Northeast Aquatic Research, LLC

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October 5, 2007

Eileen Royael, District Clerk
Town of Putnam Valley
265 Oscawana Lake Road
Putnam Valley, NY 10579

RE: Summary of Aquatic Weed Survey at Roaring Brook Lake 2007.

Dear Eileen:

On July 17, 2007, I conducted a survey of the aquatic plants in Roaring Brook Lake. The goal of the survey was collect new information about the distribution of aquatic plants in the lake between the shoreline and water depths of about 8 feet. The purpose of the study was to evaluate the use of winter water level draw down as a weed management technique by observing aquatic plant growths in the areas of the lake that are exposed during a winter drawdown.

Background

Each winter the water level of Roaring Brook Lake is lowered approximately 4.5 feet to expose the shoreline and kill dense aquatic plant beds. Every 4 years the water level is lower approximately 7 feet. This report summarizes the results from the survey and provides initial evaluation of winter drawdown as a weed management strategy at Roaring Brook Lake. No water level records were available to evaluate the actual depth of the winter drawdown or the interval of time when a full 4.5 foot drawdown was accomplished. The water volume of the lake and the flushing rate were not evaluated to determine if there is adequate refill runoff volume for either a 4.5 foot or 7 foot drawdown.

Winter drawdown exposes lake bottom to drying and freezing conditions during the winter, killing most rooted aquatic plants. Plants need to be growing in the exposed area to be affected. Plants that are in deeper water than the drawdown are not affected. Exposed lake bottom that has deep organic muds or receive significant flows of groundwater may have limited or incomplete weed control because these areas may not freeze. Also, deep snow pack over exposed lake bottom may insolate the plants keeping deeper roots from freezing.

The survey consisted of two primary objectives. First, to collect aquatic plant species presence data from around the shoreline of the lake and relate the presence of species to the water depths they occurred in, and, second, to determine the density of the plant beds within the drawdown zone in order to identify target nuisance weeds. The

water depth data was used to provide a cross-index of the species with water depth, and to verify the location of the 4.5 and 7 foot depth contours in the lake.

Methods

The rooted aquatic plants were observed at 87 distinct sites around the shoreline of the lake using GPS to locate each point. At each site the species present were identified and the water depth measured using a depth sounder. Plants that reached the surface and formed floating structures were noted. Also noted was when there were no plants on the bottom or when specific species formed a bottom covering.

Aquatic Plant Species Observed

There were 9 species of aquatic plants observed in Roaring Brook Lake during the July 17, 2007 survey. These are listed in **Table 1** in order of abundance. The abundance is determined from the frequency of occurrence at the observation points. Large leaf pond weed is listed first because of the dense beds that had widespread occurrence thought-out most of the lake littoral zone. Typically, large-leaf pondweed occurred in dense monocultures, or beds composed of a single species. Plants within these beds also reached the surface and produced either floating leaves and or aerial flower spikes. There were few areas where Eurasian milfoil was found with surface formations, although, milfoil may have produced aerial flower spikes later in the season. Milfoil, although present at slightly more sites than the large-leaf pondweed, did not occur in dense monocultures as did large-leaf pondweed.

The naiad was very common in shallow water forming dense monocultures over the bottom when water depths were less than about 3 feet. Naiad was less abundant in deeper water although could occasionally be found mixed with other species such as large-leaf pondweed and milfoil. The coontail was very abundant in the northern bay (North Bay) mixed with milfoil, and in the southern coves as well as sporadically along the south and east shoreline.

There were 4 species of aquatic plants, all pondweeds that occurred at less than 10% of the sites. These were Ribbon-leaf pondweed, Long-leaf pondweed, Small pondweed, and Curly-leaved pondweed. The first three of these pondweeds are native the last is invasive. Ribbon leaf pondweed was the most common of the four typically being found in shallow waters, less than 4.5 feet deep. The long-leaf pondweed was present within a few of the large-leaf pondweed beds, mostly along the south shore. Small pondweed was found in the shallow areas, mostly less than 4.5 feet deep, within the two large coves on the south side of the lake. Curly-leaf pondweed is an early growing plant that typically begins growth in May, reaching full maturity in June and dieing back by July. It is likely that the majority of curly-leaf pondweed in Roaring Brook Lake had died back by the time of this survey. Surveys designed to map the distribution of curly-leaf pondweed are conducted in early June.

Two prior surveys of the aquatic plants in Roaring Brook Lake where consulted to compare to the species observed during this 2007 survey. An early survey conducted on July 5, 1985 by Ecoscience, of Moscow, PA, and second partial survey conducted on August 17, 1990 by Ecosystem Consulting Service of Coventry CT.

The earlier study, conducted by Ecoscience in 1985, found that Eurasian milfoil was the most dominant plant in the lake, inhabiting roughly 75% of the lake area. Other

species observed by Ecoscience are listed in **Table 2**. Dense growths of milfoil were found between the shoreline and between 8 and 13 feet of water depth. This agrees with findings made during the 2007 study that found plants generally growing out to water depths of 12 to 12.5 feet. Water deeper than 12 feet typically supported little to no plant growths. The species identified by Ecoscience were agreed with species found during the 2007 survey, with milfoil, coontail and large-leaf pondweed (also known as Bassweed) the dominant plants. Thin-leaf or ribbon-leaf pondweed was also found, although not reported in the 1990 survey.

The survey conducted by Ecosystem Consulting Service in 1990 listed bladderwort as the most dominant plant in the lake with milfoil and large-leaf pondweed as secondary species. The species observed in the 1990 survey are given in **Table 3**.

The species recorded from the lake during each of the three surveys are compared in **Table 4**.

Table 1. Aquatic Plant Species Observed in Roaring Brook Lake July 17, 2007 by Northeast Aquatic Research.

Common Name	Scientific Name	Percent Occurrence
Large-leaf pondweed	Potamogeton amplifolius	68
Eurasian milfoil	Myriophyllum spicatum	69
Coon tail	Ceratophyllum demersum	33
Southern naiad	Najas guadalupensis	29
Ribbon-leaf pondweed	Potamogeton ephiydrus	8
Long-leaf pondweed	Potamaogeton nodosus	2
Small pondweed	Potamogeton pusillus	1
Curly-leaved pondweed	Potamogeton crispus	5
Fanwort, floating fragments only	Cabomba caroliniana	3

Table 2. Aquatic Plant Species Observed in Roaring Brook Lake July 5, 1985 by Ecoscience

Common Name	Scientific Name
Eurasian milfoil	Myriophyllum spicatum
Coon tail	Ceratophyllum demersum
Large-leaf pondweed	Potamogeton amplifolius
Ribbon-leaf pondweed	Potamogeton ephiydrus
Naiad	Najas species
Small pondweed	Potamogeton pusillus (?)
Musk grass	Nitella species
Stonewort	Chara species
Needle Rush	Eleocharis species

Table 3. Aquatic Plant Species Observed in Roaring Brook Lake August 17, 1990 by Ecosystem Consulting Service.

Common Name	Scientific Name
Bladderwort	Utricularia geminiscapa
Eurasian milfoil	Myriophyllum spicatum
Bushy Pondweed	Najas minor
Coon tail	Ceratophyllum demersum
Large-leaf pondweed	Potamogeton amplifolius
Small pondweed	Potamogeton pusillus (?)
Musk grass	Nitella flexilis
Stonewort	Chara

Table 4. Comparison of Aquatic Plant Species Lists For Roaring Brook Lake From The Three Surveys On Record.

Common Name	Ecoscience, 1985	ECS, 1990	NEAR, 2007
Large-leaf pondweed	Yes	Yes	Yes
Eurasian milfoil	Yes	Yes	Yes
Coon tail	Yes	Yes	Yes
Southern naiad	Yes	Yes (misidentified?)	Yes
Ribbon-leaf pondweed	Yes	No	Yes
Long-leaf pondweed	No	No	Yes
Small pondweed	Yes	Yes	Yes
Curly-leaved pondweed	No	No	Yes
Fanwort, floating fragments only	No	No	Yes
Bladderwort	No	No	No
Musk grass	Yes	Yes	No
Stonewort	Yes	Yes	No
Needle Rush	Yes	Yes	No

Water Depth Contours

The results of measuring water depths around the perimeter of Roaring Brook Lake are shown in the modified bathymetric map presented as **Map 2**. The original bathymetric map is shown as **Map 1**. Generally the water depths were deeper than shown on the original map. The 4.5 contour was generally found to vary only slightly from the 5 foot contour. In a few instances, the North Bay principally, the 4.5 foot contour line is shown on **Map 2**.

The lake surface area between the shore and 4.5 feet and 7 feet was calculated from both maps. The total surface area between the shore and 5 feet was found to be 23 acres as compared to 38 acres from the old map. The surface area between 5 and 7 feet was found to be 15 acres instead of 25 acres from the old map. In total, the exposed areas are 23 acres, and 37 acres, for a 4.5 and 7 foot drawdown, respectively.

When the water is lowered to 4.5 feet, all of the two southern coves and the northeastern cove are exposed and about 5 acres along the northern shore is exposed. Most of the remainder of the lake has a narrow distance from the shoreline to the 4.5 foot contour line. In some places, along the west side and southern open water part of the lake, the distance from the shore to 5 feet of water is less then 100 feet.

This suggests that the most control will occur in the coves and along the northern shoreline. A narrow band of control will be realized along the remaining shoreline but in these areas the control of aquatic plants in this narrow band may be more fruitful because the distance to open water is less meaning that only a narrow band of plants prevents access to the open water. When drawdown removes these plants access is improved. In the shallows of the North Bay there is still significant distance to open water that is not affected by the drawdown so the affect of the drawdown may not be appreciated because boating and visual impairment is still significant.

Generally, there was little plant growth between the shoreline and 4.5 feet of water. This area typically had a dense coverage of naiad that formed a blanket over the bottom in the shallow waters, between the shore and about 4 feet. It was common to find a sharp demarcation between this weed free zone and the large-leaf pondweed occurring between 4 and 5 feet of water depth. This was especially noticeable along the western shoreline.

Surface Area Coverage

The surface area coverage for the four principal plants found in Roaring Brook Lake was estimated from the observation data collected on July 17, 2007. The entire lake was not surveyed so these values are subject to modification and refinement. Specifically, there was little attempt to find the deepest plants or to mark the outer edges of the beds when they existed past about 8 feet. Generally there were no plants in waters deeper than 11 or 12 feet, and in some cases 12.5 feet. It should be noted that because most of the water depths measured during this survey did not correspond well to the prior water depths, it is likely that the deeper water contour of 15 feet probably is incorrectly portrayed on the old map. It was also not part of the study to map the 12 foot contour line. There were places along the southeast shore were 12 feet of water was found within 50 feet of the shore, significantly different than the old map.

The lake has about 76 acres of littoral zone, or the area of the lake that supports aquatic plant growths. Milfoil was the only plant that appeared to grow out to 12 feet but when it did so it did not reach the surface. Large-leaf pondweed was found growing in water depths of 7 to 9 feet with plants in 8 feet reaching the surface. This suggests that the area of the lake that supports dense surface reaching plants is closer to 55 acres, with the remaining 21 acres only supporting deep water milfoil, these areas were not surveyed as part of this study.

The estimated surface area coverage of the four principal aquatic plant species, large-leaf pondweed, Eurasian milfoil, coontail, and naiad, are given in **Table 5**. These values are estimates and should be considered subject to change based on future surveys.

Table 5. Aquatic Plant surface Area Coverage In Roaring Brook Lake In July 2007.

Species	Acres
Large-leaf Pondweed	38
Milfoil	32
Naiad	17
Coontail	12

Large-leaf pondweed is estimated to cover about 38 acres of 55 acres or about 70% of the nuisance plant zone of the lake. The distribution of large-leaf pondweed is shown in **Map 3**. The largest bed of large-leaf pondweed occurred in the North Bay, where most of the bay is dominated by dense monocultures of this plant. There are also dense stands of large-leaf pondweed on the south and southeastern shores. Pondweed was found to reach the surface in water depths up to about 7 feet. There was generally little large-leaf pondweed within the drawdown zone of the lake, that is between the shore and 4.5 feet of water depth. One exception to this was a bed of dense large-leaf pondweed located at the extreme southern end of the southwestern cove.

Eurasian milfoil was found to cover about 32 acres of the surface area of Roaring Brook Lake but part of that area was plant coverage that occurred between 8 and 12 feet of water depth. The estimated surface area coverage in the lake is shown in **Map 4**. Milfoil was not dense in any areas of the lake but instead tended to be co-dominant with large-leaf pondweed. Also, milfoil was not observed breaking the water surface with aerial shoots. However, it is likely this occurred later in the season, during August or September. Milfoil was found within the drawdown area in selected locations. Each of the three coves, the two southern coves and the eastern cove, had isolated beds of milfoil but no dense beds.

Naiad was the predominant plant in the shallow waters around the lake. The distribution of naiad is shown in **Map 5**. Each of the three coves had a dense blanket of naiad covering the bottom. The distribution of naiad in Roaring Brook Lake covered about 17 acres. This plant was also found in most, but not all, of the drawdown zone. There were some places along the shoreline were the drawdown zone had few plants.

Coontail was present in about 12 acres of the surface area of the lake, see **Map 6**. There were few areas were coontail was dominant, and it wsa plentiful only in the northern end of the North Bay. In the other areas where coontail was present it was mixed in with milfoil and pondweed.

Species and Water Depths

Generally, naiad was found in the drawdown zone, between 0 and 5 feet of water. The chart of frequency of observation, shown in **Figure 1**, illustrates that naiad was most frequently found between 3 and 4 foot depths. In water deeper than about 5.0 feet the frequency declined. No naiad was observed in water deeper than about 7 feet.

Water milfoil was most frequently found in deeper water as shown by the frequency graph in **Figure 2**. Milfoil was found in water shallower than 5 feet about 16% of the time while large-leaf pondweed, shown in **Figure 3**, was found in the drawdown zone about 11% of the time. This suggests that pondweed was better controlled with the drawdown than was milfoil, although each was affected by the

drawdown. Milfoil showed a somewhat equal frequency of occurrence across the depth range of 3 to 6 feet, with a slightly higher percentage occurrence at 7 feet. Pondweed showed low frequency at 3 and 4 foot depths, moderate frequency at 5 and 6 foot depths but high frequency at 7 feet.

Figure 1. Frequency Of Occurrence Of Naiad Vs. Water Depth In Roaring Brook Lake.

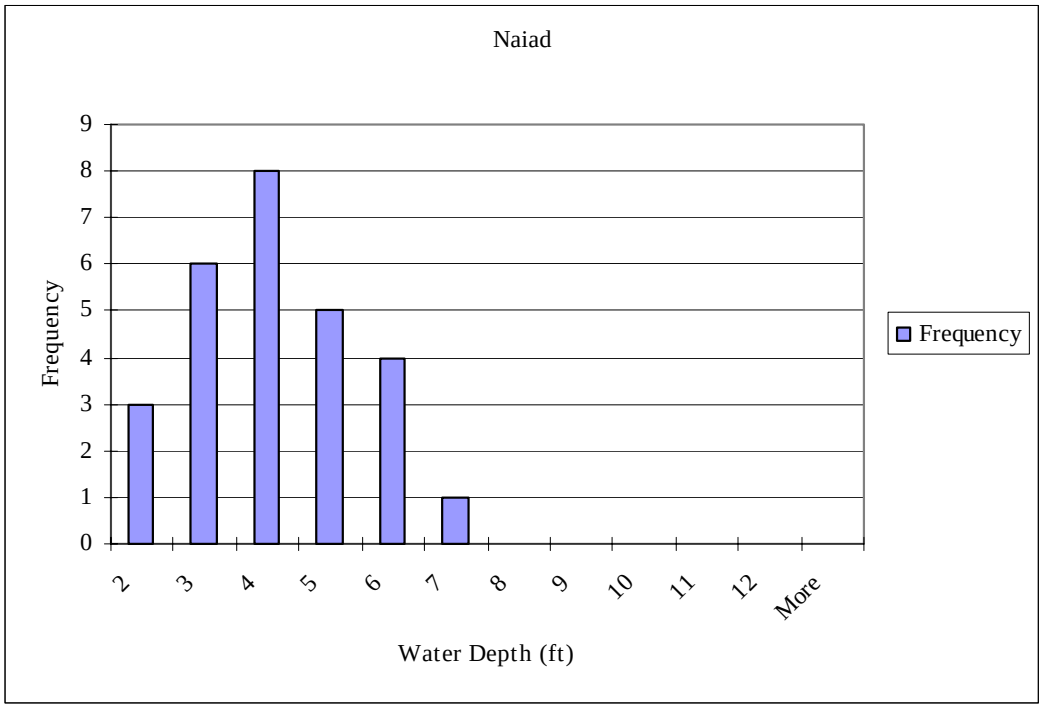


Figure 2. Frequency Of Milfoil Vs. Water Depth In Roaring Brook Lake.

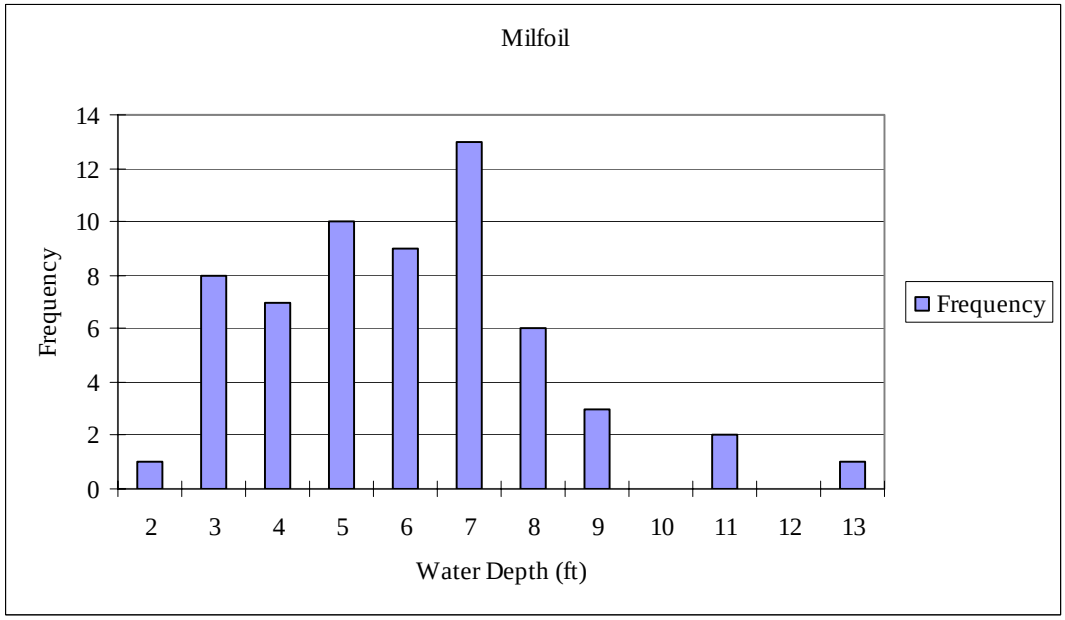
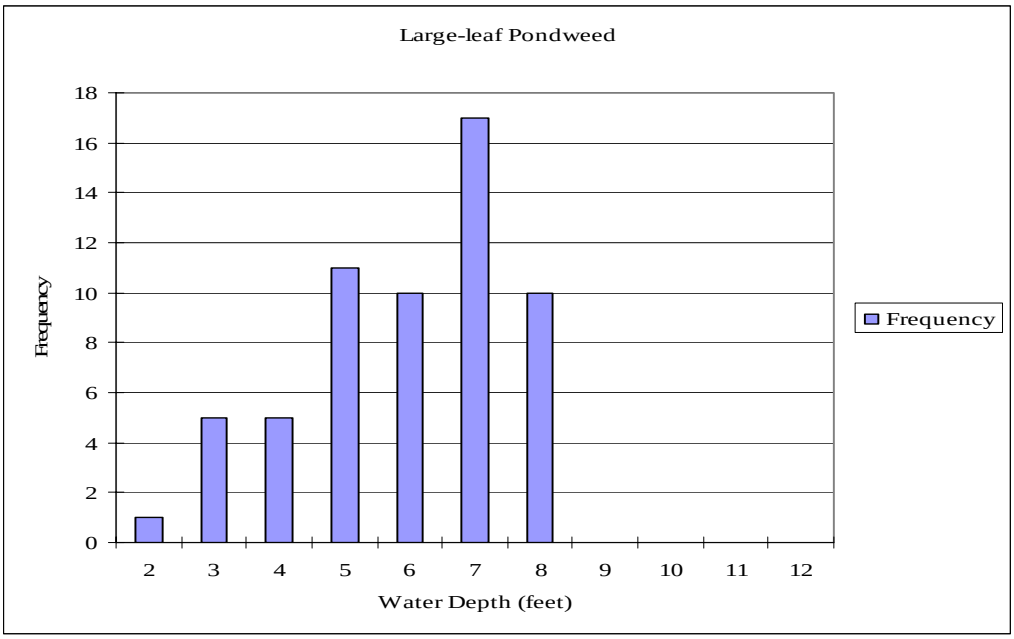


Figure 3. Frequency Of Large-Leaf Pondweed Vs. Water Depth In Roaring Brook Lake.



Conclusions

Winter drawdown of the lake water level is conducted each year at Roaring Brook Lake. Each winter the lake is lowered 4.5 feet below the normal summer level. Every 4 years the lake is lowered to 7 feet below the normal summer level. The 4.5 foot lowering exposes approximately 23 acres of the littoral zone of the lake. The 7 foot lowering exposes an additional 15 acres for a total of approximately 37 acres. These areas are shown on **Map 7**. Based on the survey conducted on July 17, 2007 aquatic plants are growing in dense nuisance beds over about 55 acres of the lake area. There is an additional 21 acres of milfoil in deeper water for a total of about 76 acres of the lake area that supports dense growths of aquatic plants. Because the milfoil in deeper water, between 8 and 12 feet deep, does not reach the surface it is probably not considered as much of a severe impairment as is the pondweed growing in the water depths up to 8 feet. A 4.5 foot drawdown affects 42% of the 55 acres of shallow water (0 – 8 feet) plant beds. A 7 foot drawdown affects 67% of the 55 acres of shallow water beds. Obviously a deeper drawdown of either 8 or 9 feet would affect all of the large-leaf pondweed beds.

The 4.5 foot drawdown appears to affectively keep dense growths of large-leaf pondweed and milfoil from proliferating within the coves. Some of the plants were seen in each of the three large coves but in each case the observed plants were in small beds of as sporadically located individual plants. And in each case the plants appeared to be located at the extreme inner ends of the coves suggesting either ground water or surface runoff was keeping these areas from freezing. This suggests that both large-leaf pondweed and milfoil would continue to colonize and expand in the coves eventually filling the coves with dense stands similar to what now occurs in the North Bay. Without drawdown the coves would be full of large-leaf pond weed and milfoil.

Drawdown also controls plants along a majority of the shoreline. Although the band of exposed lake bottom is narrow the drawdown affectively provides access to open

water by controlling the narrow band of plants that would prevent that access. Without the drawdown large-leaf pondweed and milfoil would create topped out beds along the shoreline that would further impair boating and swimming.

The North Bay has the largest area of dense plant growth as almost all of the North Bay is full of dense large-leaf pond weed and milfoil. Because of the overall shallower water depths in the North Bay drawdown has the largest affective area here. However, even with a 7 foot drawdown large areas of the North Bay retain dense pondweed and milfoil after the drawdown because of the location of the 8 foot contour within the North Bay. With a 4.5 foot drawdown most of the North Bay weed beds are untouched. So even thought about 5 acres of North Bay is exposed, 25 acres of dense pondweed and milfoil remains unexposed. In the North Bay drawdown may appear to be ineffective because so much area of dense pondweed remains unaffected.

Recommendations

It appears from the results of this study that winter water level drawdown at Roaring Brook Lake is an affective means of controlling large-leaf pondweed and Eurasian milfoil. A 4.5 foot drawdown affectively controls plants in about 23 acres or about 40% of the dense, nuisance weed beds in the lake. A 7 foot drawdown is even more affective by controlling about 60% of the nuisance weed growth areas.

Drawdown does not control all of the plant beds throughout the whole lake. In North Bay there remains about 20 acres of dense pondweed after a 4.5 foot drawdown. After a 7 foot drawdown the remaining acres of pondweed is about 10 acres. In most areas drawdown keeps pondweed and milfoil from reaching the surface and forming a band of topped out plants.

I suggest the following list of actions to be considered during future drawdowns.

1) Keep an accurate record of the lake water level during the drawdown by measuring the water level at the dam every few days. In this way the actual area of exposed shoreline can be known. The plant growth along the shore can be referenced against the duration of time that it was exposed. This also provides for detailed assessment of the volume of the lake that has been drained and is refilled.

2) After each drawdown re-evaluate the plant species presence and distribution density of plants in the drawdown range. Once a long term record is started each successive drawdown can be compared to records of conditions prior to the drawdown. In this way the increase and decrease of species and bed density can be evaluated.

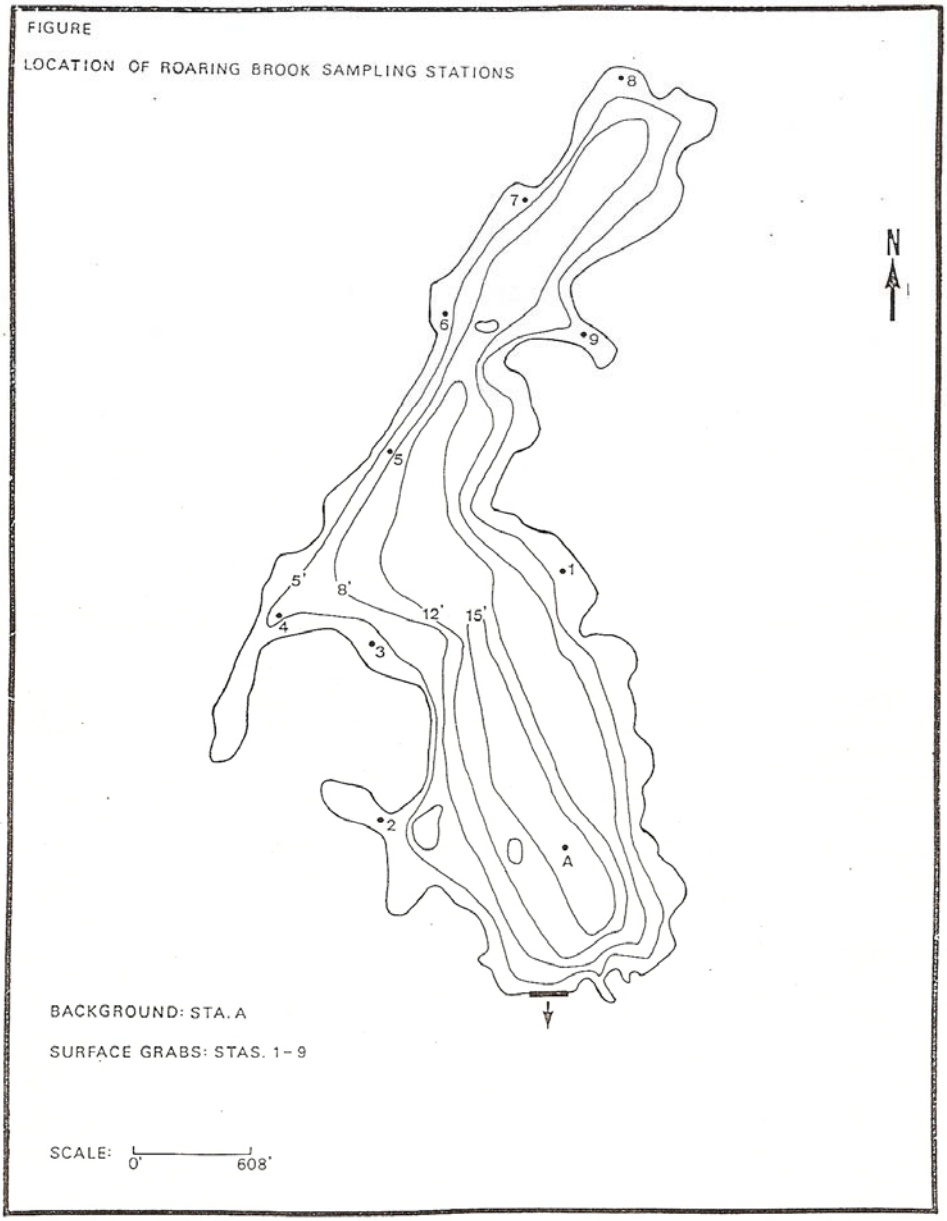
3) Keep detailed recorded of air temperature and snow pack. Also keep records of areas in the lake that don't freeze or freeze late such as the inner ends of the coves.

If you should have any questions please don't hesitate to call me,

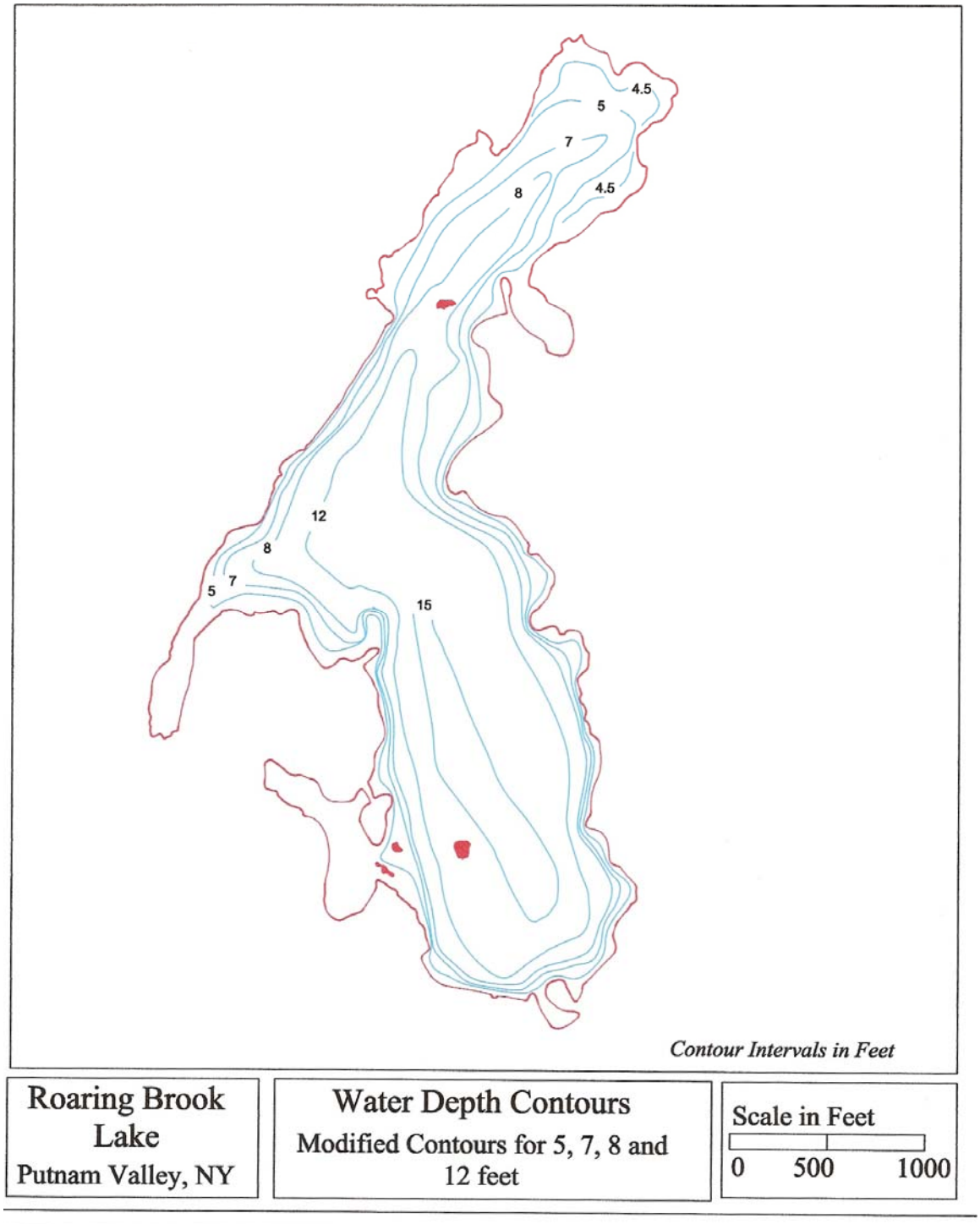
Sincerely,

George W. Knoecklein

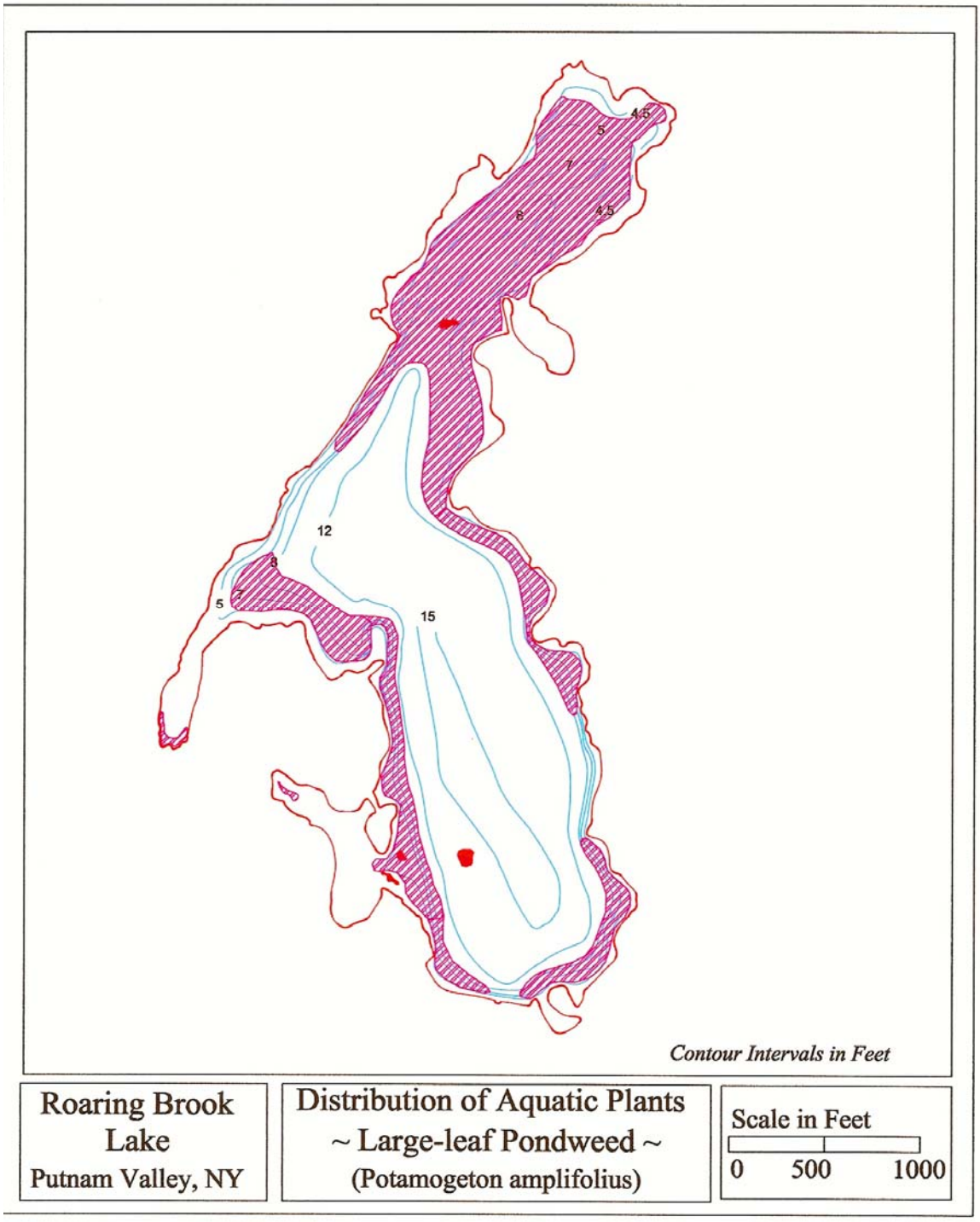
Map 1 Bathymetric Map of Roaring Brook Lake Presented in 1985 Report by Ecoscience and 1991 Report by Ecosystem Consulting Service, Inc.



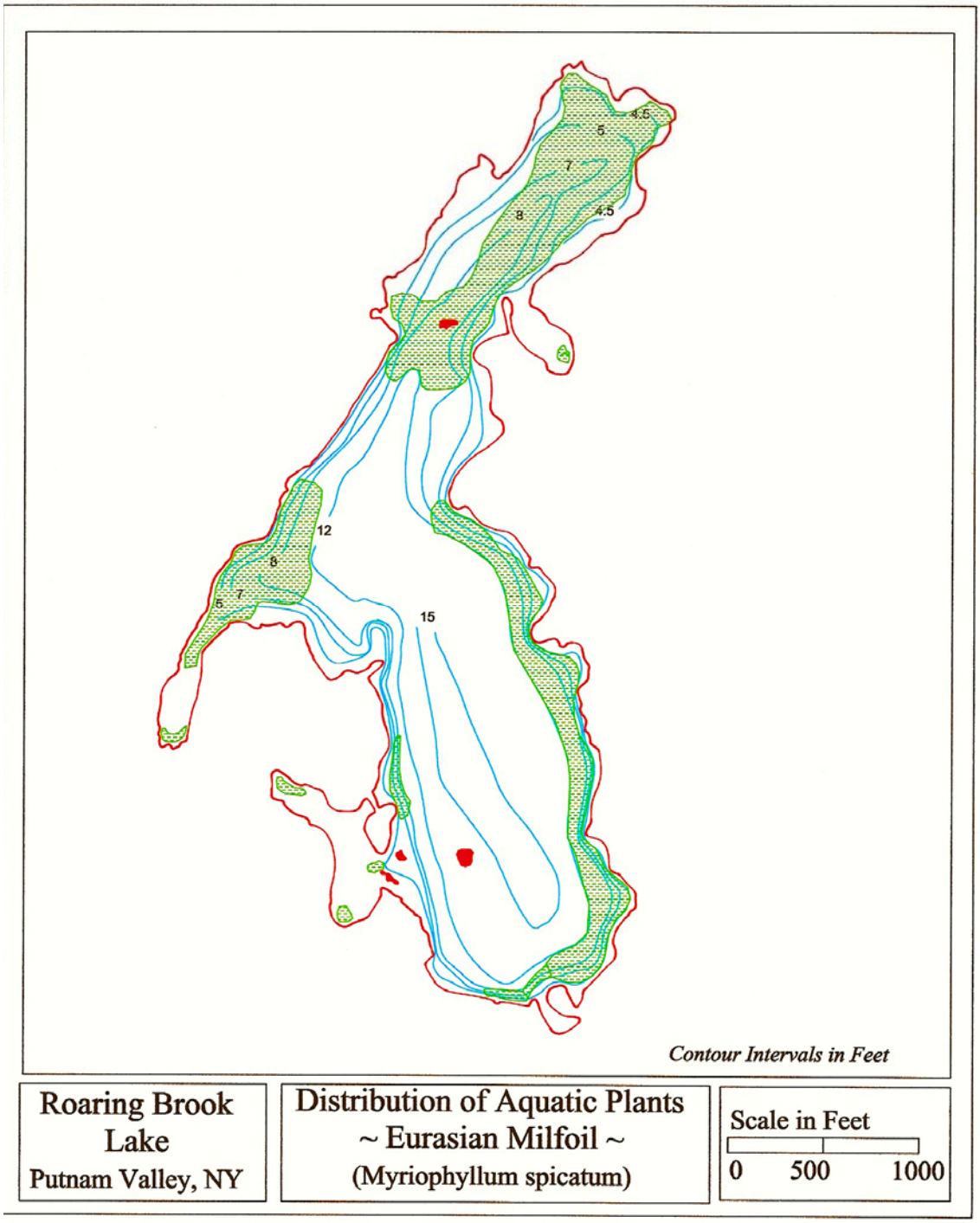
Map 2. Bathymetric Map of Roaring Brook Lake Showing Modified Water Depth Contours for 5, 7, 8, and 12 feet.



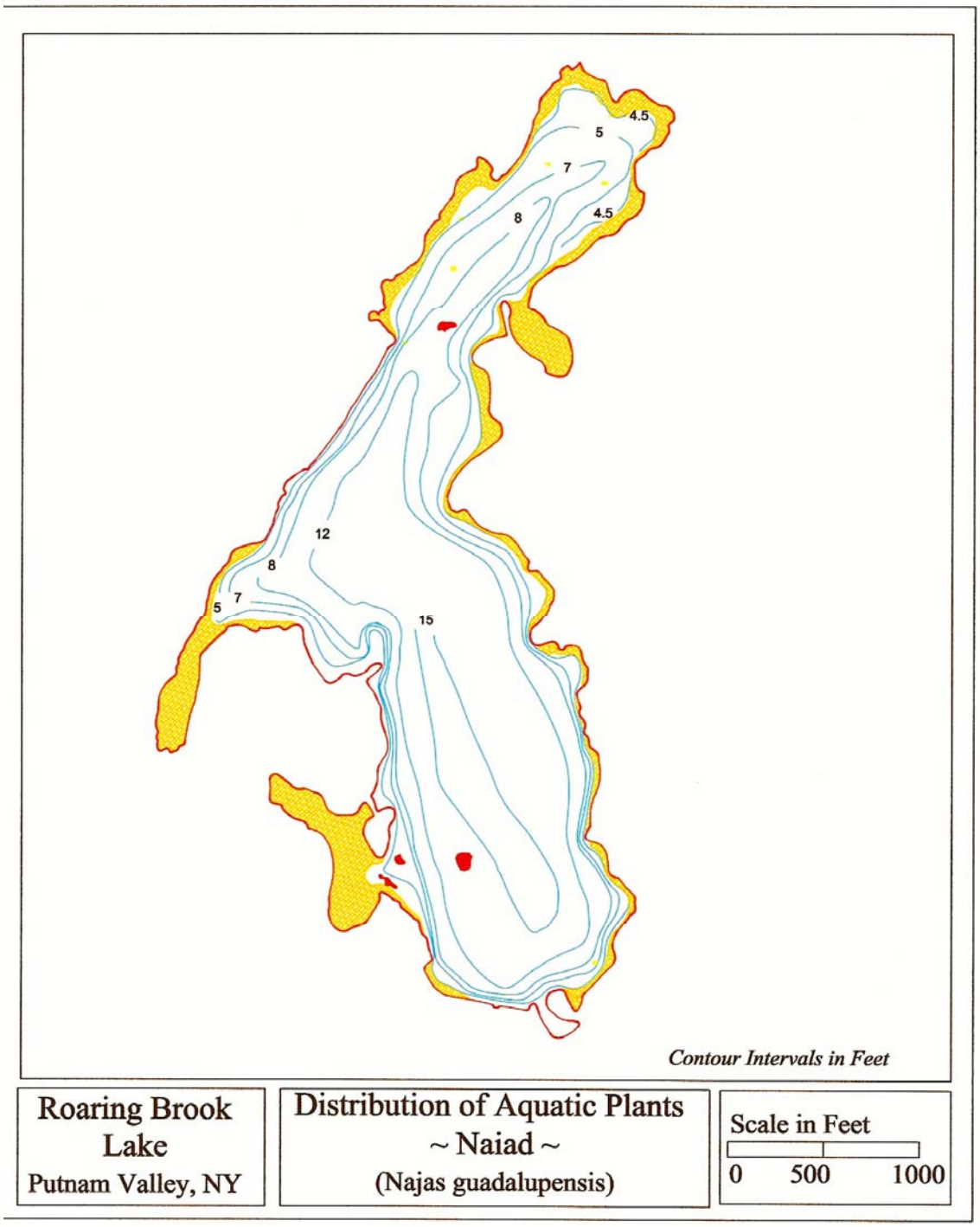
Map 3. Distribution of Large-leaf Pondweed in Roaring Brook Lake July 2007



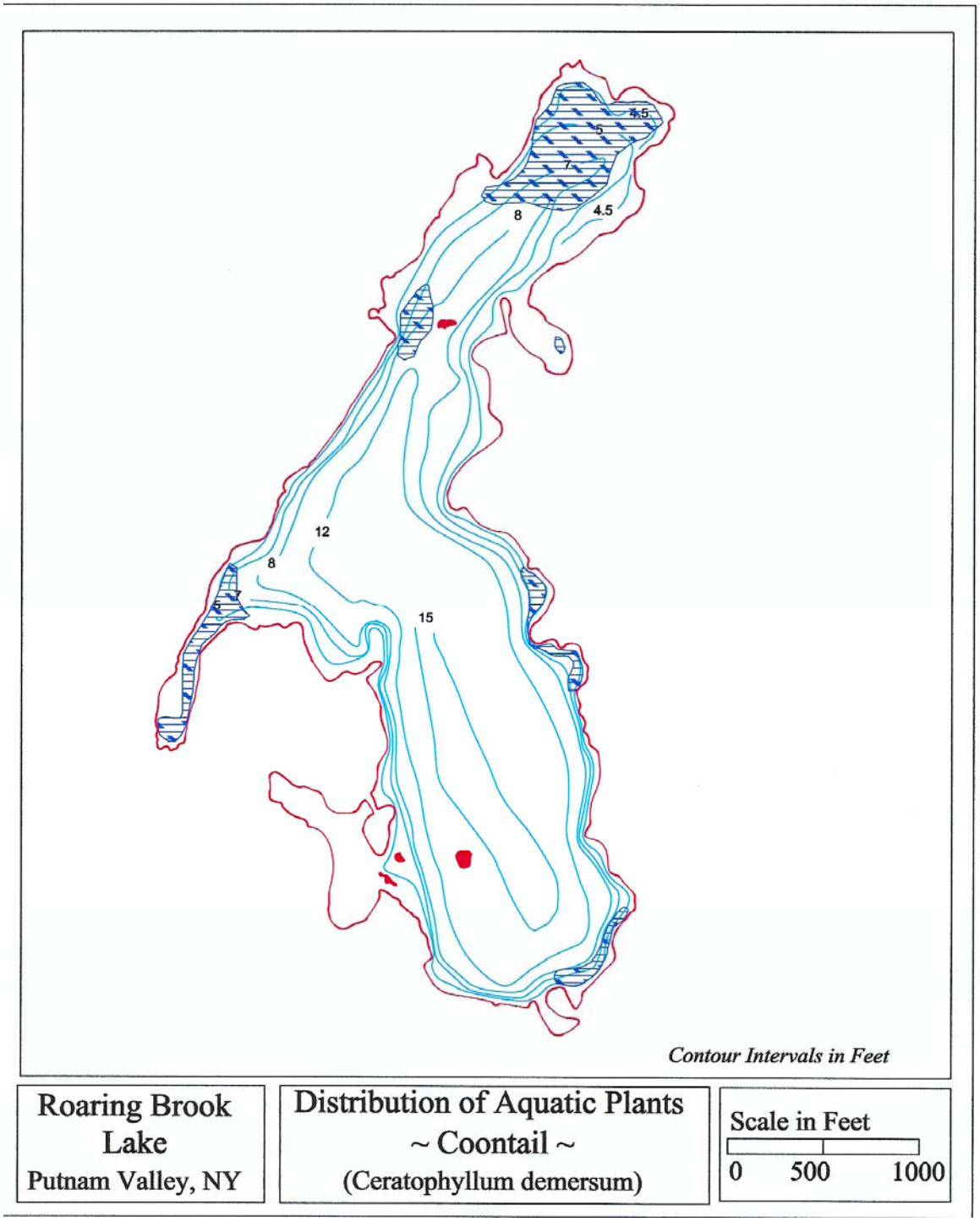
Map 4. Distribution of Eurasian Milfoil in Roaring Brook Lake, July 2007.



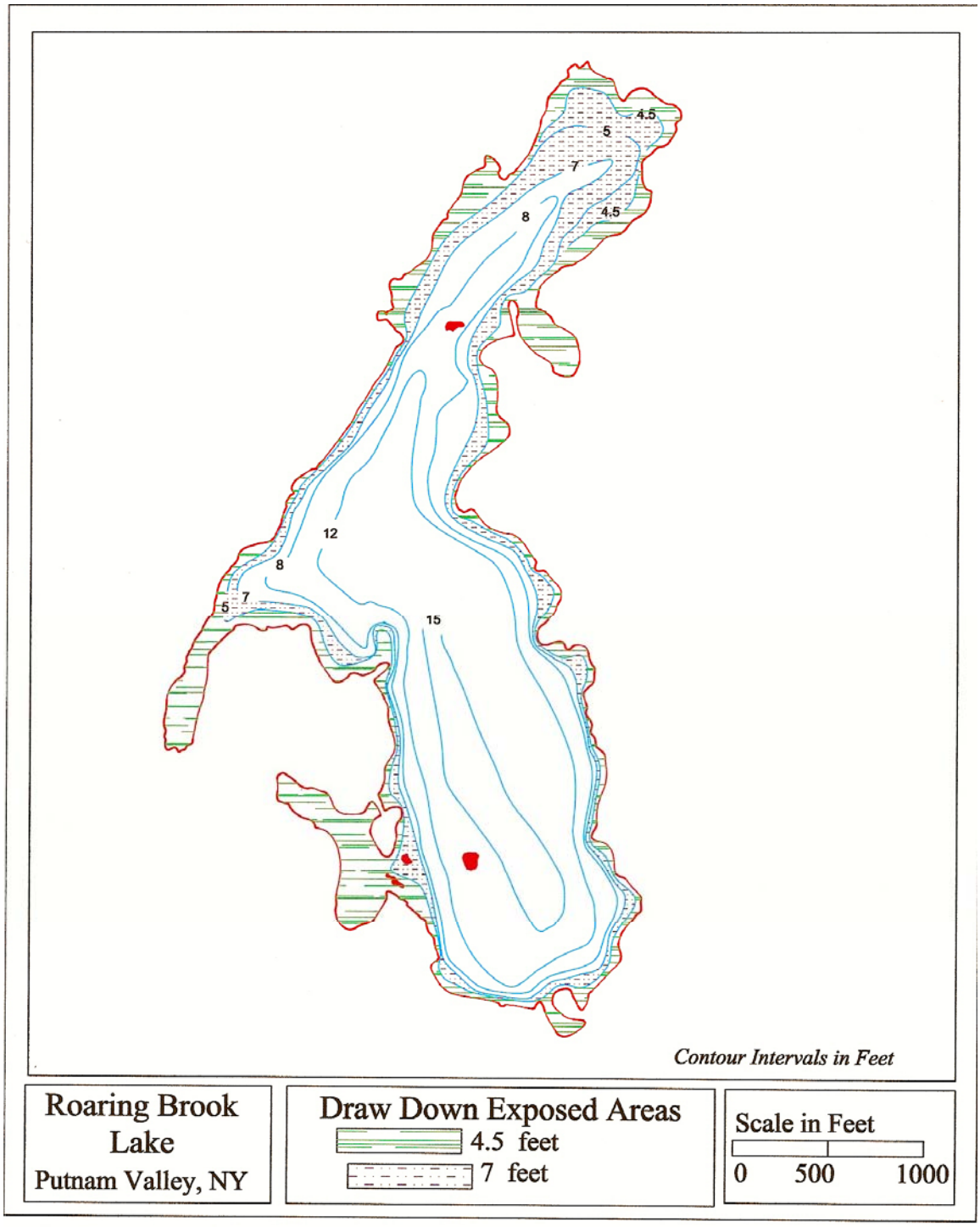
Map 5. Distribution of Naiad in Roaring Brook Lake, July 2007.



Map 6. Distribution of Coontail in Roaring Brook Lake, July 2007.

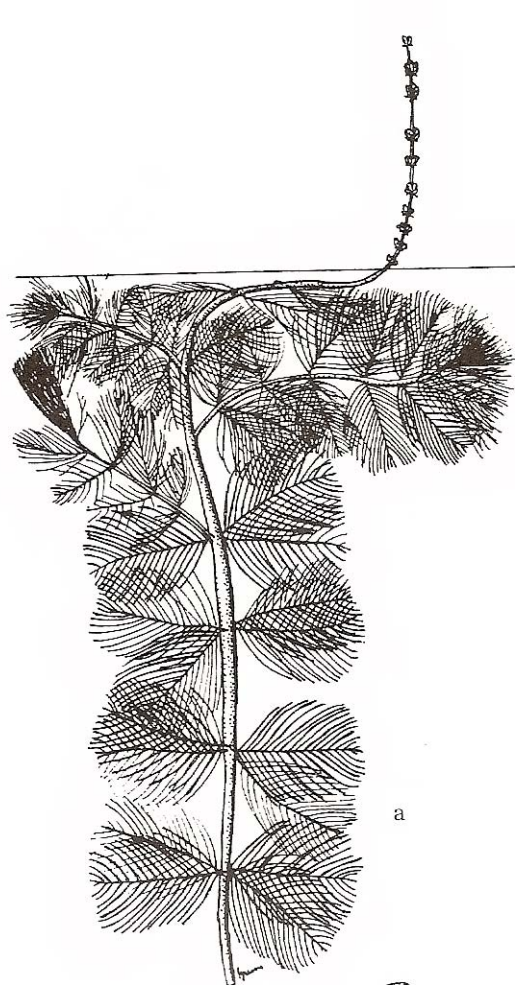

4.5
5
7
8
4.5
12
8
5
7
15
Contour Intervals in Feet
Roaring Brook Lake
Putnam Valley, NY
Distribution of Aquatic Plants
~ Coontail ~
(Ceratophyllum demersum)
Scale in Feet
0
500
1000

Map 7. Exposed Areas of Roaring Brook Lake During Different Drawdown Depths.

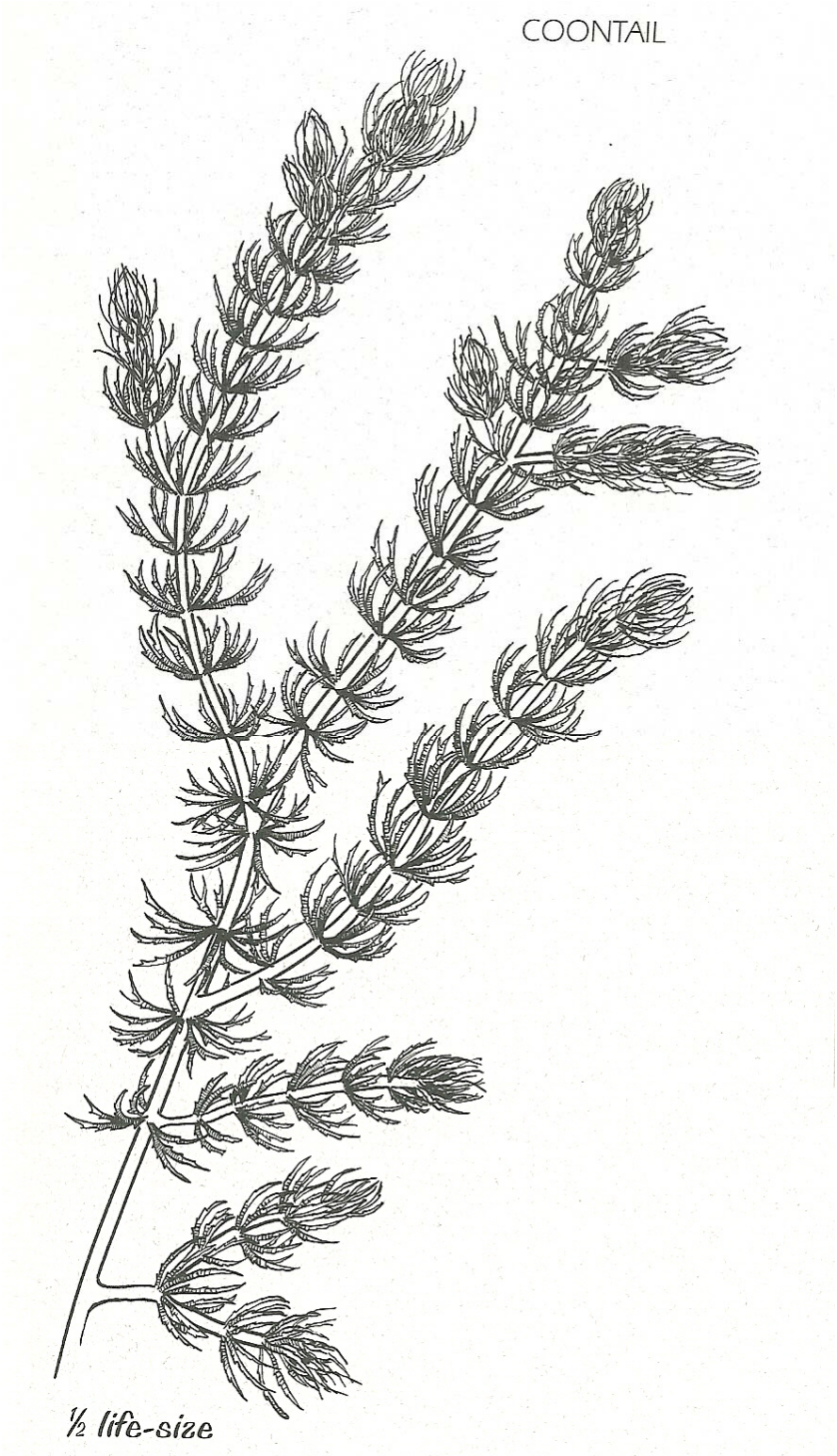


Line Drawings of Plants Observed in Roaring Brook Lake July 2007

Eurasian Milfoil



Coontail

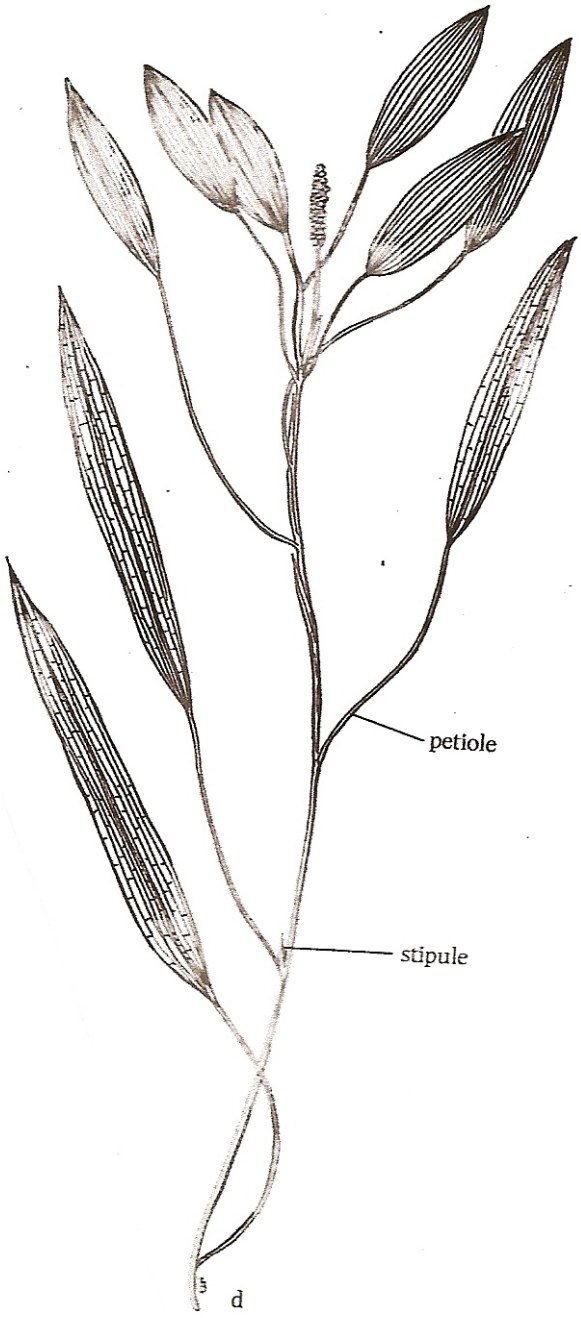


Large-leaf Pondweed

Naiad

Ribbon-leaf Pondweed

Long-leaf Pondweed



Curly-leaf Pondweed

Fanwort