Advantages and Disadvantages of Aquatic Plant Control Techniques

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Aquatic Plant Management Plan

- Prevention
- Assessment
- Site-specific management
- Evaluation
- Monitoring
- Education

Hydrilla topped out in Lake Guntersville, AL – in 12' water depth. Photo by RM Stewart.

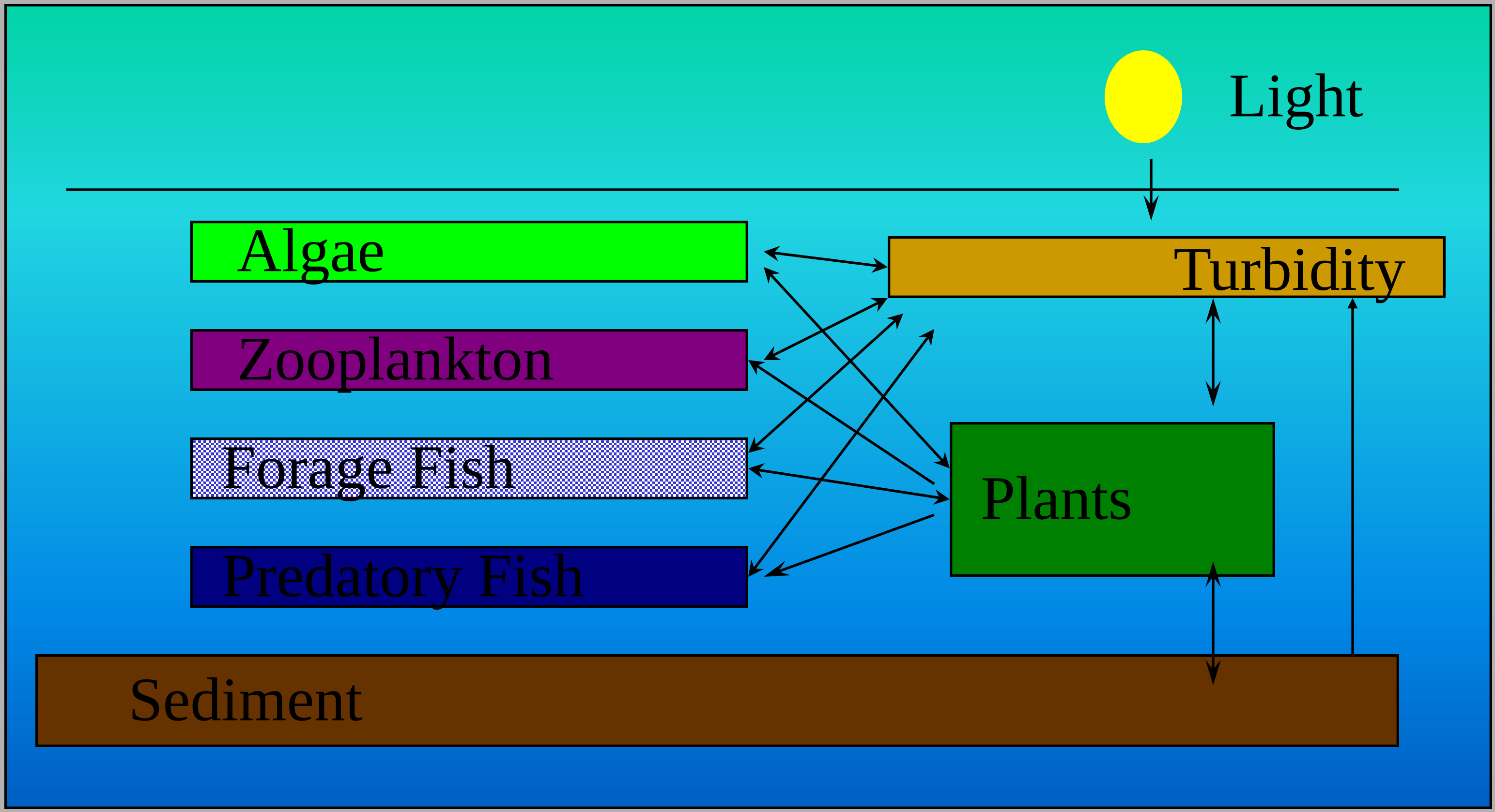
Prevention

- Prevent invasive species introductions
  - Signage
  - Regulations
  - Enforcement
  - Monitor lakes

Environmental Impacts of Aquatic Plant Management

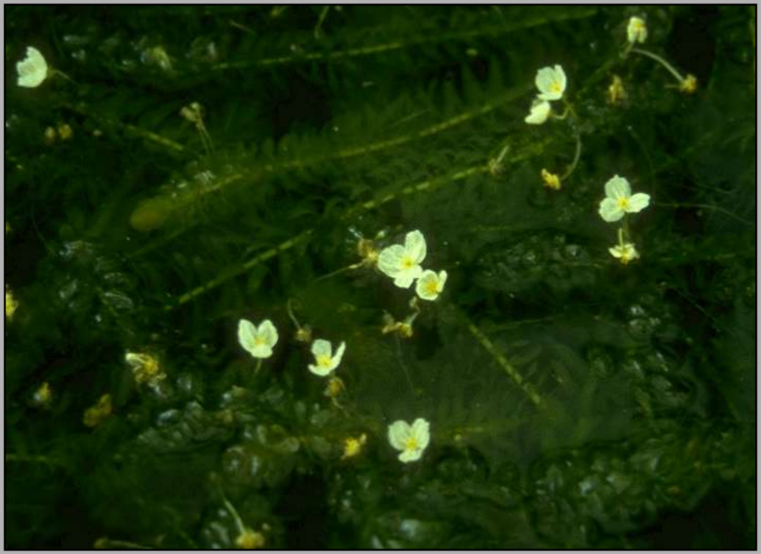
- All have environmental impacts on nontarget species and ecosystem processes
- Impacts are both direct and indirect
- Impacts have not been determined for some techniques
- Public perceptions not supported by existing knowledge

Indirect Effects



Aquatic Plant Control Techniques

- Biological Control
- Chemical Control
- Mechanical Control
- Physical Control
- “Institutional Control”
- “No (Active) Control”



Aquatic Plant Management References

Gettys, LA, WT Haller and M Bellaud, eds. 2009. Biology and control of aquatic plants: a best management practices handbook. Aquatic Ecosystem Restoration Foundation, Marietta GA. 210 pages. www.aquatics.org

Madsen, J. D. 1997. Ch. 12. Method for Management of Nonindigenous Aquatic Plants, pp. 145-171. In: J. O. Luken and J. W. Thieret, eds. Assessment and Management of Plant Invasions. Springer, New York. 316pp. ISBN 0-387-94809-0

Madsen, J.D. 2000. Advantages and Disadvantages of Aquatic Plant Management Techniques. ***US Army Engineer Research and Development Center Miscellaneous Report ERDC/EL MP-00-1***, Vicksburg, MS. September 2000.

Potential Environmental Impacts

- Water quality
- Plankton
- Nontarget plants
- Macroinvertebrates
- Fish
- Waterfowl
- Human health, welfare, and utilization

Biological Control

- Insects
  - Classical
  - Native
- Grass Carp
- Pathogens
  - Classical
  - Native
- Plant Restoration

Grass Carp

- Advantages
  - Effective
  - Inexpensive
  - Long-term
- Disadvantages
  - "All-or-none" response
  - Not selective
  - Cannot control feeding sites
  - Cannot stop fish
  - Difficult to contain
  - Reproduction?
  - Won't eat some species (e.g., Eurasian watermilfoil)
  - Regulations

Environmental Effects of Grass Carp

Abstract.—We investigated effects of triploid grass carp *Ctenopharyngodon idella* on aquatic macrophyte communities, water quality, and public satisfaction for 98 lakes and ponds in Washington State stocked with grass carp between 1990 and 1995. Grass carp had few noticeable effects on macrophyte communities until 19 months following stocking. After 19 months, submersed macrophytes were either completely eradicated (39% of the lakes) or not controlled (42% of the lakes) in most lakes. Intermediate control of submersed macrophytes occurred in 18% of lakes at a median stocking rate of 24 fish per vegetated surface acre. Most of the landowners interviewed (83%) were satisfied with the results of introducing grass carp. For sites where all submersed macrophytes were eradicated, average turbidity was higher (11 nephelometric turbidity units, NTU) than at sites where macrophytes were controlled to intermediate levels (4 NTU) or unaffected by grass carp grazing (5 NTU).

Bonar, S.A., B. Boldin, and M. Divens. 2002. Effects of triploid grass carp on aquatic plants, water quality, and public satisfaction in Washington State. N. Am. J. Fish. Manage. 22:96-105.

Classical Insect Control

- Advantages
  - Public perception
  - Low cost after R&D
  - Long-term
  - Works well for some species in some areas
- Disadvantages
  - No agents for several target invasive plants
  - Long time for R&D
  - Unpredictability of results
  - Limited distribution of effectiveness

Native Insect Biocontrol

- Advantages
  - Public perception
  - Avoid quarantine period and problems
  - Several apparent successes through natural populations
- Disadvantages
  - Not an operational technique at this time
  - Unpredictability of results
  - No current strategy for use
  - Very expensive
  - No theoretical basis for long-term success

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Fungal Pathogens

- Advantages
  - Typical plant diseases that can be effective
  - Can be combined with other techniques
- Disadvantages
  - No operational formulations
  - To date, only a "contact mycoherbicide" is under R&D

Native Plant Restoration

- Advantages
  - Provides habitat for aquatic organisms
  - May retard reinvasion
  - Public perception
- Disadvantages
  - Not a control technique
  - Restorative
  - Techniques and approach largely under R&D
  - Very labor intensive

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Chemical Control

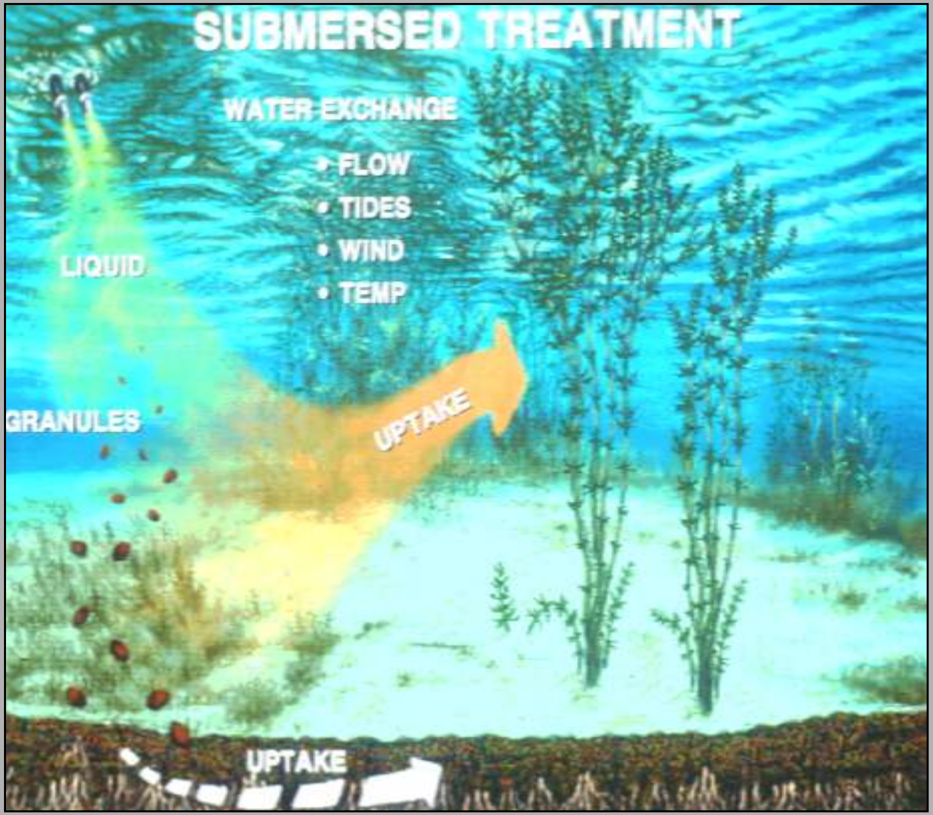
Contact
- Carfentrazone ethyl
- Complexed copper
- Diquat
- Endothall
- Flumioxazin

Systemic
- 2,4-D
- Bispyribac-sodium
- Fluridone
- Glyphosate*
- Imazamox
- Imazapyr*
- Penoxsulam
- Triclopyr

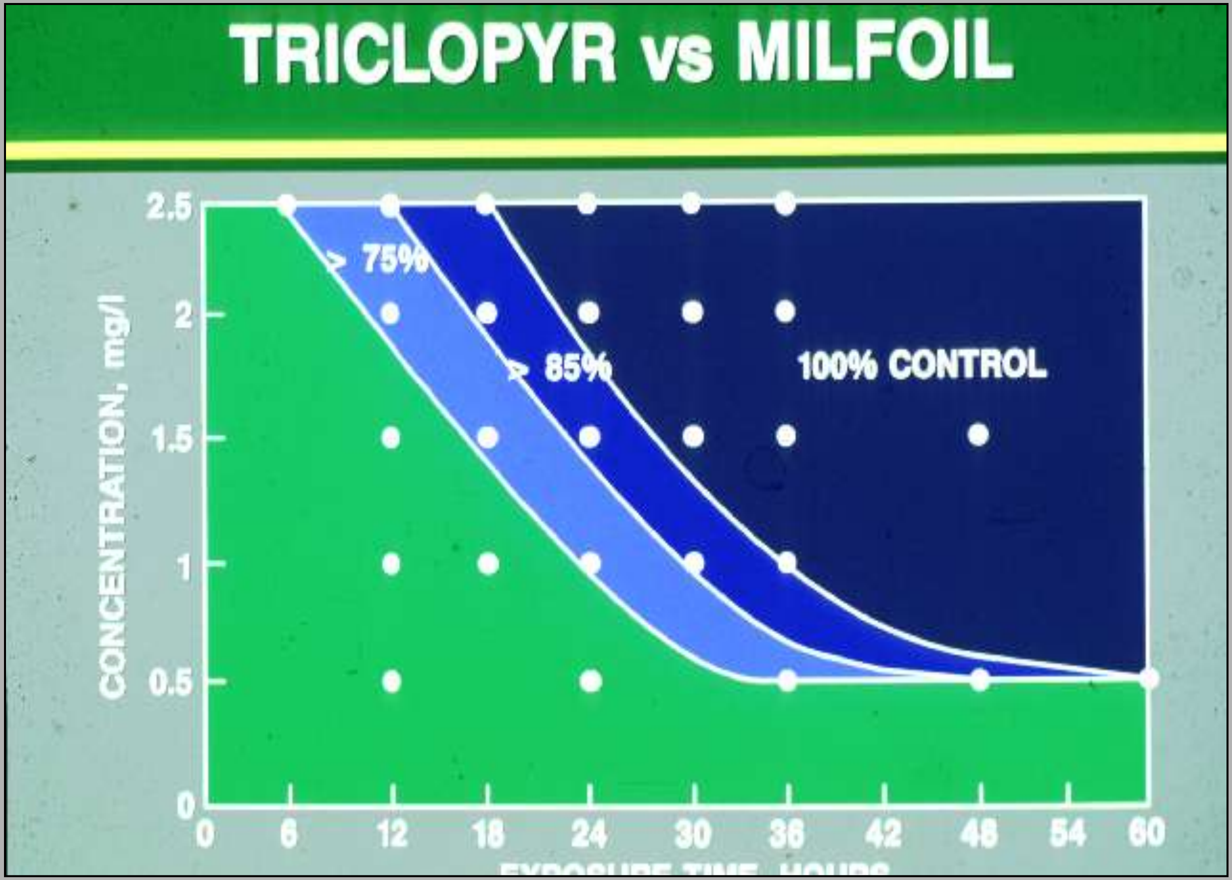
Some would also include sodium carbonate peroxyhydrate (an algaecide) and water dyes (alters water transparency)

Aquatic Applications of Herbicides

- Herbicides are applied to water, and plants take up from water
- Water movement, residence time, and concentration critical to effectiveness



Concentration / Exposure Time



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Contact Herbicides

- Advantages
  - Requires only a short exposure time (6-24 hours)
  - Broad spectrum
  - Very fast action (Usually less than 7 days)
  - Inexpensive (~$200/acre)
- Disadvantages
  - Does not kill entire plant
  - Requires more than one treatment per year
  - Not selective
  - Public perception

Contact Herbicide Impact

A nearly monotypic population of egeria (*Egeria densa* Planch.) was interfering with recreation in a popular lake in southwest Washington. In June 2003 the littoral zone was treated with the contact herbicide diquat (6,7-dihydrodipyrido [1,2-a2’,1’-c] pyrazinediium dibromide). Aquatic plant frequency and biomass data were collected on all submersed species before treatment, and eight weeks, one year and two years after treatment. Water quality and herbicide dissipation data were also collected before and for one season after the treatment. Results from the aquatic plant data showed a significant reduction in egeria frequency and biomass after the herbicide treatment, although the species did not disappear entirely. **Two native submersed species, water moss (*Fontinalis antipyretica* Hedw.) and stonewort (*Nitella* sp.), increased after treatment.** However their increase was not enough to offset the egeria population reduction, as total plant abundance was significantly reduced after treatment. The herbicide dissipation data illustrated the dispersal of diquat throughout the lake and persistence at low concentrations (up to 10.4 ppb) in the water column for at least two weeks after treatment. **Water quality data demonstrated a slight decrease in dissolved oxygen and water transparency following the herbicide treatment, potentially due to plant die-off and subsequent plant decomposition.**

Parsons, J.K., K.S. Hamel, and R. Wierenga. 2007. J. Aquat. Plant Manage. 45:35.

Systemic - 2,4-D

- Advantages
  - Selective
    - Eurasian watermilfoil
  - Intermediate exposure time
  - Inexpensive (~$300/acre)
  - Usually effective
  - Moderate response time (1-2 weeks)
- Disadvantages
  - Public perception
  - Does not work on some plants
  - Effective for 1 to 3 years

Couch and Nelson. 1982. JAPM 20:8-13

The butoxyethanol ester formulation of the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D BEE) was applied for the control of Eurasian watermilfoil (*Myriophyllum spicatum* L.) in Kerr Reservoir in 1977 and 1978. The only detrimental effect to non-target species that could be attributed to herbicide treatment was a short-term depression of phytoplankton populations in those sites sampled in 1977 where large areas of the reservoir were treated or when the treated areas were in places sheltered from the action of currents and waves. Therefore, within the restraints and conditions of this investigation, it may be concluded that 2,4-D did not adversely affect the non-target components in the sampled ecosystems.

Whitney et al. 1973. JAPM 11:13-17.

On June 4, 1968 an application of a 20% (acid equivalent) formulation of the butoxyethanol ester of (2,4-dichlorophenoxy)acetic acid (2,4-D) herbicide was conducted to 200 acres of Eurasian watermilfoil (*Myriophyllum spicatum* L.) in Currituck Sound, North Carolina. No acute adverse effects on fish and other organisms were observed. No water samples contained residues exceeding 0.10 ppm. Reduction of Eurasian watermilfoil was estimated at 95% and subsequent re-establishment of native plants was considered to be of significant benefit to waterfowl. It is conceivable that reinfestation by Eurasian watermilfoil could have been reduced and possibly prevented through total treatment of the Sound.

Systemic - Fluridone

- Advantages
  - Broad spectrum
  - Very low concentration (5-25 ppm)
  - Moderately expensive (~$600/acre)
  - No drinking or contact restrictions
- Disadvantages
  - Selective only at very low rates
  - Very long exposure time (30-60 days)
  - Very long plant response time (30-90 days)

Mechanical Control

- Hand pulling
- Cutting
- Harvesting
- Diver-operated suction harvesting
- Rotovating

Hand Harvesting

- Advantages
  - Low technology
  - Widely used in many parts of the world
  - Effective in small areas
  - Can be selective
  - Affordable (volunteers)
- Disadvantages
  - Very labor intensive
  - Not practical for large areas (<<1 acre)

Cutting / Harvesting

- Advantages
  - Direct relief
  - Immediate efficacy
  - Moderately expensive (~$400/acre)
  - Public perception
- Disadvantages
  - Not selective
  - Short-term control (2-3 harvests per season)
  - May aid spread some species
  - Slow
  - Disposal (?)

Total Fish Impact: Largemouth Bass

Mikol, G.F. 1985. Journal of Aquatic Plant Management 23:59-63.

TABLE 4. SUMMARY OF DIRET EFFECTS OF 1982 MECHANICAL HARVESTING ON JUVENILE LARGEMOUTH BASS (*Micropterus salmoides*).

	COLLECTION DATE 8/13/82[1]		
	Site #1	Site #2	Combined
Total # fish removed	11	7	18
# fish removed/ha	220	56	103
Fish standing crop estimate (#/ha)	1,894	1,894	1,894
% standing crop removed	11.6	3.0	5.4

[1]Site #1 was previously harvested in June 1982. Site #2 was previously unharvested.

Diver-operated Suction Harvester

- Advantages
  - Selective (dependent on operator and environment)
  - Longer-term control
- Disadvantages
  - Very limited areas
  - Very slow
  - Expensive (~$1,000/acre?)
  - Disposal (?)

Rotovating

- Advantages
  - Longer term than other mechanical (on Eurasian watermilfoil)
  - Moderately inexpensive
- Disadvantages
  - Turbidity
  - Spreads fragments
  - Limited environmental range by depth, sediment
  - Free-floating plant material

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Physical Control

- Dredging
- Drawdown
- Benthic Barrier
- Shading
- Nutrient Inactivation

Dredging

- Advantages
  - Very effective
  - Very long term
- Disadvantages
  - Very expensive (~$6,000/acre)
  - Not selective
  - Impacts on other organisms?
  - Dredge spoils

Drawdown

- Advantages
  - Effective
  - Very inexpensive (~$0/acre?)
  - Moderate-term
- Disadvantages
  - Not selective
  - Impacts on other organisms (?)
  - Impacts on human uses
  - Need water control structure

Drawdown and Nutrient Loading

Studies on lake sediments showed that drying and freezing, as would occur during the management practice of water level drawdown, increased the release of phosphorus from the sediments over controls. ***P release from sediments increased as a result of drying in all ten lake sites studied***, but the amount of P released varied significantly between sites. … Freezing of sediments also resulted in increased nutrient release, with 70 times more P released from frozen sediments compared to unfrozen controls. The full effect of freezing was realized within 3 days. The combined effect of drying then freezing did not increase the amount of P released above that of sediments that were frozen without prior drying. P release as a result of drying was significantly correlated with sediment P and organic content. The data indicate that the P released resulted from the death of microorganisms due to drying and freezing. ***The results show that lake drawdown may significantly increase internal P loading to lakes of central New York State.***

Klotz, R.L. and S.A. Linn. 2001. Lake Reserv. Manage. 17:48-54.

Benthic Barrier

- Advantages
  - Effective
  - Broad spectrum
  - Immediate effect
  - Moderate term (several years)
- Disadvantages
  - Small scale
  - Expensive (~$3,000/acre)
  - Impacts on other organisms, fish spawning
  - Not selective

Institutional Control

- Quarantine
- Regulation
- Prevention
- Watershed management

Institutional Control

- Advantages
  - May prevent problems from happening
  - May improve water quality over the long term
  - Relatively inexpensive (depending on solution)
- Disadvantages
  - May not redress current problems
  - Does little to alleviate short-term problems
  - May require cooperation and involvement of many diverse groups

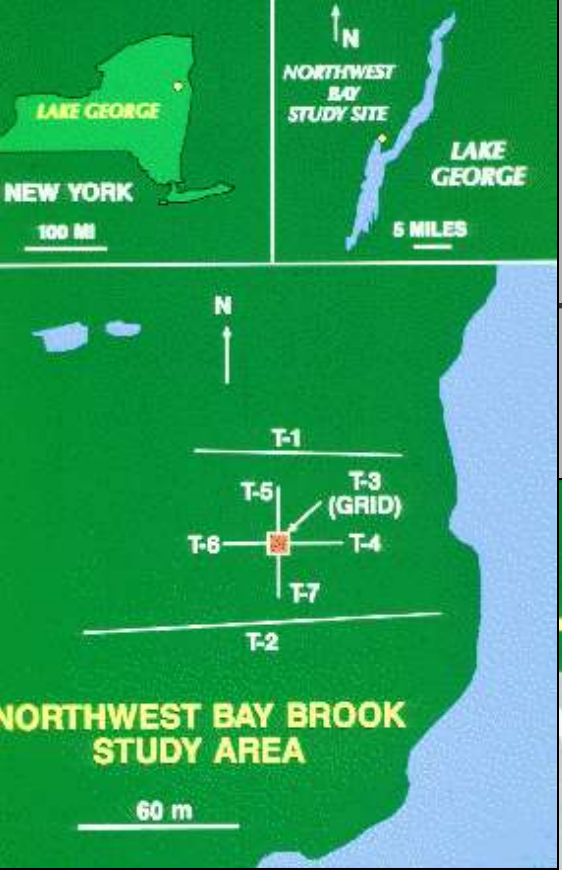
“No Control”

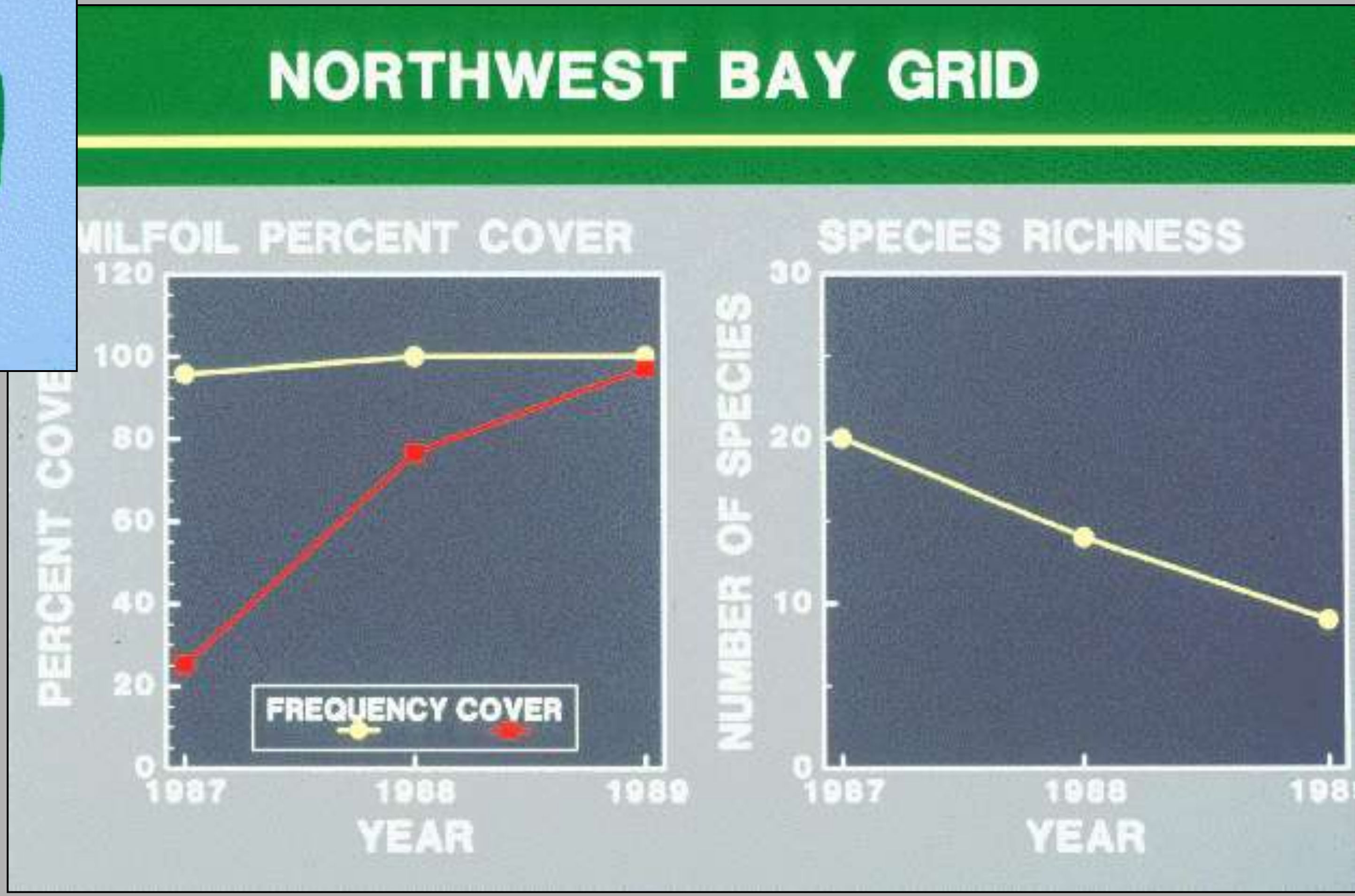
Shows a lot of hope:

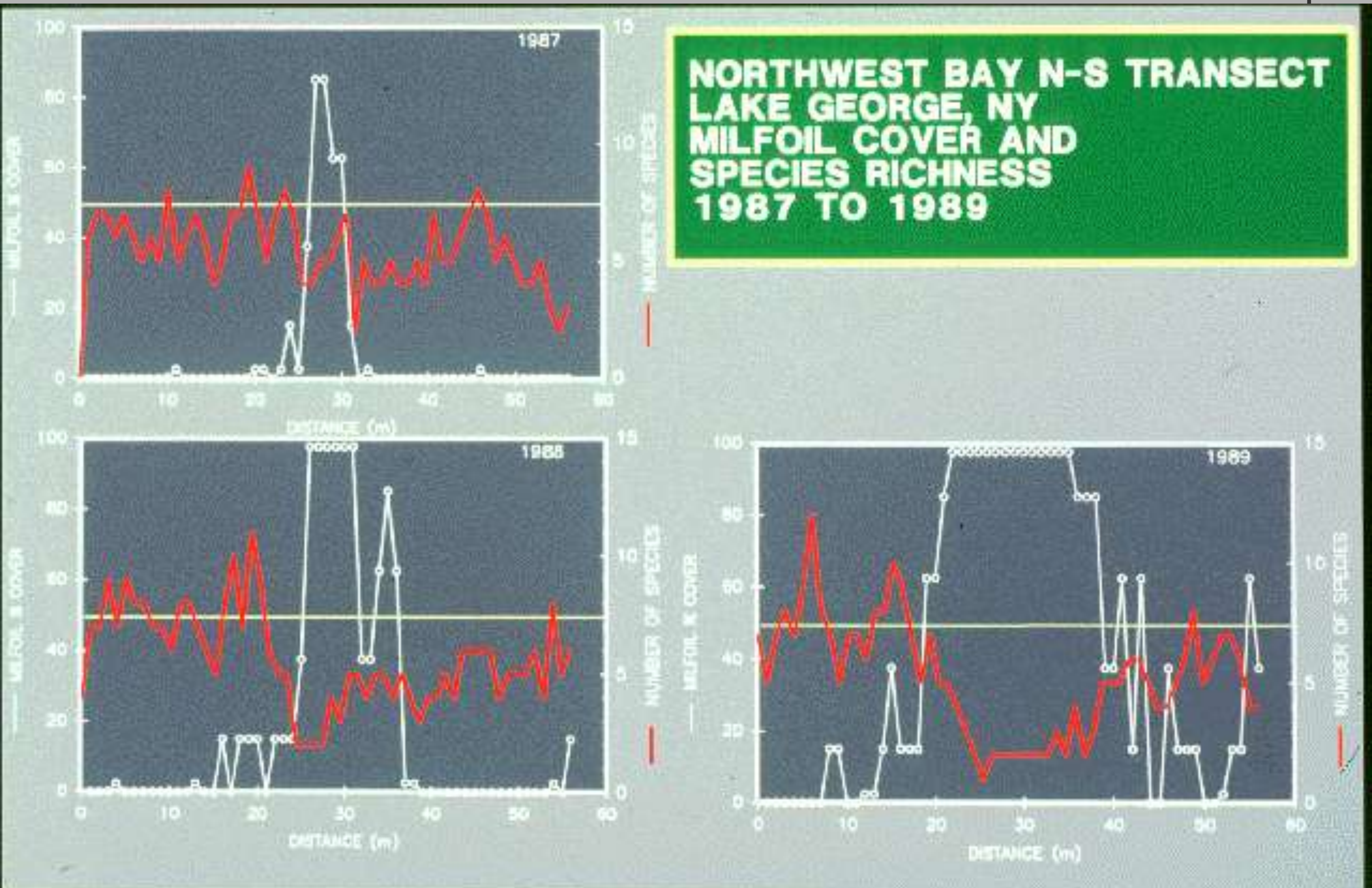
- Hope the plants go away
- Hope the people asking for permits go away
- Hope the people asking for money go away

"No Control"

- Advantages
  - Doesn't cost much in direct capital investment or cash
  - Public perception (for some groups)
  - Doesn't require decision or activity
- Disadvantages
  - May reduce tax revenues and property values - a long-term detriment
  - May reduce usability of resource
  - May have substantial ecological consequences


LAKE GEORGE
NEW YORK
100 MI
N
NORTHWEST BAY STUDY SITE
LAKE GEORGE
5 MILES
N
T-1
T-5
T-3 (GRID)
T-6
T-4
T-7
T-2
NORTHWEST BAY BROOK STUDY AREA
60 m


NORTHWEST BAY GRID
MILFOIL PERCENT COVER
SPECIES RICHNESS
PERCENT COVE
120
100
80
60
40
20
0
FREQUENCY COVER
1987
1988
1989
YEAR
NUMBER OF SPECIES
30
20
10
0
1987
1988
YEAR


NORTHWEST BAY N-S TRANSECT
LAKE GEORGE, NY
MILFOIL COVER AND
SPECIES RICHNESS
1987 TO 1989
1987
1988
1989
MILFOIL % COVER
NUMBER OF SPECIES
DISTANCE (m)
0
10
20
30
40
50
60
80
100
5
15

In other words…

- The problem (invasive aquatic plants like hydrilla and Eurasian watermilfoil) are worse than the potential solutions; that's why we would manage these plants.
- While the solutions are not without some environmental downside, the drawbacks are much less than doing nothing

Aquatic Plant Restoration Goal

Remove invasive plants and restore a diverse community of desirable native plant species

Carsons Bay, MN before treatment

Carsons Bay, MN after treatment

- GOVERNMENT
- Aquatic Plant Control Research Program
  - www.wes.army.mil/el/aqua/aqua.html
- USGS Aquatic Nonindigenous Species Site
  - nas.er.usgs.gov
- UNIVERSITY
- Center for Aquatic and Invasive Plants
  - aquat1.ifas.ufl.edu
- Mississippi State University GRI
  - www.gri.msstate.edu
- MSU ES
  - msucares.com/pubs/publications/p1532aquatic.pdf
- PROFESSIONAL SOCIETY
- Aquatic Plant Management Society
  - www.apms.org
- North American Lake Management Society
  - www.nalms.org
- FOUNDATION
- Aquatic Ecosystem Restoration Foundation
  - www.aquatics.org

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Questions?

The one in my left paw is waterhyacinth, and the one in my right paw is Eurasian watermilfoil. We can manage both with minimal damage to most native aquatic plants, and acceptable risk to the environment, or my name isn't AquaBully

Warning – Don't Mess with the Bully