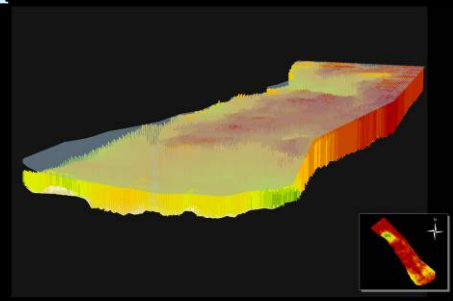
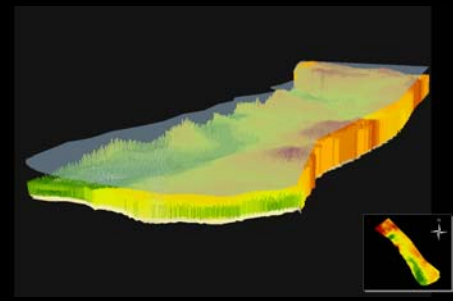
Utilizing Differential Quantitative Mapping Technologies and Traditional Botanical Knowledge to Assist Brazilian waterweed Management in the Sacramento-San Joaquin Delta: An Example from Frank's Tract





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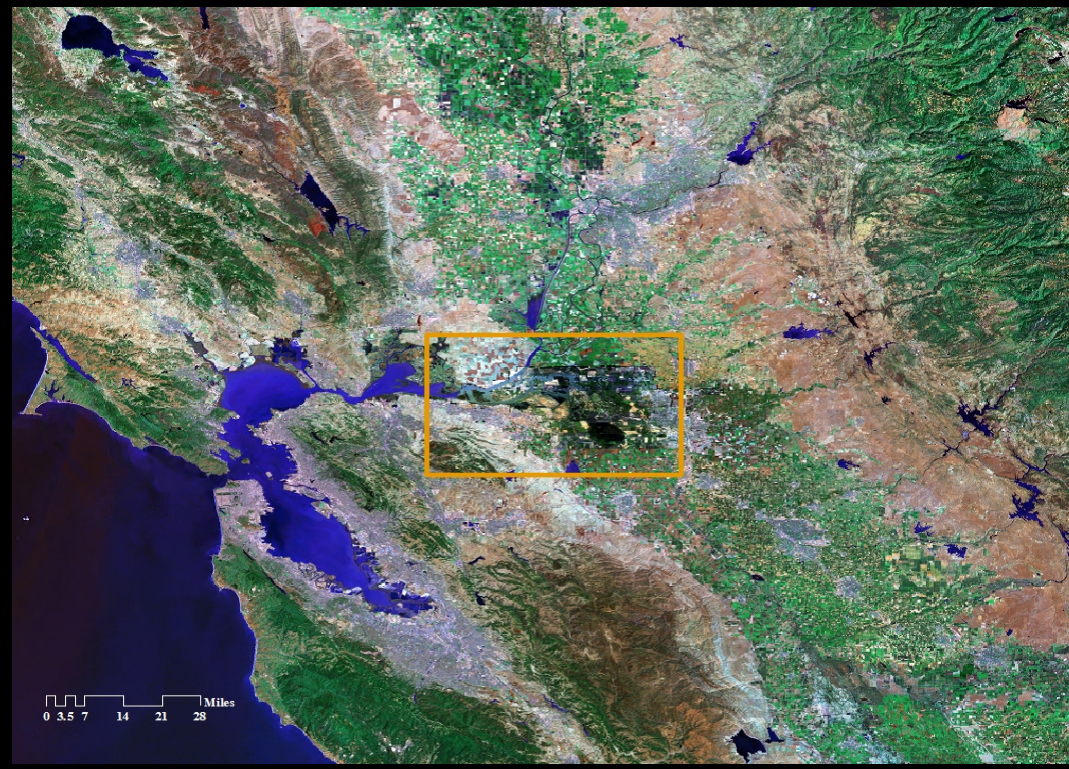

What is Brazilian waterweed *(Egeria densa)?*

Characteristics:

Rooted, robust submersed invasive plant well-suited to life in the SSJD

Imported from South America disease-free and insect-free for the aquarium trade

Few natural predators to keep growth in check

Low light requirements

Forms dense surface mats that shade out other submersed vegetation

Creates poor shallow-water fish habitat conditions

Reproduces vegetatively through fragmentation

Only male species found in the United States; no seed production

Relevancy to SSJD:

~7,000 acres currently in the Sacramento-San Joaquin Delta

Obstructs navigable waterways

Blocks irrigation channels

Impedes drainage

Summary of 2003 - 2005 Treatment Efficacy Statistics

Total Number of Treatment Sites Collected: 18

Total Number of Control Sites Collected: 6

Total Number of Treatment Statistical Plant BioVolume Coverages Analyzed: 120

Number of Coverages proving *decrease* in plant volume: 106
Number of Coverages proving *increase* in plant volume: 9
Number of Coverages proving *no change* in plant volume: 5

88% of sampled *treatments* successful in reducing *Egeria*

Total Number of Control Statistical Plant BioVolume Coverages Analyzed: 29

Number of Coverages proving *decrease* in plant volume: 2
Number of Coverages proving *increase* in plant volume: 24
Number of Coverages proving *no change* in plant volume: 3

83% of sampled *controls* prove increase in *Egeria*

Presentation Outline

1. Project Objectives
2. Methodologies
3. Results from 3-Year Analysis
4. Logical Next Steps

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California Department of Boating & Waterways *Egeria densa* Control Program

PRIMARY OBJECTIVES:

- *Improve navigation* in infested Sacramento-San Joaquin Delta by reducing growth and spread of *E. densa*
- *Control not Eradicate.* It is expected that *Egeria densa* will never be eradicated from the SSJD region
- *Adaptive Management Problem-Solving*. California DBW Scientists, Private Firms, & Government
- *Permitted By:* NOAA Fisheries, U.S. Fish & Wildlife Service, and Regional Water Resources Control Board

Scientific Assessment Consultant to *Egeria densa* Control Program

OBSERVED TREATMENT REGIMES:

- **Contact Herbicide Diquat (3 sites): 4 Sampling Events**
  Hydroacoustics: pre-treatment, 14-days post, 28-days post, 60-days post
  GPS Point Sampling: pre-, 14-days, 28-days, 60-days post

- **Systemic Herbicide Fluridone (15 sites): 2 - 7 Sampling Events**
  Hydroacoustics: pre-treatment, 60-days post, 90-days post, 120-days post, …
  GPS Point Sampling: pre-, 60-days, 90-days, 120-days post

- **Sequential: Contact & Systemic (2 sites): 2 - 7 Sampling Events**
  Hydroacoustics: pre-treatment, 14-days post, 28-days post, 60-days post, 90-days post, …
  GPS Point Sampling: pre-treatment, 14-days post, 28-days post, 60-days post, 90-days post, …

OBSERVED CONTROL SITES:

- **Identical Multi-Temporal Methods as Treatment Areas (6 sites)**

Data Collection:

1. Hydroacoustic Plant Mapping
2. Physical Vegetation Point Sampling
3. Low-Light Color Underwater Videography
4. Water Temperature, Salinity, Secchi Depth
5. Localized Benchmarked Water Level Recording

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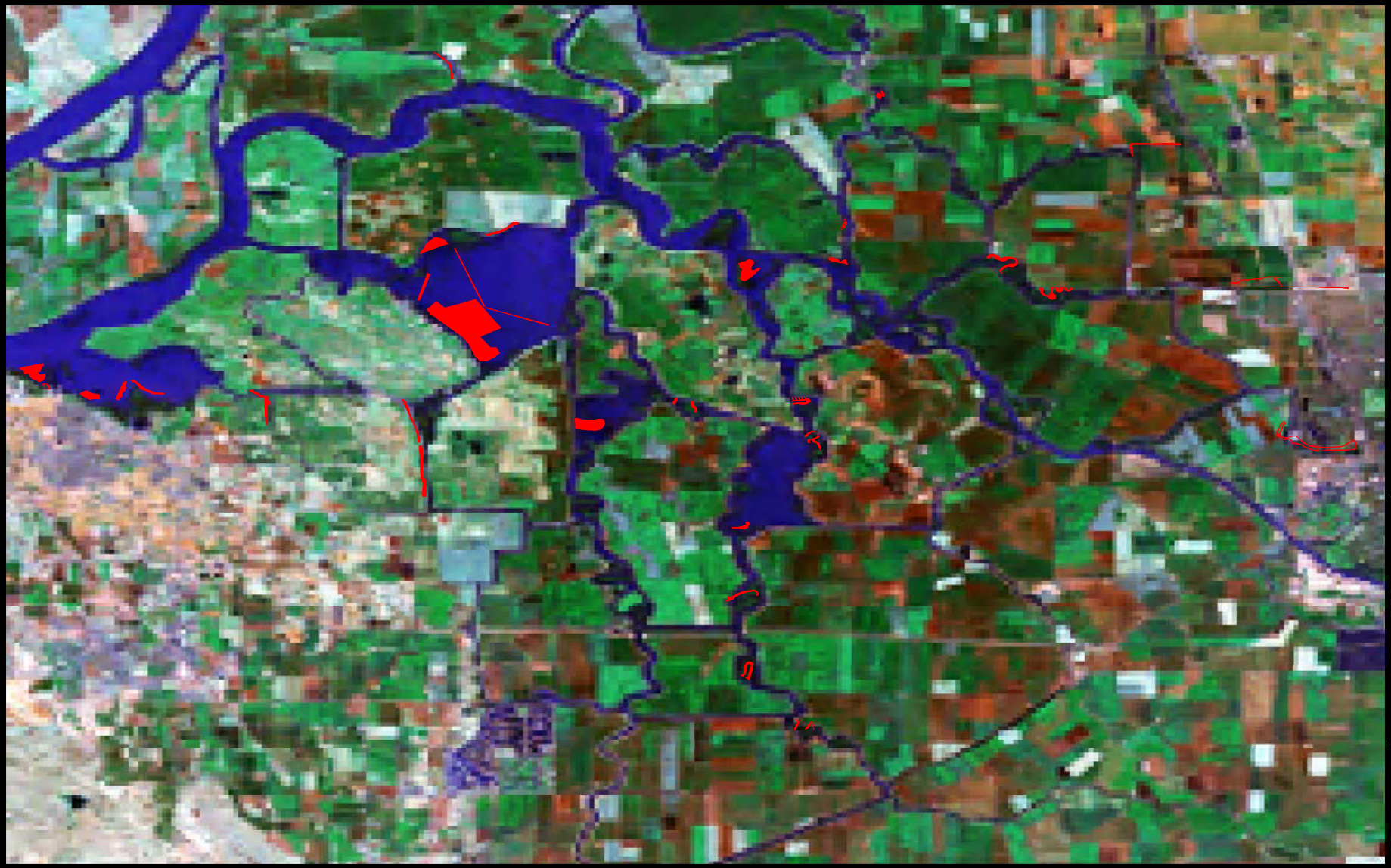
Study Area 2003 - 2005: 18 Observed Treatment and 6 Control Sites



Summary of 2003 - 2005 SSJD Sampling Statistics

Plant Samples Analyzed:

10,218 points

Vegetation Acoustic Data:

~ 2,200,000 points

Total Distance of Transects/Observation Travel:

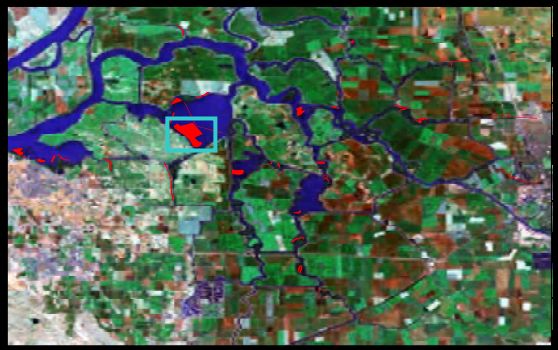
~1,000 mi (~ 1,610 km)/ ~10,000 mi (~16,100 km)

Total Acreage Mapped in High Resolution:

~11,500 acres (~47 sq km)

Total Engine Hours Logged:

2,500 hours



Frank's Tract 173

Total Study Area 467 Acres

Key

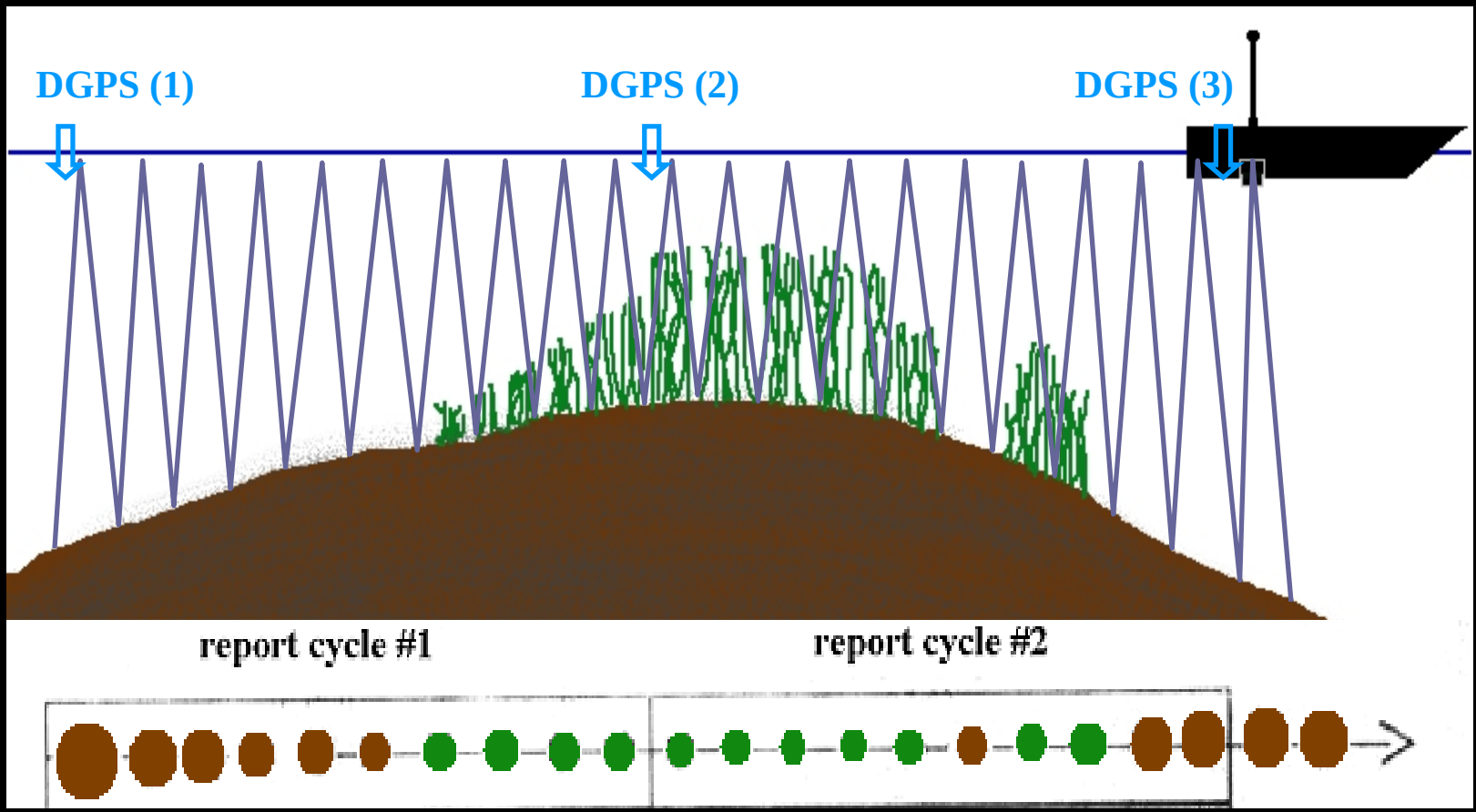
- Physical Point Samples
- Hydroacoustic Points
- Total Study Area

0 100 200 400 Meters

1:10,600

Coordinate System NAD83 UTM Zone 10N

Hydroacoustic (Sonar) Assessment:



0	0	0	0	0	0	30	30	35	45	70	75	65	70	70	0	55	45	0	0	height (cm)
150	140	130	125	120	115	115	115	110	110	110	110	110	110	115	120	125	130	135	140	depth (cm)

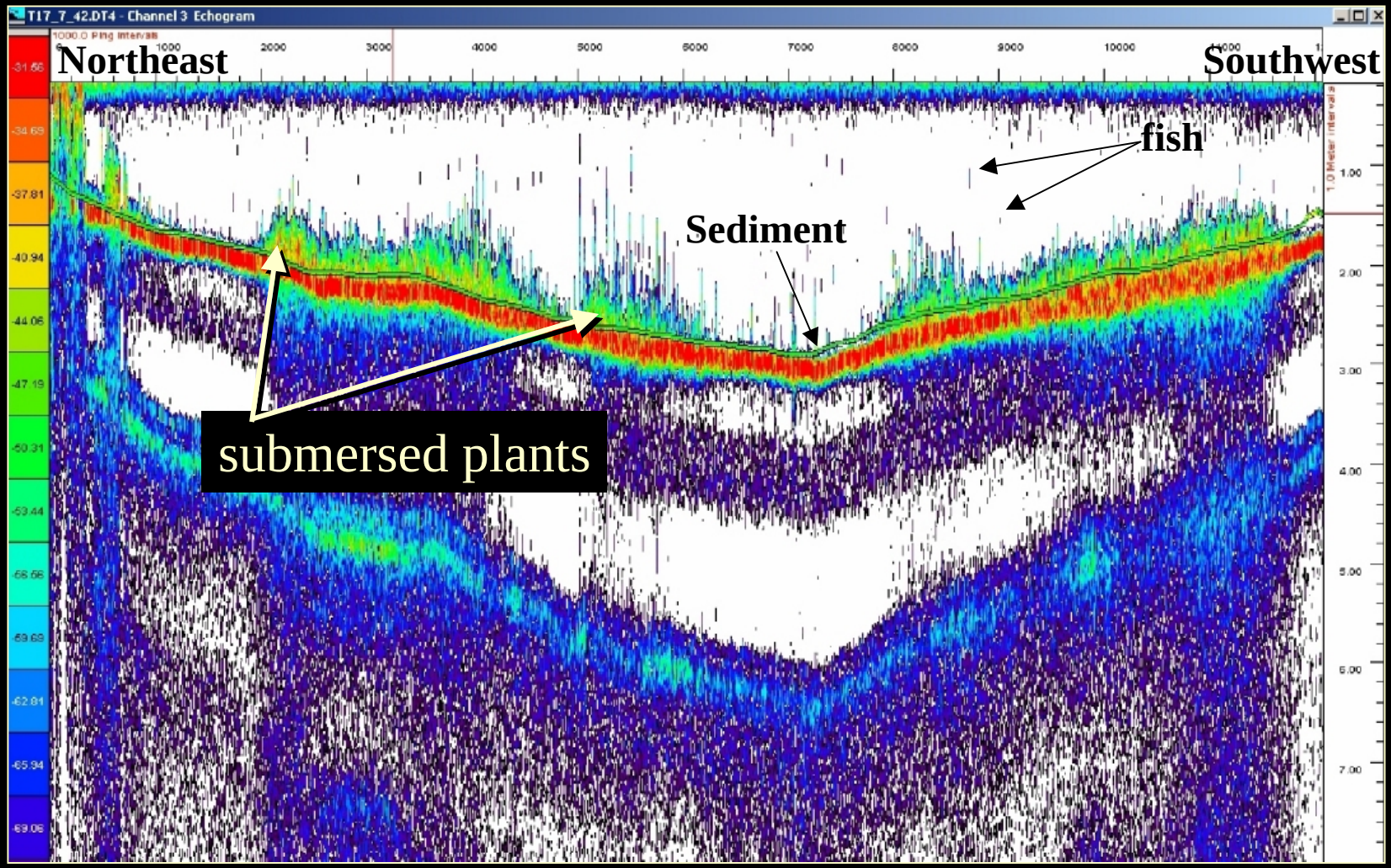
Graphic courtesy of BioSonics

The Leaky-Boat Pioneering Years

transducer

The Efficient, Integrated Present

Raw Data Output from Echosounder



[raw hydroacoustic data using BioSonics Visual Analyzer™ software]

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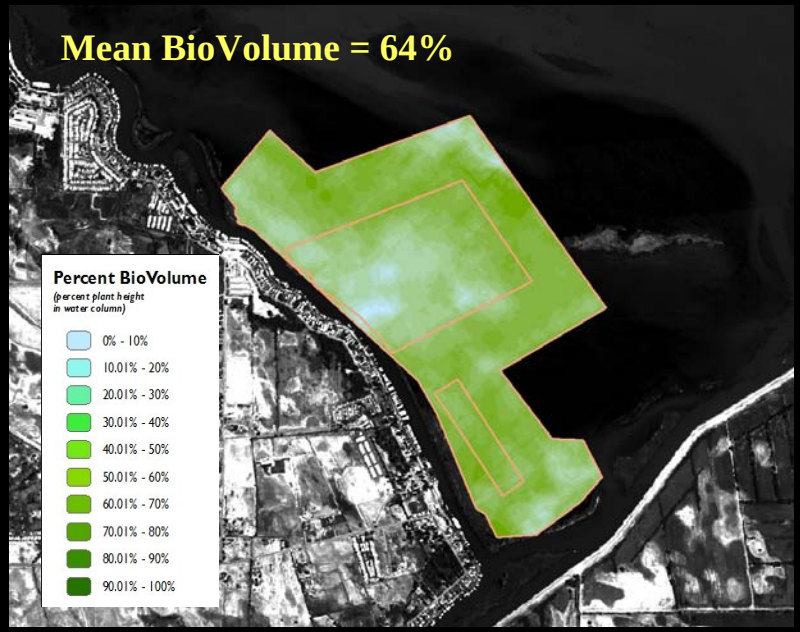
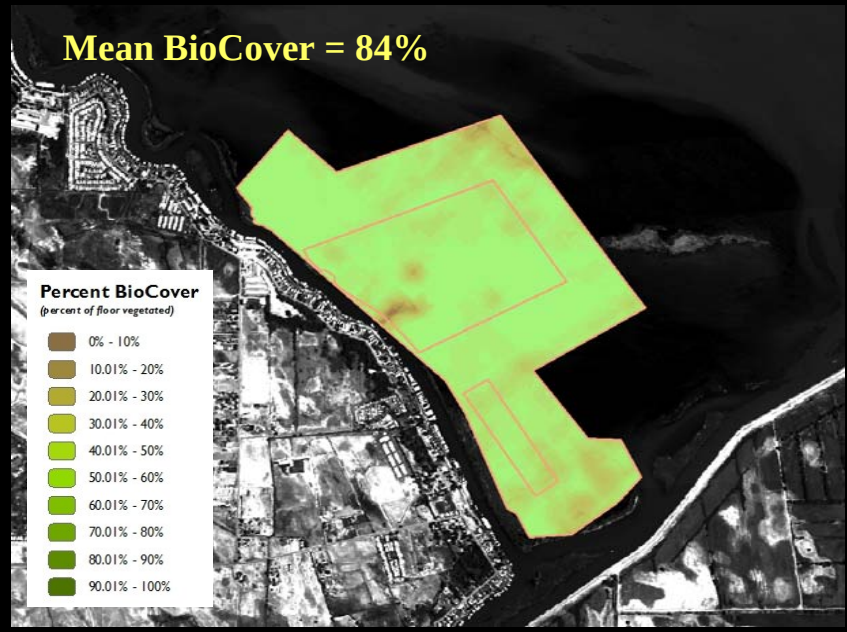
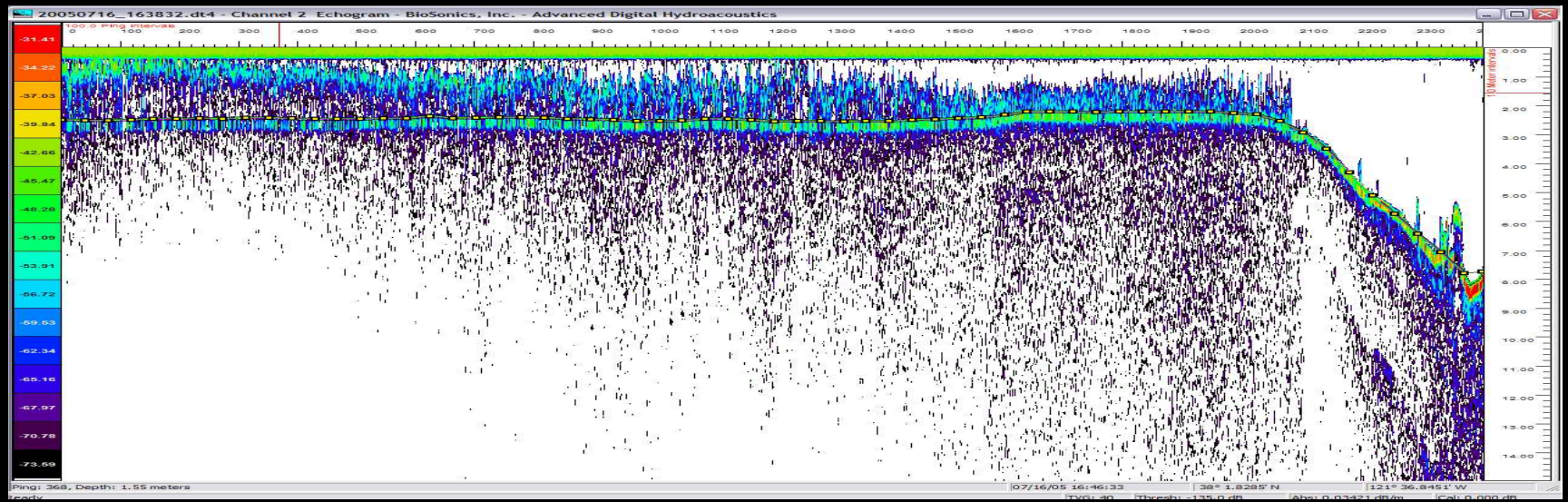
BioSonics

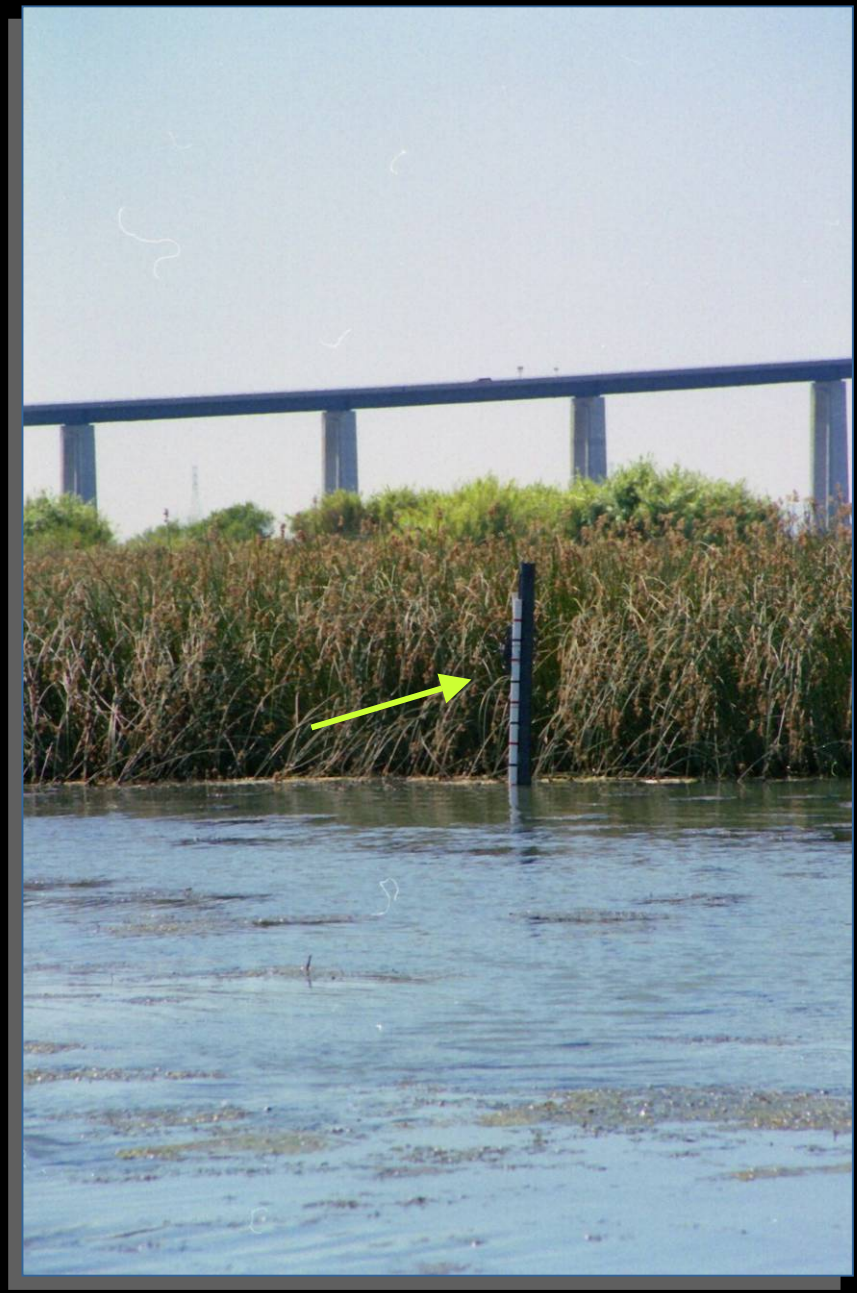
Hydroacoustic-based BioVolume and BioCoverage Statistics



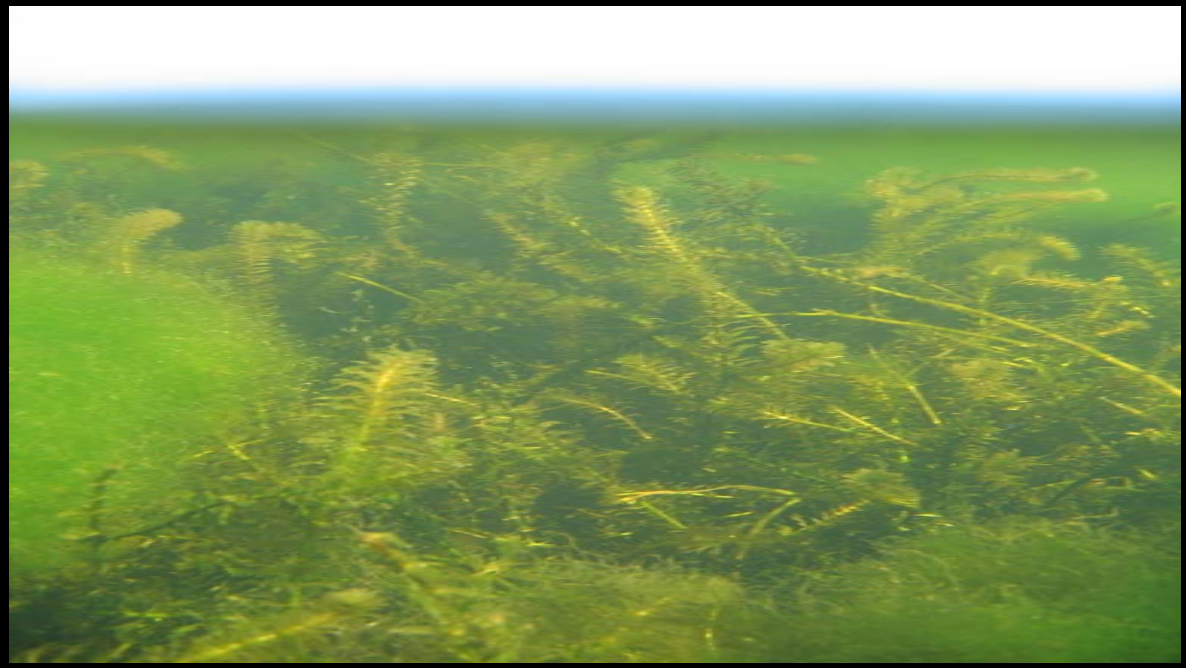




What does this BioVolume and BioCoverage Accurately Represent?



DGPS Point Sampling Technique



DGPS Point Sampling Information

2003 - 2005 EDCP Observed Submersed Vegetation Species

Common Name	Genus and species
American elodea	*Elodea canadensis*
American pondweed	*Potamogeton nodosus*
Brazilian egeria	*Egeria densa*
Coontail	*Ceratophyllum demersum*
Curlyleaf pondweed	*Potamogeton crispus*
Eurasian watermilfoil	*Myriophyllum spicatum*
Fanwort	*Cabomba carolinia*
Sago pondweed	*Stuckenia pectinatus*
Threadleaf pondweed	*Stuckenia filaformis*

2003 - 2005 EDCP Observed Floating and Free-Floating Vegetation Species

Common Name	Genus and species
Floating pennywort	*Hydrocotyle ranunculoides*
Water hyacinth	*Eichhornia crassipes*

2003 - 2005 EDCP Submerged Vegetation Health Scale

Code	Description
5	Completely healthy, green tissues
4	Leaves chlorotic or abnormal (e.g. darkened, senescent)
3	Defoliation – many leaves gone, partially defoliated along stems
2	Stem defoliated and partially necrotic (discolored)
1	Stem, any leaves necrotic, mushy, little structural integrity – easily squished; usually any roots are also necrotic, mushy, or absent

Rating Scale defined by Dr. L.W.J. Anderson, *USDA-ARS Exotic and Invasive Weed Research*

2003 - 2005 EDCP Submerged Vegetation Density Scale

Code	Description	Percentage Abundance
D	Dense	>60%
C	Common	20% - 60%
B	Sparse	3% - 20%
A	Rare	<3%

2003 - 2005 EDCP Submerged Vegetation Relative Abundance per Sample Unit

Scale	Description
100%	Present in entire sample unit
75%	Present in 75% of sample unit
50%	Present in 50% of sample unit
25%	Present in 25% of sample unit

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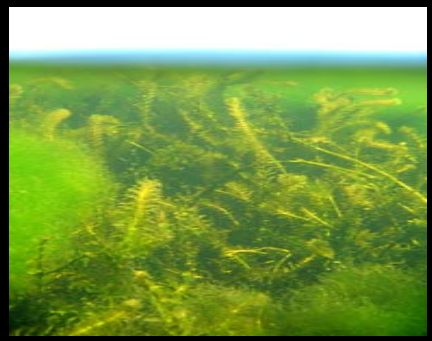
Egeria densa Plant Health Index Determinations by Photograph:

5 - Completely healthy, green tissues


4 – Leaves chlorotic, abnormal




3 – Leaf defoliation


2 – Stem defoliated, necrotic


1 – No structural integrity


Regrowth


Data Analysis...

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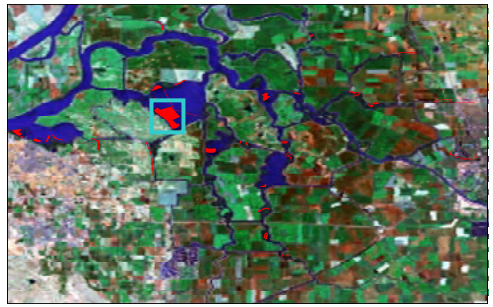
Franks Tract 173 Treatment Areas

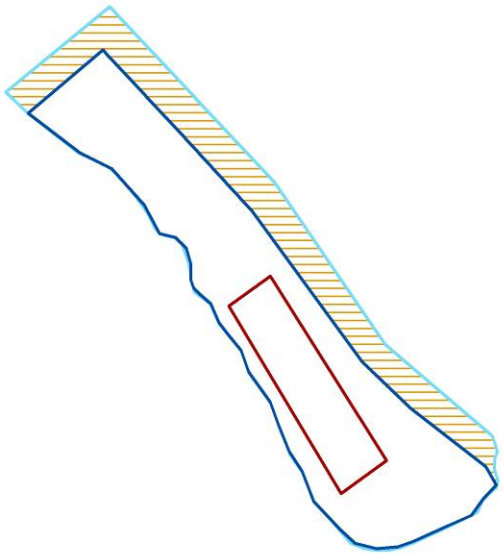
Key

- Study Area - SA
- Fluridone Treatment Area - TA
- Non-Treatment Area - NTA
- Diquat Treatment Area - DTA



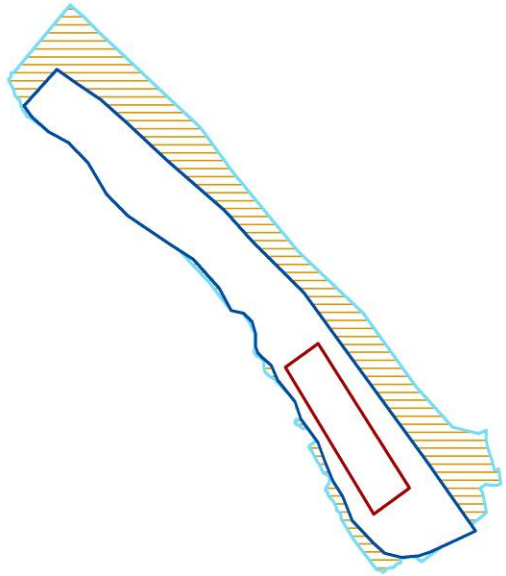
2003 site charateristics

Study Area = 165 Acres
Fluridone Treatment Area = 120 acres
Non-Treatment Area = 45 acres
Diquat Treatment Area = 20 acres



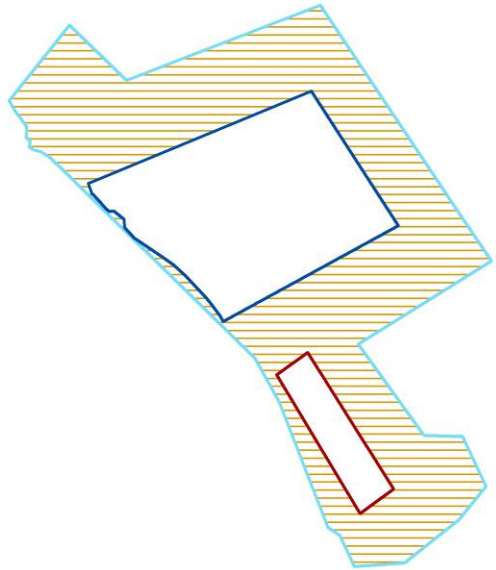
2004 site charateristics

Study Area = 235 acres
Fluridone Treatment Area = 140 acres
Non-Treatment Area = 95 acres
Diquat Treatment Area = 20 acres



2005 site charateristics

Study Area = 467 acres
Fluridone Treatment Area = 140 acres
Non-Treatment Area = 307 acres
Diquat Treatment Area = 20 acres



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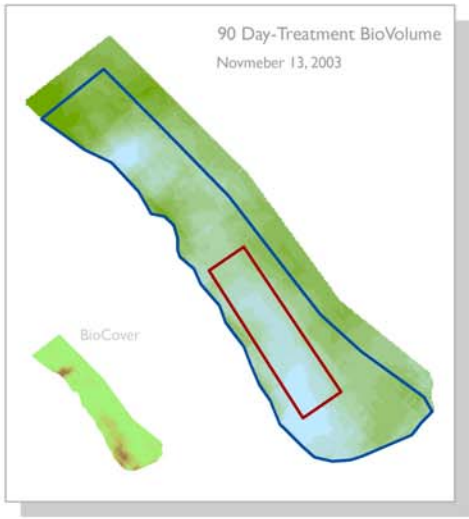
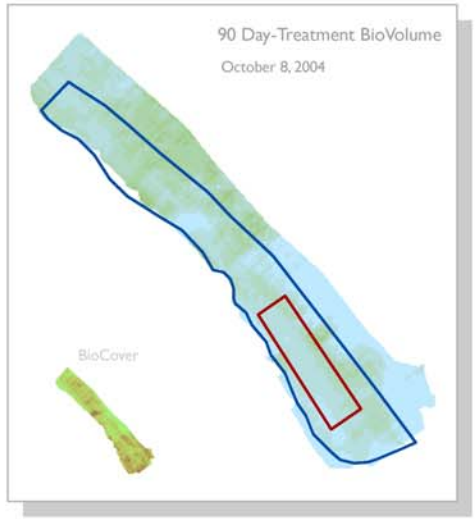
Franks Tract 173a

BioVolume and BioCover of Submersed Vegetation





BioVolume
(plant height in water column)

- 0% - 10%
- 10.01% - 20%
- 20.01% - 30%
- 30.01% - 40%
- 40.01% - 50%
- 50.01% - 60%
- 60.01% - 70%
- 70.01% - 80%
- 80.01% - 90%
- 90.01% - 100%
- Fluridone Treatment Area
- Diquat Treatment Area

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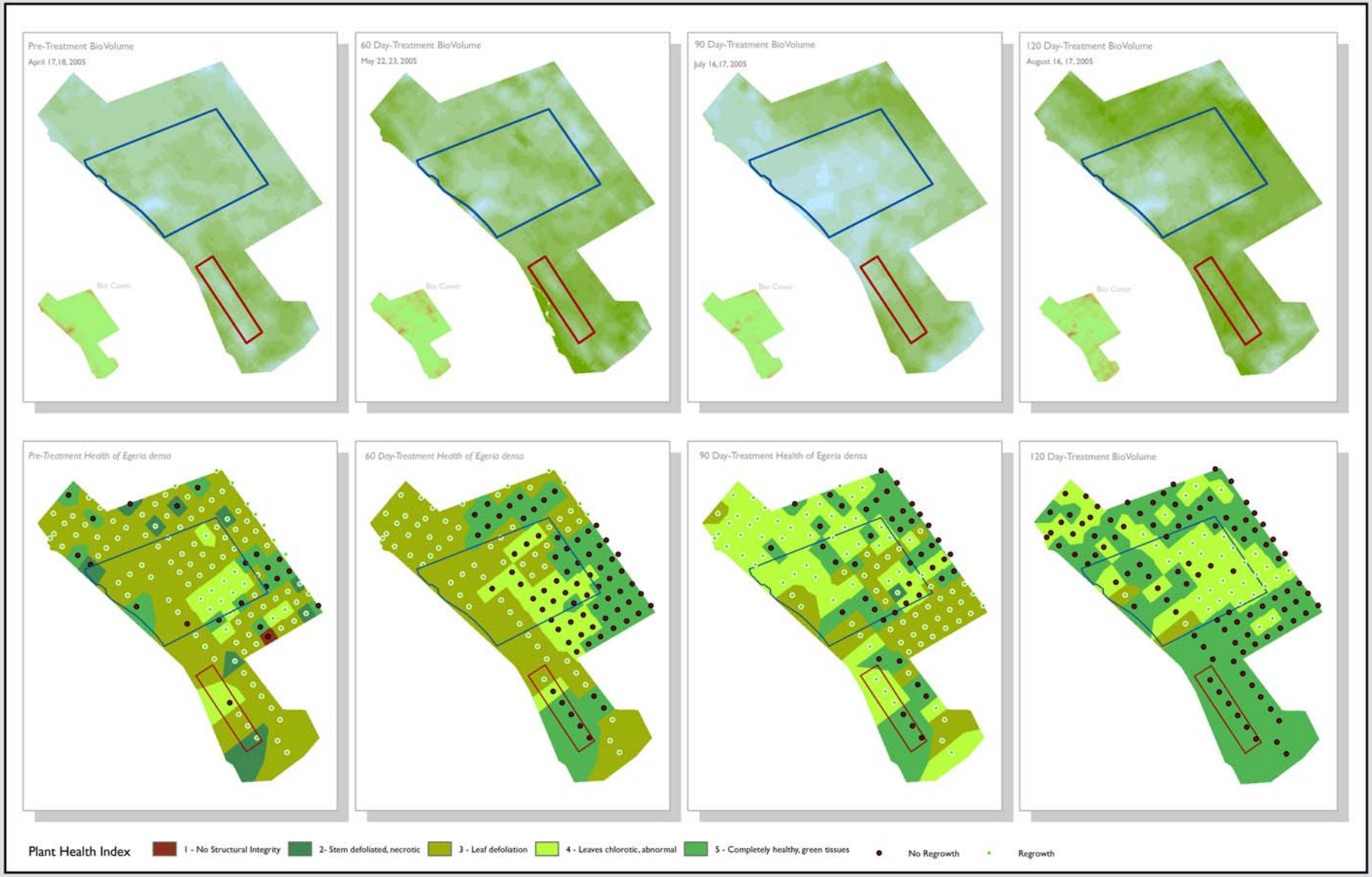


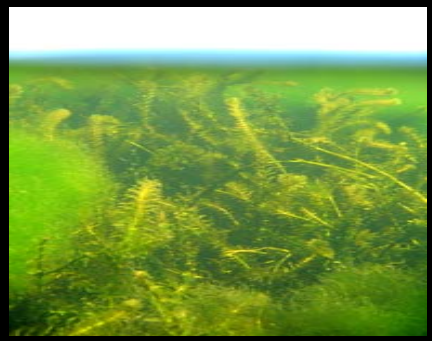
ReMetrix

Egeria densa Plant Health Index Determinations by Photograph:

5 - Completely healthy, green tissues


2 – Stem defoliated, necrotic

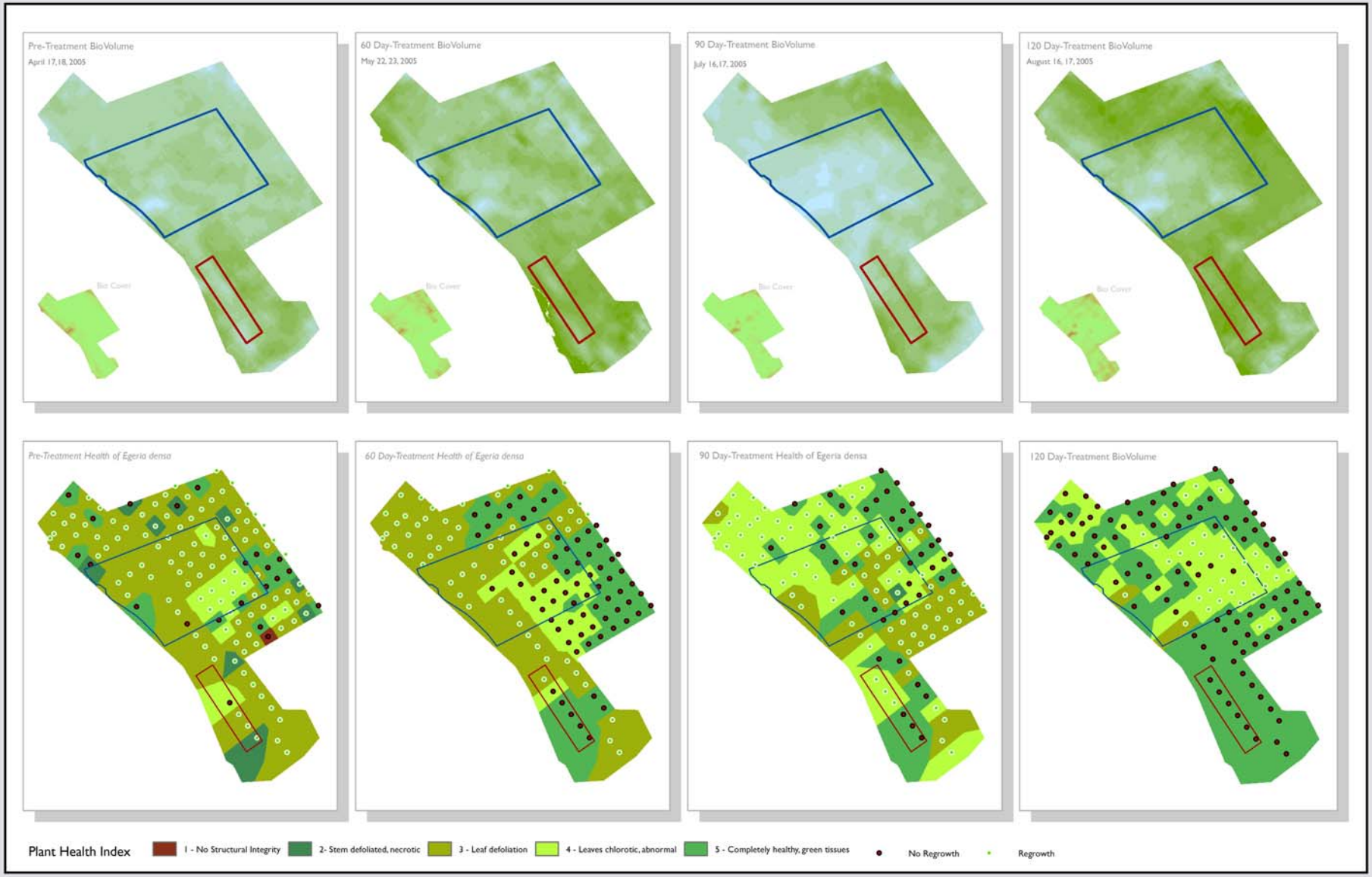

4 – Leaves chlorotic, abnormal




1 – No structural integrity


3 – Leaf defoliation


Regrowth

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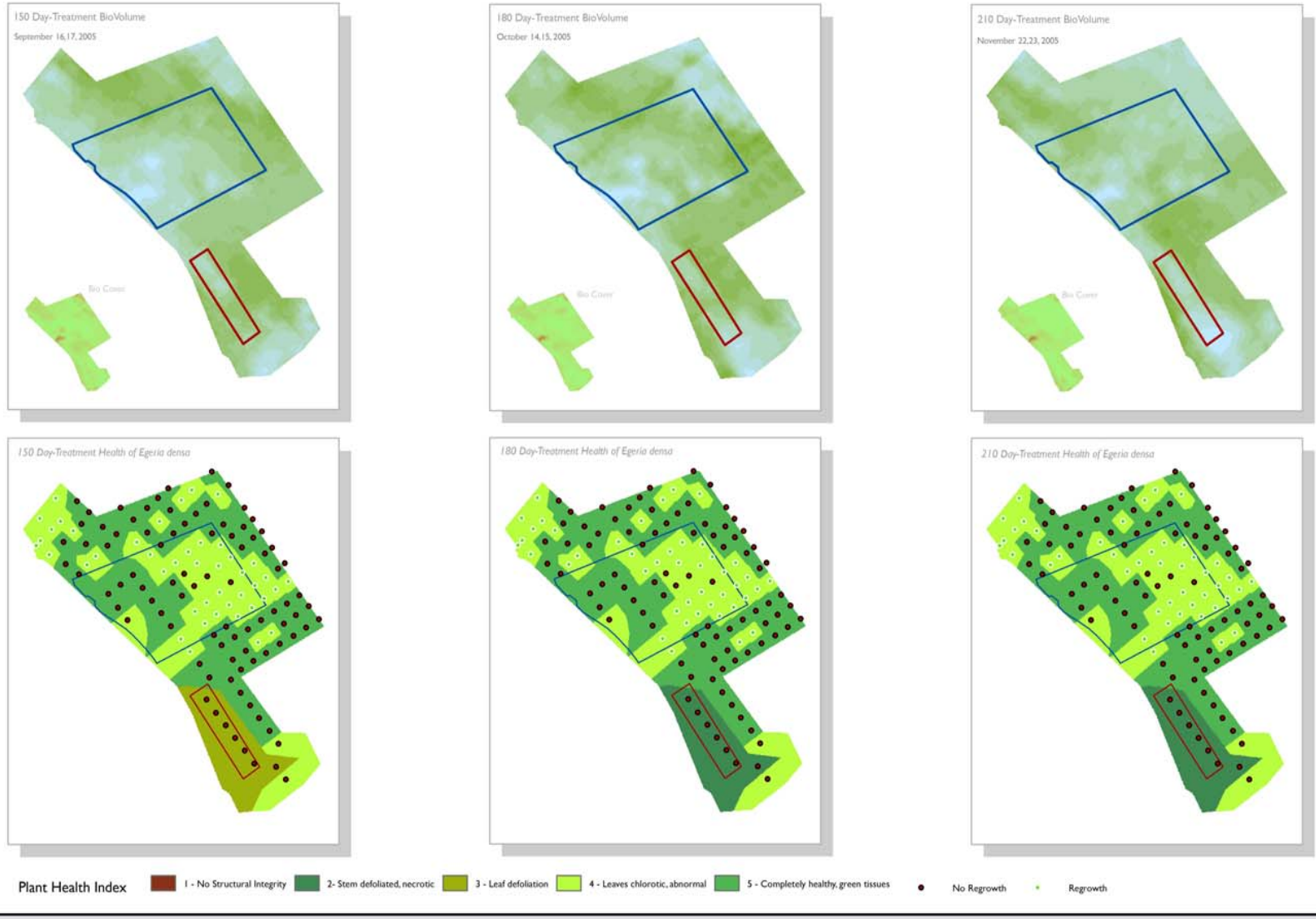

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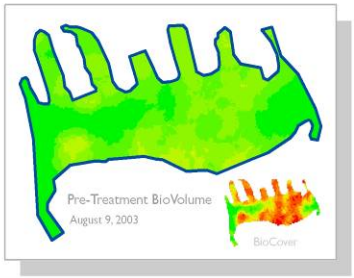
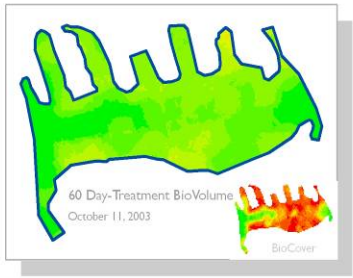
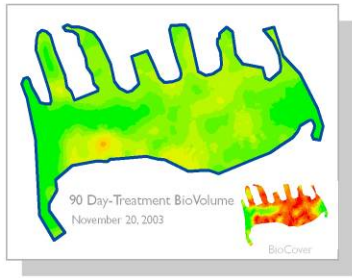
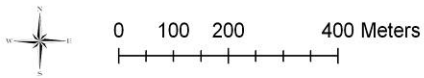
Latham Slough Five Fingers 68 *Control*

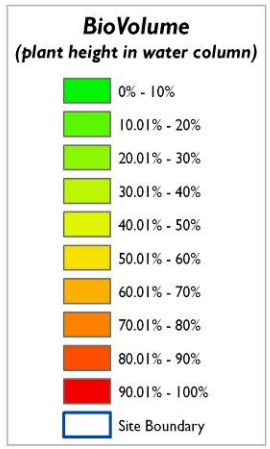
BioVolume and BioCover of Submersed Vegetation

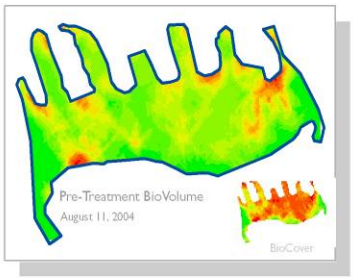


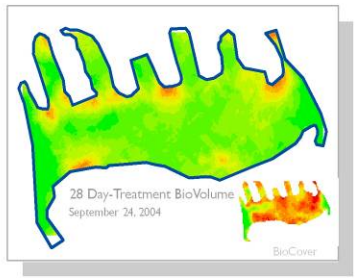


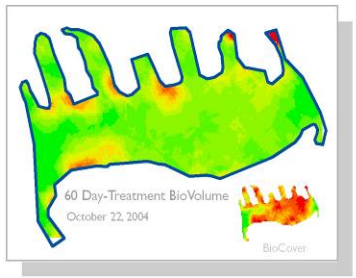


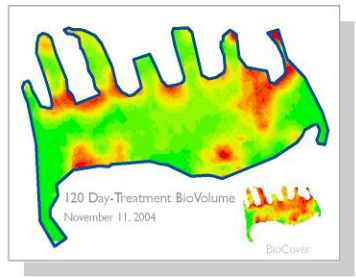


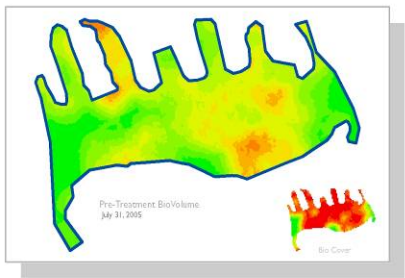


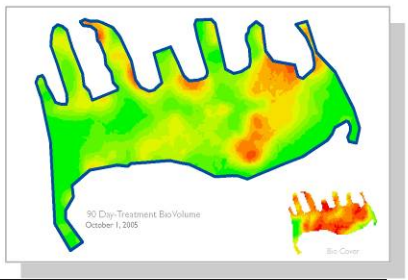


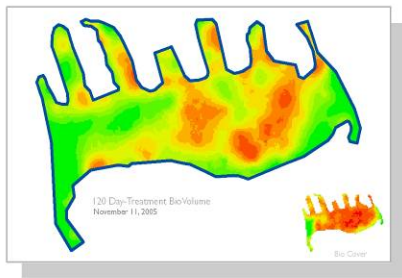


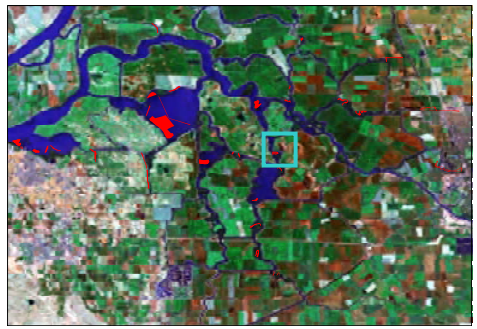


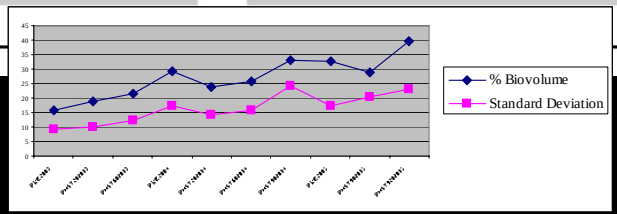








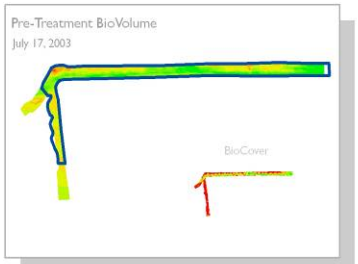


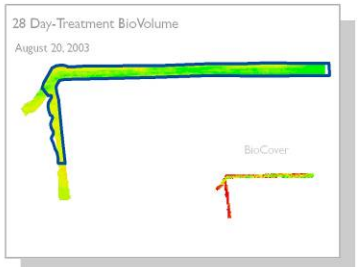


Control Site BioVolume Increase

White Slough 36

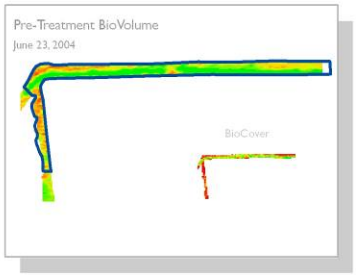
BioVolume and BioCover of Submersed Vegetation
Fluridone Treatment Area 55 Acres

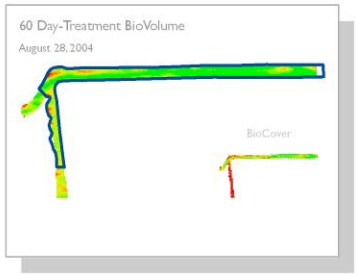


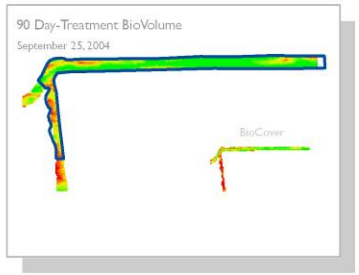


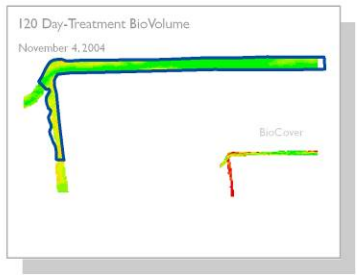
BioVolume
(plant height in water column)

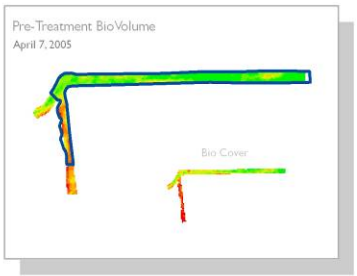
- 0% - 10%
- 10.01% - 20%
- 20.01% - 30%
- 30.01% - 40%
- 40.01% - 50%
- 50.01% - 60%
- 60.01% - 70%
- 70.01% - 80%
- 80.01% - 90%
- 90.01% - 100%
- Fluridone Treatment Area

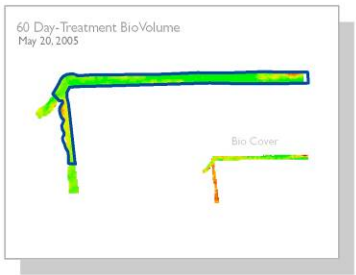


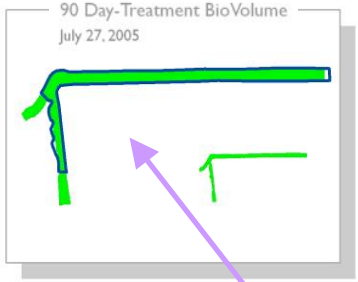


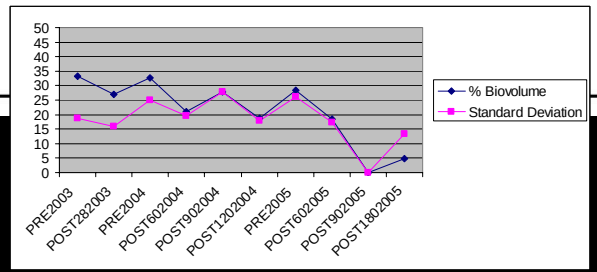


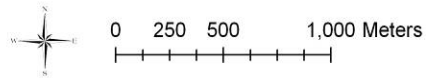






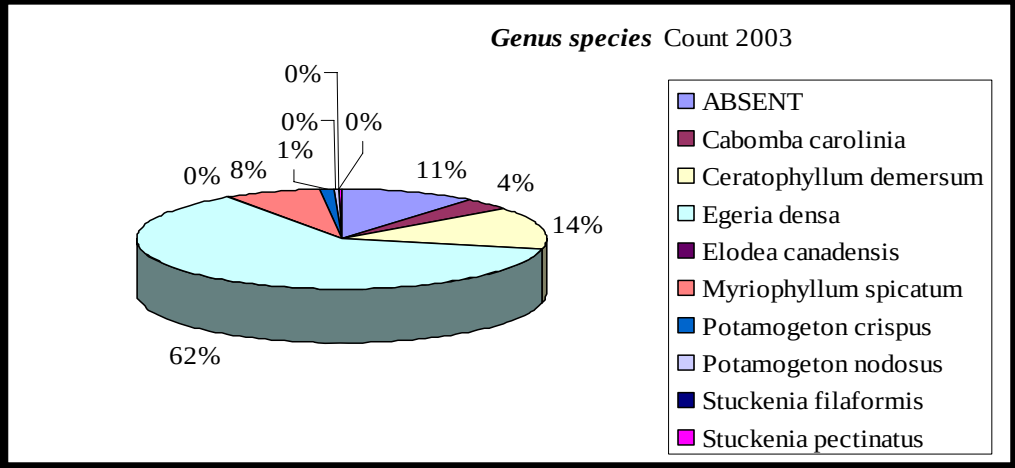


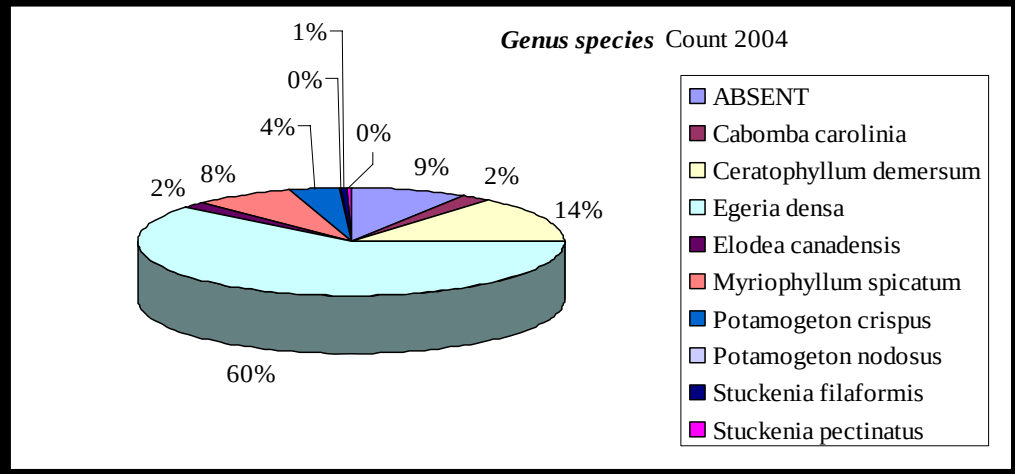


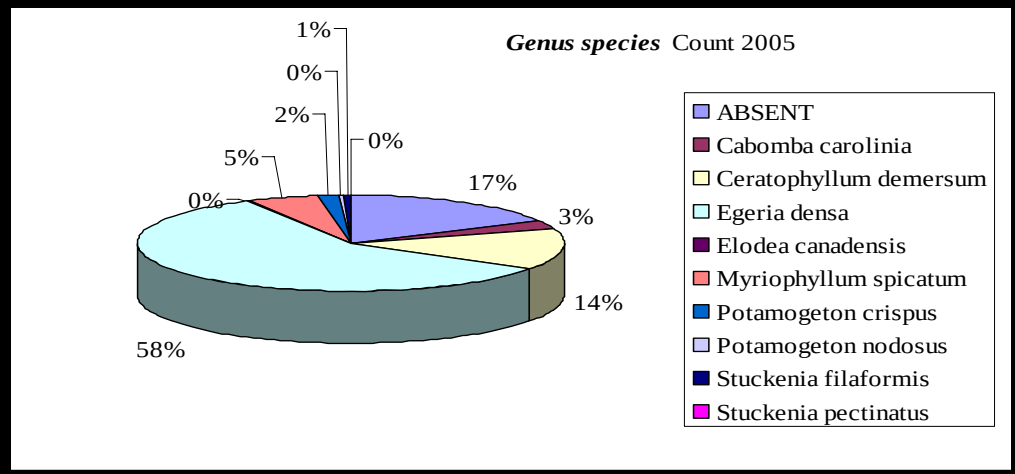


Importance of April-Start Treatments

Species Diversity







Summary of 2003 - 2005 Treatment Efficacy Statistics

Total Number of Treatment Sites Collected: 18

Total Number of Control Sites Collected: 6

Total Number of Treatment Statistical Plant BioVolume Coverages Analyzed: 120

Number of Coverages proving *decrease* in plant volume: 106
Number of Coverages proving *increase* in plant volume: 9
Number of Coverages proving *no change* in plant volume: 5

88% of sampled *treatments* successful in reducing *Egeria*

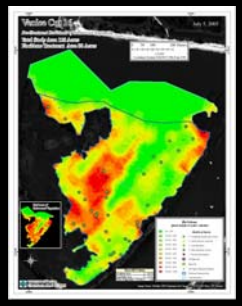
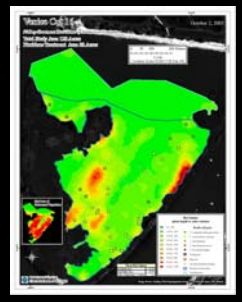
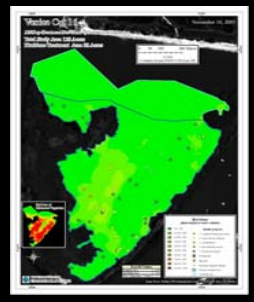
Total Number of Control Statistical Plant BioVolume Coverages Analyzed: 29

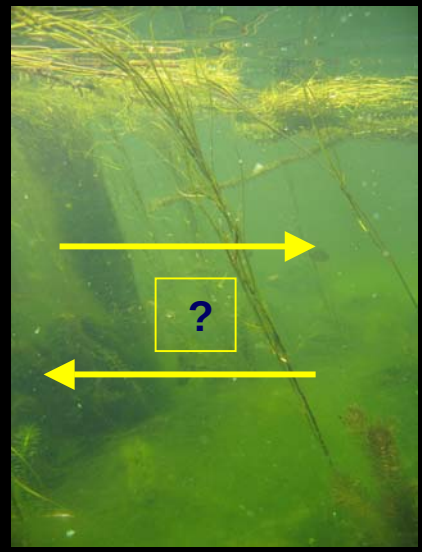
Number of Coverages proving *decrease* in plant volume: 2
Number of Coverages proving *increase* in plant volume: 24
Number of Coverages proving *no change* in plant volume: 3

83% of sampled *controls* prove increase in *Egeria*

Logical Next Steps

1. Continued Annual Monitoring & Multi-Year Reporting



2. Flow Studies to Improve Treatment Efficiency

3. Ecological Restoration Issues Involving Shallow-Water SSJD Fish Habitat

4. Sediment-Type and Sedimentation Studies

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