorelines of Long Pond and Beach Pond are only partially accessible by paved roads.

Seymour Lake, the most northern lake, is the most remote. Long Pond, although close to such smaller centers as Waterville and Augusta, is clearly more accessible than Seymour, even though they are within the same general distance band from Boston, Hartford, Worcester, Providence,

A look at our lakes quickly reveals significant differences:

TABLE 6

Percentage of Seasonal Homes

Lake/Communities	Seasonal Homes as Percentage of all Dwellings
Beach Pond (Voluntown, Conn. only)	21
Columbia Lake	14
Granite Lake (Stoddard only)	72
Lake Lashaway	
(East Brookfield)	13
(North Brookfield)	3.95
Long Pond (Belgrade only)	60
Seymour	73

SOURCE: Adapted from James Novak, Judy Pickering, Richard Andrews The Economic Profile: A Method of Analysis for Six Study Lakes, p. 32.

Unfortunately, a detailed housing survey for each lake watershed was not possible. It is difficult to tell, except through local observations, how densely the lakeshore and the drainage basin are occupied in terms of the numbers of people, the overall length of stay, and the pattern of density distribution. (In other words, is housing and population evenly spaced or concentrated in one area?) However, one can infer that total human residence time per year in the lakeshed and related lake surface use are social impact factors likely to grow fastest at Lake Seymour, followed by Long Pond, Beach Pond, Lake Lashaway and Columbia Lake, where the potential for expansion is large. The degree to which this potential will be realized depends on each lake's general desirability, the cost of property ownership, community organization, and management efforts. How much these potential impacts can affect each lake depends on various physical constellations. Each lake has a different degree of physical sensitivity.

5. Property Values

The cumulative net effect of all conflicting elements of the human dimension -- the social fabric of the lakeshed - is property value. Of course, property values are also subject to variables which have nothing to do with the lakesheds. Nevertheless, property value differences, when they are large and cannot be explained by non-lake-related factors, are significant indicators. The following table presents a 1975 appraisal of shorefront lot values per shorefront foot ranked in order:

TABLE 7

Shorefront Property Values

($/foot)

Columbia	$250
Granite	150
Beach	125
Lashaway	100
Seymour	85
Long	80

SOURCE: Gary R. Filteau, Value of Select Properties on Study Lakes in Regional Project "The Impact of Urbanization on New England Lakes." Hyde Associates, Concord, New Hampshire, January, 1976.

If we are to assume that these numbers at least roughly reflect the differences in current attractiveness of the six lakes, then clearly lakefront property value at Columbia Lake is highest. It should be recalled that Columbia, of all the lakes, is positioned closest to a vast reservoir of people (Hartford) and is within easy commuting distance. The area ranks low in seasonal homes and, not surprisingly, had the highest median income. Interestingly enough, property value at Lake Lashaway, though equally close to a metropolitan area (Worcester) is more similar to the two northern, remote lakes, and lakeshore property is not even half as valuable as that of Columbia and is fifty percent less than that of the clearly more remote Granite Lake. Most of these differences can be accounted for by the undesirable physical characteristics of Lake Lashaway. In addition, the difference between Lake Lashaway and Columbia

TABLE 8

Problems, Institutions, and Action For Lake Management

	Condition of the Lake	Lake Problems Perceived by Local Public	Institutions for Lake Management	Actions Taken or Contemplated at the Local Level to Manage Lake
Beach Pond	Resilient lake but fragile oxygen layer.	A sense of crisis exists with lakeshore property owners, primarily on the CT side. Overcrowding, noise pollution, general concern about the future appears	Border of CT and RI, Rhode Island State Park; Connecticut; town of Voluntown. No lake association, no joint forum for lake problems though planning does take place.	RI operates, maintains public beach and CT has boat launch, DEP in CT Dept. of Natural Resources in RI concern over development tract led to Voluntown planning, zoning.
Columbia Lake	Shallow but good flushing rates. Could be vulnerable if upland watershed is developed.	Lake property owners are vitally concerned with the quality of the lake's water. But concern is not really as great by non-lakefront property owners. Adequate financing for lake management measures are bone of contention.	Single townships, zoned for residential property only. Columbia Lake Assoc. & town government are major political institutions. Their interests do not coincide but concessions are made. State wetlands legislation.	Major actions related to zoning. Size of lot, Conservation Comm. has informal relationship with Planning-Zoning Board. Lake Assoc. and town do not collaborate.
Granite Lake	Deep and small, tends to stagnate. Recovery from deterioration would be long-term.	Concern by local lakefront property owners (mostly from Keene) is high, concern over degree of access, road construction, erosion, additional lake property development, but interest is limited and focused primarily on road location.	Towns of Nelson and Stoddard, Granite Lake Association is active, NH planning and highway department.	Plans were made, detailed information is available, but action has not been taken. Lake property owners, town governments (Sierra Club local chapter) are in disagreement. State is confronted by difficult highway decision.
Lake Lashaway	Quick flow through, shallow, but short flushing time offset other inputs, high levels of nutrients, of chemicals, of bacteria.	Lake property owners are concerned about the degree of pollution, algae bloom and macrophytes. Communities at large are decidedly less concerned, but fear tax loss.	Lake bisected by towns of N. Brookfield and E. Brookfield. Watershed extends into Spencer Lake Lashaway Assoc. No unified focus. Joint meetings difficult to arrange, but dialogue has begun.	Little joint coordination, chemical treatment of macrophytes. Division among two towns' interests and between the Lake Assoc. and towns.
Long Pond	Large lake, high flushing rate, resistant to algae blooms, some near-shore macrophytes.	Lakeshore property owners are less concerned than at the preceding four lakes. A focus is the level of the lake, control over privately owned dams and possible long term development somewhere in the large basin, not necessarily at Long Pond.	Towns of Belgrade, Rome and Mount Vernon. Belgrade Lakes Association. The problem focus is lacking. The state of Maine plays a strong legislative role. Tourism development important source of local revenue.	Major concerns are lake level, over control of abandoned dams.
Seymour Lake	Large and deep, ratio of land to water volume in lake small, tends to stagnate. What goes into lake tends to stay.	A small well educated summer population together with the local residents are concerned over recreational development along steep uplands and in a small watershed. Tourism and recreational growth worries summer residents; community is concerned with improved tax base.	Morgan Town government and Lake Association. Cooperation is fairly well advanced.	Planning has started (lot size zoning) small lots on shore -- larger lots away from shore -- good for taxes, not good for lakes. Better than nothing.

SOURCE: NECWCD (from Lake Study, 1977)