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Prepared For:

Regional Water Authority

South Central Connecticut Regional Water Authority

A BIOLOGICAL ASSESSMENT OF UPPER LAKE WHITNEY

MARCH 2008

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 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 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, 2006 and 2007, during the first three years of water withdrawal. This report summarizes the biological features of upper Lake Whitney in 2007, during the third 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).

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.

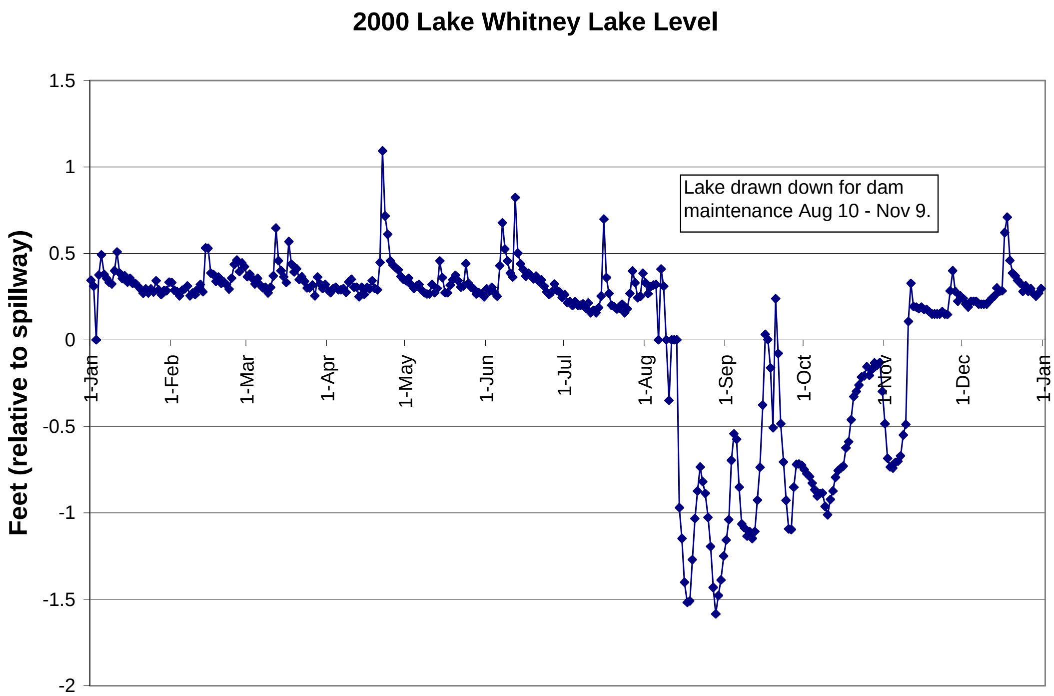

Figure 1. Water level graph for Lake Whitney during 2000.

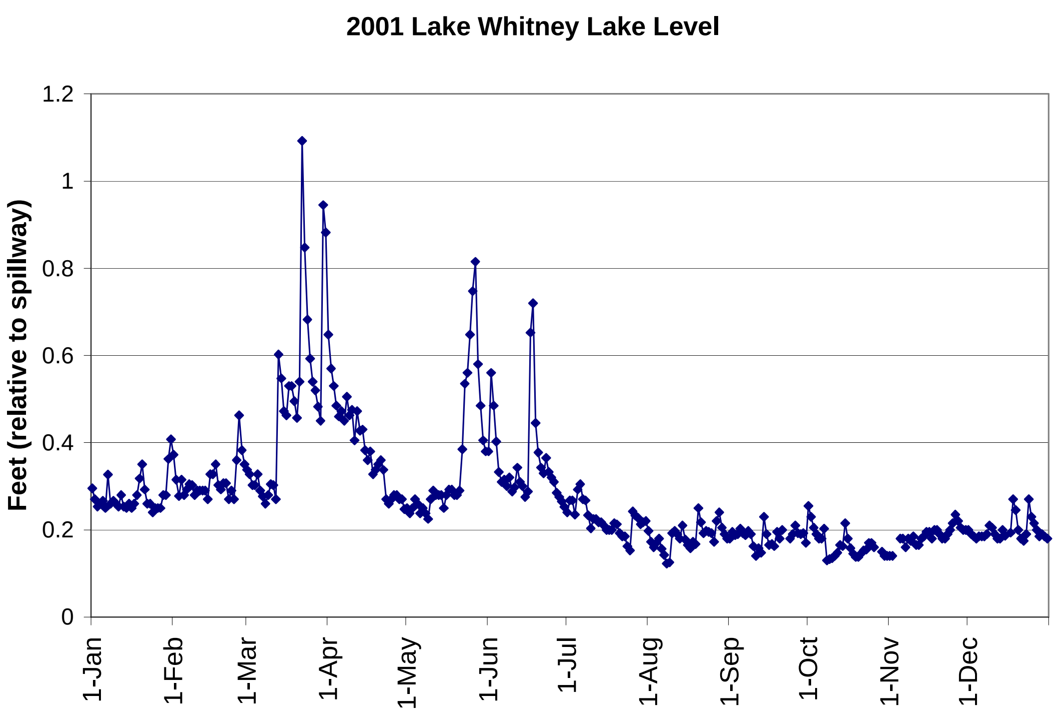

Figure 2. Water level graph for Lake Whitney during 2001.

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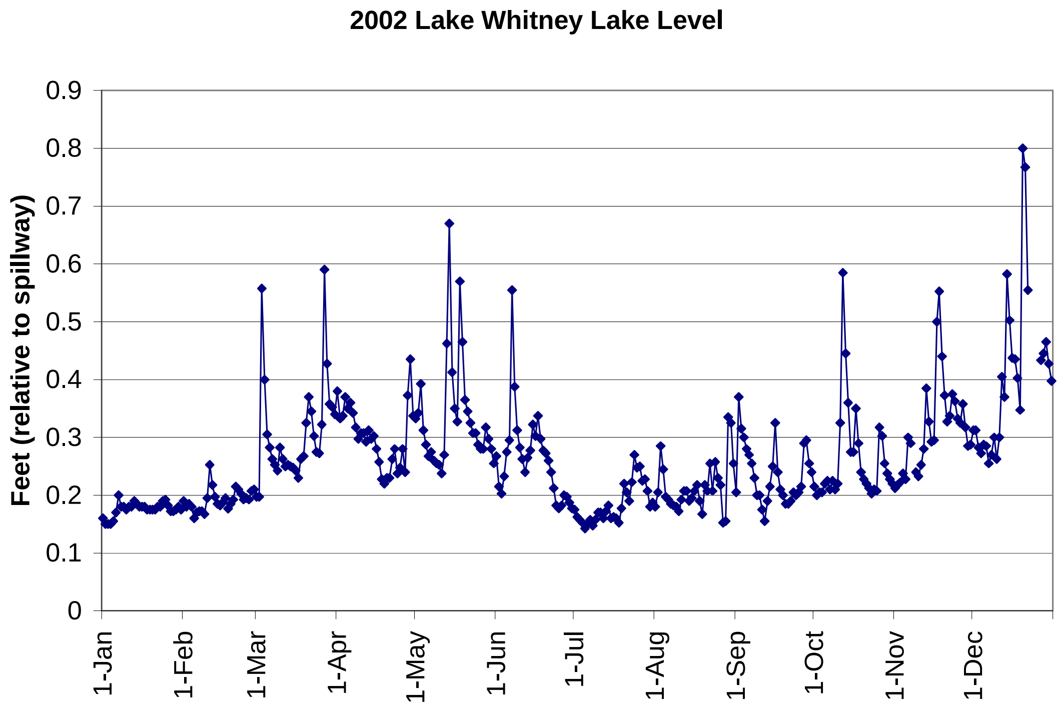

Figure 3. Water level graph for Lake Whitney during 2002.

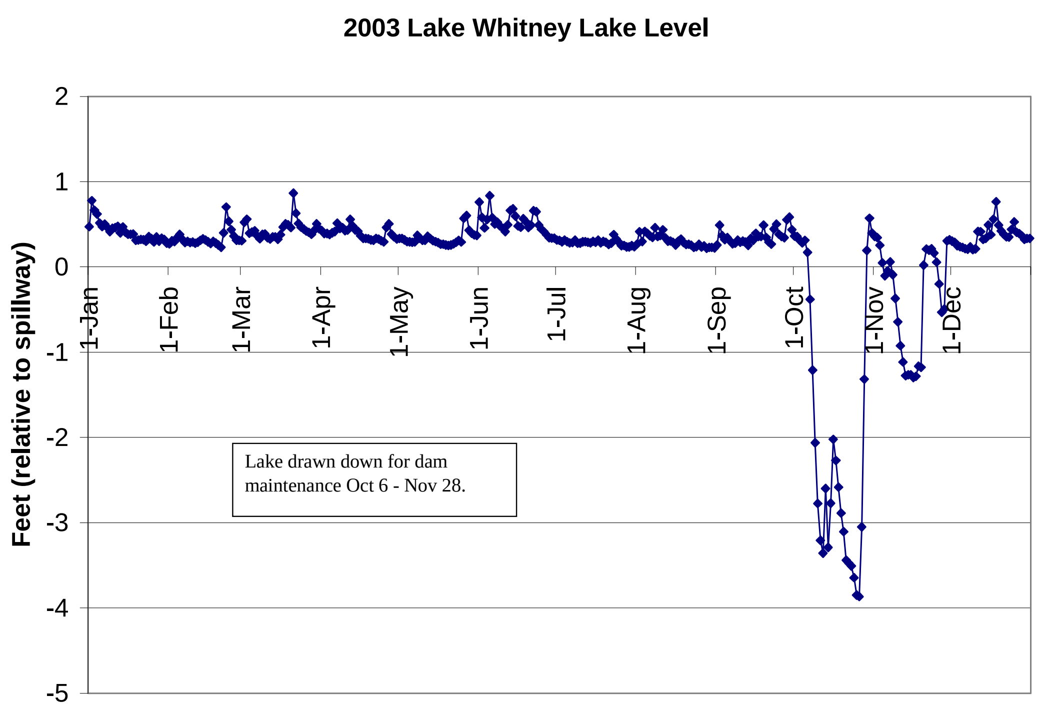

Figure 4. Water level for Lake Whitney during 2003.

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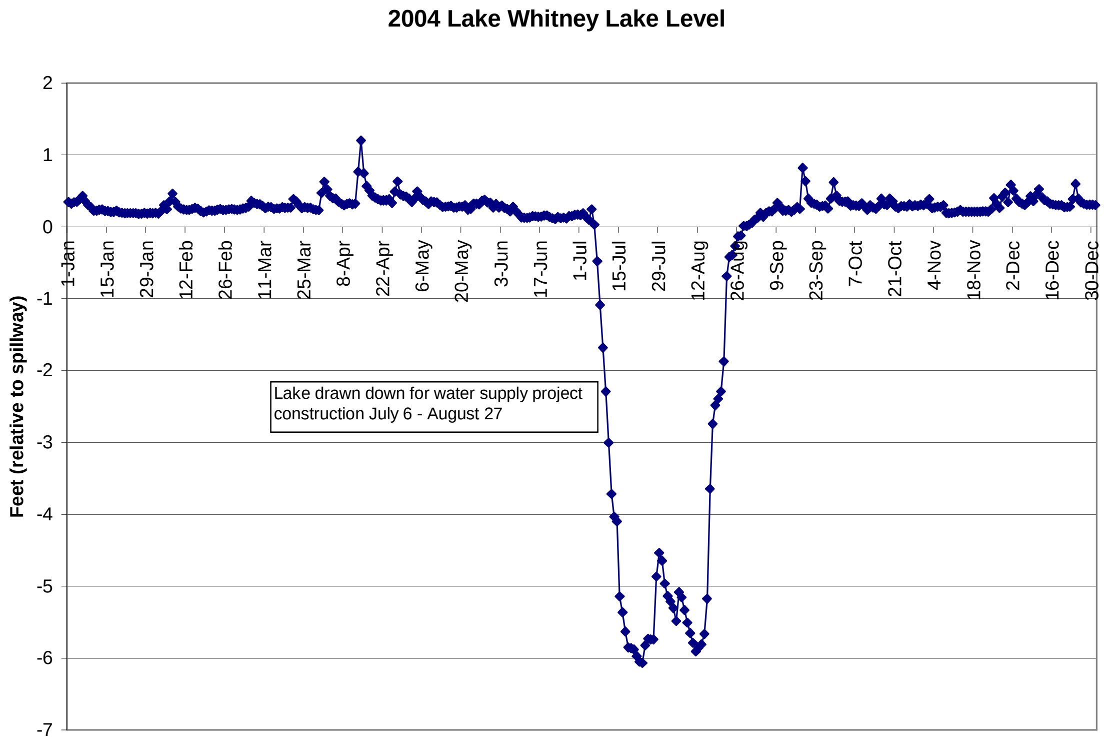

Figure 5. Water level for Lake Whitney during 2004.

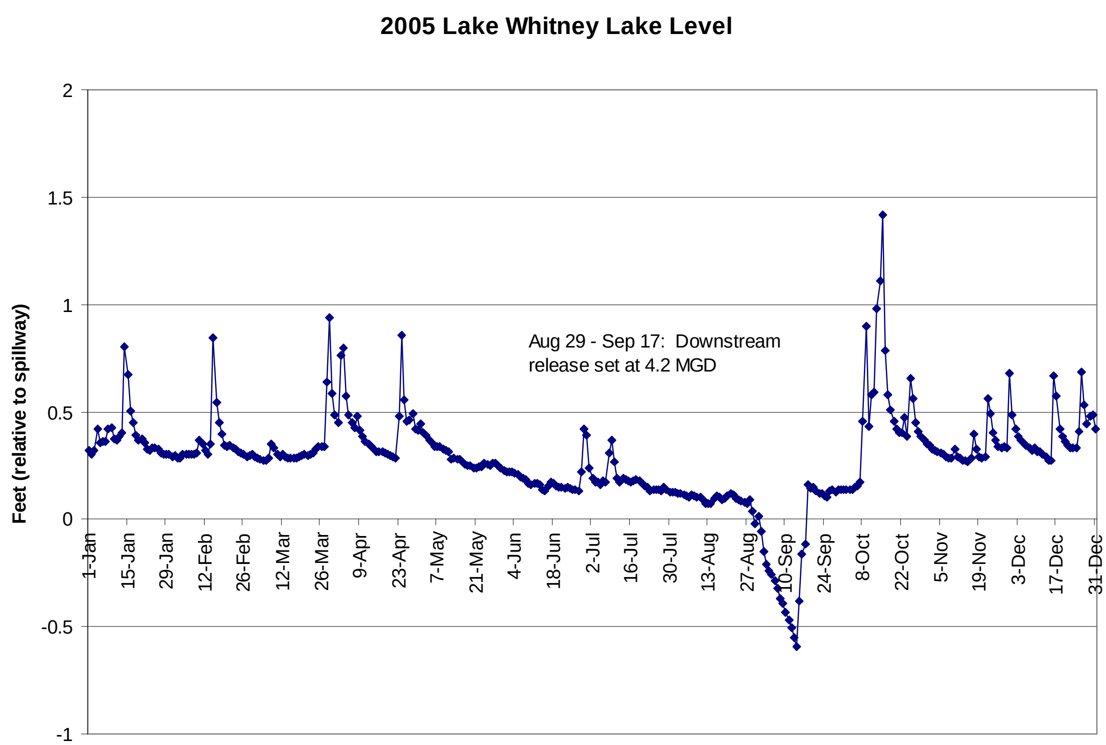

Figure 6. Water level for Lake Whitney during 2005.

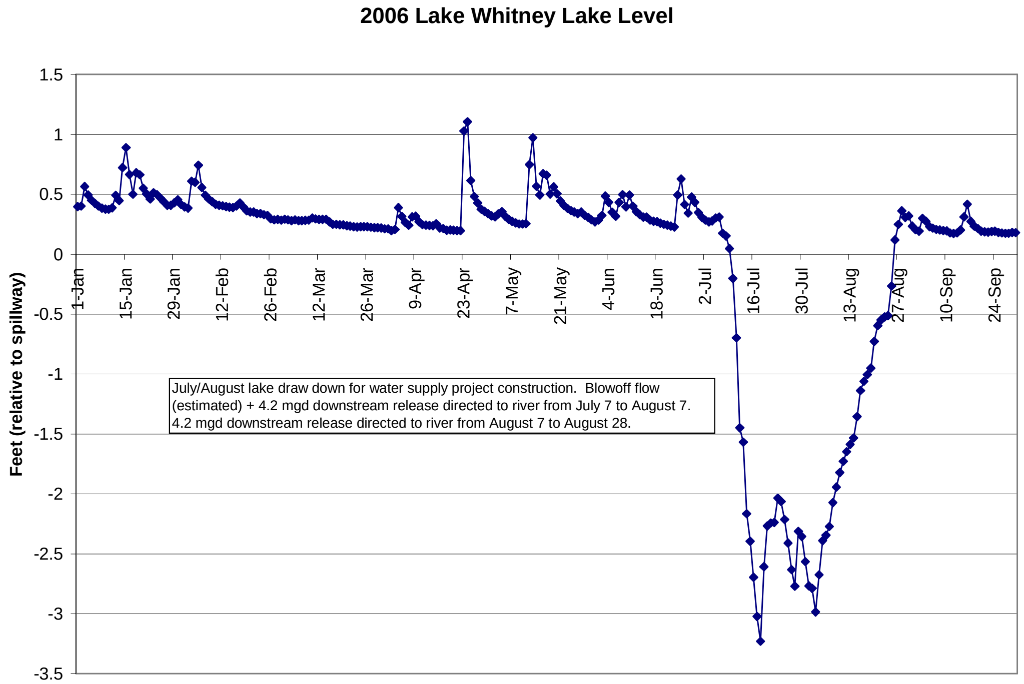

Figure 7. Water level for Lake Whitney during 2006.

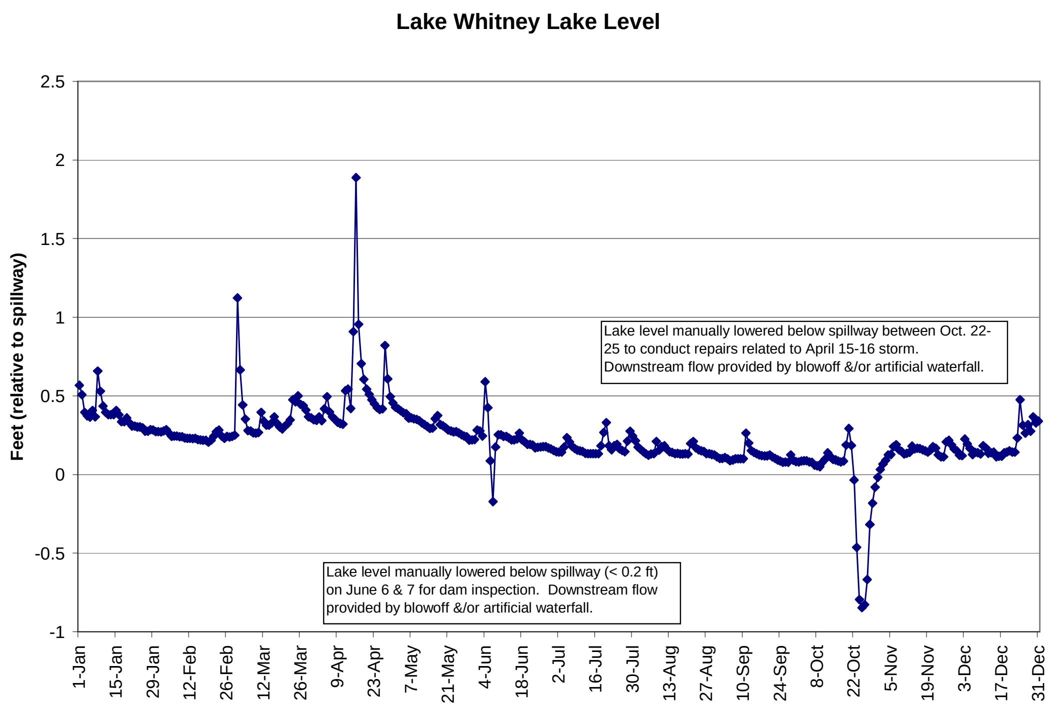

Figure 8. Water level for Lake Whitney during 2007.

Methods

This assessment incorporates evaluations of phytoplankton, zooplankton, aquatic macrophytes, benthic macroinvertebrates, fish, and water quality in upper Lake Whitney (Figure 9). Phytoplankton were assessed from a whole water sample collected as a near-surface grab sample once on June 19, 2007. 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, 2007 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, 2007. 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, 2007 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, 2007 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 2 hours. Each captured fish was measured to the nearest mm, and weighed to the nearest gram before being released.

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Results

Water quality as measured on June 19, 2007 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, 2007.

Date	Depth (meters)	Temp ℃	Dissolved Oxygen (% saturation)	Dissolved Oxygen (mg/L)	Turbidity (NTUs)	pH	Conductivity (µS/cm)
6/19/2007	0.2	23.5	124.3	10.6	3.8	8.4	245
6/19/2007	1	21.8	90.8	7.8	-	7.9	244
6/19/2007	2	20.4	72.7	6.6	-	7.7	247
6/19/2007	3	18.5	46.4	4.3	-	7.6	246
6/19/2007	3.3	17.9	36	3.4	-	7.6	252

Phytoplankton

The location of phytoplankton sampling is indicated in Figure 9. Phytoplankton cell counts and biomass estimates are provided in Table 2. Golden algae (Chrysophyta) and green algae (Chlorophyta) were the major components of the phytoplankton in 2007, 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 or 2007 samplings. Diversity and evenness values in 2007 were lower than both the 2005 and 2006 samplings. Taxonomic richness in 2007 has decreased compared to the 2006 sampling. Once again the composition of the phytoplankton community suggested high nutrient levels.

Overall cell counts and biomass estimates were high in the June 2007 sample. Cell density levels in 2007 were approximately 6 times greater than 2006 levels and 4 times greater than 2005 levels. Cell biomass in 2007 was roughly 20 times greater than the 2005 and 2006 samples, mostly due to 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 this biomass.

High flushing appears to be a dominant influence in this system, and precipitation in 2007 prior to sampling was above average. Although precipitation and flushing in 2007 were likely impacting Lake Whitney, higher algal biomass was observed at the time of sampling. While the high density represents odor and filter clogging potential, it is fortunate when nutrient ratios and other factors favor golden algae instead of blue-greens.

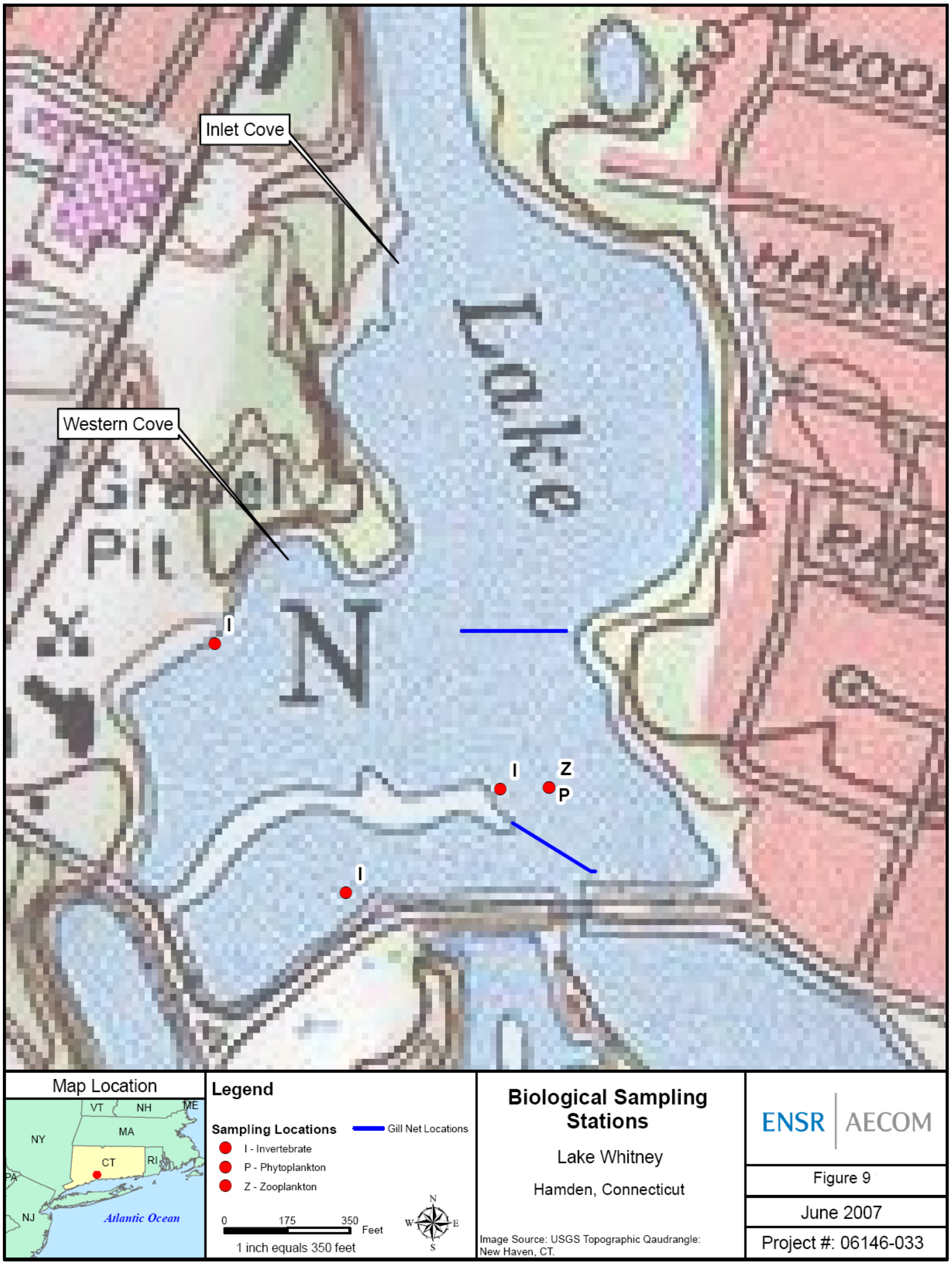

Figure 9. Map of upper Lake Whitney including sampling locations for phytoplankton, zooplankton, invertebrates and gill net set locations.

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Table 2. Phytoplankton density (cells/mL) and biomass (μg/L) for the sample collected in upper Lake Whitney in June 19, 2007.

	Density (cells/mL)		Biomass (μg/L)
	LW-1		LW-1
	6/19/2007		6/19/2007
Taxon		Taxon	
BACILLARIOPHYTA		**BACILLARIOPHYTA**	
Araphid Pennate Diatoms		**Araphid Pennate Diatoms**	
Asterionella	80	*Asterionella*	16
Biraphid Pennate Diatoms		**Biraphid Pennate Diatoms**	
Cymbella/related taxa	20	*Cymbella/related taxa*	20
Navicula/related taxa	20	*Navicula/related taxa*	10
CHLOROPHYTA		**CHLOROPHYTA**	
Flagellated Chlorophytes		**Flagellated Chlorophytes**	
Pandorina	800	*Pandorina*	80
Coccoid/Colonial Chlorophytes		**Coccoid/Colonial Chlorophytes**	
Elakatothrix	80	*Elakatothrix*	8
Oocystis	160	*Oocystis*	64
Scenedesmus	180	*Scenedesmus*	18
Sphaerocystis	160	*Sphaerocystis*	32
CHRYSOPHYTA		**CHRYSOPHYTA**	
Flagellated Classic Chrysophytes		**Flagellated Classic Chrysophytes**	
Dinobryon	3220	*Dinobryon*	9660
Mallomonas	140	*Mallomonas*	70
Synura	640	*Synura*	512
CRYPTOPHYTA		**CRYPTOPHYTA**	
Cryptomonas	220	*Cryptomonas*	352
PYRRHOPHYTA		**PYRRHOPHYTA**	
Ceratium	50	*Ceratium*	870
DENSITY (CELLS/ML) SUMMARY		**BIOMASS (UG/ML) SUMMARY**	
BACILLARIOPHYTA	120	**BACILLARIOPHYTA**	46
CHLOROPHYTA	1380	**CHLOROPHYTA**	202
CHRYSOPHYTA	4000	**CHRYSOPHYTA**	10242
CRYPTOPHYTA	220	**CRYPTOPHYTA**	352
CYANOPHYTA	0	**CYANOPHYTA**	0
EUGLENOPHYTA	0	**EUGLENOPHYTA**	0
PYRRHOPHYTA	50	**PYRRHOPHYTA**	870
TOTAL	**5770**	**TOTAL**	**11712**
CELL DIVERSITY	**0.68**	**BIOMASS DIVERSITY**	**0.32**
CELL EVENNESS	**0.61**	**BIOMASS EVENNESS**	**0.29**

Zooplankton

The location of zooplankton sampling is indicated in Figure 9. Zooplankton counts and biomass estimates are provided in Table 3. 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 are responsible for more biomass than the protozoans. Taxonomic richness was higher than the 2006 sample. Average body length in 2007 was lower compared to 2005 and 2006. The 2007 sample had increased organism density and biomass values compared to 2006, but still well below the observed values in 2005. 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, and precipitation levels prior to sampling were above average. 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) LW-1Z 6/19/2007		Biomass (μg/L) LW-1Z 6/19/2007
PROTOZOA		**PROTOZOA**	
Ciliophora	5.2	**Ciliophora**	0.10
ROTIFERA		ROTIFERA	
Conochilus	0.6	*Conochilus*	0.02
Keratella	0.2	Keratella	0.02
Polyarthra	0.1	Polyarthra	0.01
COPEPODA		**COPEPODA**	
Copepoda-Cyclopoida		**Copepoda-Cyclopoida**	
Mesocyclops	0.1	Mesocyclops	0.13
Copepoda-Calanoida		**Copepoda-Calanoida**	
Other Copepoda-Nauplii	0.3	**Other Copepoda-Nauplii**	0.69
CLADOCERA		**CLADOCERA**	
Bosmina	0.2	*Bosmina*	0.20
Ceriodaphnia	0.4	*Ceriodaphnia*	1.08
Chydorus	0.3	*Chydorus*	0.31
Daphnia galeata	0.1	*Daphnia galeata*	0.30
Daphnia pulex	0.2	*Daphnia pulex*	1.21
SUMMARY STATISTICS		**SUMMARY STATISTICS**	
DENSITY		**BIOMASS**	
PROTOZOA	5.2	**PROTOZOA**	0.10
ROTIFERA	0.9	**ROTIFERA**	0.05
COPEPODA	0.4	**COPEPODA**	0.82
CLADOCERA	1.2	**CLADOCERA**	3.10
OTHER ZOOPLANKTON	0.0	**OTHER ZOOPLANKTON**	0.00
TOTAL ZOOPLANKTON	7.7	**TOTAL ZOOPLANKTON**	4.08
TAXONOMIC RICHNESS		**S-W DIVERSITY INDEX**	0.57
PROTOZOA	1	**EVENNESS INDEX**	0.55
ROTIFERA	3		
COPEPODA	2	**MEAN LENGTH (mm): ALL FORMS**	0.14
CLADOCERA	5	**MEAN LENGTH: CRUSTACEANS**	0.48
OTHER ZOOPLANKTON	0		
TOTAL ZOOPLANKTON	11		

Macrophytes

Macrophytes are a visibly dominant feature of upper Lake Whitney in the summer. Mapping points and transects are shown in Figure 10. Collected macrophyte data are provided in Table 4. Maps of total plant cover and total plant biovolume are presented in Figures 11 and 12.

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 2007 was very similar to macrophyte cover in 2006. In both years, 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 2006. Biovolume only exceeded the 50% level in the western cove and southeastern corner of Lake Whitney. 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 water lilies 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 2005-2007 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, coontail, European water clover, and small pondweed being the only aquatic plants noted other than the plants mentioned above. In addition, benthic blue-green algae mats were also observed in 2007. Blue-green algae, or cyanobacteria, are photosynthetic, aquatic bacteria. In 2007 macrophyte diversity was similar to 2006. All species present are tolerant of low light or prefer shallow water (where low light is less of an issue). During the June 19, 2007 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. The 2007 survey was the second 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, but was 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 but blue-green algae mats were also observed. 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.

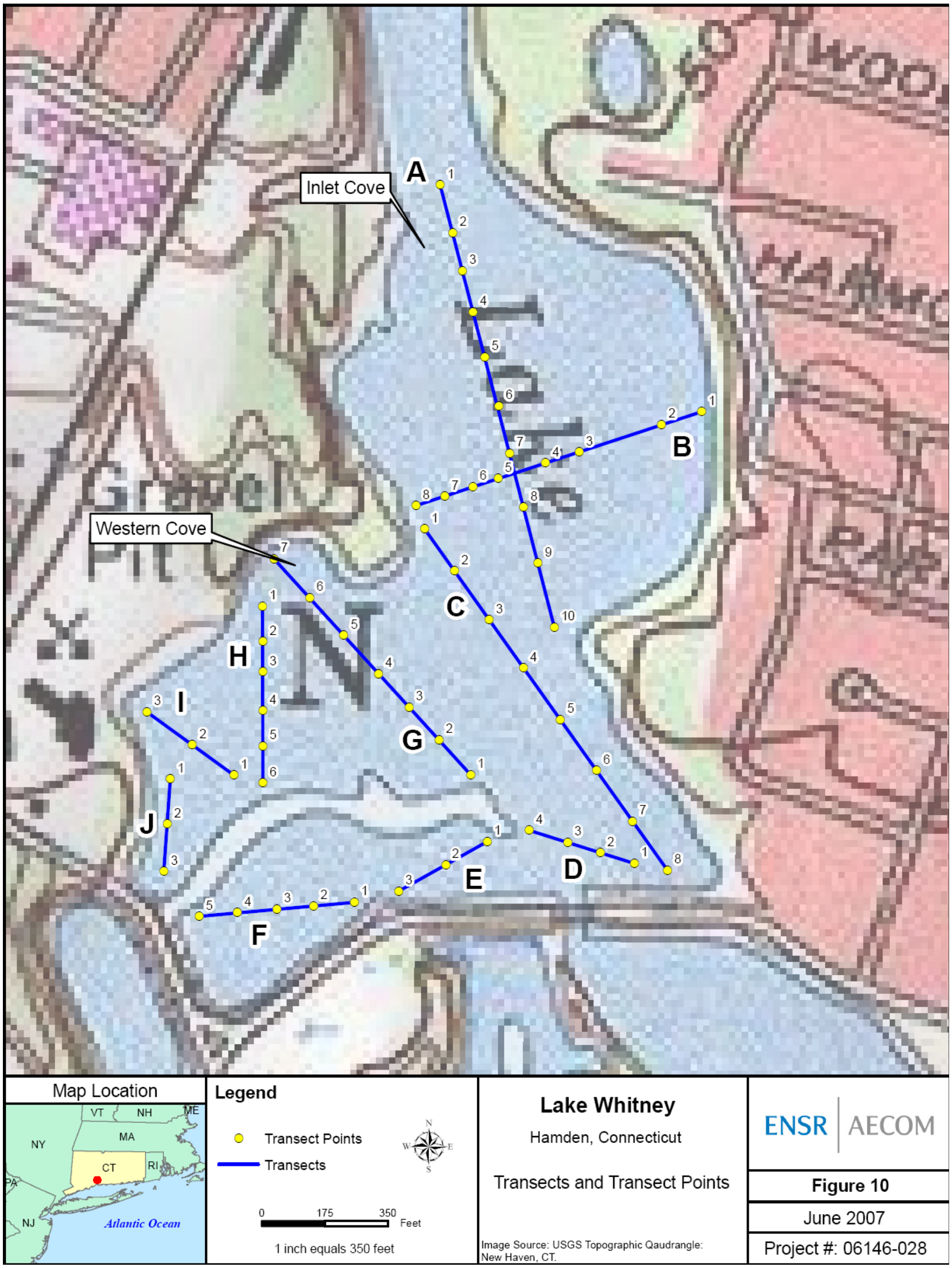

Figure 10. A map of upper Lake Whitney containing aquatic macrophyte survey transects and points.

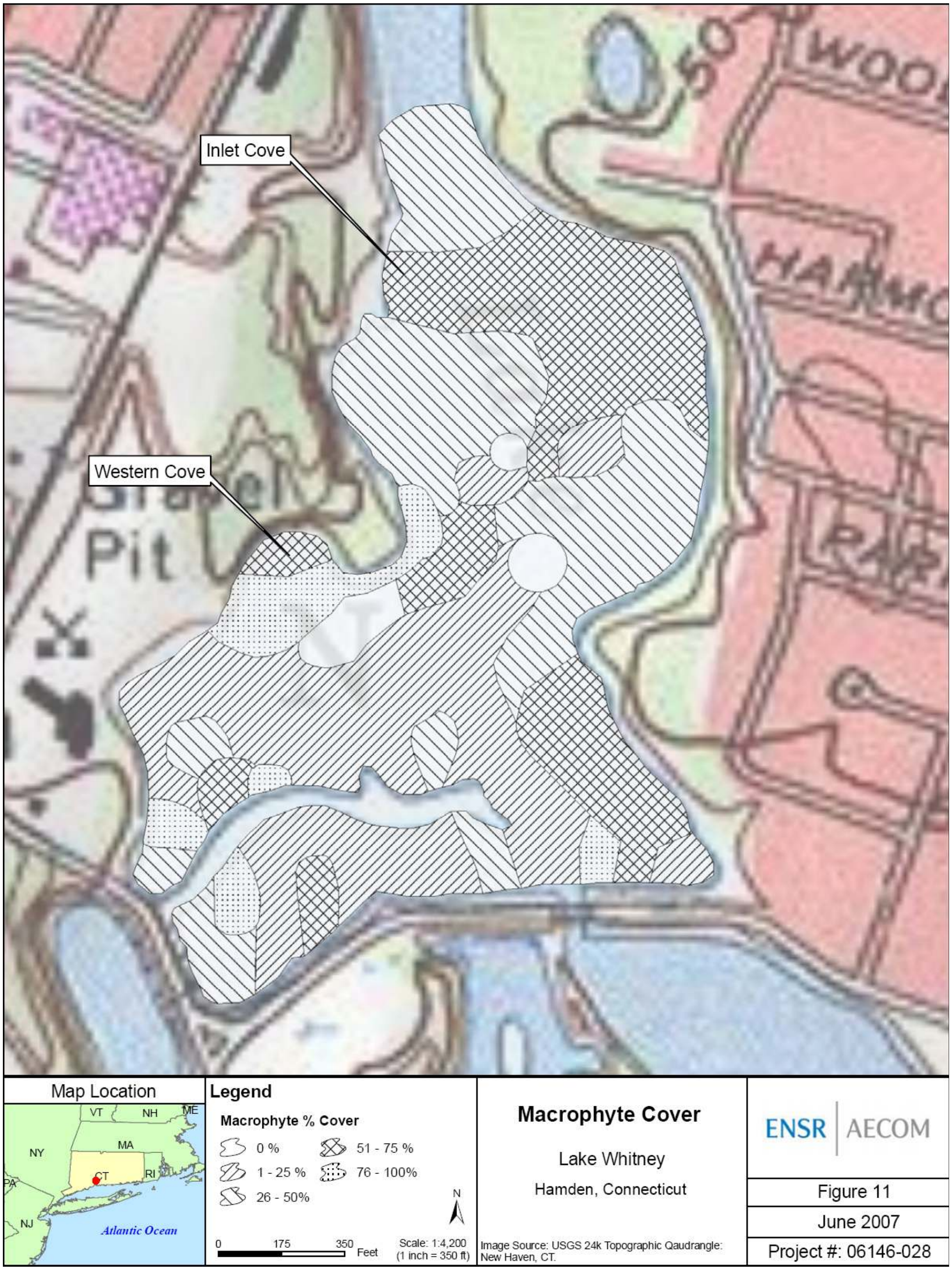

Figure 11. A map of upper Lake Whitney and corresponding plant cover on June 19, 2007.

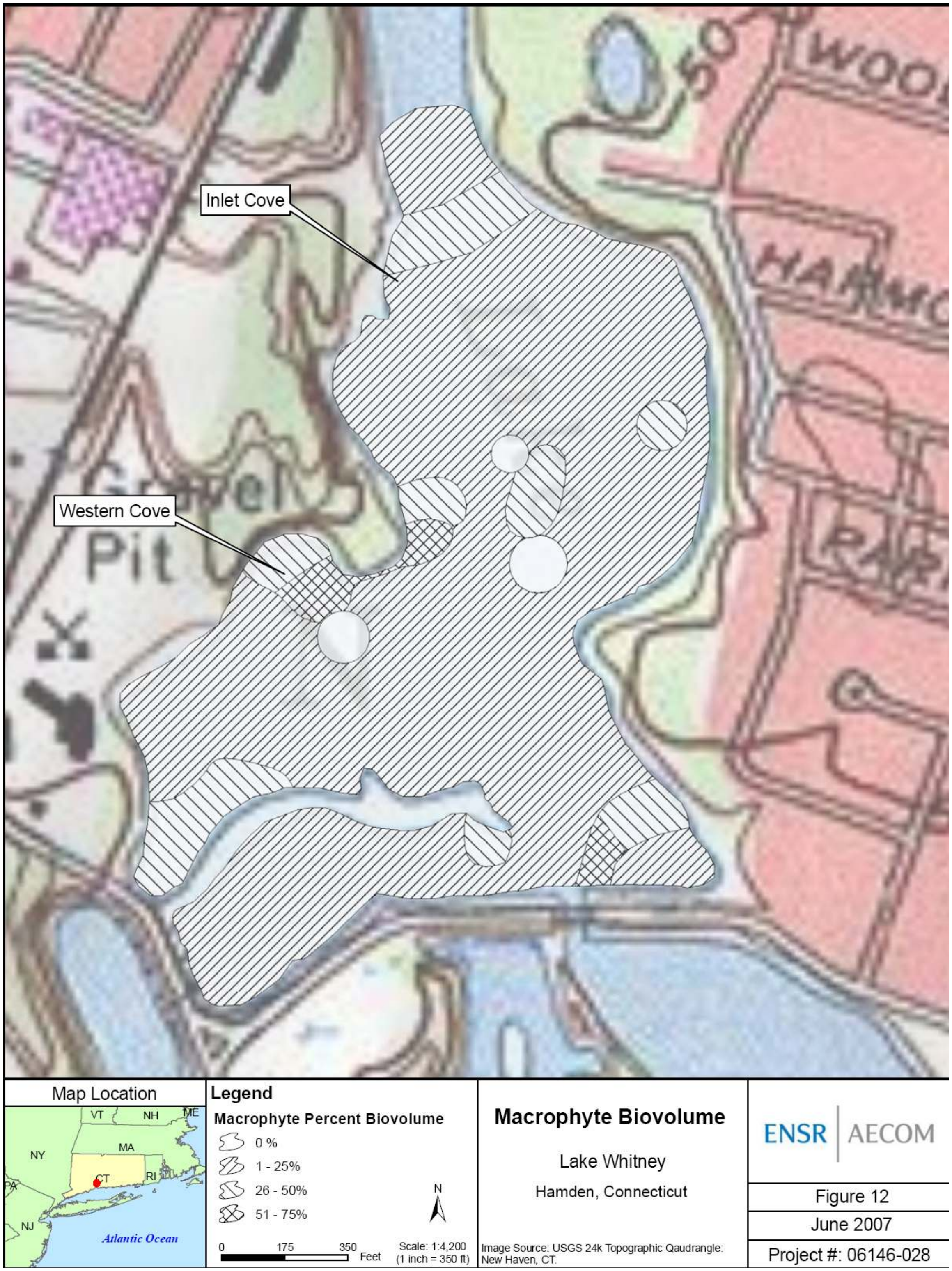

Figure 12. A map of upper Lake Whitney and corresponding plant biovolume on June 19, 2007.

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-2007). 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
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	nod
A-6	0.5	1.5	mu	2	1	alg, nod, lmi
A-7	0.6	2.0	mu	0	0	alg
A-8	0.9	3.0	mu	2	2	nod, eca
A-9	1.5	5.0	mu	0	0	
A-10	1.7	5.5	mu	2	1	alg, eca
B-0	0.3	1.0	sa	1	1	alg, lmi
B-1	0.9	3.0	mu	3	1	alg, eca, lmi, wco
B-2	1.2	4.0	mu	2	2	alg, nod
B-3	0.9	3.0	mu	1	1	nod, eca
B-4	0.9	3.0	mu	3	2	alg, eca
B-5	1.1	3.5	mu	1	1	eca
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	3	nod, eca, alg, cde
C-2	1.4	4.5	mu	3	1	alg, eca
C-3	1.2	4.0	mu	1	1	eca
C-4	1.5	5.0	mu	2	1	alg, eca
C-5	1.1	3.5	mu,sa	3	1	alg
C-6	1.4	4.6	mu,sa	3	1	alg, nod
C-7	1.5	5.0	mu	3	2	nod, eca, alg
C-8	1.8	6.0	mu	1	1	alg
D-1	1.8	5.8	mu	3	1	alg, eca, nod
D-2	1.8	5.8	mu	4	3	nod, eca, cde, wco, lmi
D-3	2.7	8.8	mu	1	1	alg
D-4	2.1	7.0	mu	1	1	nod, eca
E-1	0.9	3.0	mu	2	2	nod, ppu, alg
E-2	2.7	9.0	mu	1	1	alg
E-3	0.9	3.0	sa, ro	1	1	ppu, cde
F-1	0.9	3.0	sa, ro	1	1	alg
F-2	2.4	8.0	mu	3	1	nod
F-3	2.1	7.0	mu	1	1	alg, eca
F-4	2.0	6.5	mu	4	1	nod, eca
F-5	1.5	5.0	mu	2	1	nod, eca, alg

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	2	1	nod, alg, eca, lmi
G-3	1.5	5.0	mu	1	1	alg
G-4	1.8	5.9	mu	1	1	alg,
G-5	1.8	5.9	mu	0	0	
G-6	0.8	2.5	mu	4	3	nod, eca, cde, ppu
G-7	1.1	3.5	mu	3	2	nod, cya, eca
H-1	1.0	3.2	mu,sa	4	1	cya
H-2	1.2	4.0	mu,sa	4	1	alg, nod
H-3	1.0	3.2	mu	1	1	alg
H-4	0.9	3.0	mu	1	1	nod
H-5	1.0	3.2	mu	1	1	alg
H-6	0.6	2.0	mu,sa	4	2	nod, nva, dve, lmi, wco
I-1	0.6	2.0	mu	3	2	nod, lmi, wco, eca
I-2	1.2	4.0	mu	2	1	eca, alg, nod
I-3	1.4	4.5	mu	1	1	cya, alg, lmi, wco
J-1	1.2	4.0	mu	1	1	cya, mqu
J-2	1.0	3.2	mu	4	2	cya, nod, lmi, wco
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).
ppu - Potamogeton pusillis (small pondweed)

Benthic Macroinvertebrates

Locations of benthic invertebrate sampling are shown in Figure 9. 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 2007 were nearly identical to the species observed in 2006. ENSR biologists noted that overall abundance in 2007 appeared to be higher than previous years, although numbers of organisms present was not quantified. 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 2007. Taxonomic richness in 2007 (11) was lower than in 2006, 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, 2007. 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			

Fish

Locations of gill net sets are shown in Figure 9, and fish data are presented in Table 6. In addition to the species listed in Table 6, several species were visually observed, including common carp and numerous sunfish species. 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 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 dominated the biomass as seen in Figure 13. While no common carp were collected in 2004, 2005, 2006 or 2007, numerous large specimens were visually observed jumping and swimming in the shallow north cove. Despite the lack of captured specimens in 2007, common carp may still dominate fish biomass in the lake as seen in 2000. Three species of fish were captured during the 2007 survey. These included white perch, yellow perch, and white sucker. No golden shiners were collected in 2007. 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 2007 was higher than in 2006 and approached numbers captured in previous years.

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, although no golden shiners were captured in 2007. 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 8, 2006. These data do not include visual observations of species that were not collected in the gill net

White Perch		**Yellow Perch**	**White Sucker**
TL (mm)	TL (mm)	TL (mm)	TL (mm)
232	215	187	177
218	236	195	
227	235		
226	220		
170	190		
210	187		
214	223		
207	198		
220	230		
226	209		
231	206		
241	213		
218			
218			
211			
222			
216			
225			
223			
230			
226			
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220			
215			
218			
213			

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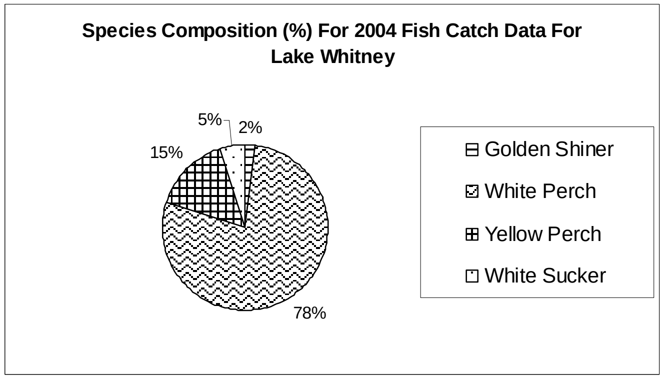
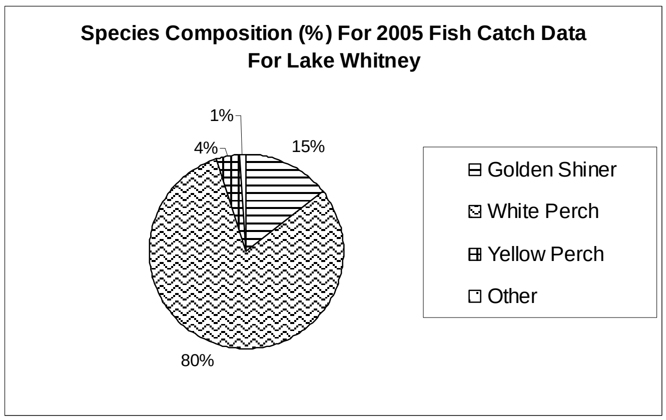
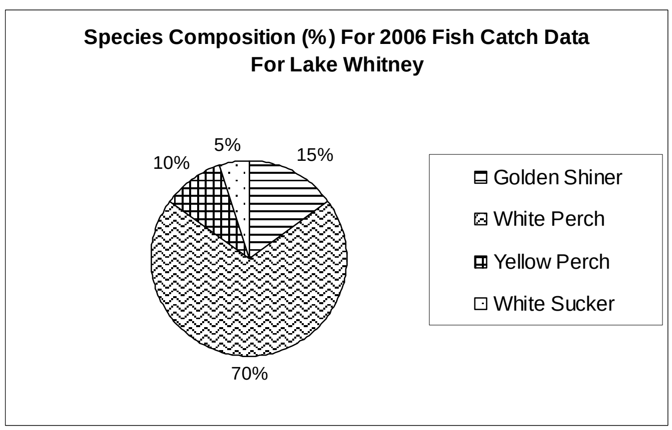
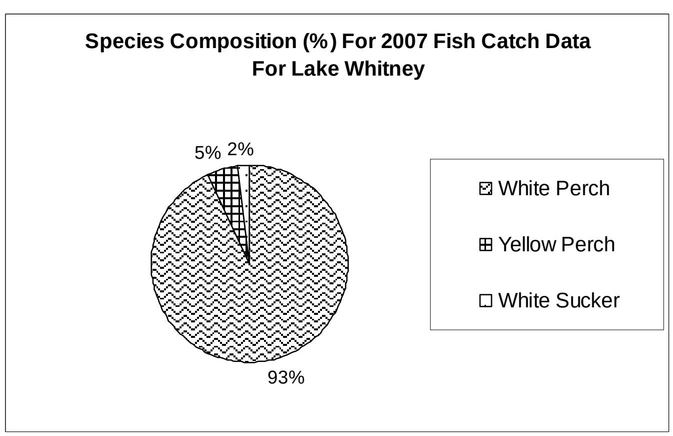
Figure 13. A graphical representation of species composition (number of fish) for the 2004, 2005, 2006 and 2007 sampling events.









Discussion

Phytoplankton, zooplankton, macroinvertebrate and fish populations assessed in 2007 are very similar to those observed in 2004-2006. 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 and are achieving a sustained level of cover and biomass. 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 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. Yet the plant community in 2007 is very similar to 2006 and invertebrate abundance decreased between years. However, there were no drastic changes in the macroinvertebrate 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 2007 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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