Prepared For:

South Central Connecticut Regional Water Authority

A BIOLOGICAL ASSESSMENT OF UPPER LAKE WHITNEY

JANUARY 2009

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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 drawdown exceeds 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 did in the period from August 1991 to April 2005 when the reservoir was out of 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, 2006, 2007 and 2008, during the first four years of water withdrawal. This report summarizes the biological features of upper Lake Whitney in 2008, during the fourth 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 7). Brief drawdowns of less than 1 foot below spillway elevation occurred during June and October 2007 for dam inspection and maintenance. (Figure 8). In 2008, water levels exceeded spillway elevation at all times (Figure 9).

Public water supply withdrawals do not appear to have had a significant 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.

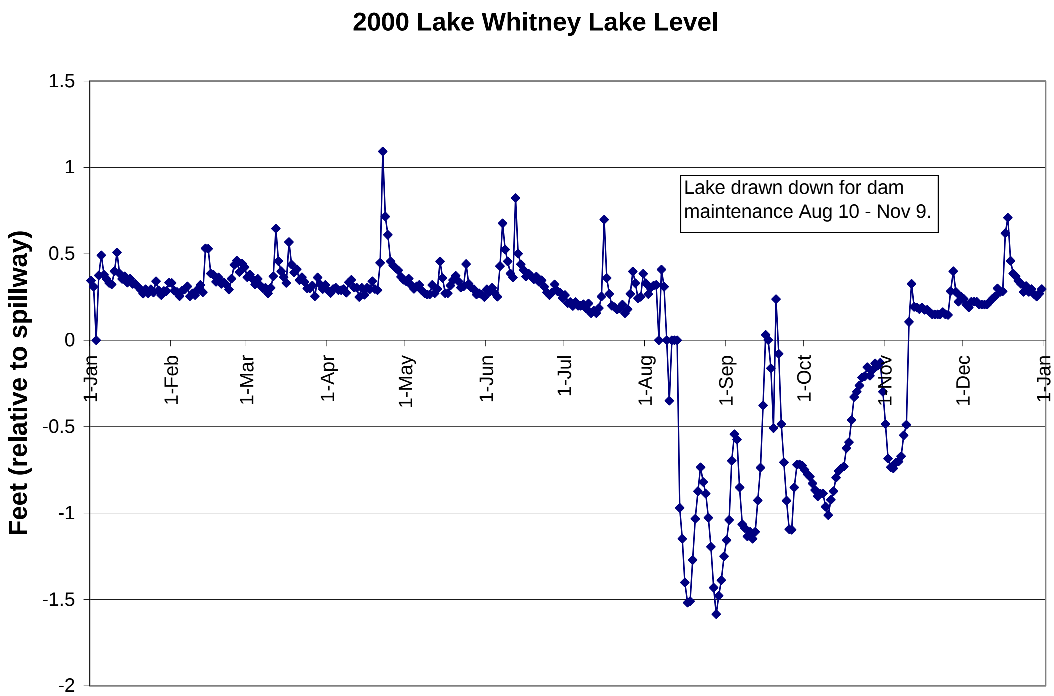


Figure 1. Water level graph for Lake Whitney during 2000.

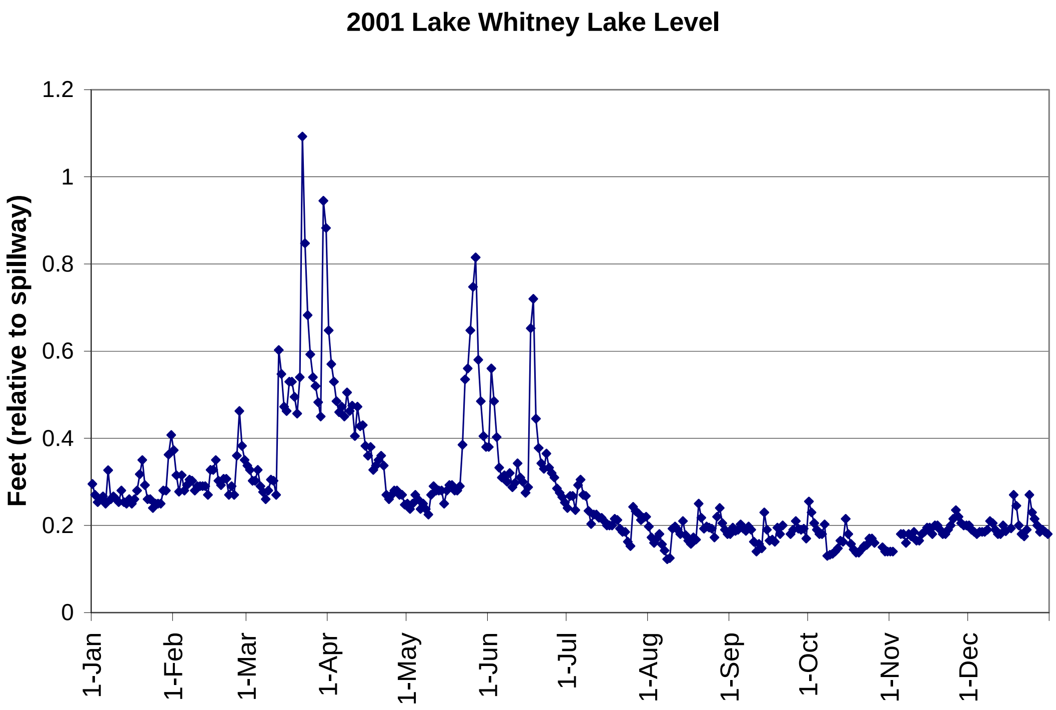


Figure 2. Water level graph for Lake Whitney during 2001.

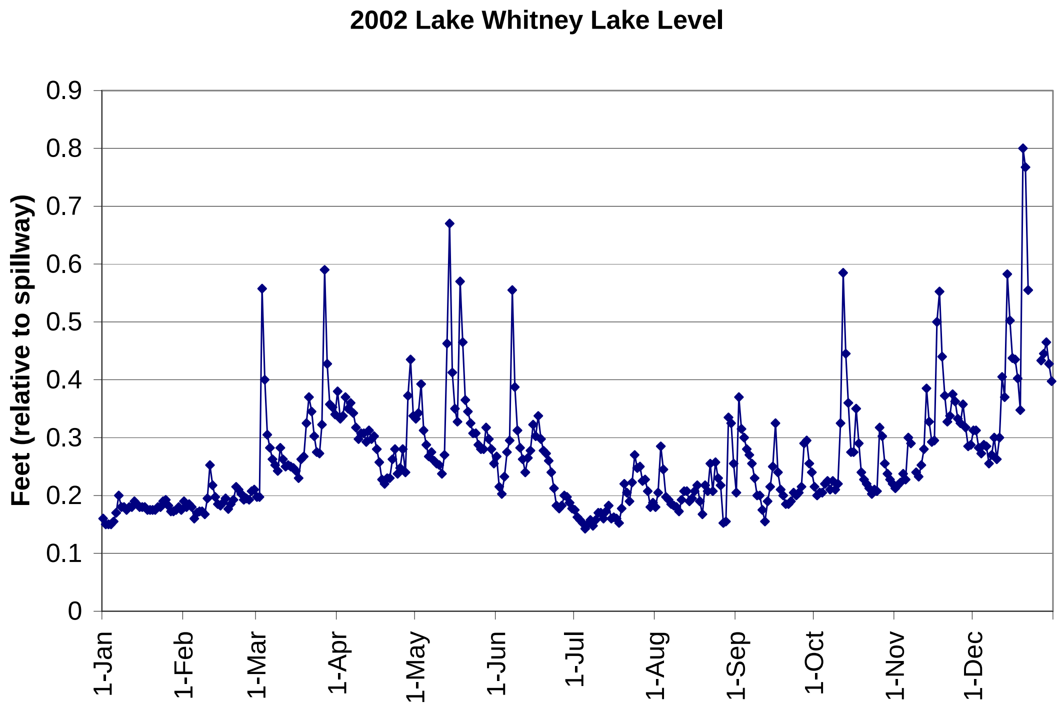


Figure 3. Water level graph for Lake Whitney during 2002.

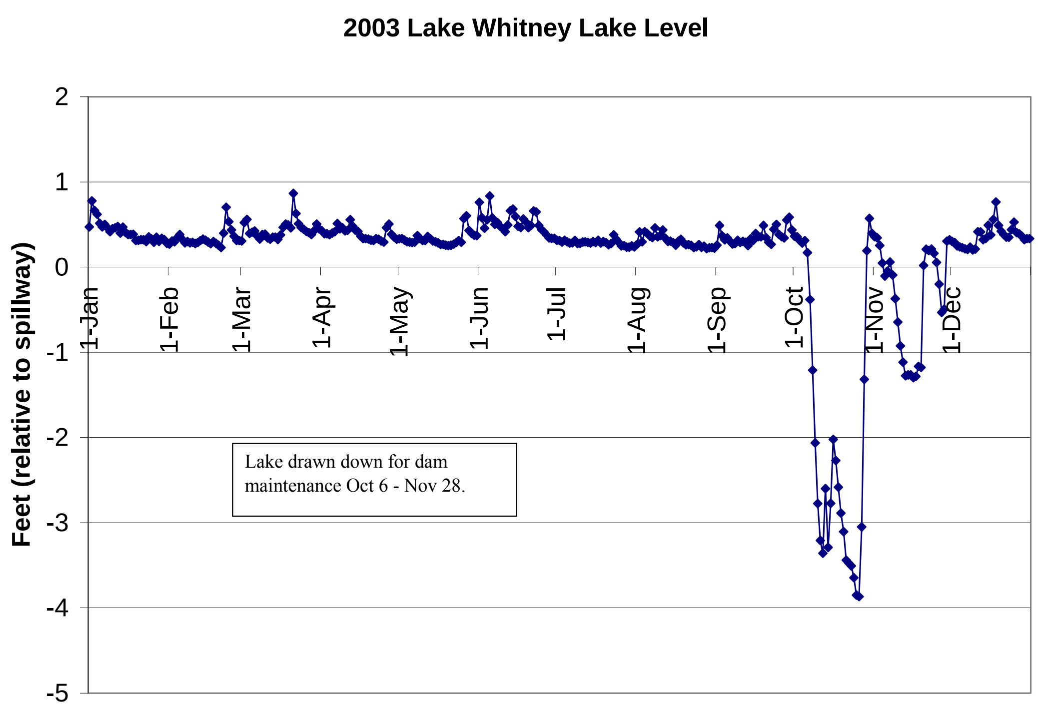


Figure 4. Water level for Lake Whitney during 2003.

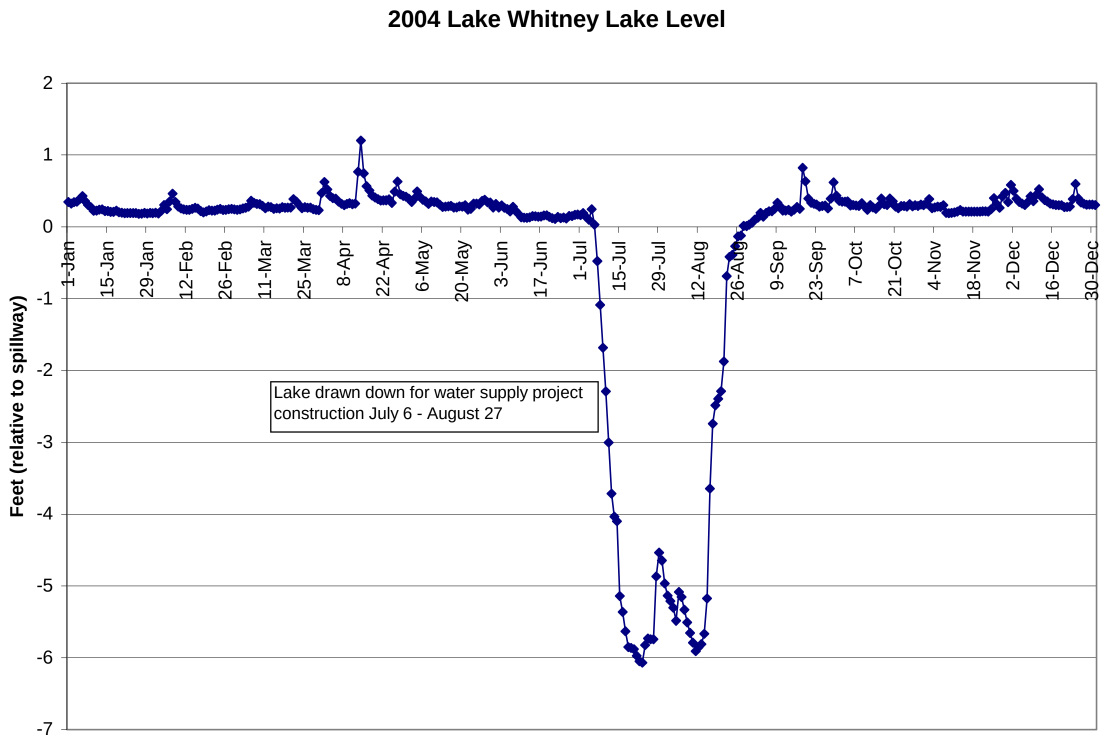


Figure 5. Water level for Lake Whitney during 2004.

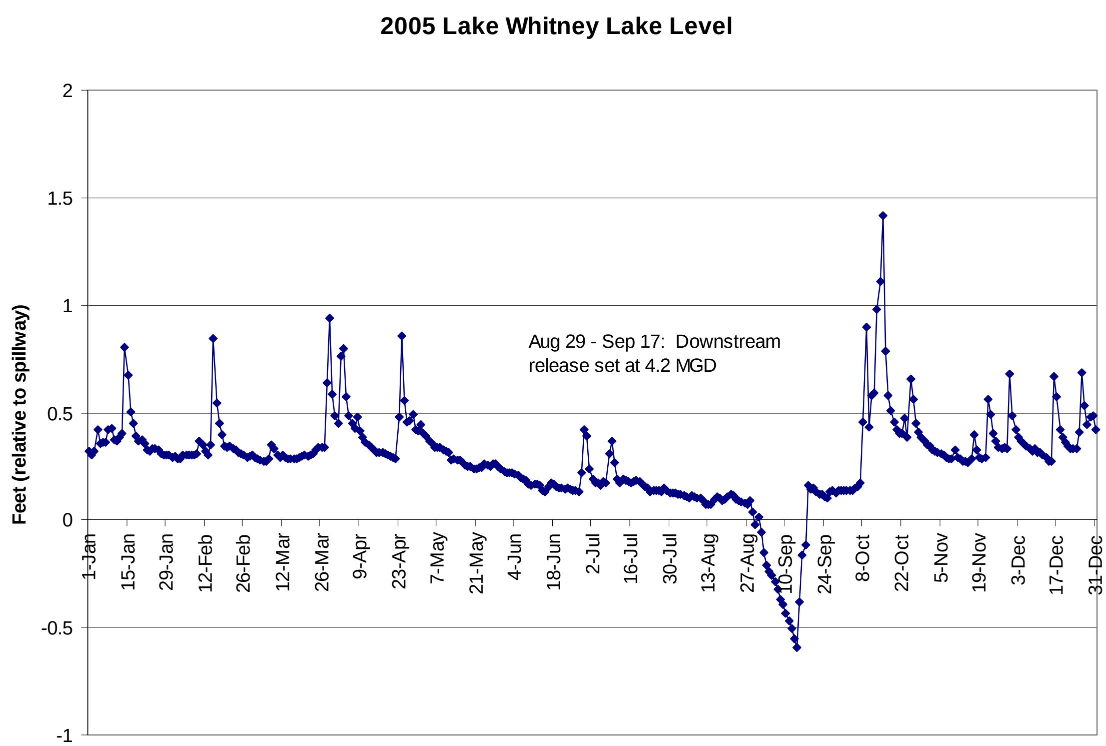


Figure 6. Water level for Lake Whitney during 2005.

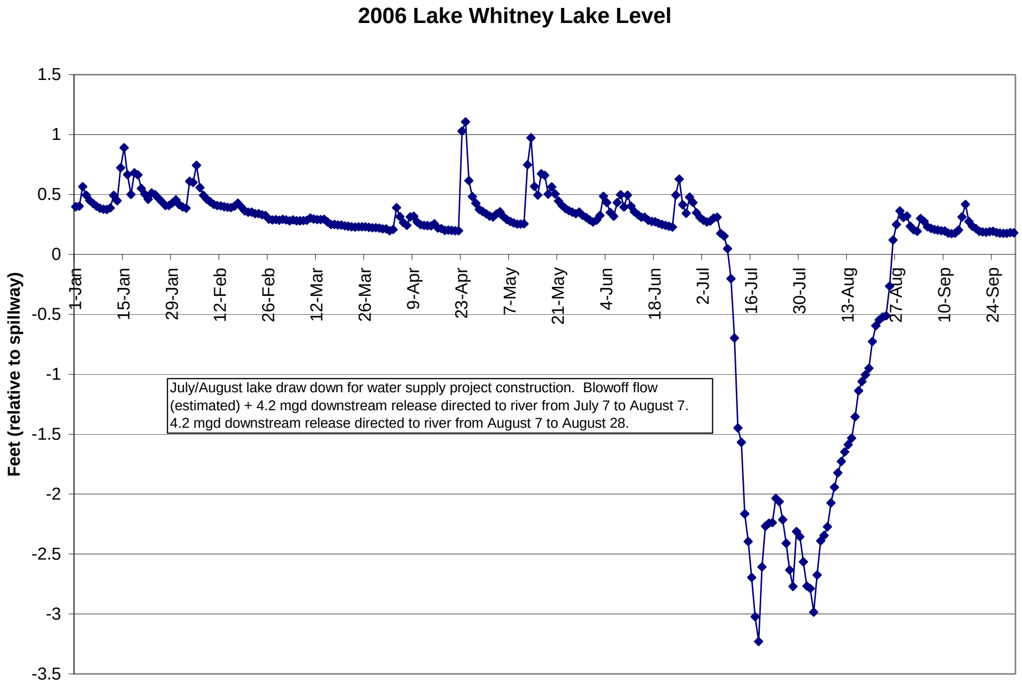


Figure 7. Water level for Lake Whitney during 2006.

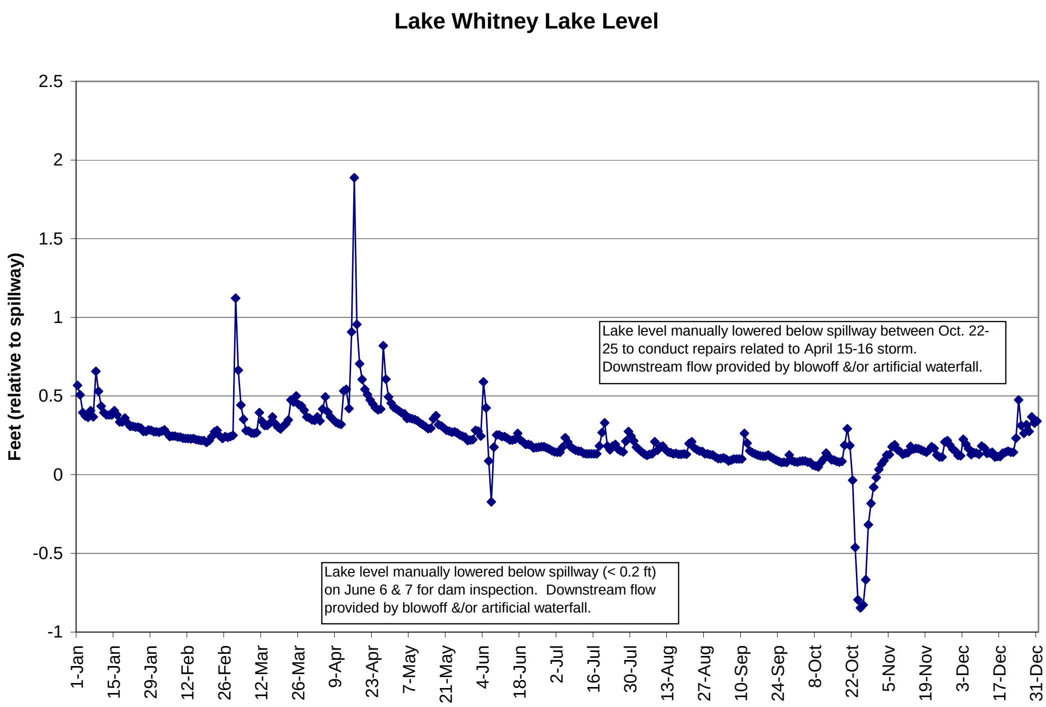


Figure 8. Water level for Lake Whitney during 2007.

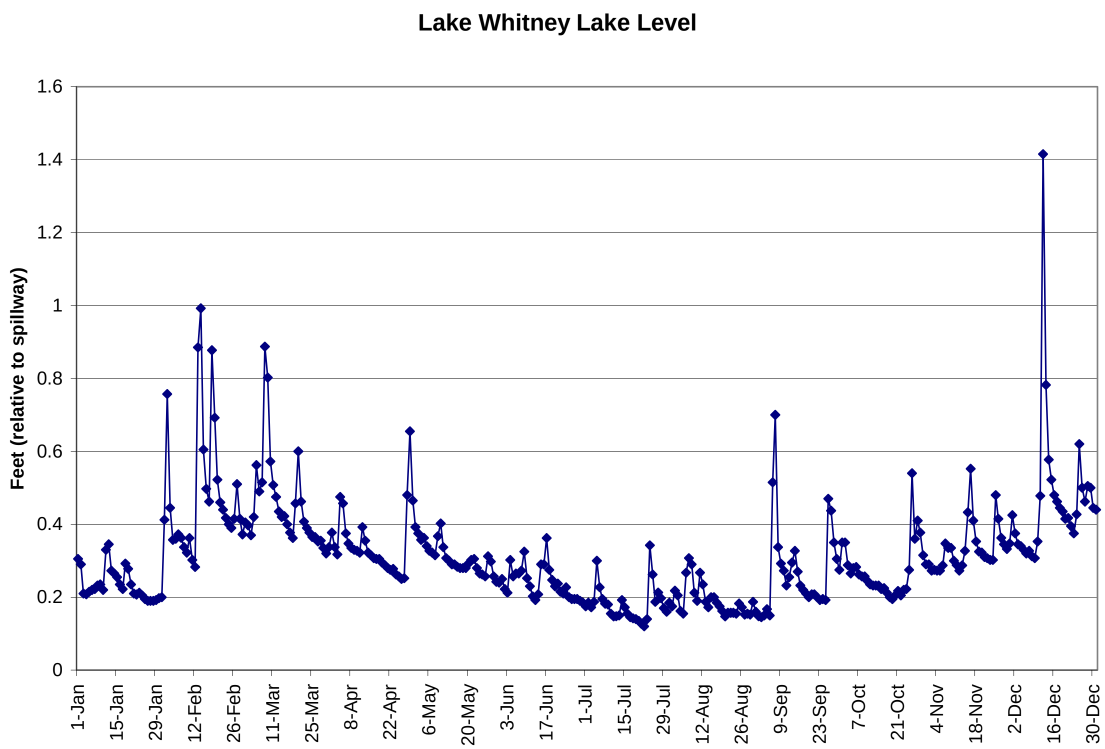


Figure 9. Water level for Lake Whitney during 2008.

Methods

This assessment incorporates evaluations of phytoplankton, zooplankton, aquatic macrophytes, benthic macroinvertebrates, fish, and water quality in upper Lake Whitney (Figure 10). Phytoplankton were assessed from a whole water sample collected as a near-surface grab sample once on June 19, 2008. 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 19, 2008 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 19, 2008. 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 19, 2008 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 19, 2008 by visual observation and through the use of gill nets. 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 hour. Each captured fish was measured to the nearest mm before being released.

Results

Water quality as measured on June 19, 2008 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 19, 2008.

Date	Depth (meters)	Temp °C	Dissolved Oxygen (% saturation)	Dissolved Oxygen (mg/L)	Turbidity (NTUs)	pH	Conductivity (µS/cm)
6/19/2008	0.3	21.2	77.0	6.53	3.4	7.59	215
6/19/2008	1	20.4	70.9	6.08		7.42	218
6/19/2008	2	18.9	61.8	5.58		7.26	207
6/19/2008	2.5	18.5	55.4	5.51		7.22	206
6/19/2008	3	18.3	56.8	5.11		7.23	206

Phytoplankton

The location of phytoplankton sampling is indicated in Figure 10. Phytoplankton cell counts and biomass estimates are provided in Table 2. Golden algae (Chrysophyta) were the major component of the phytoplankton at the time of sampling in 2008, although representatives of four other algal divisions were encountered. Blue-greens (more properly cyanobacteria) were present in the plankton sample, but not at abundant levels. Blue-greens had not been encountered during the biological assessments of Lake Whitney since 2005, although they are known to persist in the late summer and early fall months. Compared to 2007, diversity and evenness values increased in 2008. Taxonomic richness in 2008 (17 species) increased compared to the 2007 sampling (13 species). Once again the composition of the phytoplankton community suggested high nutrient levels.

Overall cell counts and biomass estimates were moderate in the June 2008 sample. Cell density levels in 2008 were roughly 50% lower than levels observed in June 2007. Cell biomass in 2008 experienced a reduction of nearly 60% from 2007 levels. The 2007 phytoplankon levels were driven mostly by a bloom of the golden alga Dinobryon. While common and not a major problem in most water supplies, this alga could impart taste and odor at biomass levels observed in 2007.

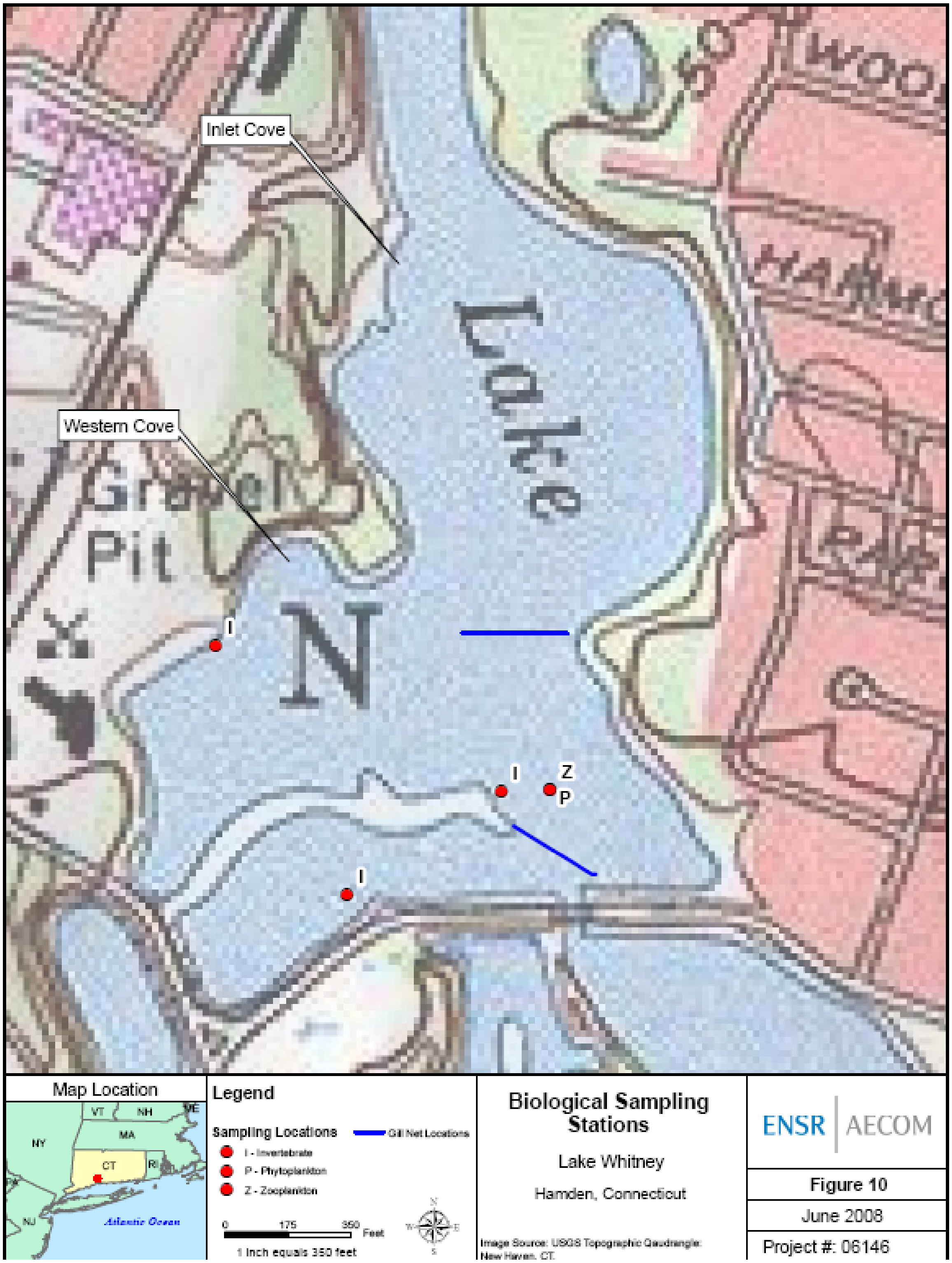


Figure 10. Map of upper Lake Whitney including sampling locations for phytoplankton, zooplankton, invertebrates and gill net set locations.

Table 2. Phytoplankton density (cells/mL) and biomass (μg/L) for the sample collected in upper Lake Whitney in June 19, 2008.

	Density (cells/mL) LW-1 06/19/08		Biomass (μg/ LW-1 06/19/08
TAXON		**TAXON**	
BACILLARIOPHYTA		**BACILLARIOPHYTA**	
Centric Diatoms		**Centric Diatoms**	
Aulacoseira	150	*Aulacoseira*	45
Araphid Pennate Diatoms		**Araphid Pennate Diatoms**	
Asterionella	80	*Asterionella*	16
Fragilaria/related taxa	100	*Fragilaria/related taxa*	30
Synedra	20	*Synedra*	16
Biraphid Pennate Diatoms		**Biraphid Pennate Diatoms**	
Navicula/related taxa	10	*Navicula/related taxa*	5
Nitzschia	20	*Nitzschia*	16
CHLOROPHYTA		**CHLOROPHYTA**	
Flagellated Chlorophytes		**Flagellated Chlorophytes**	
Eudorina	160	*Eudorina*	64
Pandorina	160	*Pandorina*	16
Coccoid/Colonial Chlorophytes		**Coccoid/Colonial Chlorophytes**	
Scenedesmus	120	*Scenedesmus*	12
Schroederia	20	*Schroederia*	50
Treubaria	10	*Treubaria*	2
CHRYSOPHYTA		**CHRYSOPHYTA**	
Flagellated Classic Chrysophytes		**Flagellated Classic Chrysophytes**	
Dinobryon	1380	*Dinobryon*	4140
Mallomonas	20	*Mallomonas*	10
Synura	20	*Synura*	16
CRYPTOPHYTA		**CRYPTOPHYTA**	
Cryptomonas	460	*Cryptomonas*	92
CYANOPHYTA		**CYANOPHYTA**	
Unicellular and Colonial Forms		**Unicellular and Colonial Forms**	
Dactylococcopsis	90	*Dactylococcopsis*	1
Filamentous Non-Nitrogen Fixers		**Filamentous Non-Nitrogen Fixers**	
Pseudanabaena	100	*Pseudanabaena*	1
DENSITY (CELLS/ML) SUMMARY		**BIOMASS (UG/ML) SUMMARY**	
BACILLARIOPHYTA	**380**	**BACILLARIOPHYTA**	**128**
CHLOROPHYTA	**470**	**CHLOROPHYTA**	**144**
CHRYSOPHYTA	**1420**	**CHRYSOPHYTA**	**4166**
CRYPTOPHYTA	**460**	**CRYPTOPHYTA**	**92**
CYANOPHYTA	**190**	**CYANOPHYTA**	**1.9**
EUGLENOPHYTA	**0**	**EUGLENOPHYTA**	**0**
PYRRHOPHYTA	**0**	**PYRRHOPHYTA**	**0**
TOTAL	**2920**	**TOTAL**	**4532**
CELL DIVERSITY	**0.82**	**BIOMASS DIVERSITY**	**0.21**
CELL EVENNESS	**0.67**	**BIOMASS EVENNESS**	**0.17**

Zooplankton

The location of zooplankton sampling is indicated in Figure 10. Zooplankton counts and biomass estimates are provided in Table 3. In 2008, zooplankton included protozoans, rotifers, copepods, and cladocerans. Protozoans 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). Larger cladocerans and copepods are each responsible for more biomass than the protozoans. Taxonomic richness in 2008 was lower than the 2007 sample and higher than the 2006 sample. Average body length in 2008 was lower compared to the previous three years. The 2008 sample had increased organism density, but decreased biomass values compared to 2007. Phytoplankton food resources are of generally good quality, and should support a larger zooplankton community. Rapid flushing of upper Lake Whitney likely acts to 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 19, 2008. S-W is Shannon-Wiener diversity index.

TAXON	Density (#/L) LW-1Z 6/19/08	TAXON	Biomass (μg/L LW-1Z 6/19/08
PROTOZOA		**PROTOZOA**	
Ciliophora	10.7	**Ciliophora**	0.2
ROTIFERA		**ROTIFERA**	
Asplanchna	0.1	*Asplanchna*	0.1
Brachionus	0.1	*Brachionus*	0.0
Conochilus	0.4	*Conochilus*	0.0
Keratella	0.4	*Keratella*	0.0
COPEPODA		**COPEPODA**	
Copepoda-Cyclopoida		**Copepoda-Cyclopoida**	
Cyclops	0.2	*Cyclops*	0.4
Copepoda-Calanoida		**Copepoda-Calanoida**	
Other Copepoda-Nauplii	0.3	**Other Copepoda-Nauplii**	0.7
CLADOCERA		**CLADOCERA**	
Ceriodaphnia	0.2	*Ceriodaphnia*	0.5
Chydorus	0.3	*Chydorus*	0.3
SUMMARY STATISTICS		**SUMMARY STATISTICS**	
DENSITY		**BIOMASS**	
PROTOZOA	10.7	**PROTOZOA**	0.2
ROTIFERA	0.9	**ROTIFERA**	0.1
COPEPODA	0.5	**COPEPODA**	1.2
CLADOCERA	0.5	**CLADOCERA**	0.7
OTHER ZOOPLANKTON	0.0	**OTHER ZOOPLANKTON**	0.0
TOTAL ZOOPLANKTON	12.5	**TOTAL ZOOPLANKTON**	2.2
TAXONOMIC RICHNESS		**S-W DIVERSITY INDEX**	0.30
PROTOZOA	1	**EVENNESS INDEX**	0.32
ROTIFERA	4		
COPEPODA	2	**MEAN LENGTH (mm): ALL FORMS**	0.08
CLADOCERA	2	**MEAN LENGTH: CRUSTACEANS**	0.42
OTHER ZOOPLANKTON	0		
TOTAL ZOOPLANKTON	9		

Macrophytes

Macrophytes are a visibly dominant feature of upper Lake Whitney in the summer. Mapping points and transects are shown in Figure 11. Collected macrophyte data are provided in Table 4. Maps of total plant cover and total plant biovolume are presented in Figures 12 and 13.

Cover by macrophytes varied throughout the lake, with the densest cover generally in the northern portion of the lake. Cover in the inlet cove in 2008 was very similar to macrophyte cover in 2006 and 2007, with individual points experiencing slight increases or slight decreases in score. Compared to 2004 and 2005, where the inlet cove experienced cover between 75 and 100%, 2008 macrophyte cover was decreased (50-75%). 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 were filamentous green algae, *Elodea canadensis*, and *Ceratophyllum demersum*. Biovolume followed a similar pattern compared to the previous three years (2005-2007), although individual areas showed slight decreases in score. In 2008, no areas within Lake Whitney exceeded 50% biovolume levels. 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 water lilies and the submergent waterweed (*Elodea*), coontail (*Ceratophyllum*) 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 2005-2008 surveys. However, the plant community in the lake appears to be approaching pre-drawdown levels, and the lower density in places compared to pre-2004 drawdown 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, European water clover and small pondweed being the only aquatic plants noted other than the plants mentioned above. Although present in 2007, no benthic blue-green algae mats were observed. Blue-green algae, or cyanobacteria, are photosynthetic, aquatic bacteria. In 2008 macrophyte diversity was similar to 2006 and 2007. All species present are tolerant of low light or prefer shallow water (where low light is less of an issue). During the June 19, 2008 survey, non-native plants European water clover, and purple loosestrife were observed. In 2006, curly-leaf pondweed was observed for the first time, but was not located in 2007 or 2008. The 2008 survey was the third time European water clover was observed by ENSR, although European water clover 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 is 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 decreased compared to the 2004 survey.

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.

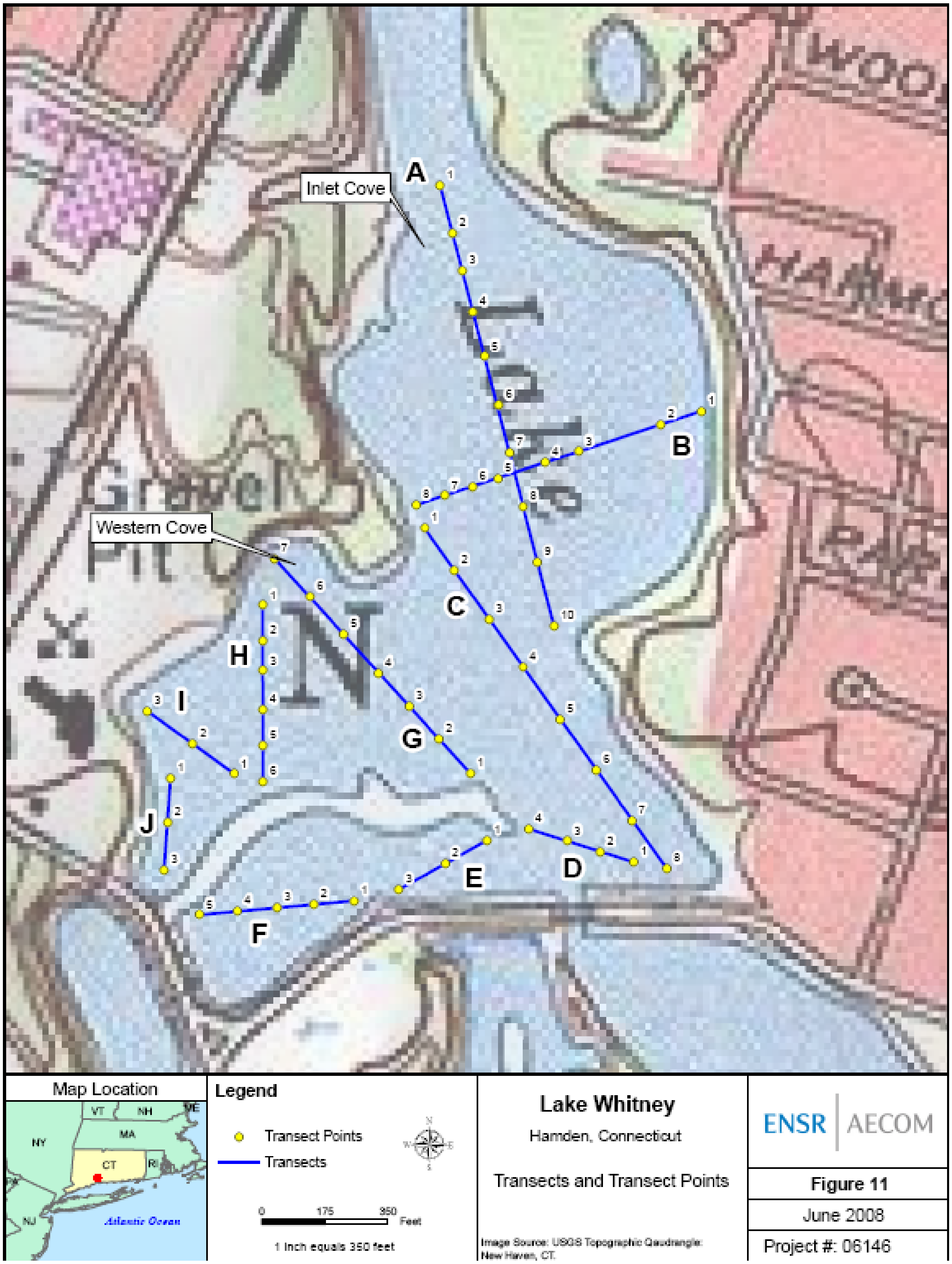


Figure 11. A map of upper Lake Whitney containing aquatic macrophyte survey transects and points.

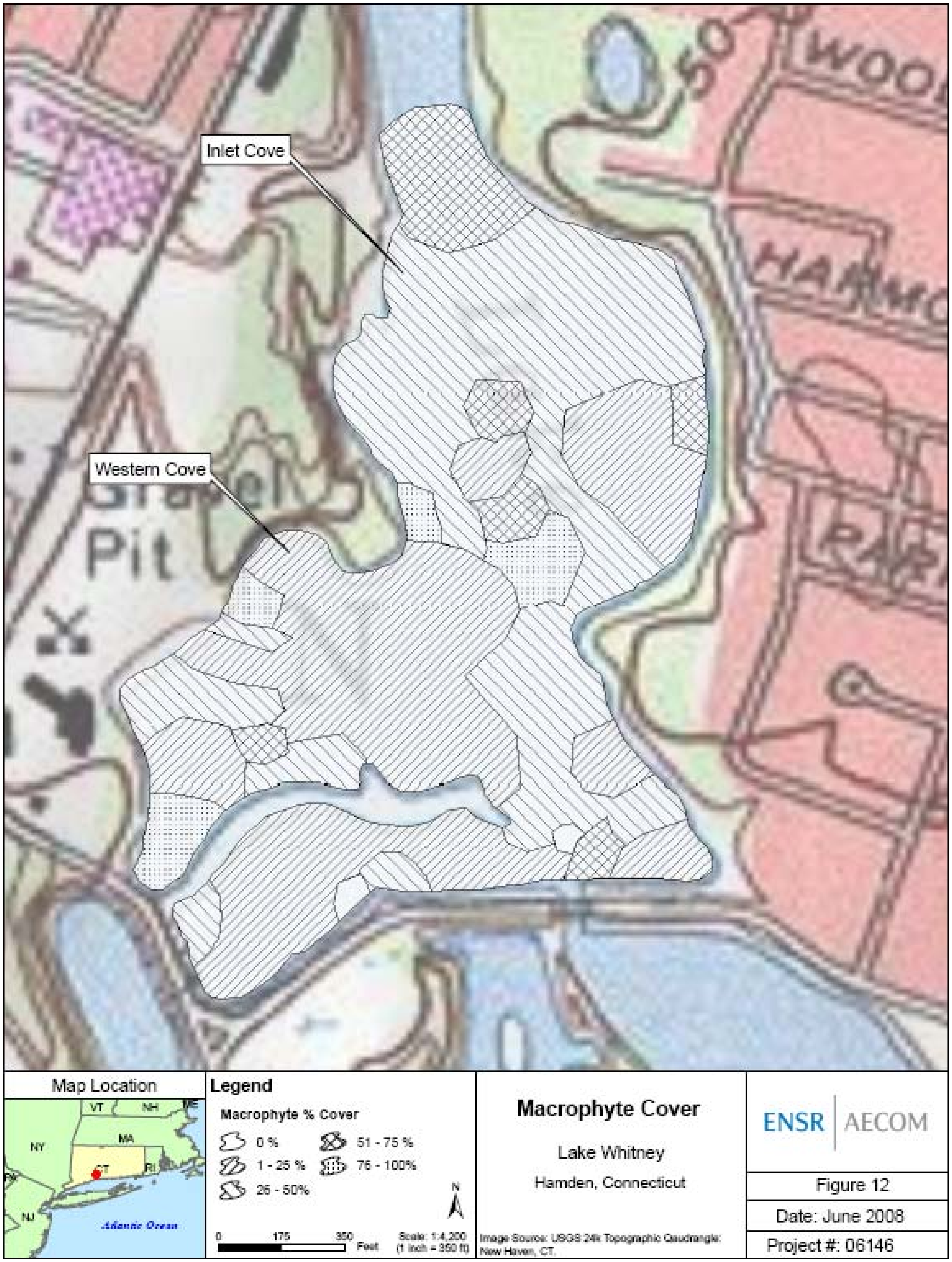


Figure 12. A map of upper Lake Whitney and corresponding plant cover on June 19, 2008.

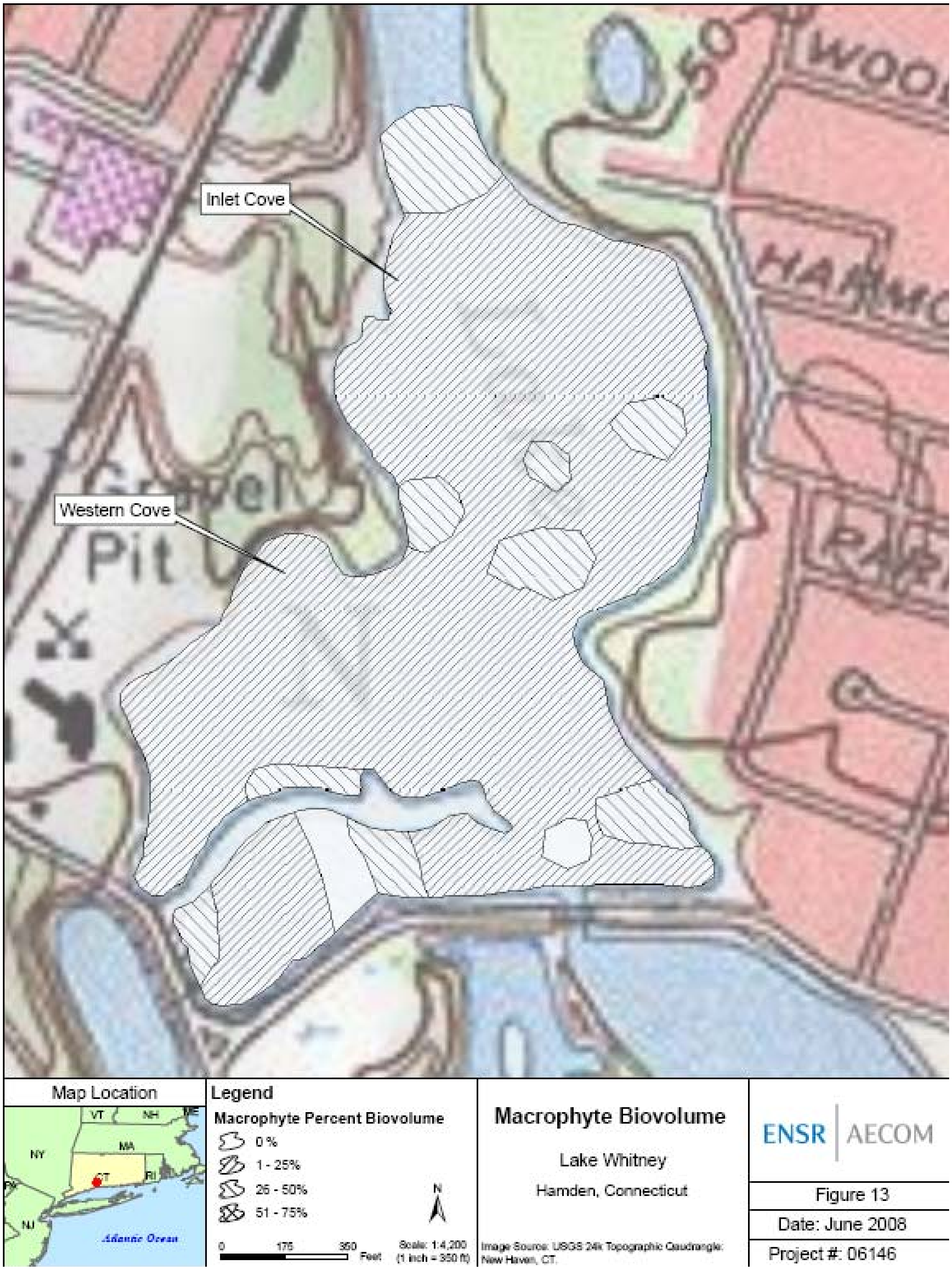


Figure 13. A map of upper Lake Whitney and corresponding plant biovolume on June 19, 2008.

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 (19-June-2008). 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	3	2	nod
A-2	0.6	2.0	mu	3	1	nod, eca, cde
A-3	0.6	2.0	mu	2	1	nod, eca, cde
A-4	0.5	1.5	mu	2	1	cde, ecg, lmi, wco
A-5	0.3	1.0	mu	2	1	nod, eca, lmi, lma, wco
A-6	0.5	1.5	mu	3	1	alg, nod
A-7	0.6	2.0	mu	1	1	alg
A-8	0.9	3.0	mu	3	1	alg, nod, cde
A-9	1.5	5.0	mu	4	2	eca, alg, cde, nod
A-10	1.7	5.5	mu	2	1	alg, eca
B-0	0.3	1.0	sa	3	1	alg, lmi
B-1	0.9	3.0	mu	3	1	alg, eca, lmi, wco
B-2	1.2	4.0	mu	1	2	eca, cde, wco
B-3	0.9	3.0	mu	1	1	nod, eca
B-4	0.9	3.0	mu	2	2	alg, eca, nod
B-5	1.1	3.5	mu	1	1	alg
B-6	1.2	4.0	mu	1	1	eca, alg
B-7	1.2	4.0	mu	2	2	nod, eca
B-8	1.5	5.0	mu,sa,ro	4	2	nod, eca, alg, cde
C-1	1.2	4.0	mu,sa	4	2	eca, nod, cde
C-2	1.4	4.5	mu	1	1	eca
C-3	1.2	4.0	mu	1	1	alg
C-4	1.5	5.0	mu	2	1	alg, eca, cde
C-5	1.1	3.5	mu,sa	2	1	alg, eca
C-6	1.4	4.6	mu,sa	1	1	alg, eca, cde, nod
C-7	1.5	5.0	mu	2	2	nod, eca, cde, alg
C-8	1.8	6.0	mu	1	1	nod, wco, cde, lmi
D-1	1.8	5.8	mu	1	1	alg, eca, nod
D-2	1.8	5.8	mu	3	1	eca
D-3	2.7	8.8	mu	0	0	
D-4	2.1	7.0	mu	2	1	alg, eca, nod, lmi, wco, lma
E-1	0.9	3.0	mu	1	1	alg, ppu, nod, wco
E-2	2.7	9.0	mu	1	1	alg, ppu
E-3	0.9	3.0	sa, ro	2	2	ppu, alg, mqu
F-1	0.9	3.0	sa, ro	0	0	
F-2	2.4	8.0	mu	1	1	alg, nod
F-3	2.1	7.0	mu	1	1	alg, cde
F-4	2.0	6.5	mu	1	1	cde, ecu
F-5	1.5	5.0	mu	2	2	cde, eca

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, eca
G-2	1.8	6.0	mu	1	1	nod, eca
G-3	1.5	5.0	mu	1	1	eca
G-4	1.8	5.9	mu	1	1	alg
G-5	1.8	5.9	mu	1	1	alg, eca
G-6	0.8	2.5	mu	1	1	alg
G-7	1.1	3.5	mu	1	1	nod, alg, eca
H-1	1.0	3.2	mu,sa	4	1	alg
H-2	1.2	4.0	mu,sa	2	1	alg, nod, eca
H-3	1.0	3.2	mu	1	1	alg
H-4	0.9	3.0	mu	2	1	nod, eca, cde
H-5	1.0	3.2	mu	3	1	alg
H-6	0.6	2.0	mu,sa	2	2	alg, nod, eca
I-1	0.6	2.0	mu	1	1	alg, nod, eca
I-2	1.2	4.0	mu	1	1	alg, eca
I-3	1.4	4.5	mu	2	1	alg, nod, eca, lmi, wco
J-1	1.2	4.0	mu	1	1	cya, mqu
J-2	1.0	3.2	mu	4	1	alg, nva, eca, lmi, wco
J-3	1.1	3.5	mu	4	1	eca, wco

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);
lma - *Lemna major* (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).
ppu - Potamogeton pusillis (small pondweed)

Benthic Macroinvertebrates

Locations of benthic invertebrate sampling are shown in Figure 10. 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.

The types of species present in 2008 were nearly identical to the species observed in 2006 and 2007. ENSR biologists noted that overall abundance in 2008 appeared lower than 2007, although numbers of organisms present was not quantified. Invertebrate abundance appeared to be similar to 2006. Most of the invertebrate taxa found in Lake Whitney were tolerant of impacted environments and/or opportunistic species (e.g., pulmonate snails; sowbugs, and scuds such as *Gammarus*). Lack of large-bodied invertebrate taxa in Lake Whitney suggests possible strong predation by fish. With a depressed zooplankton community, invertebrates may represent a large portion of the prey available for the fish community. 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 2008. Taxonomic richness in 2008 (12) was higher than in 2007 (11), but lower than in 2006 (13), 2005 (14), 2004 (18) or 2000 (26), however, the same taxa were most 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 19, 2008. 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.

phylum or subphylum	class	order or subclass	family	taxon	feeding group(s) primary	feeding group(s) 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 (pupae)				

Fish

Locations of gill net sets are shown in Figure 10, and fish data are presented in Table 6. In addition to the species listed in Table 6, several sunfish species were visually observed. No largemouth bass were visually observed but that does not indicate this species is no longer present in Upper Lake Whitney. Centrarchids are adept at avoiding gill nets 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 often 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 in 2008 (Figure 14). In 2008, common carp were collected during the gill net sampling. In addition to the two captured carp, three others fell out of the net during retrieval. Numerous large carp specimens were visually observed jumping and swimming in the shallow north cove. Despite the limited number of carp captured in 2008 and previous years, common carp may still dominate fish biomass in the lake as seen in 2000. Five species of fish were captured during the 2008 survey. These included white perch, yellow perch, common carp, golden shiner and white sucker. All fish appeared healthy, and none of the perch captured appeared to be hosting the parasitic fungus seen in past years. The total number of fish collected in 2008 was almost identical to 2007, although more species were collected in 2008.

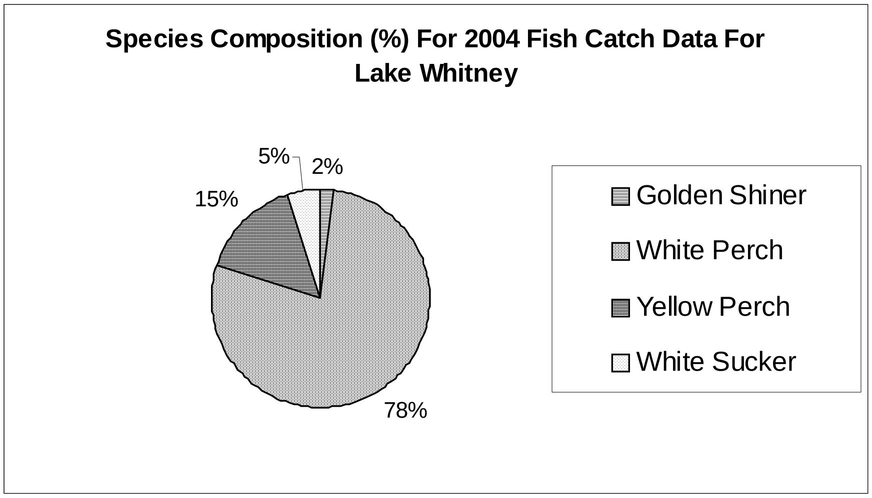
Although the zooplankton community structure is similar to lakes with landlocked alewife (i.e., few individuals, small body size), no clupeid fishes (e.g., alewife, shad) have been captured or observed in upper Lake Whitney since monitoring began, nor have they been found in Connecticut Department of 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. In 2008 golden shiners were captured but they did not appear to be present in large numbers. The lack of numbers and size of zooplankton may result in some planktivorous fishes moving out of the area in search of more abundant food sources.

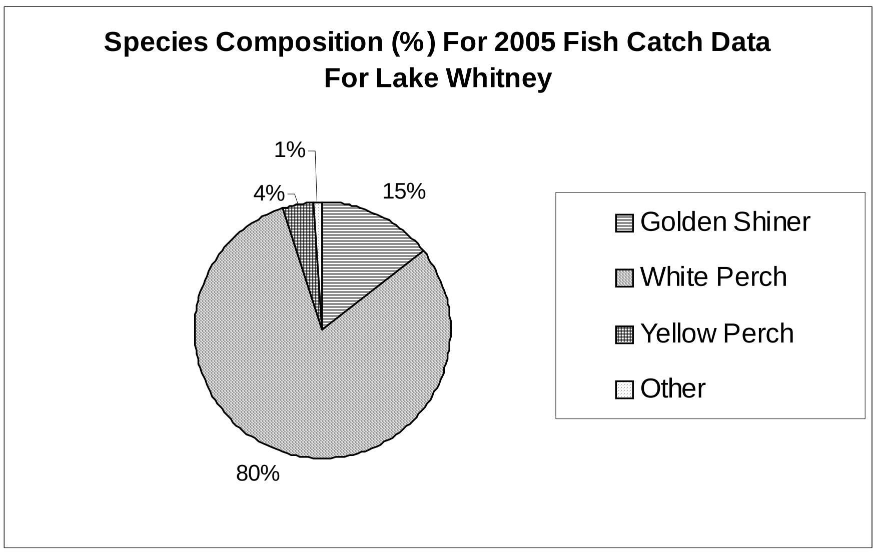
Upper Lake Whitney supports a substantial warmwater fish community. Coldwater species would not be expected to inhabit Lake Whitney. The unhindered connection to the lower portion of Lake Whitney allows fish to move freely between the lake segments, so rapid re-population after any times of stressful 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 19, 2008. 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	Common carp
TL(mm)	TL (mm)	TL (mm)	TL (mm)	TL (mm)	TL (mm)
203	208	158	204	119	197
196	209	147	198	153	574
192	192	162	176		
181	187	198	131		
170	131	184			
	135	177			
	158	131			
	161	162			
	147	171			
	144				
	208				
	206				
	171				
	184				
	193				
	170				
	161				

Figure 14. A graphical representation of species composition (number of fish) for the 2004, 2005, 2006, 2007, and 2008 sampling events.





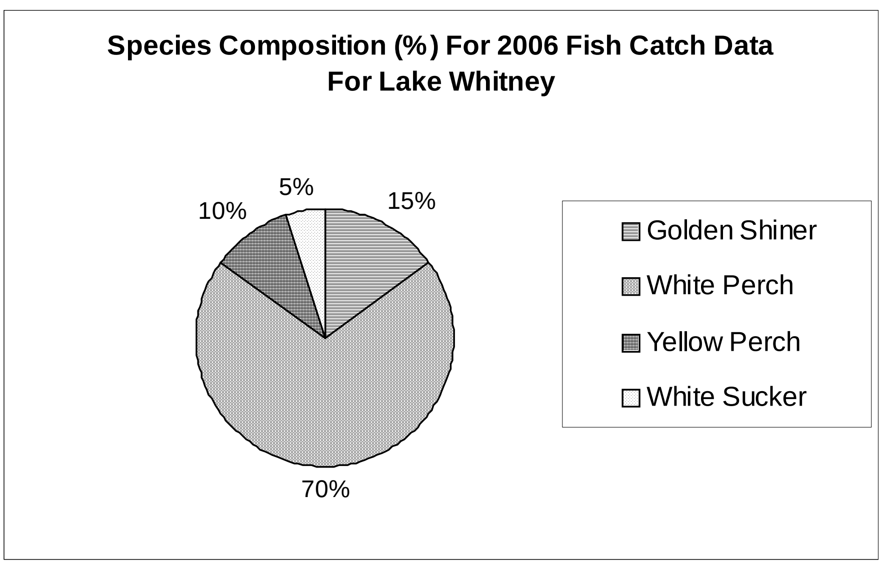
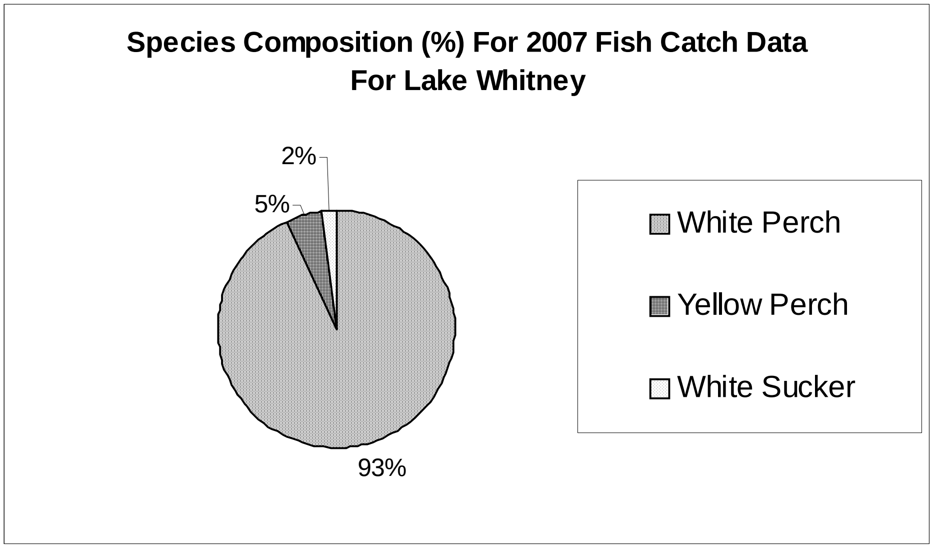
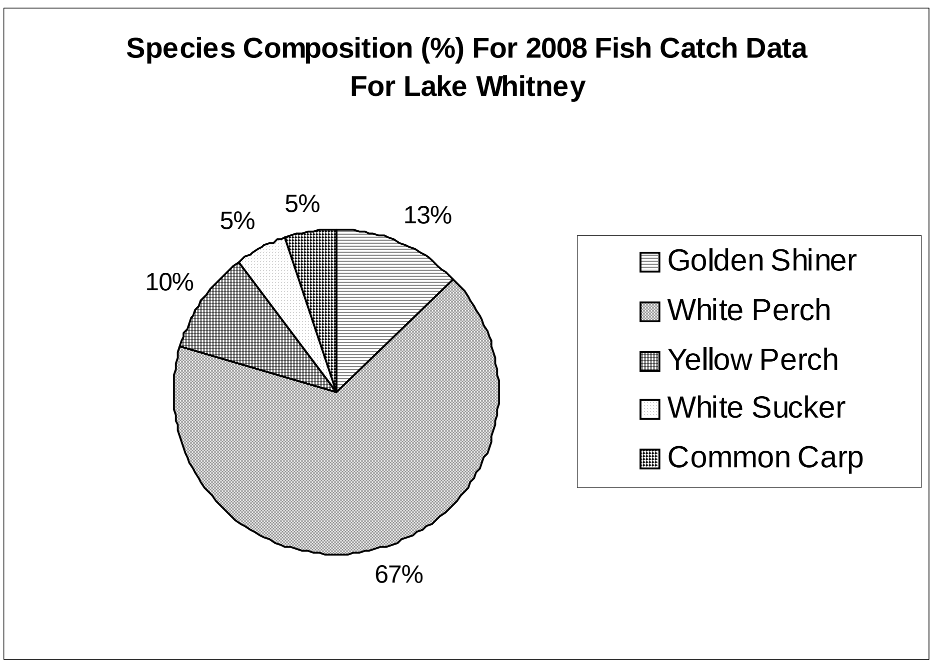


Figure 14 (continued). A graphical representation of species composition (number of fish) for the 2004, 2005, 2006, 2007, and 2008 sampling events.





Discussion

Phytoplankton, zooplankton, macroinvertebrate and fish populations assessed in 2008 are very similar to those observed in 2004-2007. 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. In 2008, a slight decrease in plant cover and biovolume was observed. During the 2008 survey, ENSR biologists noted an increased presence of the aquatic macrophyte coontail (Ceratophyllum demersum) compared to previous years. In some areas, growths of coontail had nearly reached the surface of the water, but do not pose a threat to the health of Lake Whitney. 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.

A slight increase in macroinvertebrate richness was observed in 2008 and could be related to hydrology or the plant community. The plant community between 2006 and 2008 has been similar, yet richness has ranged from 11 to 14 species. Macroinvertebrate abundance is patchy, so changes in species richness by a small margin is not cause for concern. Overall, there were no major changes in the macroinvertebrate features of upper Lake Whitney during 2008.

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 2008 is consistent with those previous lake drawdown studies. Upper Lake Whitney macrophyte levels are lower than pre-drawdown but support a healthy fish and invertebrate community. 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.

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