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Prepared For:

Regional Water Authority

South Central Connecticut Regional Water Authority

A BIOLOGICAL ASSESSMENT OF UPPER LAKE WHITNEY

February 2007

Prepared By:

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Introduction

Lake Whitney is a public water supply reservoir that had been inactive since 1991 until a. new water treatment facility went online in April 2005. Lake Whitney's lower watershed is heavily urbanized and the South Central Connecticut Regional Water Authority (SCCRWA) is implementing a number of watershed management actions to control water quality impacts caused by nonpoint sources of contaminants. In addition, the SCCRWA is operating the treatment plant in accordance with a Management Plan designed to balance the water needs of the region with those of the environment. The shallow nature of Lake Whitney's upper basin makes it susceptible to substantial exposure of bottom sediments when lake drawdowns exceed two feet.

In response to public concerns raised about the effect of future water withdrawals on the shallow upper basin, the SCCRWA commissioned the upper Lake Whitney Management Study in 2000 to determine the most environmentally sensitive and cost effective way to manage upper Lake Whitney as a water supply while maintaining the ecological and aesthetic quality of the area (Milone and MacBroom, Inc. et al., 2002). The study concluded that watershed management actions should take priority over dredging of accumulated sediments, as dredging would provide minimal water quality benefits while damaging potentially valuable habitat. Hydrologic modeling of water levels under various scenarios conducted as part of the study concluded that drawdowns as a result of public water supply withdrawals will be extremely infrequent. However, extended lake drawdowns of noticeable extent and duration related to maintenance of the dam and various town and state bridges crossing the lake will occur just as they have in the period since August 1991 when the reservoir and the original water treatment plant were removed from service as a public water supply.

As part of an ongoing effort to document existing conditions and to provide baseline information for ongoing environmental monitoring after water withdrawals resume, the SCCRWA requested that ENSR conduct biological assessments of upper Lake Whitney after the initial 2000 investigation. The 2004 evaluation included a period with a large drawdown for maintenance, but without active water withdrawal. ENSR evaluated biological features of upper Lake Whitney in 2005, during the first year of water withdrawal. This report summarizes the biological features of upper Lake Whitney in 2006, during the second year of water withdrawal.

Beginning in 2000, the reservoir was drawn down for maintenance activities on four occasions. From August to November 2000, Lake Whitney was drawn down by a maximum of about 1.6 ft for dam maintenance (Figure 1). Water levels were unaffected by SCCRWA operations in 2001 and 2002 (Figures 2 and 3). In October and November 2003 the reservoir was drawn down by a maximum of 3.9 ft, also for dam maintenance

(Figure 4). In 2004 the reservoir's water level was again lowered from early July to late August, reaching a maximum drawdown of about 6 feet below spillway elevation (Figure 5). In 2005, the lake's water level was slightly below spillway elevation during the first half of September due to water withdrawals and downstream releases to the Mill River, coupled with an extended period of low precipitation (Figure 6). Following data collection for this study, the lake was drawn down in July/August 2006 to facilitate a wetland construction project to help protect the water quality of the lake (Figure 6).

Actual water withdrawal does not appear to have had a measurable effect on water levels, but continued monitoring has provided data on the impact of changing water levels on basic biological components that help present a picture of conditions under the range of water levels in the lake.

2000 Lake Whitney Lake Level

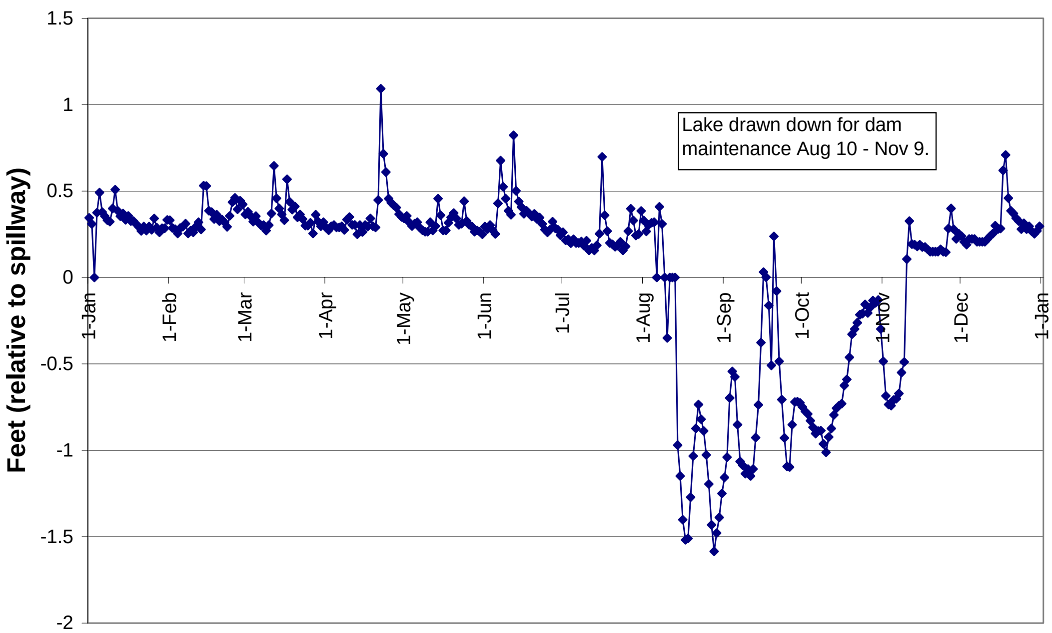

Figure 1. Water level graph for Lake Whitney during 2000.

2001 Lake Whitney Lake Level

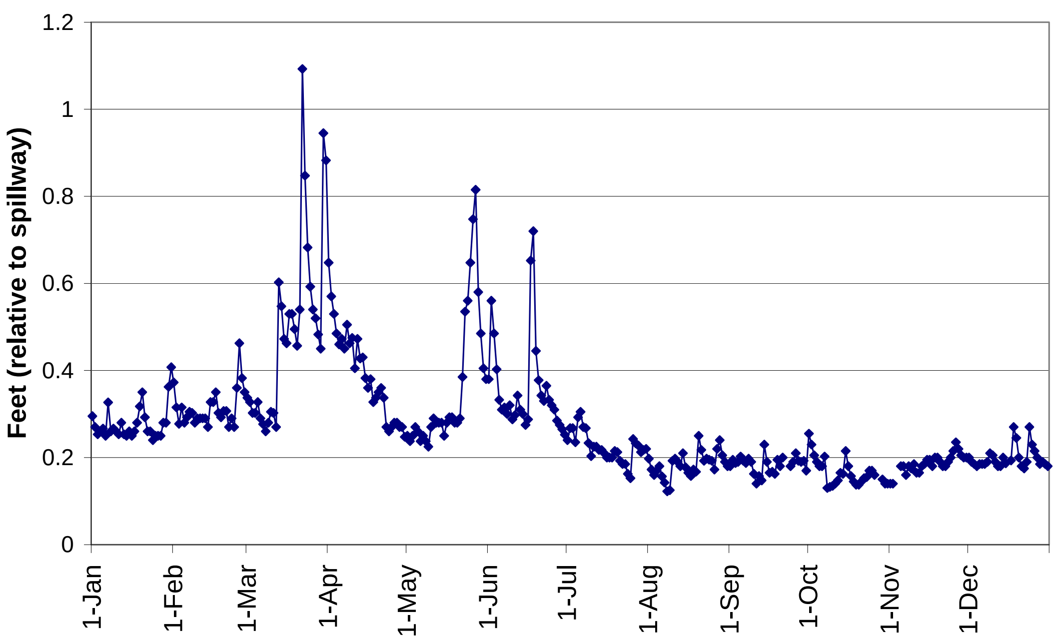

Figure 2. Water level graph for Lake Whitney during 2001.

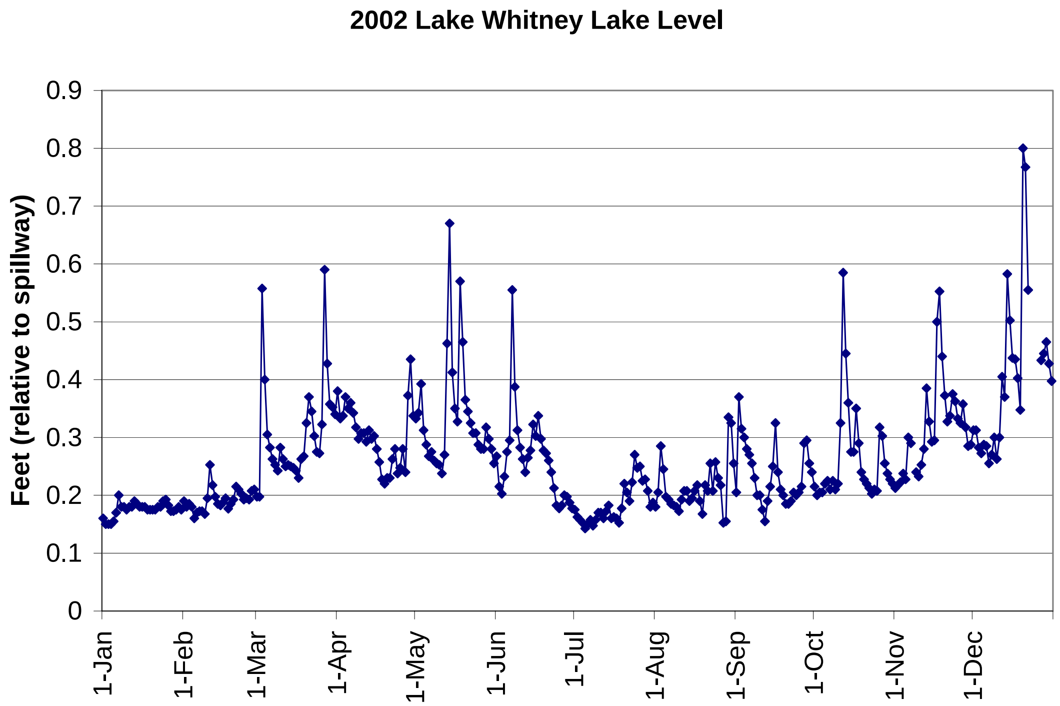

Figure 3. Water level graph for Lake Whitney during 2002.

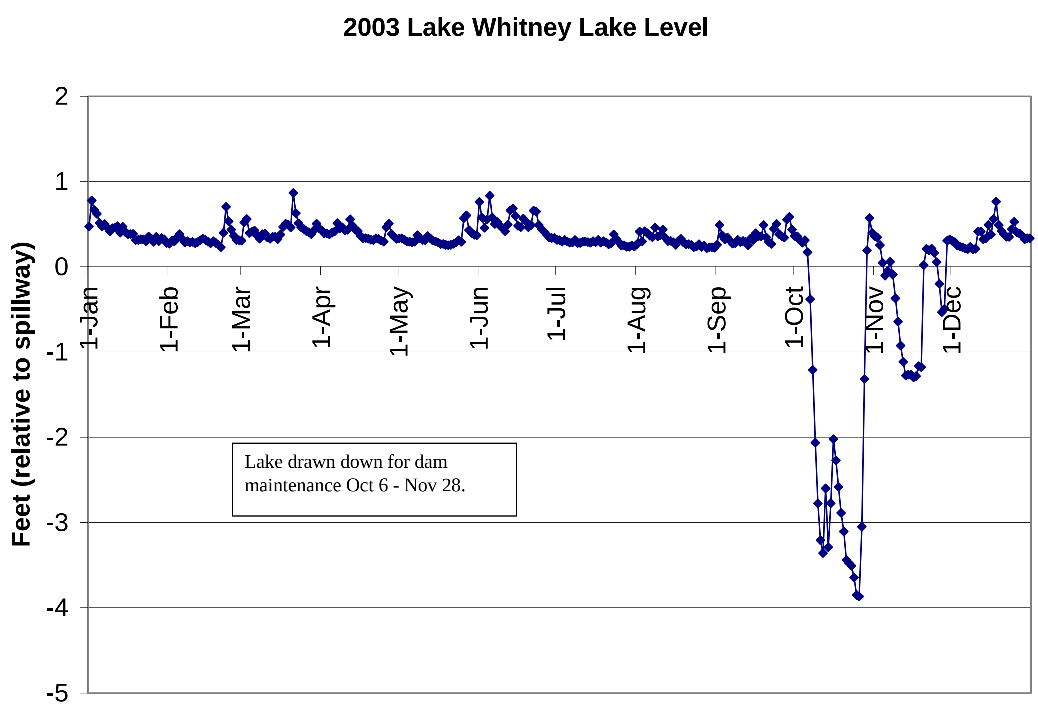

Figure 4. Water level for Lake Whitney during 2003.

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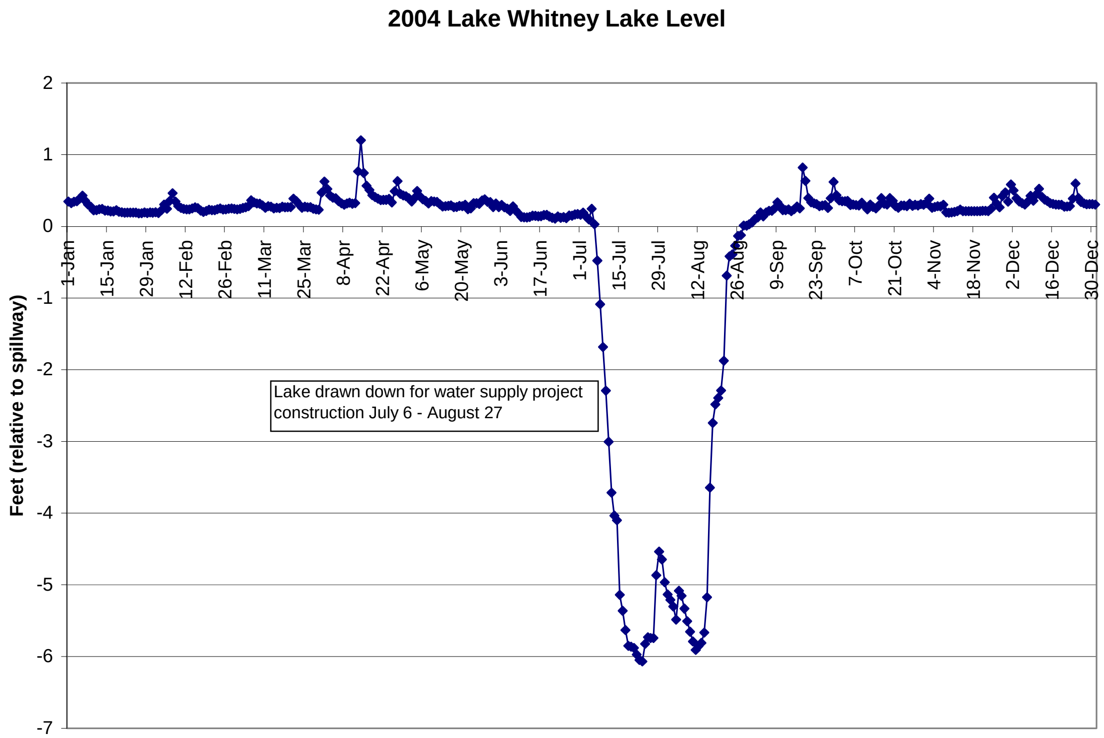


Figure 5. Water level for Lake Whitney during 2004.

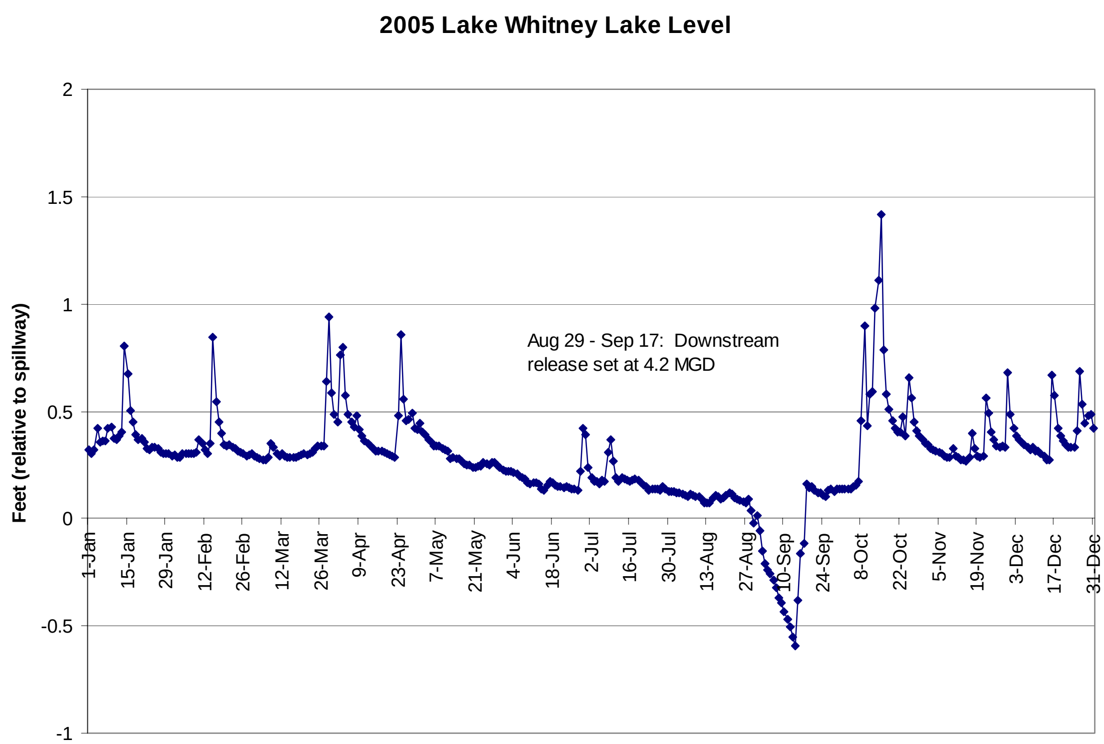


Figure 6. Water level for Lake Whitney during 2005.

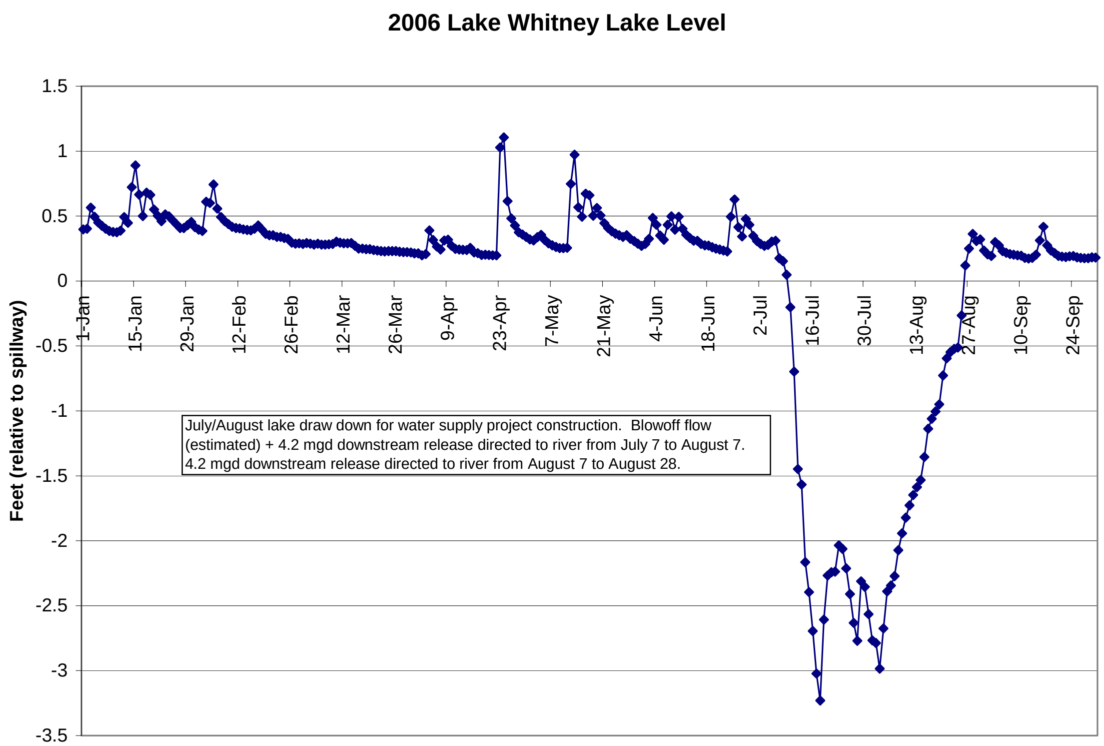


Figure 7. Water level for Lake Whitney during 2006.

Methods

This assessment incorporates evaluations of phytoplankton, zooplankton, aquatic macrophytes, benthic macroinvertebrates, fish, and water quality in upper Lake Whitney. Phytoplankton were assessed from a whole water sample collected as a near-surface grab sample once on June 8, 2006. Samples were preserved in gluteraldehyde, concentrated by settling, and examined under phase contrast optics at 400X. Cell counts were converted to biomass estimates on a volumetric basis based on cell measurements.

Zooplankton were collected with a 53 micron mesh net towed through up to 30 meters of water on an oblique angle, yielding a sample of about 100 ml that represents nearly 1000 liters of lake water. One sample was collected at the June 8, 2006 phytoplankton sampling site. The sample was preserved and settled in the same manner as the phytoplankton, and examined at 100X under brightfield optics. Individual counts were converted to biomass estimates based on measured organism dimensions.

Macrophytes were mapped by assessing composition and density at numerous points along multiple transects across the lake on June 8, 2006. In addition to recording the species of plants and their overall and relative abundance, water depth and sediment type were also noted. A rating system was used to evaluate cover (two dimensions) and biovolume or biomass (three dimensions). In this system, a 0 represents no plants, while a 5 represents complete cover or filling of the water column. Ratings of 1 through 4 correspond to quartiles in between (i.e., 1-25%, 26-50%, 51-75%, and 76-99%).

Benthic macroinvertebrates were collected on June 8, 2006 with a D-frame dip net according to Rapid Bioassessment Protocols (EPA 1999). Basically, all habitats within the area of the selected stations are sampled for a timed interval and the collected invertebrates are identified and counted. The dip net was used in water up to 5 ft deep, generally in areas of plants and soft sediments. Invertebrates were sorted, and identified with the help of dichotomous keys.

Fish were assessed on June 8, 2006 by visual observation and through the use of gill nets. Plant densities proved too high for summer seining, and the sediment was too unsteady to allow electroshocking with a backpack unit. Sinking 1.0 inch bar monofilament gill nets were used to sample the fish community in Lake Whitney. Gill nets were set and checked approximately every 2 hours. Each captured fish was measured to the nearest mm, and weighed to the nearest gram before being released.

Results

Water quality as measured on June 8, 2006 using digital meters and water grab test kits, are presented in Table 1.

Table 1. Water quality data for four stations at Lake Whitney collected on June 9, 2005.

Date	Depth (meters)	Temp (^oC)	Dissolved Oxygen (% saturation)	Dissolved Oxygen (mg/L)	Turbidity (NTUs)	pH	Conductivity (mS/cm)
6/9/2005	0	16.0	73	7.2	5.8	6.9	205
6/9/2005	1	15.3	73	7.4	-	6.7	178
6/9/2005	2	14.4	66	6.8	-	6.7	150
6/9/2005	2.8	14.3	73	7.5	-	6.7	147

Phytoplankton

The location of phytoplankton sampling is indicated in Figure 7. Phytoplankton cell counts and biomass estimates are provided in Table 2. Diatoms (Bacillariophyta) and green algae (Chlorophyta) were the major components of the phytoplankton, although representatives of two other algal divisions were encountered. Unlike the 2005 phytoplankton sampling, blue-greens (more properly cyanobacteria) were not present during the 2006 sampling. Diversity in 2006 is higher than 2005 and evenness values are similar, spanning the moderate range. Taxonomic richness in 2006 is more than double the 2005 value. Once again the composition of the phytoplankton community suggested high nutrient levels.

Overall cell counts and biomass estimates were low in the June 2006 sample. High flushing would appear to be a dominant influence in this system. Another important factor is probably light, which is reduced below the water surface by high turbidity. This turbidity includes organic remains of algae and vascular plants, but is also a function of visibly high levels of fine suspended particles in the incoming water. The combination of low light and high flushing limits the accumulation of phytoplankton biomass in Upper Lake Whitney.

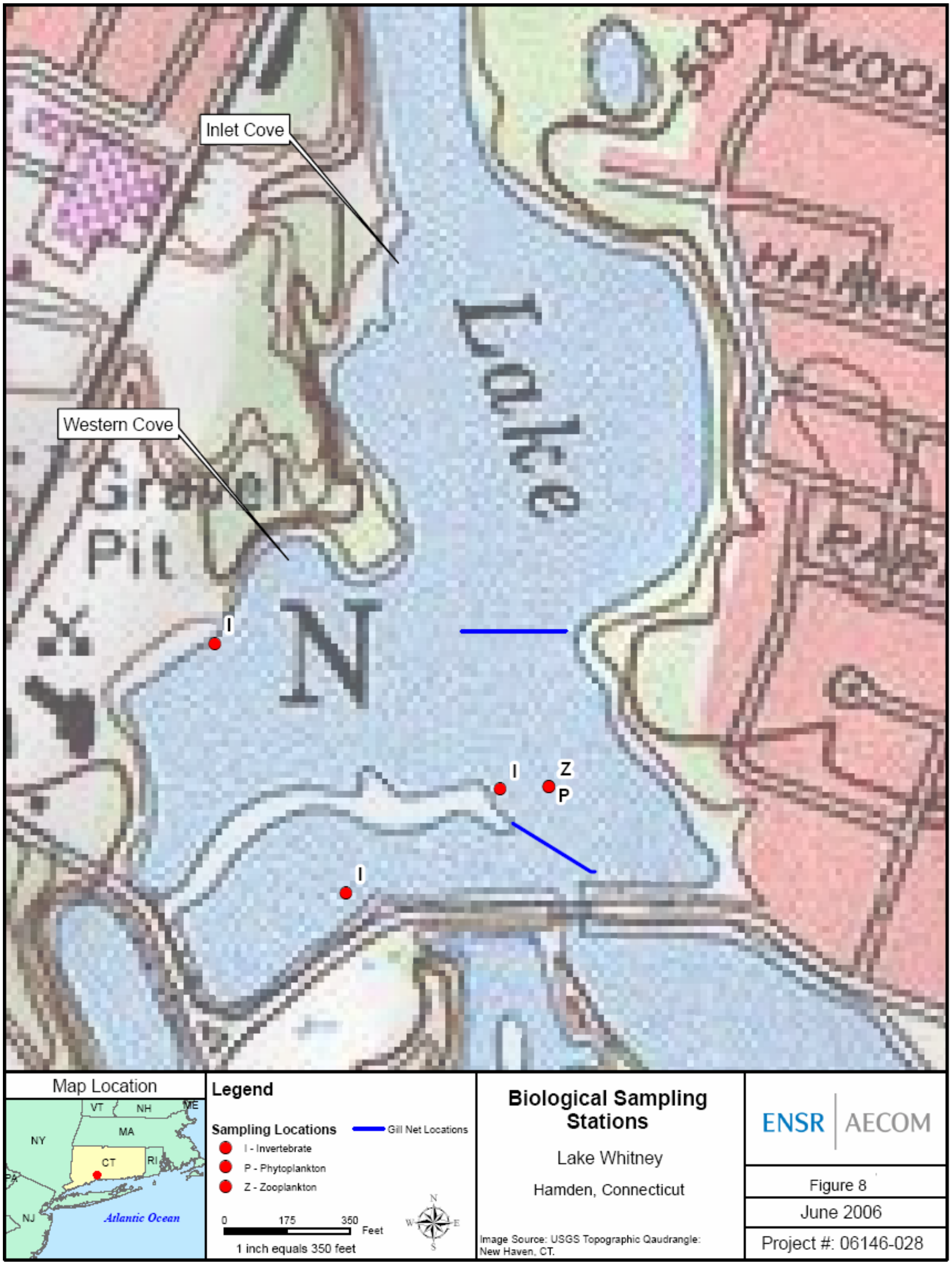


Figure 8. Map of upper Lake Whitney including sampling locations for phytoplankton, zooplankton, invertebrates and gill net set locations.

Table 2. Phytoplankton density (cells/mL) and biomass (µg/L) for the sample collected in upper Lake Whitney in June 8, 2006.

	Density (cells/mL)		Biomass (µg/L)
	LW-1		LW-1
	6/8/2006		6/8/2006
Taxon		Taxon	
BACILLARIOPHYTA		**BACILLARIOPHYTA**	
Centric Diatoms		**Centric Diatoms**	
Aulacoseira	90	Aulacoseira	27
Cyclotella	6	Cyclotella	15
Melosira	30	Melosira	9
Araphid Pennate Diatoms		**Araphid Pennate Diatoms**	
Asterionella	12	Asterionella	2.4
Diatoma	12	Diatoma	16.8
Fragilaria/related taxa	264	Fragilaria/related taxa	79.2
Synedra	18	Synedra	14.4
Tabellaria	6	Tabellaria	4.8
Monoraphid Pennate Diatoms		**Monoraphid Pennate Diatoms**	
Achnanthidium/related taxa	18	Achnanthidium/related taxa	1.8
Biraphid Pennate Diatoms		**Biraphid Pennate Diatoms**	
Cymatopleura	6	Cymatopleura	48
Gomphonema/related taxa	18	Gomphonema/related taxa	18
Gyrosigma	6	Gyrosigma	19.2
Navicula/related taxa	84	Navicula/related taxa	42
Nitzschia	126	Nitzschia	100.8
CHLOROPHYTA		**CHLOROPHYTA**	
Coccoid/Colonial Chlorophytes		**Coccoid/Colonial Chlorophytes**	
Pediastrum	48	Pediastrum	9.6
Scenedesmus	48	Scenedesmus	4.8
Schroederia	6	Schroederia	15
CHRYSOPHYTA		**CHRYSOPHYTA**	
Flagellated Classic Chrysophytes		**Flagellated Classic Chrysophytes**	
Dinobryon	66	Dinobryon	198
CRYPTOPHYTA		**CRYPTOPHYTA**	
Cryptomonas	96	Cryptomonas	52.8
DENSITY (CELLS/ML) SUMMARY		**BIOMASS (UG/ML) SUMMARY**	
BACILLARIOPHYTA	696	**BACILLARIOPHYTA**	398.4
CHLOROPHYTA	102	**CHLOROPHYTA**	29.4
CHRYSOPHYTA	66	**CHRYSOPHYTA**	198
CRYPTOPHYTA	96	**CRYPTOPHYTA**	52.8
CYANOPHYTA	0	**CYANOPHYTA**	0
EUGLENOPHYTA	0	**EUGLENOPHYTA**	0
PYRRHOPHYTA	0	**PYRRHOPHYTA**	0
TOTAL	960	**TOTAL**	678.6
CELL DIVERSITY	1.03	**BIOMASS DIVERSITY**	1.02
CELL EVENNESS	0.81	**BIOMASS EVENNESS**	0.80

Zooplankton

The location of zooplankton sampling is indicated in Figure 7. Zooplankton counts and biomass estimates are provided in Table 3. Zooplankton included rotifers, copepods, and cladocerans. Cladocera form the major zooplankton component, but they still fall below densities desirable for phytoplankton biomass control (densities >20 larger individuals/L or biomass >200 µg/L as indicative thresholds). Taxonomic richness and evenness were moderate and did not vary appreciably between the 2005 and 2006 sampling events, although there was decreased diversity. Average body length in 2006 was lower compared to 2005, as were organism density and biomass values. Density and biomass values were substantially lower in 2006 compared to 2005. Phytoplankton food resources are of generally good quality, and while phytoplankton quantity is not high, it should support a larger zooplankton community. Rapid flushing of upper Lake Whitney may minimize accumulation of zooplankton. Predation is also likely to be a strong influence, with abundant planktivorous fish indicated. The very low abundance of zooplankton provides limited food for the fish community and almost no grazing pressure on algae.

Table 3. Zooplankton density (#/L) and biomass (μg/L) for the sample collected in upper Lake Whitney during June 8, 2006. S-W is Shannon-Wiener diversity index.

	Density (#/L)		Biomass (μg/L)
	LW-1Z		LW-1Z
	6/8/2006		6/8/2006
Taxon		Taxon	
ROTIFERA		**ROTIFERA**	
Lepadella	0.03	Lepadella	0.003
COPEPODA		**COPEPODA**	
Copepoda-Cyclopoida		**Copepoda-Cyclopoida**	
Mesocyclops	0.03	Mesocyclops	0.038
Copepoda-Calanoida		**Copepoda-Calanoida**	
Diaptomus	0.03	Diaptomus	0.014
Other Copepoda-Nauplii	0.03	Other Copepoda-Nauplii	0.080
CLADOCERA		**CLADOCERA**	
Bosmina	0.39	Bosmina	0.382
Ceriodaphnia	0.03	Ceriodaphnia	0.078
Chydorus	0.06	Chydorus	0.059

Summary Statistics		Summary Statistics	
DENSITY (#/L)		**BIOMASS (μg/L)**	
PROTOZOA	0	**PROTOZOA**	0.000
ROTIFERA	0.03	**ROTIFERA**	0.003
COPEPODA	0.09	**COPEPODA**	0.131
CLADOCERA	0.48	**CLADOCERA**	0.519
OTHER ZOOPLANKTON	0	**OTHER ZOOPLANKTON**	0.000
TOTAL ZOOPLANKTON	0.6	**TOTAL ZOOPLANKTON**	0.653
TAXONOMIC RICHNESS		**MEAN LENGTH (mm): ALL FORMS**	0.33
PROTOZOA	0	**MEAN LENGTH: CRUSTACEANS**	0.34
ROTIFERA	1		
COPEPODA	3	**S-W DIVERSITY INDEX**	0.55
CLADOCERA	3	**EVENNESS INDEX**	0.65
OTHER ZOOPLANKTON	0		
TOTAL ZOOPLANKTON	7		

Macrophytes

Macrophytes are a visibly dominant feature of upper Lake Whitney in the summer. Mapping points and transects are shown in Figure 8. Collected macrophyte data are provided in Table 4. Maps of total plant cover and total plant biovolume are presented in Figures 9 and 10.

Cover by macrophytes varied throughout the lake, with the densest cover in the western cove. There was a decrease in macrophyte cover in the inlet cove compared to 2004 and 2005 where some areas in the inlet cove experienced cover between 75 and 100%. The western cove and southern portions of the lake have recovered since the 2004 drawdown and are approaching pre-drawdown levels. As expected, macrophyte coverage was greatest near shore, and decreased with increased distance from the shore. The dominant species in deeper water was filamentous green algae. Biovolume followed a similar pattern compared to 2005, and never exceeded the 50% level in the lake. Similar to macrophyte cover, macrophyte biovolume in the western cove and southern portion of the lake have returned to pre-drawdown levels. The presence of largely floating (e.g., duckweed) or floating leaved (e.g., lilies) species gives an impression of greater plant biomass than really exists in this lake. Areas of densest cover and biovolume contained both waterlilies and the submergent waterweed (*Elodea*) or algal mats. The 2004 lake level drawdown for dam maintenance is the likely cause for general decrease in cover and biovolume of floating leaved plants observed during the 2005 and 2006 surveys. However, the plant community in the lake appears to be approaching pre-drawdown levels, and currently represents an ecological improvement compared to the overly high densities of plants present before the drawdown, by providing enhanced light penetration and oxygen transfer.

In general, upper Lake Whitney hosts relatively few plant species, with swamp loosestrife, coontail, European water clover and curly-leaf pondweed being the only aquatic plants noted other than the plants mentioned above. In 2006 macrophyte diversity increased slightly as coontail, water clover and curly-leaf pondweed were encountered during the survey. All species present are tolerant of low light or prefer shallow water (where low light is less of an issue). During the June 8, 2006 survey, non-native plants curly-leaf pondweed, European waterclover, and purple loosestrife were observed. The 2006 survey was the first time European waterclover or curly-leaf pondweed were observed by ENSR, although European waterclover has been observed within Lake Whitney on previous occasions by employees of the South Central Connecticut Regional Water Authority (J. Hudak, personal communication).

Duckweed (*Lemna minor*) was found mainly in the northern portion of the lake. This floating vascular plant depends upon the water column for nutrition and is an indicator of high nutrient levels, especially for nitrate. As it is not anchored to the sediment, this plant can be flushed through the system readily, and probably is delivered to upper Lake Whitney on a regular basis from upstream ponds and wetlands.

Waterweed (*Elodea canadensis*) is a rooted submergent vascular plant that tolerates low light and high sediment loads. It is present throughout the entire Upper Lake Whitney except for the western coves. Waterweed abundance in 2006 was similar to 2005 levels but are below the levels observed in 2004. While the 2004 drawdown may be partially responsible, natural variability is also a factor in shallow systems such as this.

Waterlilies (*Nymphaea odorata* and *Nuphar variegata*) are mainly peripheral species in upper Lake Whitney, but provide the densest surface cover and dominate the plant assemblage where they occur. Lilies cover nearly all the inlet channel and occupy a major portion of the western cove. Lily cover and abundance is decreased compared to the 2004 survey, but are similar to 2005 levels.

Benthic algal mats are not obvious in upper Lake Whitney, as they are submergent growths at the sediment-water interface. Algal mats are the dominant macrophytes in areas without vascular plants, but do not achieve the densities sometimes associated with nutrient rich sediments in shallow areas. The filamentous green alga *Spirogyra* was especially abundant. Low light and high flushing rate are probably major factors in controlling these mats, as with the phytoplankton.

Maximum water depth in upper Lake Whitney is only about 10 ft, with much of the upper basin less than 5 ft deep. Surficial sediments in Upper Lake Whitney are primarily mucks and sands, with some larger rocks and various leaf litter and other woody debris.

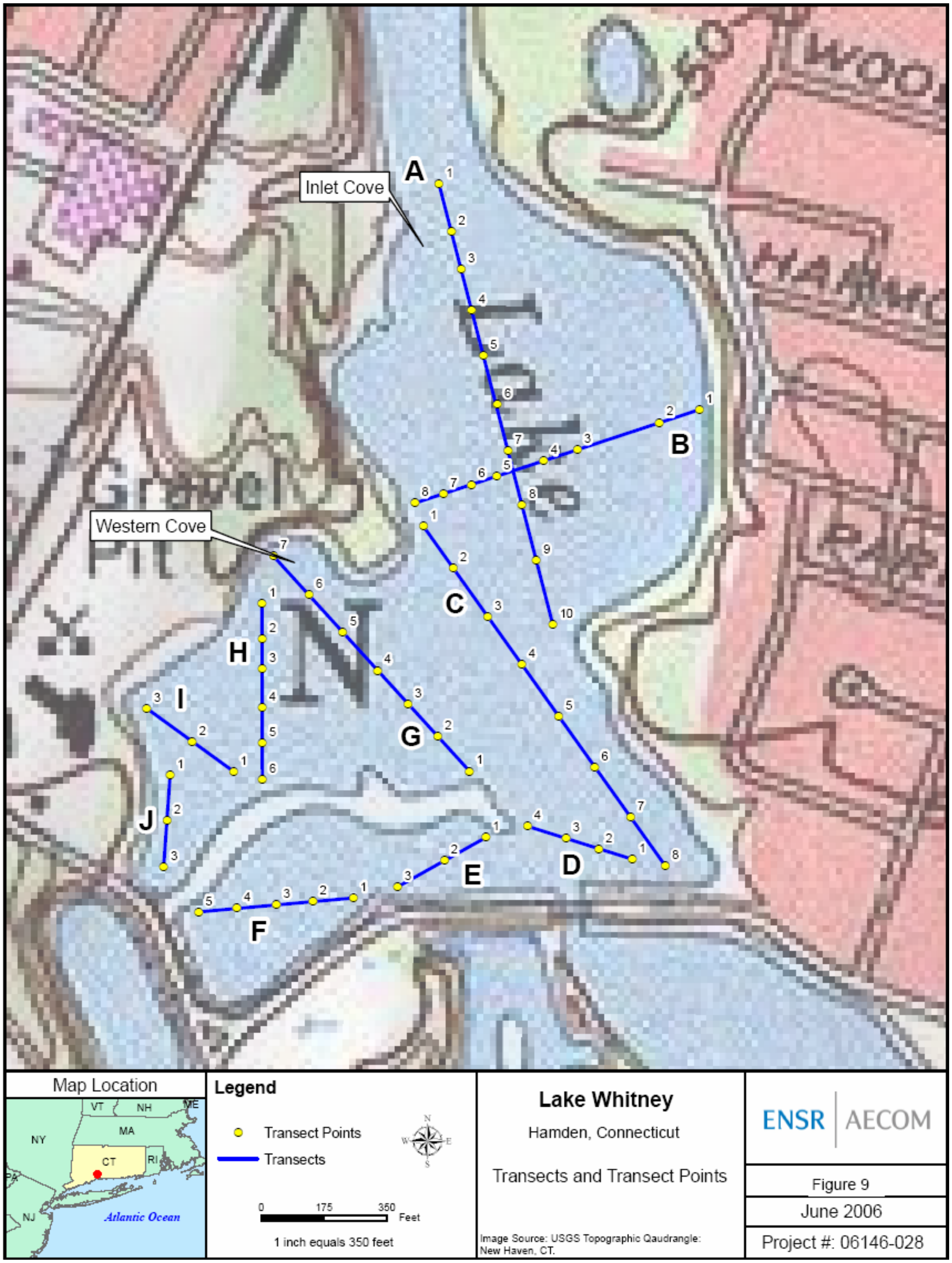


Figure 9. A map of upper Lake Whitney containing aquatic macrophyte survey transects and points.

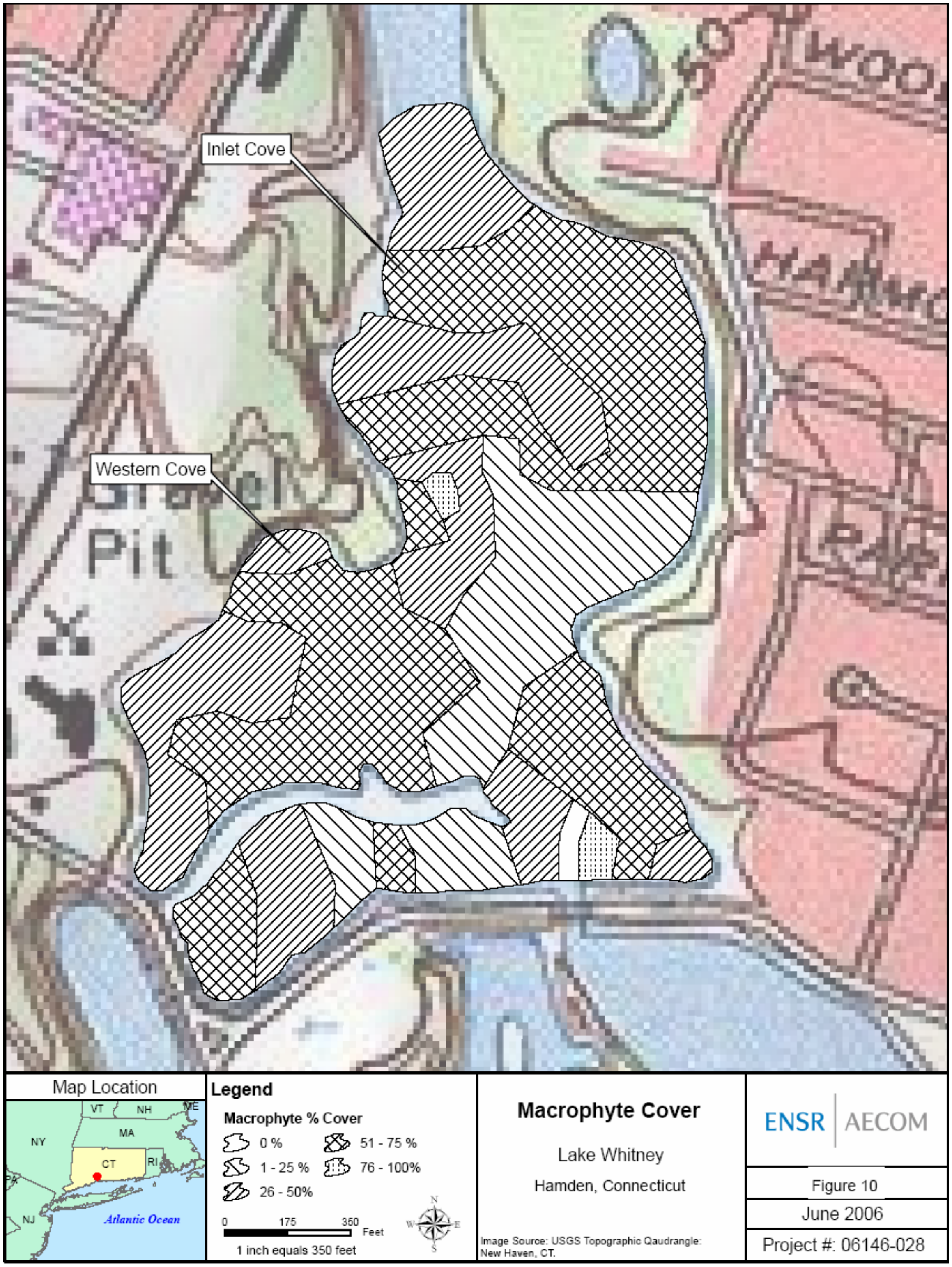


Figure 10. A map of upper Lake Whitney and corresponding plant cover on June 8, 2006.

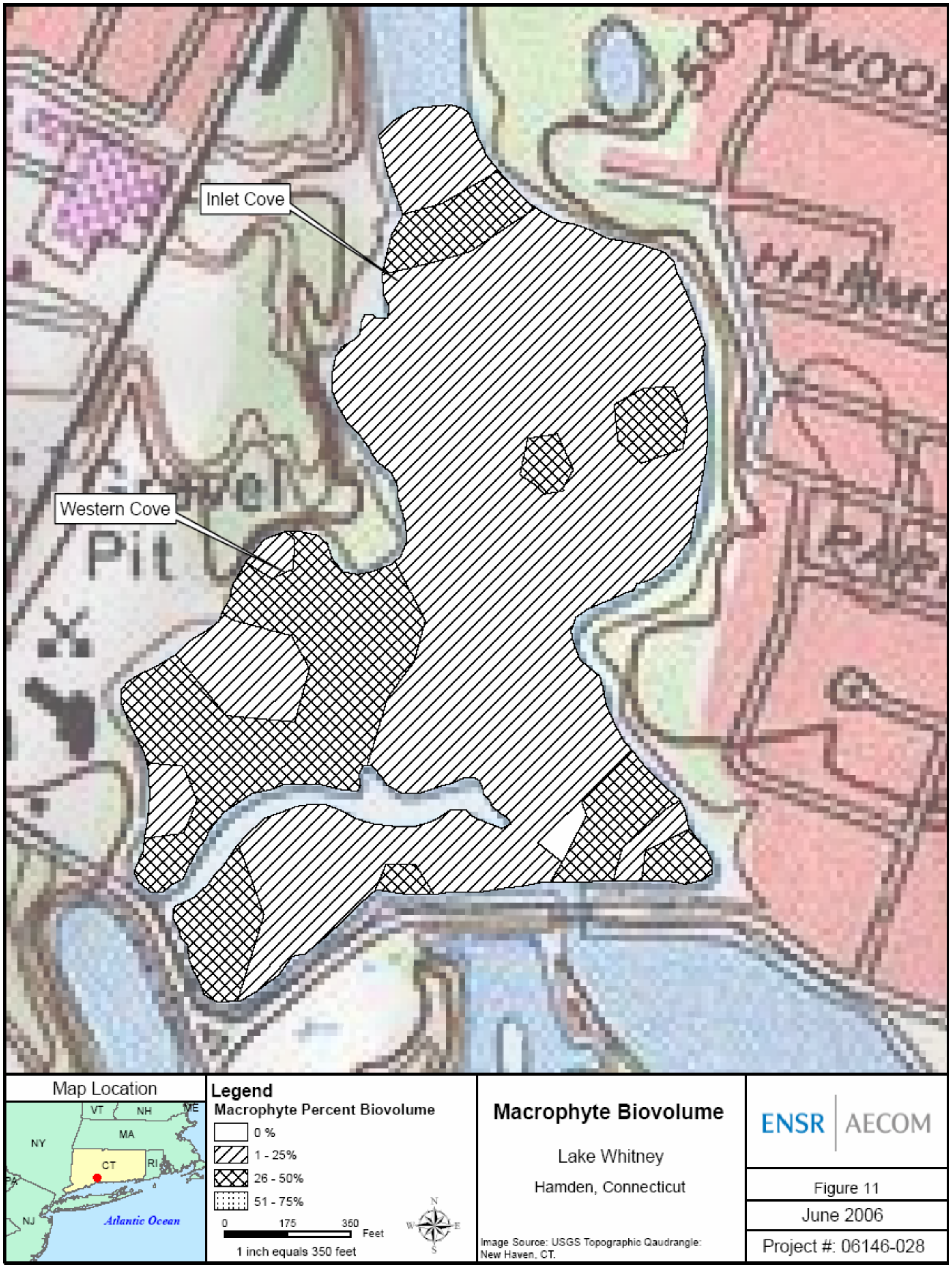


Figure 11. A map of upper Lake Whitney and corresponding plant biovolume on June 8, 2006.

Table 4. Physical characteristics (water depth, sediment type), total plant percent cover and biovolume, and plant taxa recorded at each transect point during the survey (8-June-2006). Plant taxa are reported left to right from the most abundant to the least abundant for each transect point. For full names of plant taxa, sediment type codes, and total plant percent cover and biovolume codes, see notes at the end of table.

	water depth			total plant		
trans. pt. ID	m	ft	sediment type	% cover	% biovol.	plant taxa (% relative abundance)
A-1	0.6	2.0	mu,sa	2	1	nod, alg, lmi, wco, cde, eca, lsa
A-2	0.6	2.0	mu	2	2	nod, alg, lmi
A-3	0.6	2.0	mu	3	1	nod, alg, lmi
A-4	0.5	1.5	mu	3	1	nod, nva, alg, lmi
A-5	0.3	1.0	mu	2	1	nva, alg
A-6	0.5	1.5	mu	3	1	alg, nod, lmi
A-7	0.6	2.0	mu	1	1	alg
A-8	0.9	3.0	mu	1	1	alg, eca, nod
A-9	1.5	5.0	mu	1	1	eca, alg, nod
A-10	1.7	5.5	mu	1	1	alg
B-0	0.3	1.0	sa	1	1	alg, lmi
B-1	0.9	3.0	mu	3	1	alg
B-2	1.2	4.0	mu	3	2	alg, nod, eca
B-3	0.9	3.0	mu	2	1	alg, eca, nod
B-4	0.9	3.0	mu	3	2	alg, eca
B-5	1.1	3.5	mu	1	1	alg, eca
B-6	1.2	4.0	mu	2	1	eca, alg
B-7	1.2	4.0	mu	4	1	alg, nod
B-8	1.5	5.0	mu,sa	3	1	alg, nod
C-1	1.2	4.0	mu,sa	3	1	alg, pcr
C-2	1.4	4.5	mu	2	1	alg
C-3	1.2	4.0	mu	1	1	alg, eca
C-4	1.5	5.0	mu	1	1	alg, eca
C-5	1.1	3.5	sa,mu	3	1	alg, eca, pcr
C-6	1.4	4.6	mu,sa	3	1	alg, nod
C-7	1.5	5.0	mu	3	2	alg, nod
C-8	1.8	6.0	mu	2	2	alg, lmi
D-1	1.8	5.8	mu	3	1	alg, nod
D-2	1.8	5.8	mu	4	2	alg, eca
D-3	2.7	8.8	mu	0	0	
D-4	2.1	7.0	mu	2	1	nod, eca
E-1	0.9	3.0	mu	1	1	alg, eca, wco, lmi, nod
E-2	2.7	9.0	mu	1	1	alg
E-3	0.9	3.0	sa, ro	3	2	dve, lsa, alg, mqu, nod
F-1	0.9	3.0	sa, ro	1	1	alg
F-2	2.4	8.0	mu	2	1	alg, nod
F-3	2.1	7.0	mu	2	1	alg, wco
F-4	2.0	6.5	mu	3	2	alg, nod, wco
F-5	1.5	5.0	mu	3	2	alg, nod, wco

Table 4 (continued). Physical characteristics (water depth, sediment type), total plant percent cover and biovolume, and plant taxa recorded at each transect point during the survey.

trans. pt. ID	water depth m	water depth ft	sediment type	total plant % cover	total plant % biovol.	plant taxa (% relative abundance)
G-1	1.7	5.5	mu	1	1	alg
G-2	1.8	6.0	mu	1	1	alg
G-3	1.5	5.0	mu	3	1	alg, eca
G-4	1.8	5.9	mu	3	2	alg, eca
G-5	1.8	5.9	mu	3	2	alg, eca
G-6	0.8	2.5	mu	3	2	alg, eca, nod
G-7	1.1	3.5	sa	2	1	alg
H-1	1.0	3.2	sa	3	2	alg, eca, nod
H-2	1.2	4.0	mu,sa	2	1	alg
H-3	1.0	3.2	mu	2	1	alg, nod
H-4	0.9	3.0	mu	2	1	alg
H-5	1.0	3.2	mu	3	2	alg
H-6	0.6	2.0	mu,sa	3	2	alg, wco, nod, nva, dve
I-1	0.6	2.0	mu	3	2	alg, cde, nod
I-2	1.2	4.0	mu	3	2	alg, nod
I-3	1.4	4.5	mu	3	2	alg, eca, nod
J-1	1.2	4.0	mu	2	1	alg
J-2	1.0	3.2	mu	2	1	alg, nod
J-3	1.1	3.5	mu	2	2	alg, nva, nod

Notes:

sediment type: **co** - cobble; **gr** - gravel; **ll** - leaf liter; **mu** - muck; **ro** - rock; **sa** - sand

plant taxa: **alg** - green algae (Chlorophyta); **cya** - blue-green algae (Cyanophyta)
dve - *Decodon verticillatum* (swamp loosestrife);
eca - *Elodea canadensis* (waterweed);
lmi - *Lemna minor* (duckweed);
nod - *Nymphaea odorata* (fragrant or white-flower waterlily);
nva - *Nuphar variegata* (yellow-flower waterlily);
wco - *Wolfia columbiana* (watermeal);
mqu - *Marsilea quadrafolia (* european waterclover*)*
lsa - *Lythrum salicaria* (purple loosestrife);
cde - *Ceratophyllum demersum* (coontail);
pcr - *Potamogeton crispus* (curly-leaf pondweed).

Benthic Macroinvertebrates

Locations of benthic invertebrate sampling are shown in Figure 7. Data for the types of organisms found are provided in Table 5.

Overall low habitat quality (mucky bottom, low density of truly submerged vascular plants) and possibly high fish predation, could limit macroinvertebrate communities in Lake Whitney.

Most of the invertebrate taxa found in Lake Whitney were tolerant of impacted environments and/or opportunistic species (e.g., pulmonate snails; sowbugs, scuds such as *Gammarus,* and the mayfly *Caenis*). Lack of large-bodied invertebrate taxa in Lake Whitney suggests possible strong predation by fish. In particular, common carp (abundant in Upper Lake Whitney) is known to cause drastic reductions in invertebrate densities. Accordingly, total macroinvertebrate species diversity was relatively low in 2006. Taxonomic richness in 2006 (13) was lower than in 2005 (14), 2004 (18) or 2000 (26), however, the same taxa were abundant in all years.

The macroinvertebrate community of Lake Whitney was characterized by dominance by primary consumers, and a small but diverse assemblage of predators (e.g., damselfly larvae, the Dobsonfly larva *Corydalus*) indicates that Lake Whitney supports multiple trophic levels within the benthic invertebrate community. Overall low invertebrate density, diversity, and body size once more suggest that fish predation may be high in Lake Whitney. In the absence of intense predation, it is possible that a relatively complex benthic food web would develop.

Table 5. Taxonomic and ecological (feeding ecology) characterization of each benthic macroinvertebrate taxon found in Upper lake Whitney on June 8, 2006. For those taxa with multiple feeding mode, primary and secondary modes are given. Generalist primary consumers feed on both living and dead plant tissues with no evident preference. Feeding ecology obtained from several sources, mainly Thorp and Covich (1991), Merrit and Cummins (1995), and direct observations by ENSR staff.

					feeding group(s)	
phylum or subphylum	class	order or subclass	family	taxon	primary	secondary
Mollusca	Gastropoda	Pulmonata	Physidae	Physa gyrina	generalist	
Mollusca	Gastropoda	Pulmonata	Planorbidae	Gyraulus parvus	generalist	
Annelida	Hirudinea	Rhynchobdellida	Glossiphoniidae	Glossiphonia complanata	predator	
Crustacea	Malacostraca	Amphipoda	Gammaridae	Gammarus sp.	generalist	
Uniramia	Insecta	Odonata	Zygoptera	Enallagma sp.	predator	
Uniramia	Insecta	Megaloptera	Corydalidae	Corydalus sp.	predator	detritivore
Uniramia	Insecta	Hemiptera	Corixidae	Palmacorixa sp.	generalist	
Uniramia	Insecta	Coleoptera	Haliplidae	Peltodites sp.	herbivore	
Uniramia	Insecta	Diptera	Chironomidae	Tanypodinae spp.	predator	
Uniramia	Insecta	Diptera	Chironomidae	Chironominae spp.	generalist	
Uniramia	Insecta	Hemiptera	Veliidae			
Uniramia	Insecta	Diptera	Psychodidae			
Uniramia	Insecta	Diptera (pupae)				

Fish

Locations of gill net sets are shown in Figure 7, and fish data are presented in Table 6. In addition to the species listed in Table 6, several species were visually observed, including largemouth bass, common carp and numerous sunfish species. Centrarchids are adept at avoiding gill nets, however, and other sampling was not possible within the physical constraints of the lake and the time allotted for assessment. Common carp appeared to be concentrated in the northern cove; these larger fish are not likely to be captured in 1.0 inch gill nets, but are easily visible in the shallow areas that they frequent in Upper Lake Whitney.

White perch were the most abundant species collected, and also dominated the biomass as seen in Figure 11. While no common carp were collected in 2004, 2005 or 2006, numerous large specimens were visually observed jumping and swimming in the shallow north cove. Despite lack of captured specimens in 2006, common carp may still dominate fish biomass in the lake as seen in 2000. Four species of fish were captured during the 2006 survey. These included white perch, yellow perch, golden shiner, and white sucker. All fish appeared healthy, although some yellow perch were hosting a parasitic fungus. The total number of fish collected in 2006 was down compared to previous years, although not unexpected given the large volume of rainfall and flushing effect in upper Lake Whitney just prior to sampling. Although zooplankton community structure is similar to lakes with landlocked alewife (i.e., few individuals, small body size), no clupeid fishes (e.g., alewife, shad) have been captured or observed in upper Lake Whitney since monitoring began, nor have they been found in

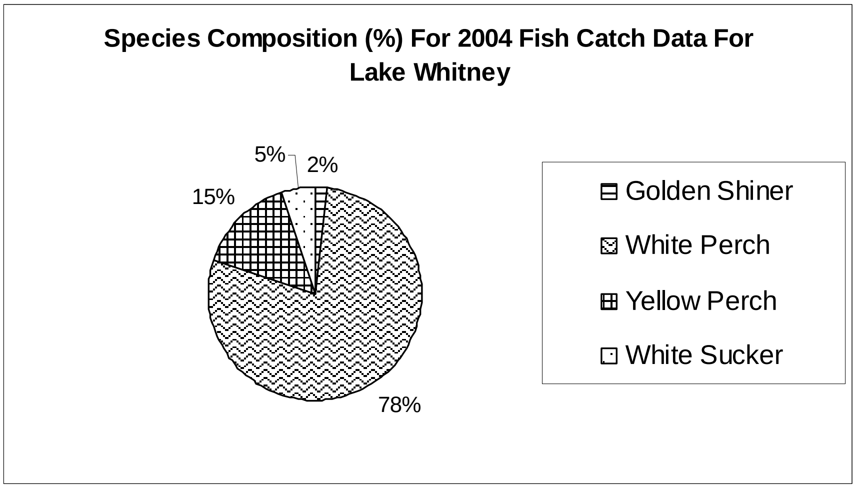
Connecticut Department of Environmental Protection electrofishing surveys in other areas of the lake.. Other factors could also lead to this structure, including high flushing rate and predation by other planktivorous fishes such as golden shiner. The lack of numbers and size of zooplankton may result in some plantivorous fishes moving out of the area in search of more abundant food sources.

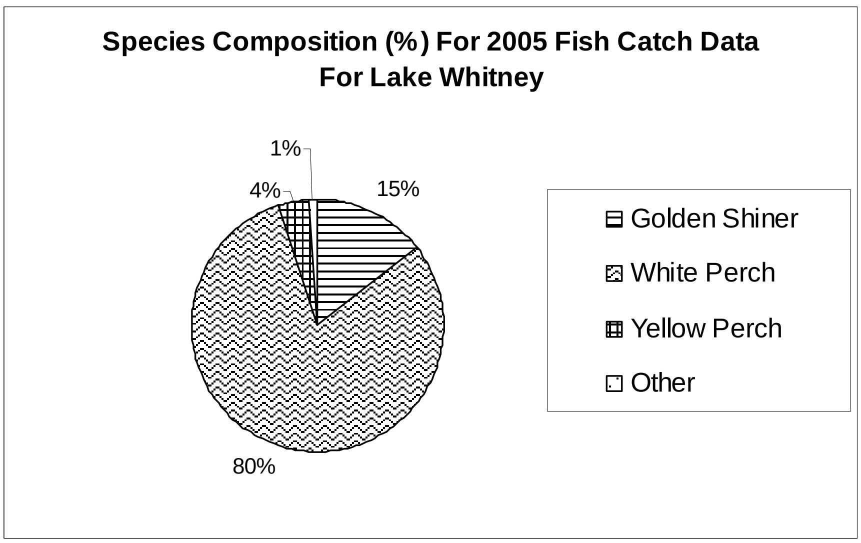
Upper Lake Whitney supports a substantial warmwater fish community. Coldwater species would not be expected to inhabit Lake Whitney. The unhindered connection to the lower portion of Lake Whitney allows fish to move freely between the lake segments, so rapid re-population after any times of stressful conditions in upper Lake Whitney is expected. Daily movements in response to food resource availability may also occur. Zooplankton resources in Upper Lake Whitney might constrain planktivorous fish growth, but captured individuals appeared to have average condition factors (length vs. weight). Visually, fish appeared abundant in upper Lake Whitney; shallow depth makes many fish easy to spot. Habitat conditions are not ideal for fish, but are sufficient to sustain a thriving warmwater fish community that would be accessible to piscivorous wildlife, most notably wading birds.

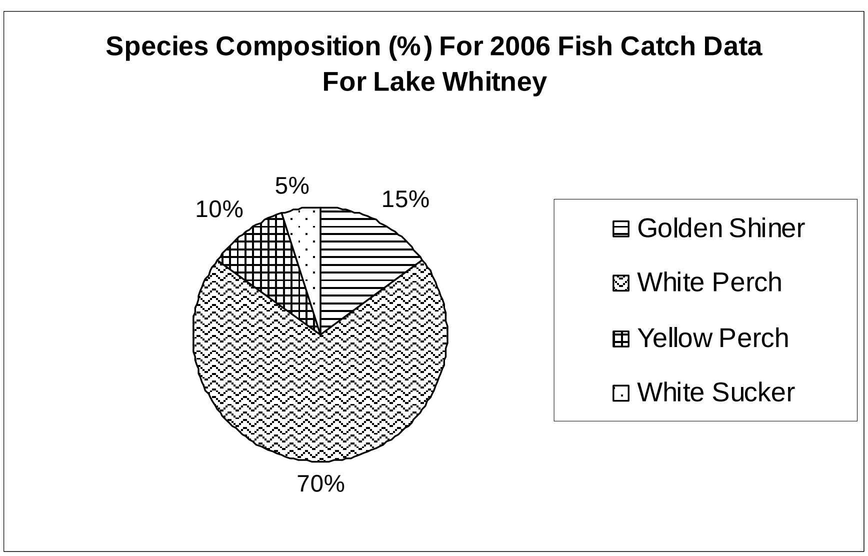
Table 6. Results of the gill net fish survey in upper Lake Whitney on June 8, 2006. These data do not include visual observations of species that were not collected in the gill net

Golden Shiner	White Perch	Yellow Perch	White Sucker
TL (mm)	TL (mm)	TL (mm)	TL (mm)
175	210	191	220
136	213	173	
180	198		
	187		
	212		
	120		
	188		
	210		
	213		
	221		
	220		
	188		
	210		
	193		

Figure 12. A graphical representation of species composition (number of fish) for the 2004, 2005 and 2006 sampling events.







Discussion

Phytoplankton, zooplankton, macroinvertebrate and fish populations assessed in 2006 are very similar to those observed in 2004 and 2005. A drawdown ranging up to six feet that lasted over a month in summer of 2004 was performed to allow construction at the Lake Whitney dam, and appears to have had slight impacts on the system, mainly with regard to aquatic macrophytes, which have not fully returned to pre-drawdown levels. Some areas of the lake have returned to or are approaching pre-drawdown levels. In general, the reduced coverage and biovolume of plants represents an ecological improvement over pre-drawdown levels. The current macrophyte community is adequate to support fish and wildlife functions without overwhelming shallow water areas and inlets. Abundance of non-native plants curly-leaf pondweed and European water clover will be assessed during the next macrophyte survey. A slight reduction in macroinvertebrate richness was also observed and could be related to drawdown, either directly from the period of dryness or indirectly by effects on the plant community. However, there were no drastic changes in the biological features of upper Lake Whitney.

The drawdown of 2004 was more severe than previous drawdowns and occurred during the prime growing season. Drawdowns are a common management technique for controlling susceptible rooted plant growth (Holdren et al. 2001). Studies on other lakes performed by ENSR have indicated that changes from a single drawdown are usually limited and vegetative communities typically recover from drawdown impacts in about two years, although there is certainly variability based on the plant community and severity and timing of drawdown. The lack of major change in the aquatic community in Lake Whitney between 2004 and 2006 is consistent with those previous lake drawdown studies. Monitoring in the future may discern any lasting effects to the macrophyte community, but most postulated impacts are transient. The SCCRWA may periodically repeat the data collection performed here to assess any long-term changes in biological communities.

References

Holdren, C., W. Jones, and J. Taggart. 2001. Managing Lakes and Reservoirs. N. Am. Lake Manage. Soc. and Terrene Inst., in coop. with Off. Water Assess. Watershed Prot. Div. U.S. Environ. Prot. Agency, Madison, WI.

Merritt R. W., & K. W. Cummins (editors), 1996. An Introduction to the Aquatic Insects of North America, third Edition. Kendall/Hunt Publishing, Dubuque, IA.

Milone and MacBroom 2002. CH2M Hill, ENSR, Roald Haestad, Inc. Upper lake Whitney Management Study, Mill River Watershed, Hamden, CT. Report prepared for the South Central Connecticut Regional Water Authority, New Haven, CT.

Thorp, J. H., and A. P. Covic (editors), 1991. Ecology and Classification of North American Freshwater Invertebrates. Academic Press, Sand Diego, CA.