# Houghton Lake, Michigan:

## Submerged Vegetation Response Five-Years After A Large-Scale, Low-Dose, Whole-Lake Sonar® Treatment

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**Paul Hausler**
*Progressive AE, Grand Rapids, MI*

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# Background

- **20,044-acre meso-eutrophic lake in Northern Michigan**
- **Avg. depth is 8.6-feet (21-feet max)**
- **Dense, lake-wide Eurasian watermilfoil infestation by summer of 2000**
- **Treated with a precision Sonar application in May 2002**
  - *6-bump-6 ppb treatment of top 10-feet of water column*

# Goals of Long-term Monitoring

1. manage regrowth of Eurasian watermilfoil to prevent another lake-wide infestation
2. observe response of native vegetation to a large-scale, low-dose, whole-lake treatment
3. observe aquatic vegetation cover and structure (habitat) since treatment

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# Types and frequency of sampling

- Physical (rake) sampling – 7 years
  *over 6,300 points collected*
- Hydroacoustic transects – 6 years
  *over 600,000 echosounder pings*
- Diver transects – 2 years
  *1.5 km of transects*
- Water quality points– 7 years
  *84 points with 7 parameters each*
- Satellite imagery – 2 years

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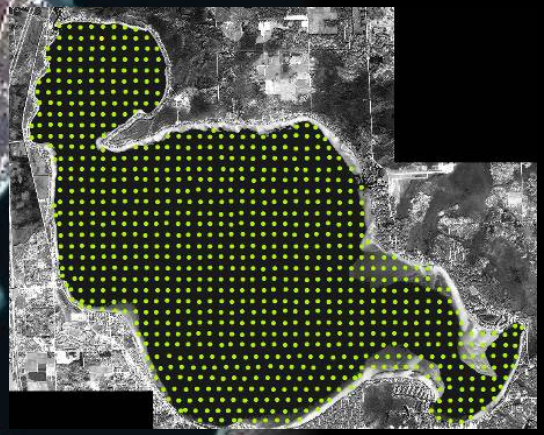
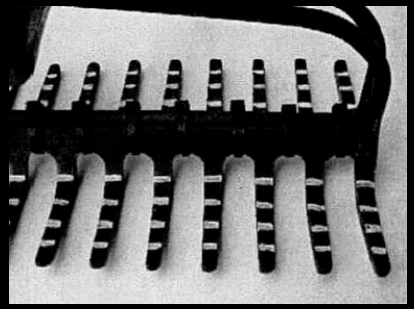
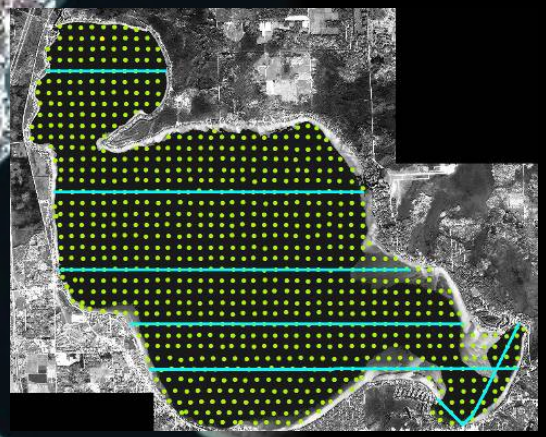


# Physical (rake) sampling

**7 years (ongoing)**

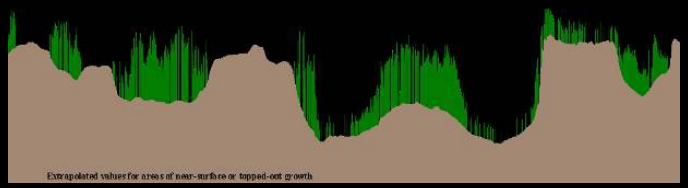
- 912 points per survey (300-meter spacing)
- Two rake tosses per point
- Species presence/absence
- Species density
  - Rare (<3%)
  - Sparse (3%-20%)
  - Common (20%-60%)
  - Dense (>60%)



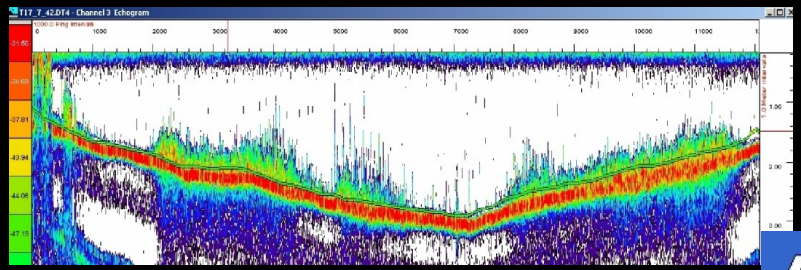


# Hydroacoustic transects

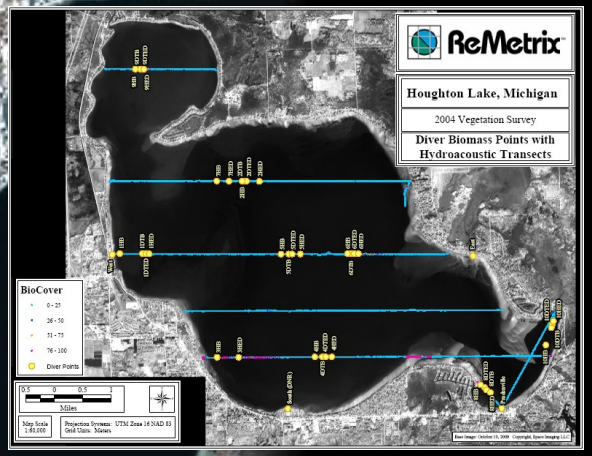
## 6 years (ongoing)



- Six representative transects
- Overlaps the point sampling grid
- Quanitifes bottom coverage
- Quantifies plant height (biovolume)



BioSonics




# Diver transects*

## 2 years

- Eight 100-meter transects
- Species recorded every 1-meter
- Overlap physical points & hydroacoustic transects
- Species density
  - Present (1%-10%)
  - Common (10%-60%)
  - Dense (>60%)

***Diving conducted by the U.S. Army Corps and SePRO.***

# Water quality points
## 6 years (ongoing)

- Twelve sites (5 in-lake, 7 in tributaries)
- Parameters
  - Temperature
  - DO
  - pH
  - Total alkalinity
  - Total phosphorous
  - Sechhi transparency
  - Chlorophyll-a

# Satellite Imagery

## 2 years



- 4-meter spatial resolution

# Goals:

1. manage regrowth of Eurasian watermilfoil to prevent another lake-wide infestation
2. observe response of native vegetation to a large-scale, low-dose, whole-lake treatment
3. observe aquatic vegetation cover and structure (habitat) since treatment

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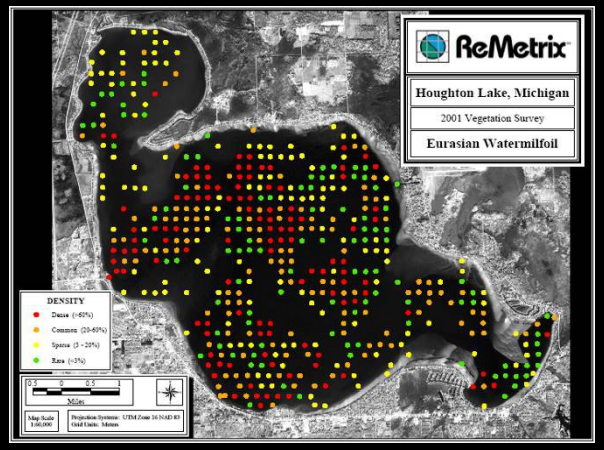
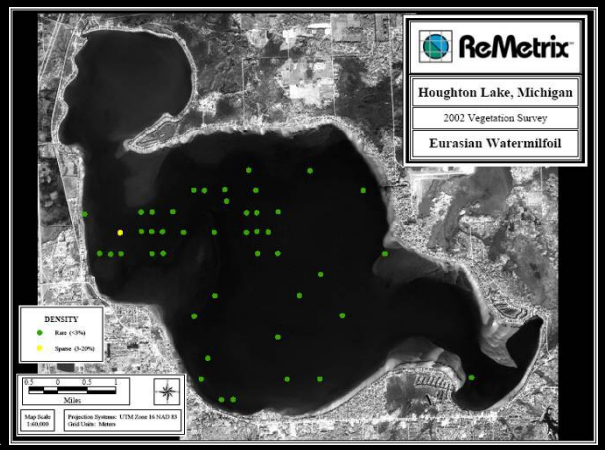
# Eurasian watermilfoil: Location and Density 2001-07



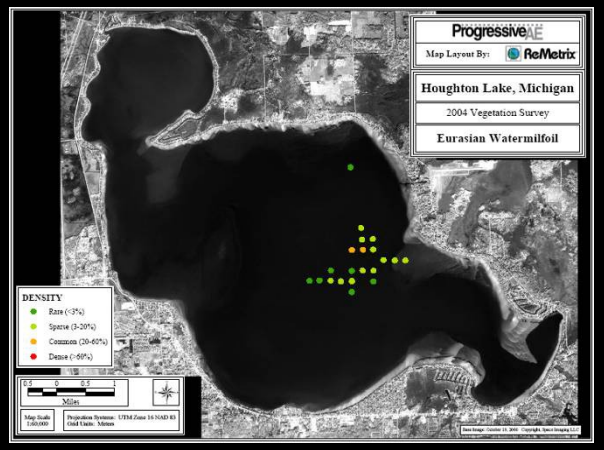

August 2001



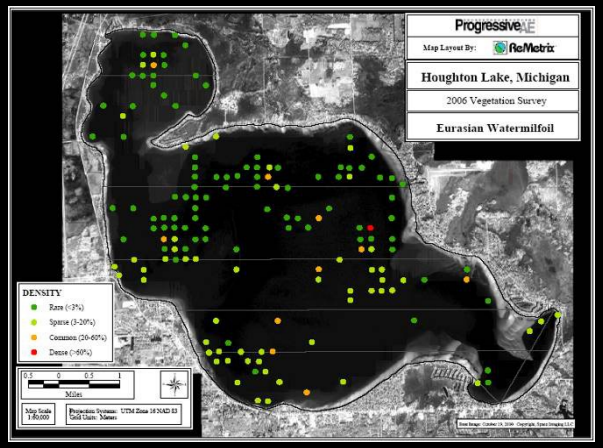

August 2002


August 2003

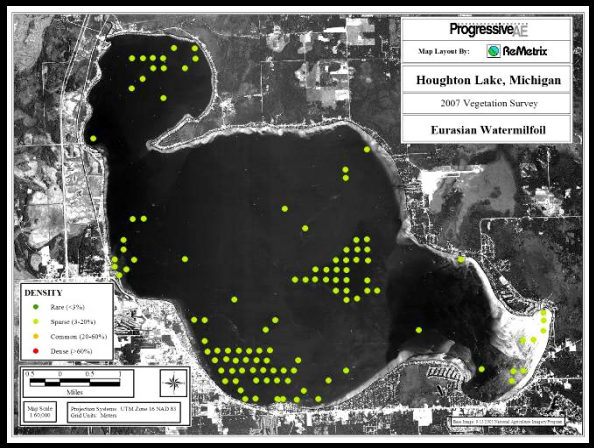
Treatment (May '02)




August 2004




August 2006




June 2007

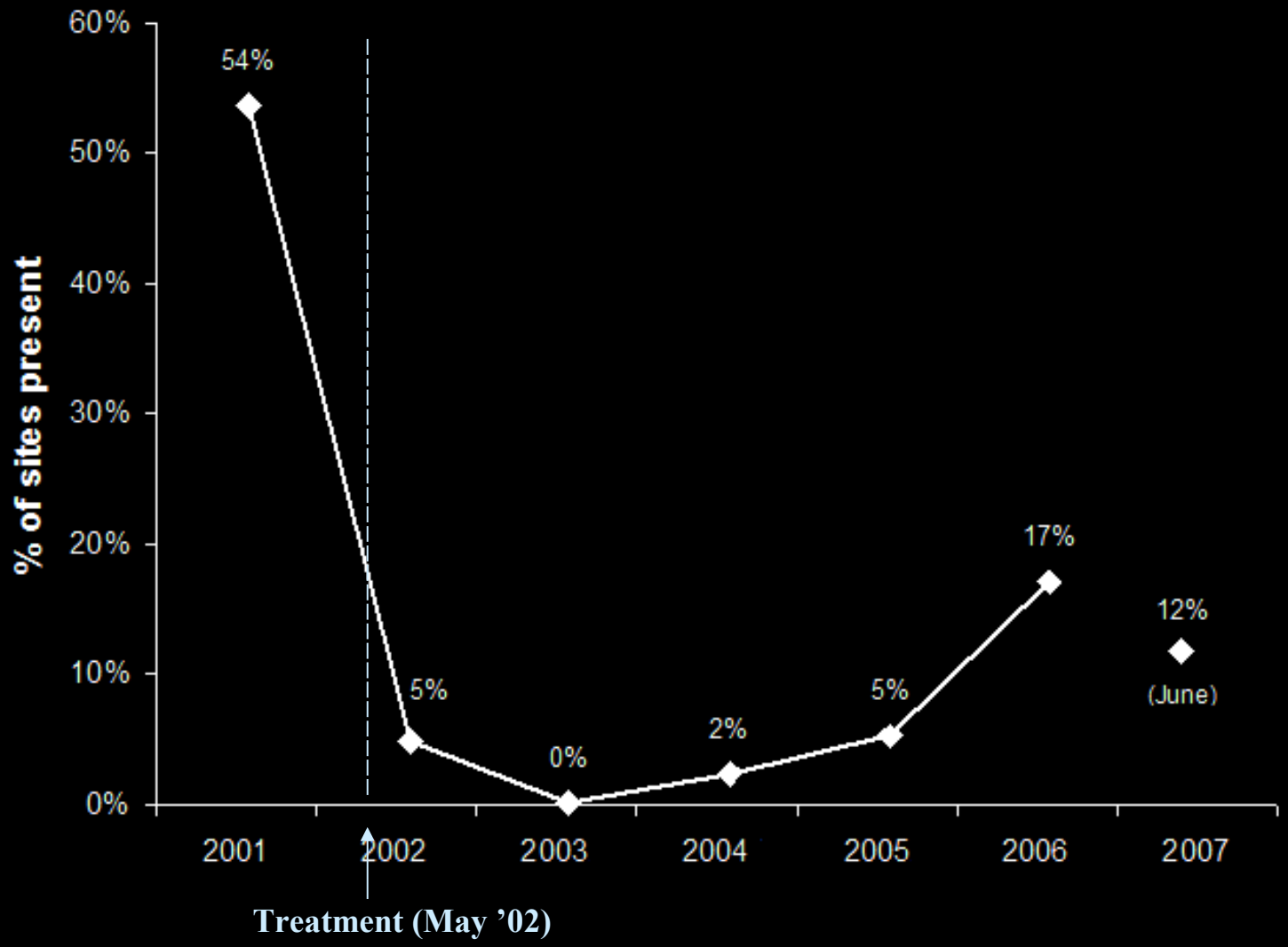
# Treatment History

TABLE 2
HOUGHTON LAKE PLANT CONTROL HISTORY

| | Herbicides (acres treated) | | | Acres | Milfoil Weevils |
|---|---|---|---|---|---|
| | Sonar® | Contacts | Systemic | Harvested | (# Stocked) |
| 2002 | 20,044 | 17 | | | |
| 2003 | | | 32 | | |
| 2004 | | | 44 | 81 | 5,000 |
| 2005 | | 50 | 395 | 84 | 28,000 |
| 2006 | | 59 | 444 | 105 | |

*Treatments are done by Professional Lake Management, MI

# Eurasian watermilfoil trend



# Goals:

1. manage regrowth of Eurasian watermilfoil to prevent another lake-wide infestation
2. observe response of native vegetation to a large-scale, low-dose, whole-lake treatment
3. observe aquatic vegetation cover and structure (habitat) since treatment

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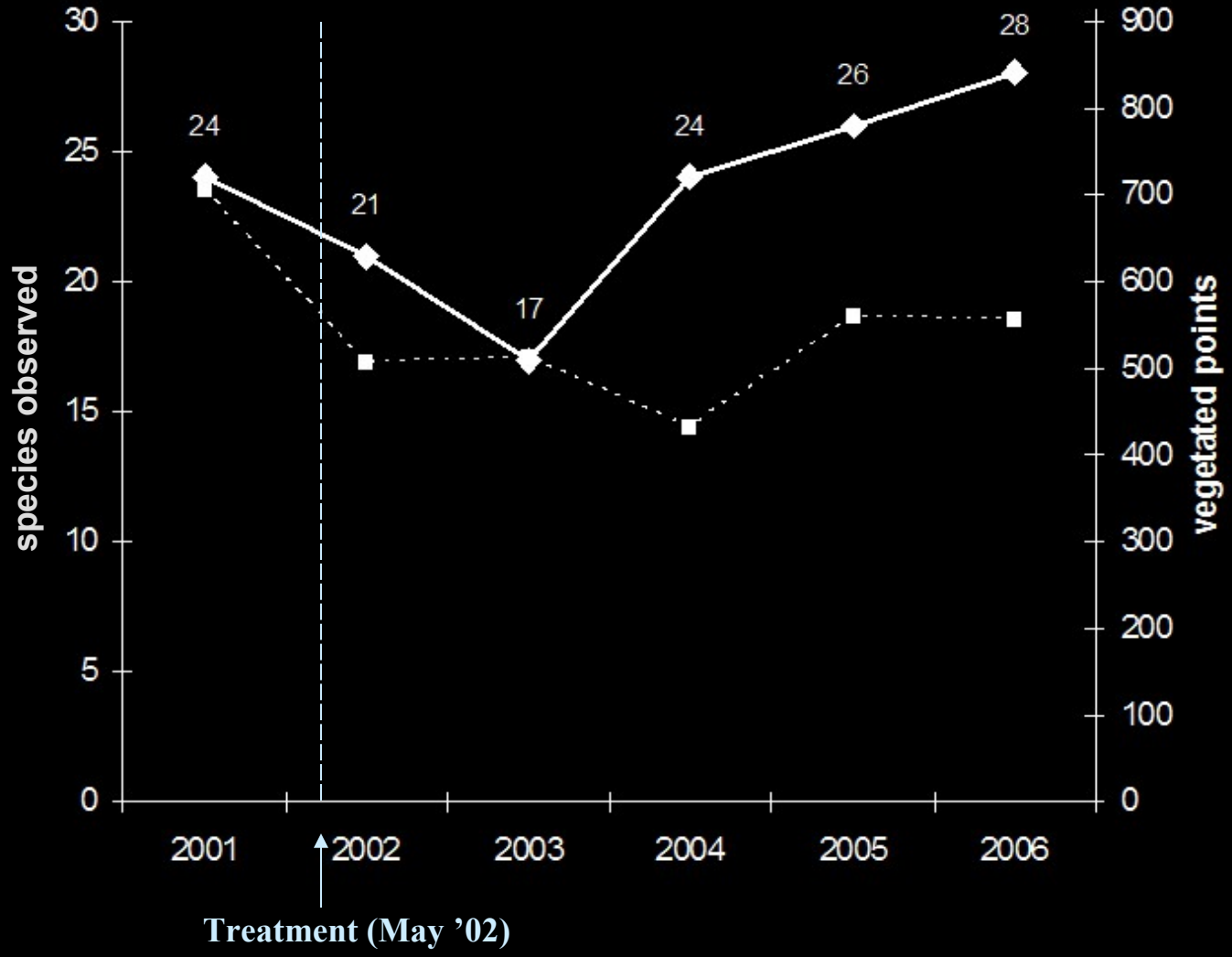
# Summary notes on species

36 total species have been identified since 2001

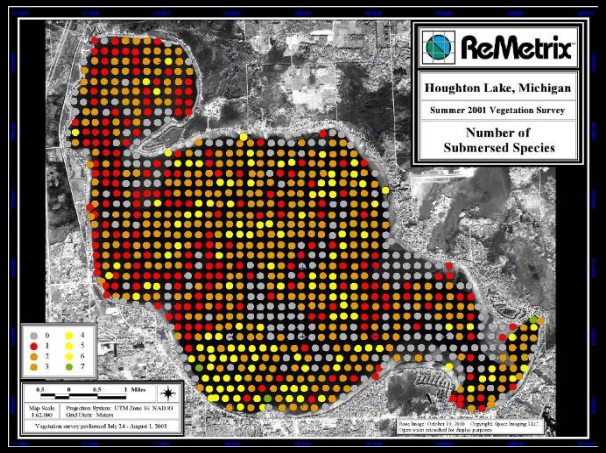
2 species have not been identified since 2002

8 species have appeared/reappeared since 2002

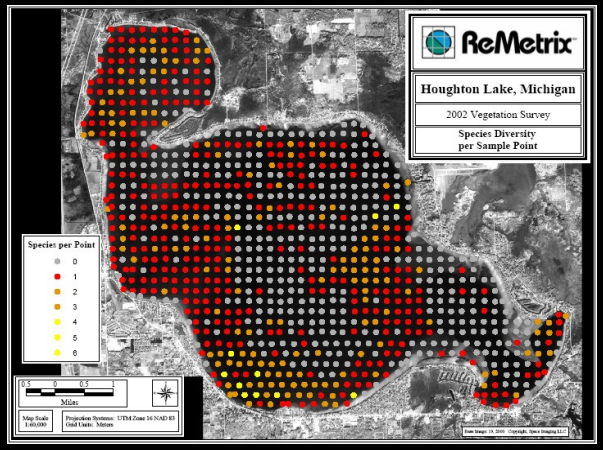
# Species trend



# Species Diversity Maps 2001-06

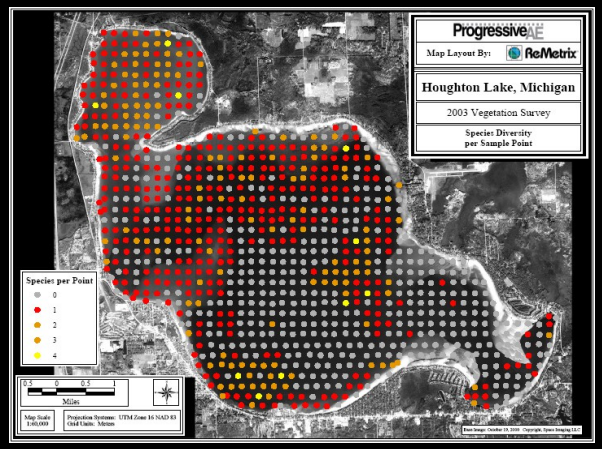



August 2001

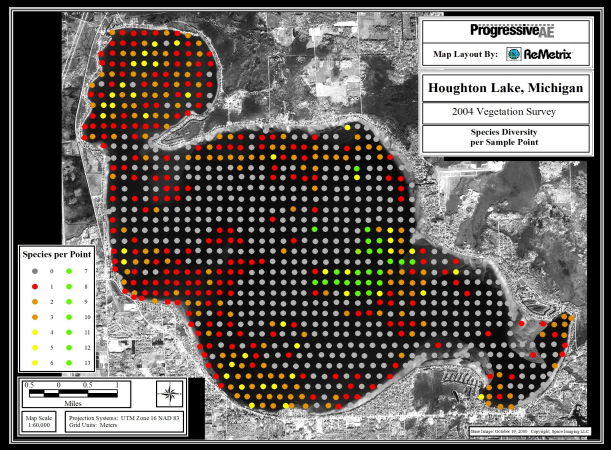



August 2002

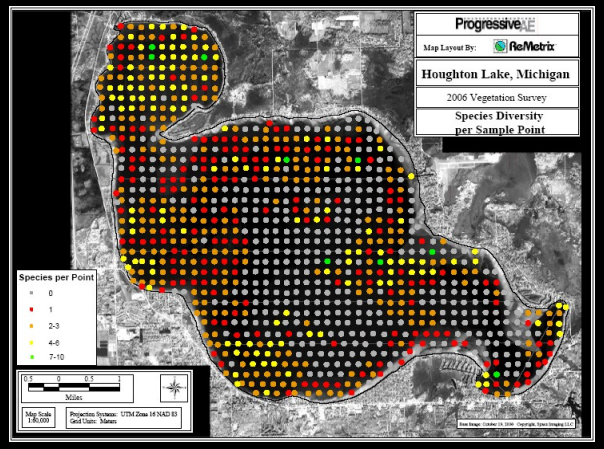
Treatment (May '02)




August 2003

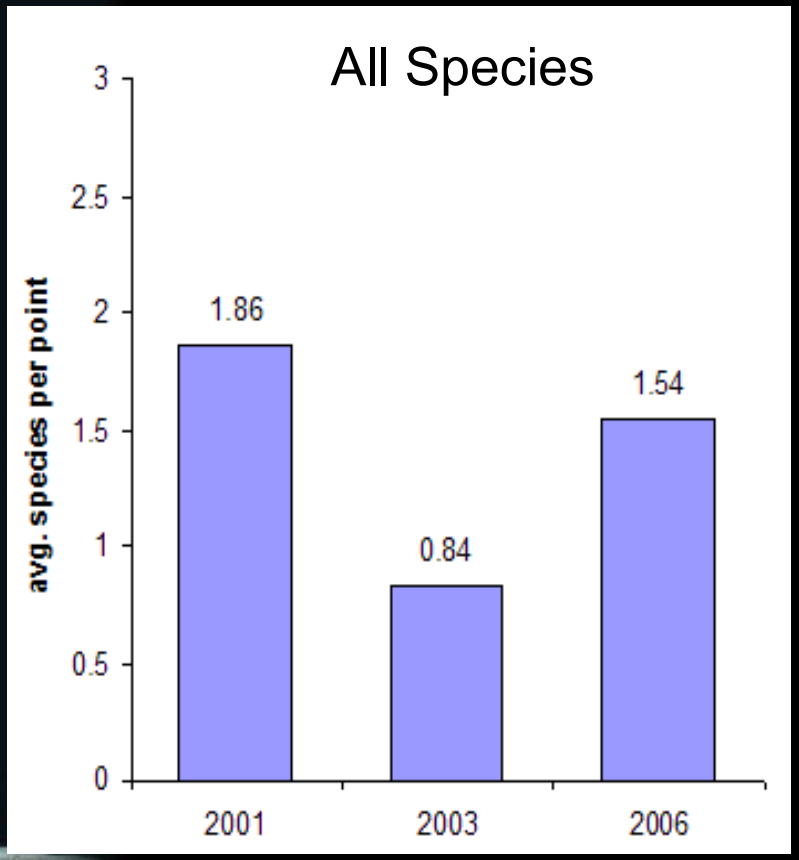


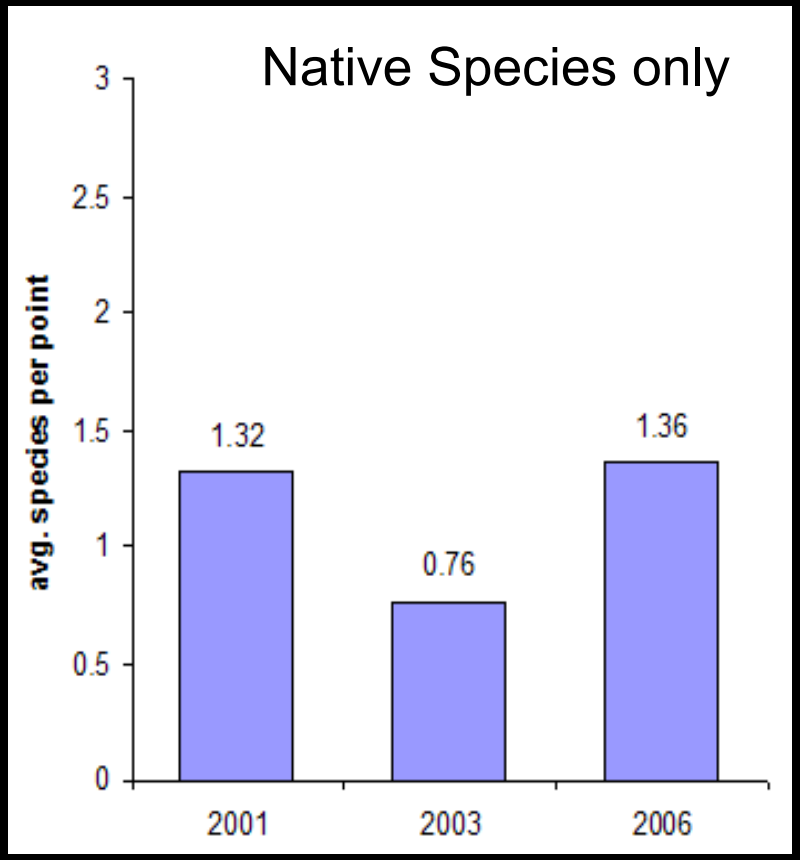

August 2004




August 2006

# Species diversity
## (2001-2006)

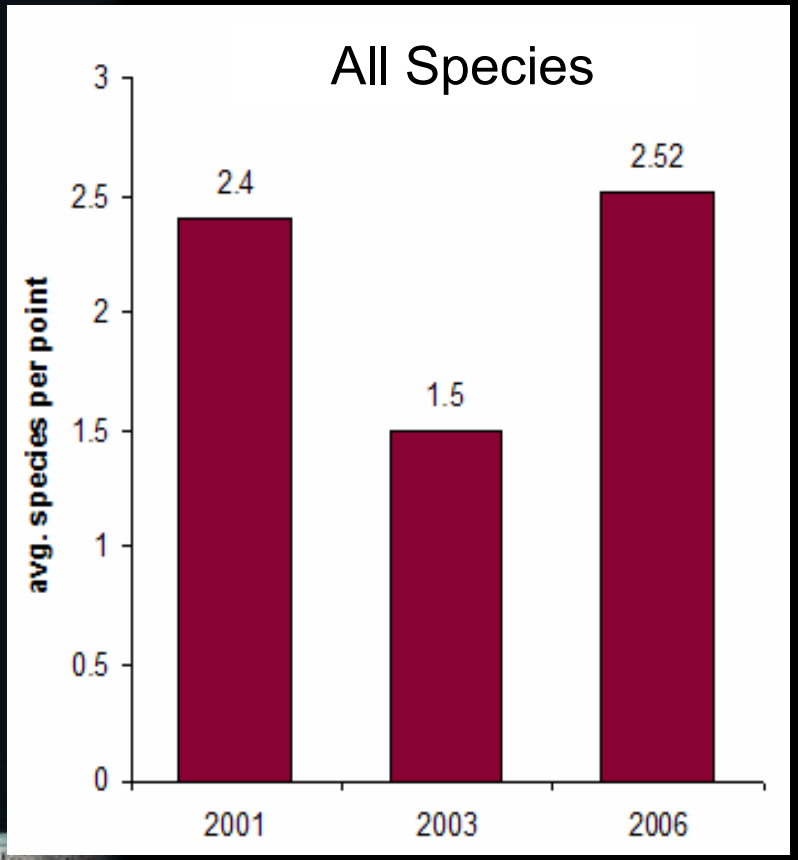


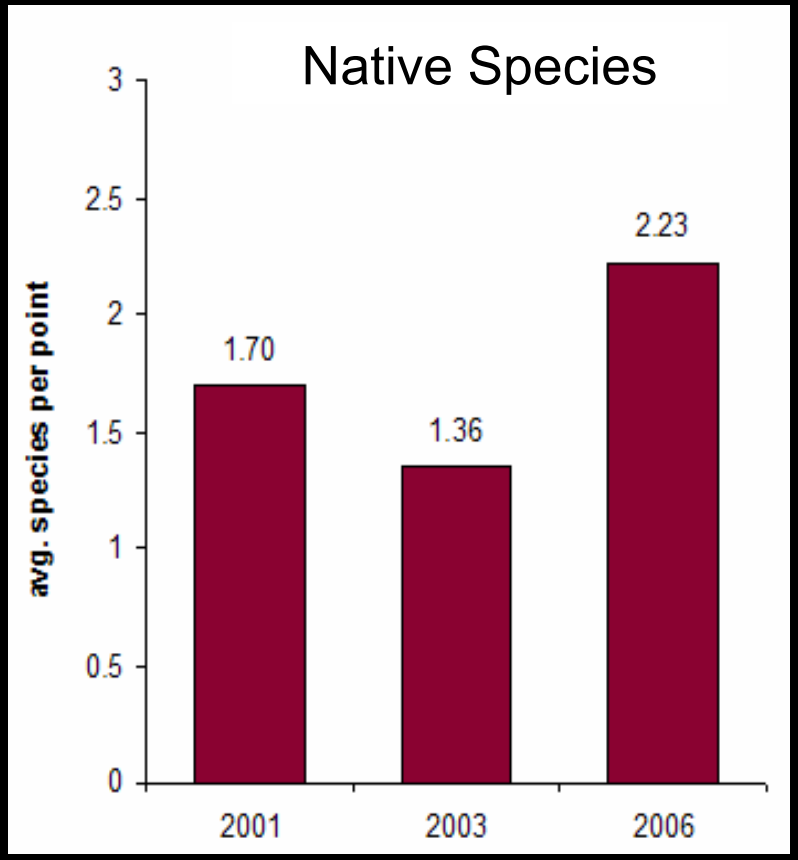




significant difference
2001-2006
p<0.0005

no significant difference
2001-2006
p<0.0005

# Species richness
## (2001-2006)

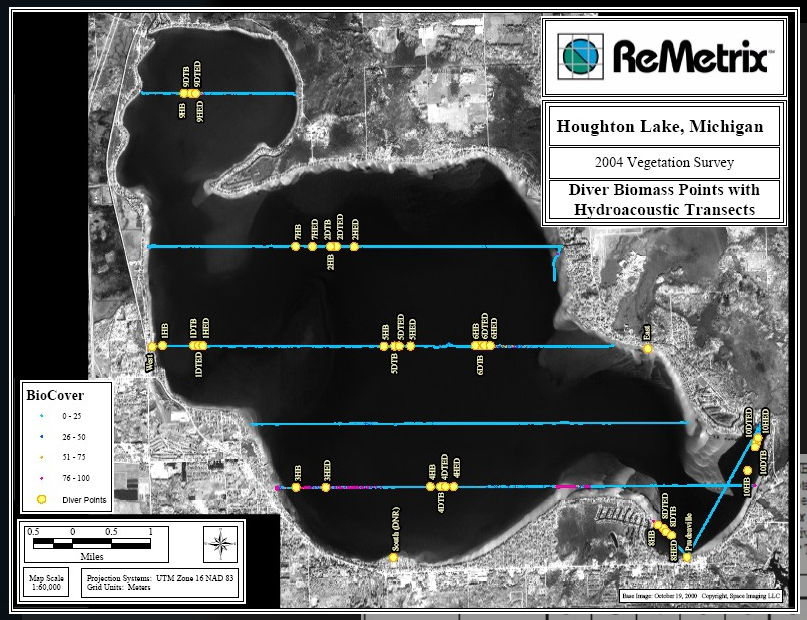



no significant difference
2001-2006
p<0.0005

significant difference
2001-2006
p<0.0005

# Diver Biomass Survey Results




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 9 | 10 |
| *Ceratophyllum demersum* | Coontail | | | (46) | (2) | | | (50) | (73) |
| *Chara sp.* | Muskgrass | | | 13 | | 80 (52) | 1 | 2 (12) | |
| *Elodea canadensis* | Elodea | (1) | 10 (57) | 40 (100) | 24 (38) | 86 (38) | (6) | (49) | 7 (79) |
| *Megalodonta beckii* | Water marigold | | | (2) | | (49) | | (16) | |
| *Myriophyllum spicatum* | Eurasian watermilfoil | (100) | (99) | (28) | (99) | 15 (48) | (100) | (51) | (1) |
| *Najas sp.* | Naiad | | | | 1 | 17 | 2 | 21 | 4 |
| *Potamogeton amplifolius* | Large-leaved pondweed | | 1 | | | 5 | 73 (6) | | |
| *Potamogeton crispus* | Curly-leaved pondweed | | | | | 21 | 9 | | |
| *Potamogeton gramineus* | Variable pondweed | | 1 | | 3 | 2 | 46 | | 1 |
| *Potamogeton illinoensis* | Illinois pondweed | | | | (2) | | 13 (11) | | 3 (2) |
| *Potamogeton praelongus* | Whitestem pondweed | | (13) | 3 (22) | 2 (8) | | (3) | 10 | 3 (12) |
| *Potamogeton pusillus* | Thin-leaved pondweed | | 1 (46) | 5 | 2 (16) | (2) | (15) | 1 (6) | 11 (88) |
| *Potamogeton richardsonii* | Richardson's pondweed | | | 1 (10) | 1 (1) | 3 | (1) | 2 (4) | 1 (6) |
| *Potamogeton robbinsii* | Robbin's pondweed | | | | | | | (3) | 76 (86) |
| *Potamogeton zosteriformis* | Flatstem pondweed | | | 31 (31) | | 41 | 8 (1) | 3 | (10) |
| *Ranunculus longirostris* | White Water-crowfoot | | | | | | | (1) | |
| *Stuckenia pectinata* | Sago pondweed | | 1 | 15 | | 23 | 7 | 91 | |
| *Utricularia sp.* | Bladderwort | | | | | | | | |
| *Vallisneria americana* | Wild celery | | | | | (28) | (10) | 14 (36) | |
| *Zosterella dubia* | Water stargrass | | | 1 (6) | 1 | 37 (45) | | 3 | 1 (9) |

Key results:

- Species richness declined from 2002-2004
- Species richness was greatest in waters <10-feet in depth
- Milfoil control was still effective 2 YAT (only 1 diver transect had milfoil)
- Provided ground truth data for hydroacoustic and rake sampling

# Goals:

1. manage regrowth of Eurasian watermilfoil to prevent another lake-wide infestation
2. observe response of native vegetation to a large-scale, low-dose, whole-lake treatment
3. observe aquatic vegetation cover and structure (habitat) since treatment

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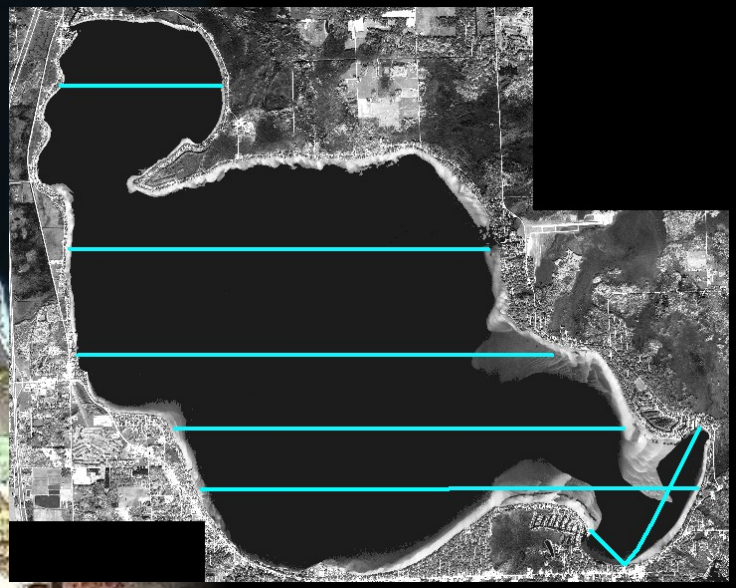
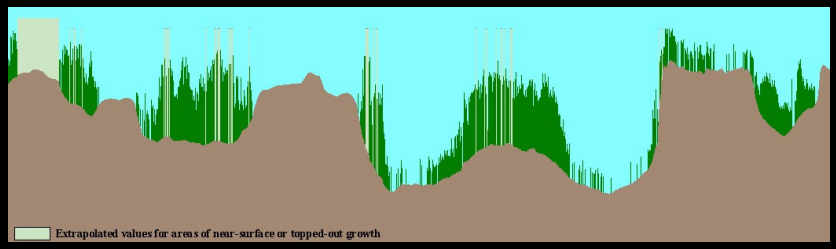
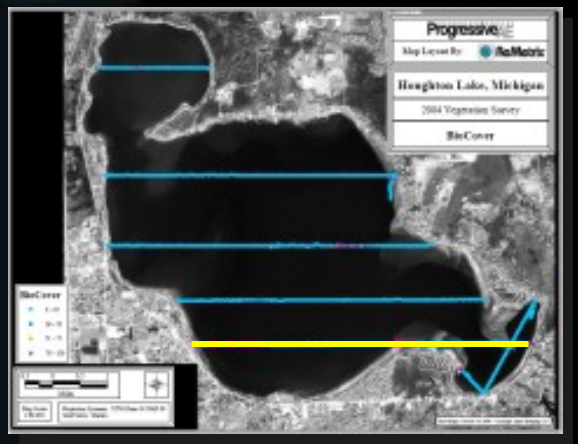
# Hydroacoustic data

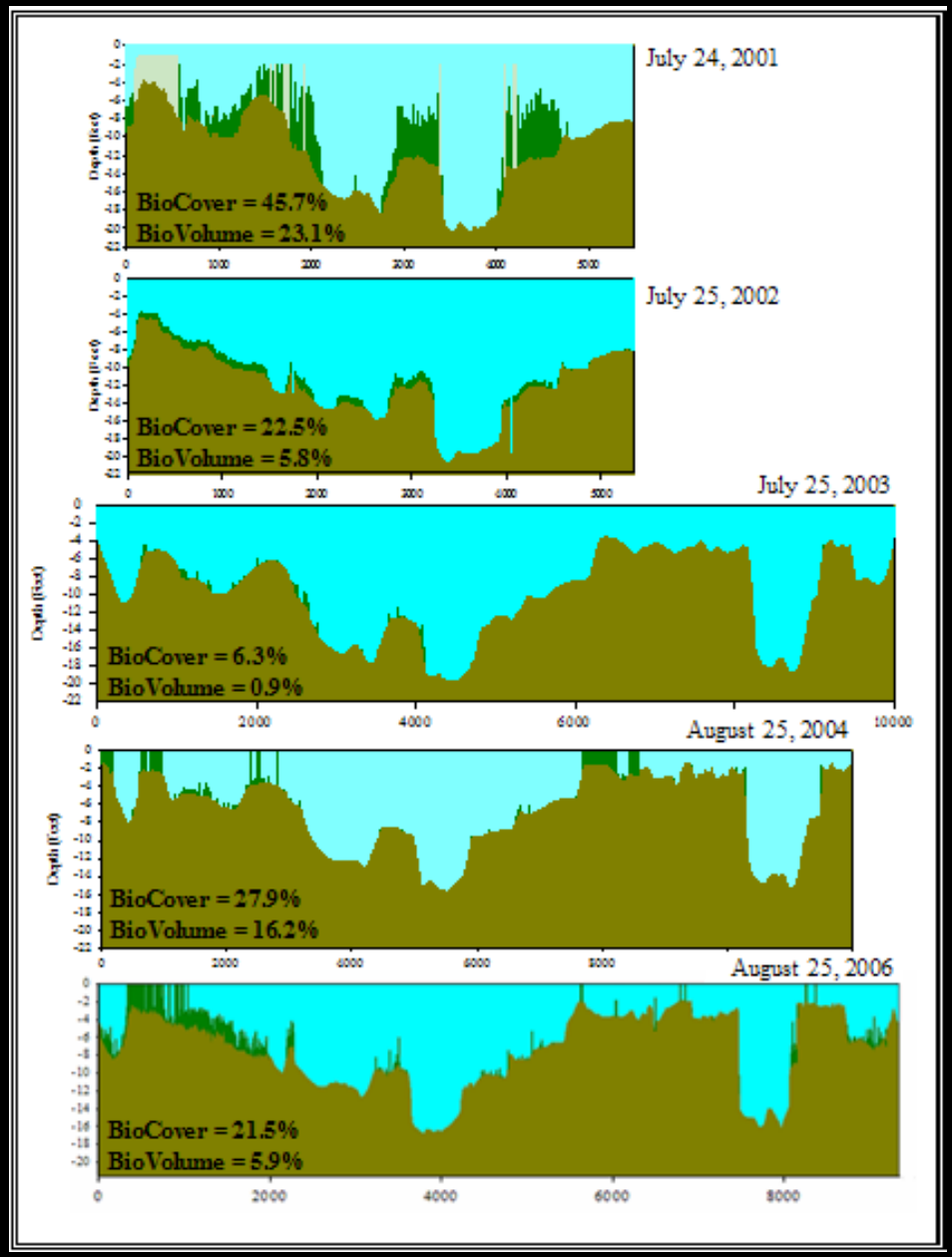
- Biovolume quantifies habitat structure and sheds light on where plants are regrowing in the water column.
- How does biovolume relate to EFH at Houghton Lake?

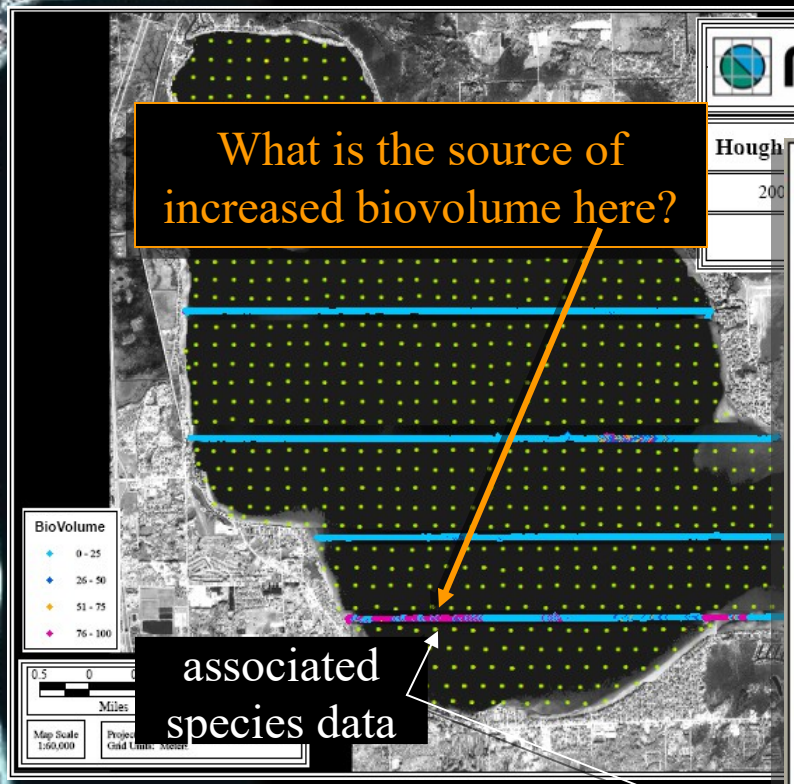




# Transect 5, 2001-06






associated species data

***Correlation of results***

**Table 7. Species Identified at Points Correlating to Hydroacoustic BioCover**

*These are the plant species found at vegetated GPS-points adjacent to the hydroacoustic transects.*
*The data in the table below are courtesy of ProgressiveAE (Grand Rapids, MI).*

| Site | No Plants Found | Bladderwort | Bulrush | Chara | Curly-leaf pondweed | Elodea | Eurasian watermilfoil | Flat-stem pondweed | Illinois pondweed | Large-leaf pondweed | Water Marigold (*Megalodonta*) | Slender naiad (*Najas flexilis*) | *P. diversifolius* | *P. pusillus* | Richardson's pondweed | Robbins' pondweed | *Scirpus subterminalis* | Southern naiad | Thin-leaf pondweed | Variable leaf pondweed | Water stargrass | White-stem pondweed | Wild celery | Wild rice | Yellow waterlily |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 37 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 48 | | | | X | | | | | | | | | | | | | | | X | | | | | | |
| 49 | | | | X | | | | | | | | | | | | | | | X | | | | | | |
| 50 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 51 | | | | X | | | | | X | | | | | | | | | | | X | | | | | |
| 52 | | | | X | | | | | X | | | | | | | | | | | | | | | | |
| 53 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 54 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 55 | | | | X | | | | | | | | | | | | | | | X | | | | | | |
| 56 | | | | X | | | | | | | | | | | | | | | X | | | | | | |
| 97 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 201 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 206 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 207 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 208 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 305 | | | | X | | | | X | | | | | | | | | | | | | | | | | |
| 314 | | | | | | | | | | | | | | | | | X | | | | | | | | |
| 316 | | | | | | | | | | | | | | | | | | X | | | | | | | |
| 317 | | | | X | | | | | | | | | X | | | | | | X | | | | | | |
| 318 | | | | | | | | | | | | | | | | | X | | X | | | | | | |
| 319 | | | | | | | | | | | | | | | | | | X | | | | | | | |
| 320 | | | | X | | | | | | | | | | | X | | X | | | | | X | | | |
| 321 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 322 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 323 | | | | X | X | | | | | | | | | | | | | X | X | | | | | | |
| 325 | | | | X | | | | | | | | | | | | | | | X | | | | | | |
| 326 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 327 | | X | | X | | | | | | | | | | | | | | | | | | | | | |
| 328 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 333 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 334 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 335 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 336 | | | | X | | | | | | | | | | | | | | | | | | | | | |
| 406 | | | | X | | | | | | | | | | | | | | | | | | X | | | |
| 407 | | | | | | | | | | | | | | | | | | | | | | X | | | |
| 409 | | | | | | X | | | | X | | | | | | | | | | | | | | | |
| 410 | | | | X | | | | | | | | | | | | | | | | | | | | | |

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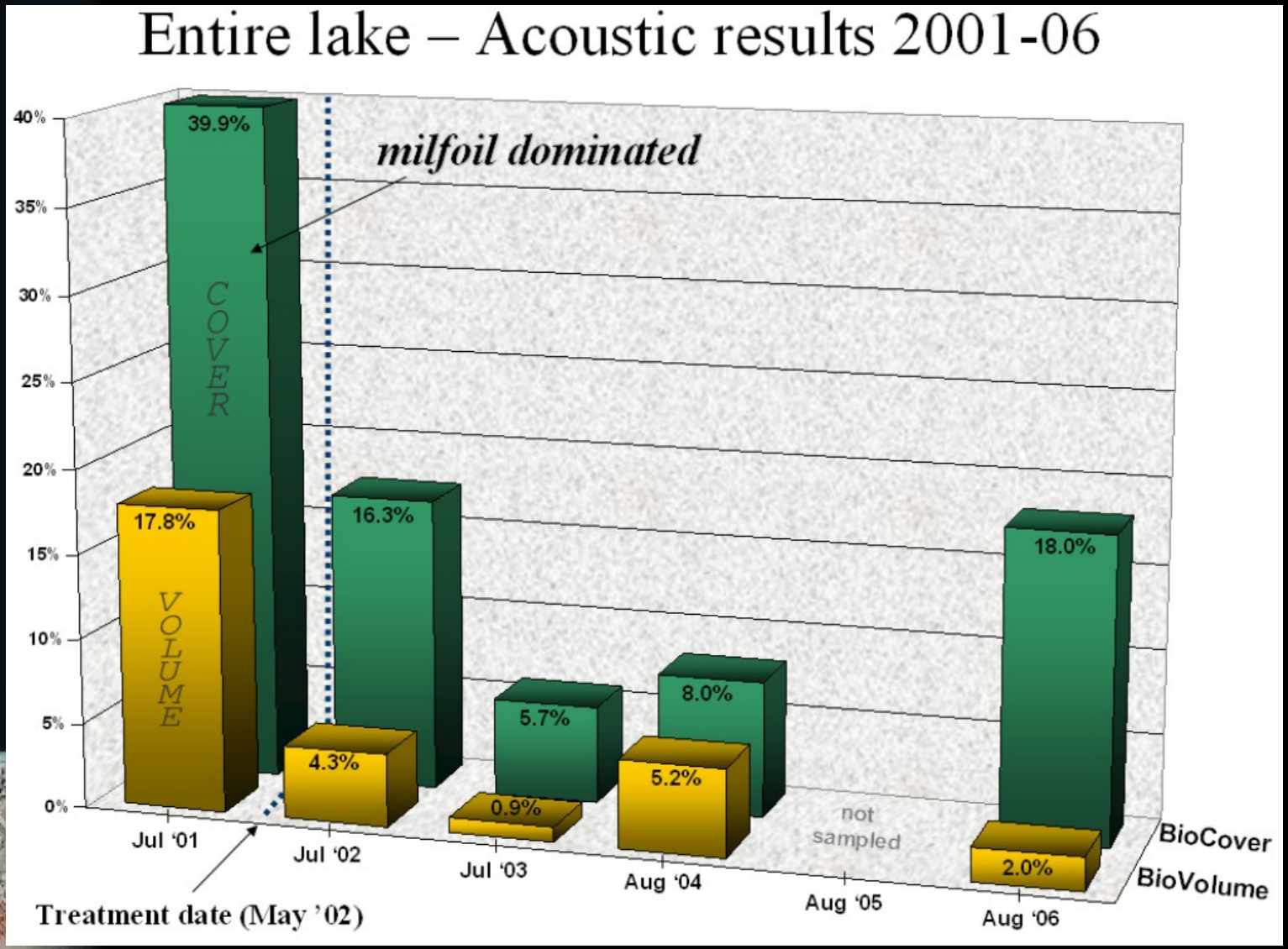
# BioCover and BioVolume: Sum of representative transects



# Long-term Monitoring Goals:

1. Manage regrowth of Eurasian watermilfoil to prevent another lake-wide infestation...

✓ No whole-lake treatment necessary 5-years after low-dose treatment

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# Long-term Monitoring Goals:

2. Observe response of native vegetation to a large-scale, low-dose, whole-lake treatment...

✓ Native species diversity is not significantly different than pre-treatment population

✓ Number of native species exceeds pre-treatment levels

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# Long-term Monitoring Goals:

3. Observe aquatic vegetation cover and structure (habitat) since treatment

✓ Hydroacoustic data are tracking post-treatment habitat trends at Houghton Lake

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# Thank you.

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