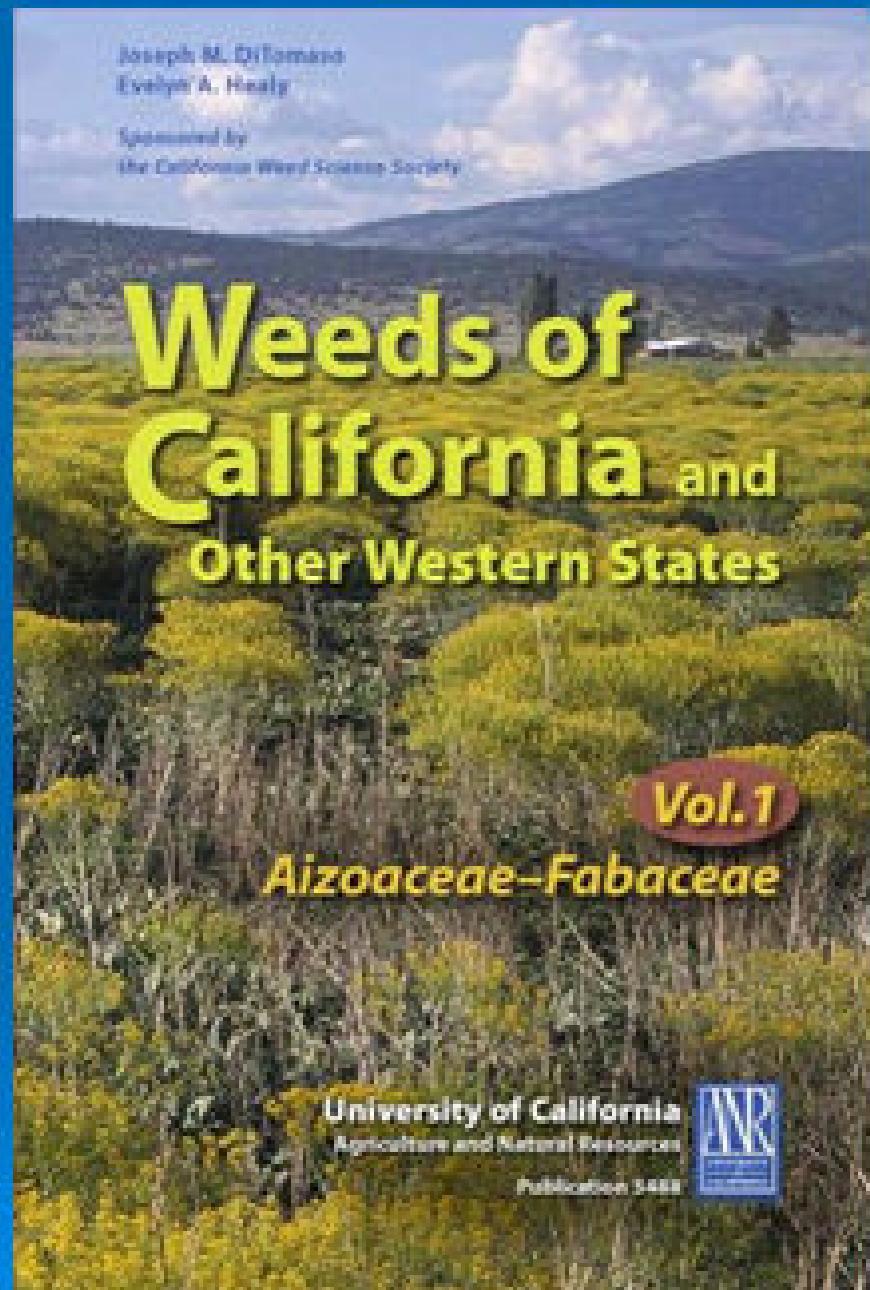
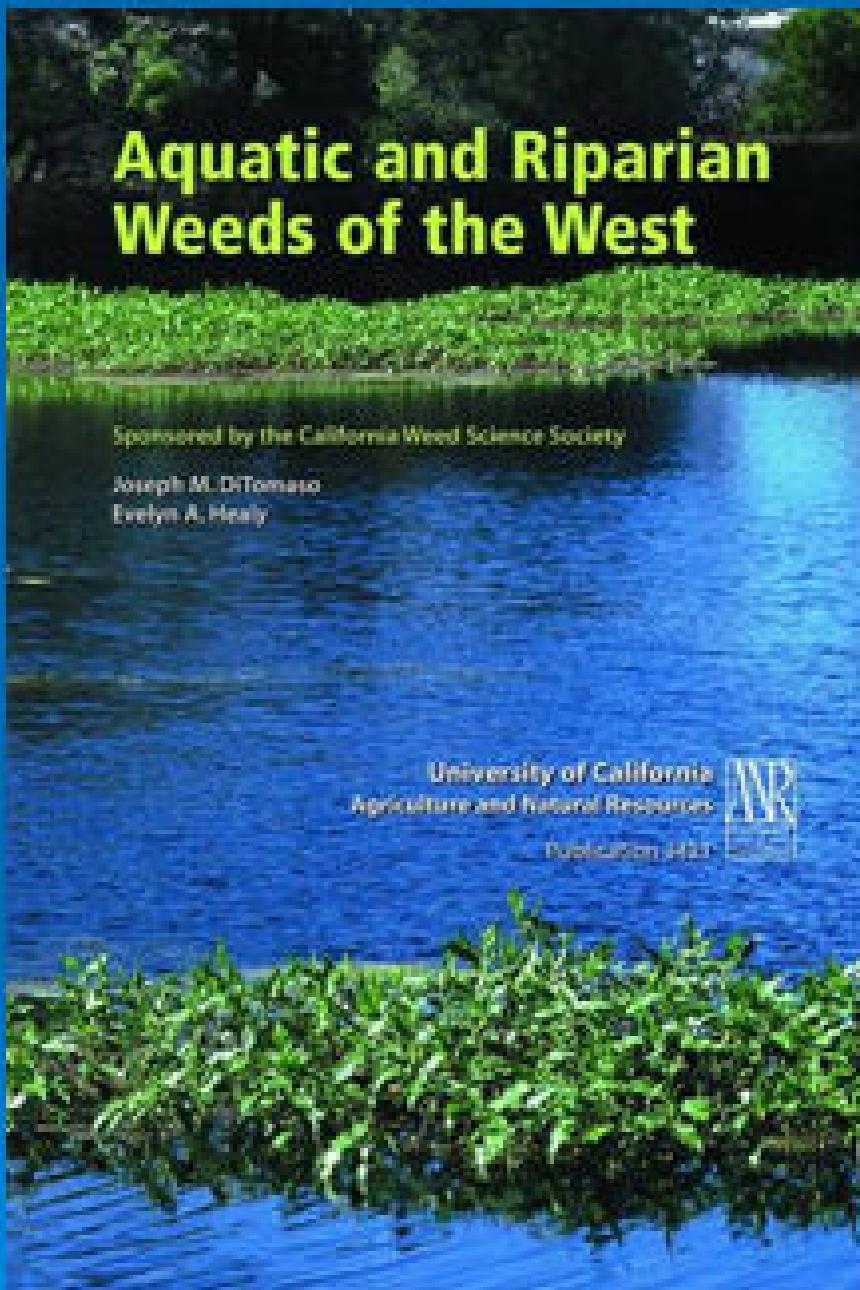


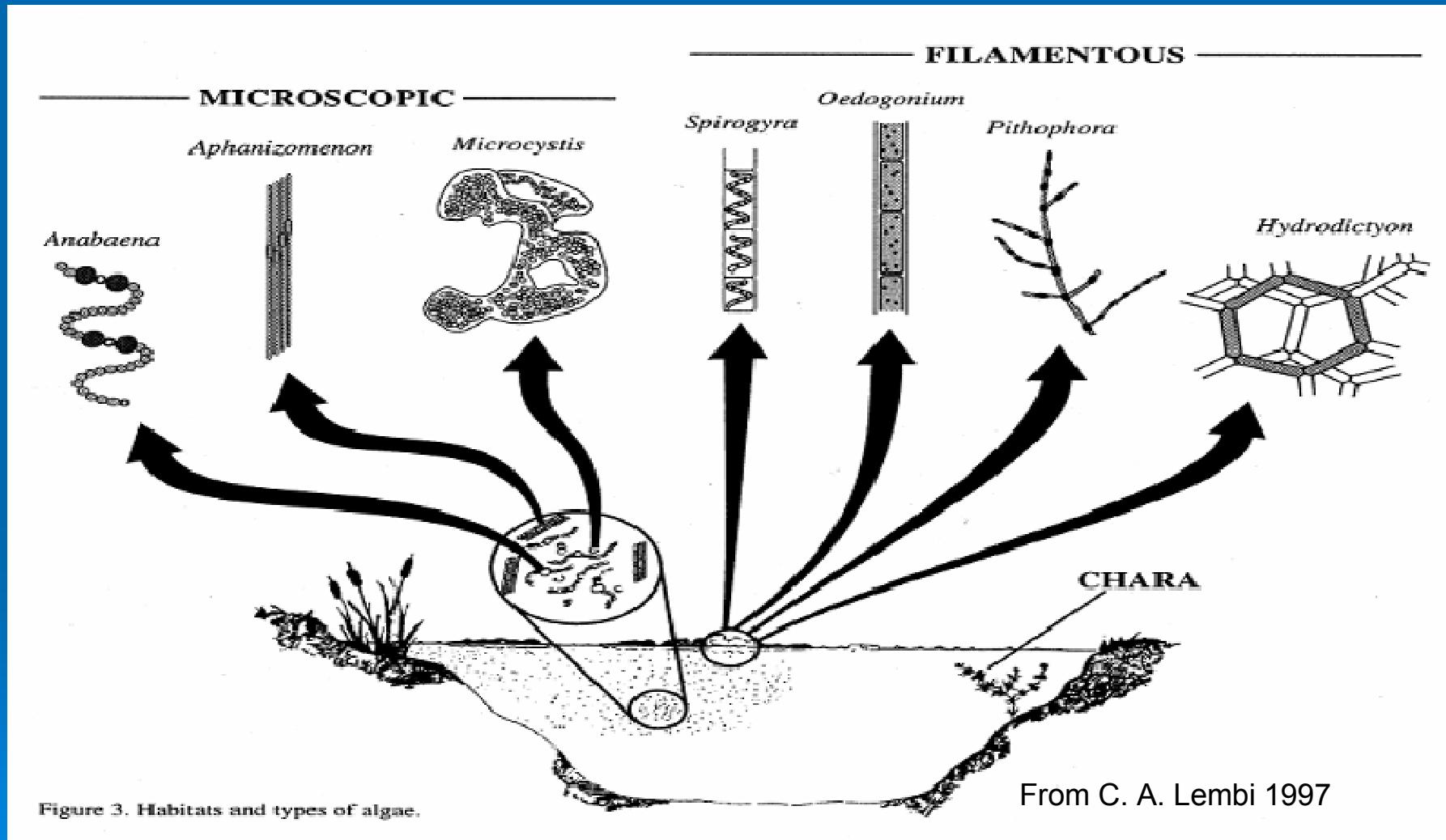
Aquatic Weed Identification and Biology

John Roncoroni
UCCE Weed Science Advisor, Napa

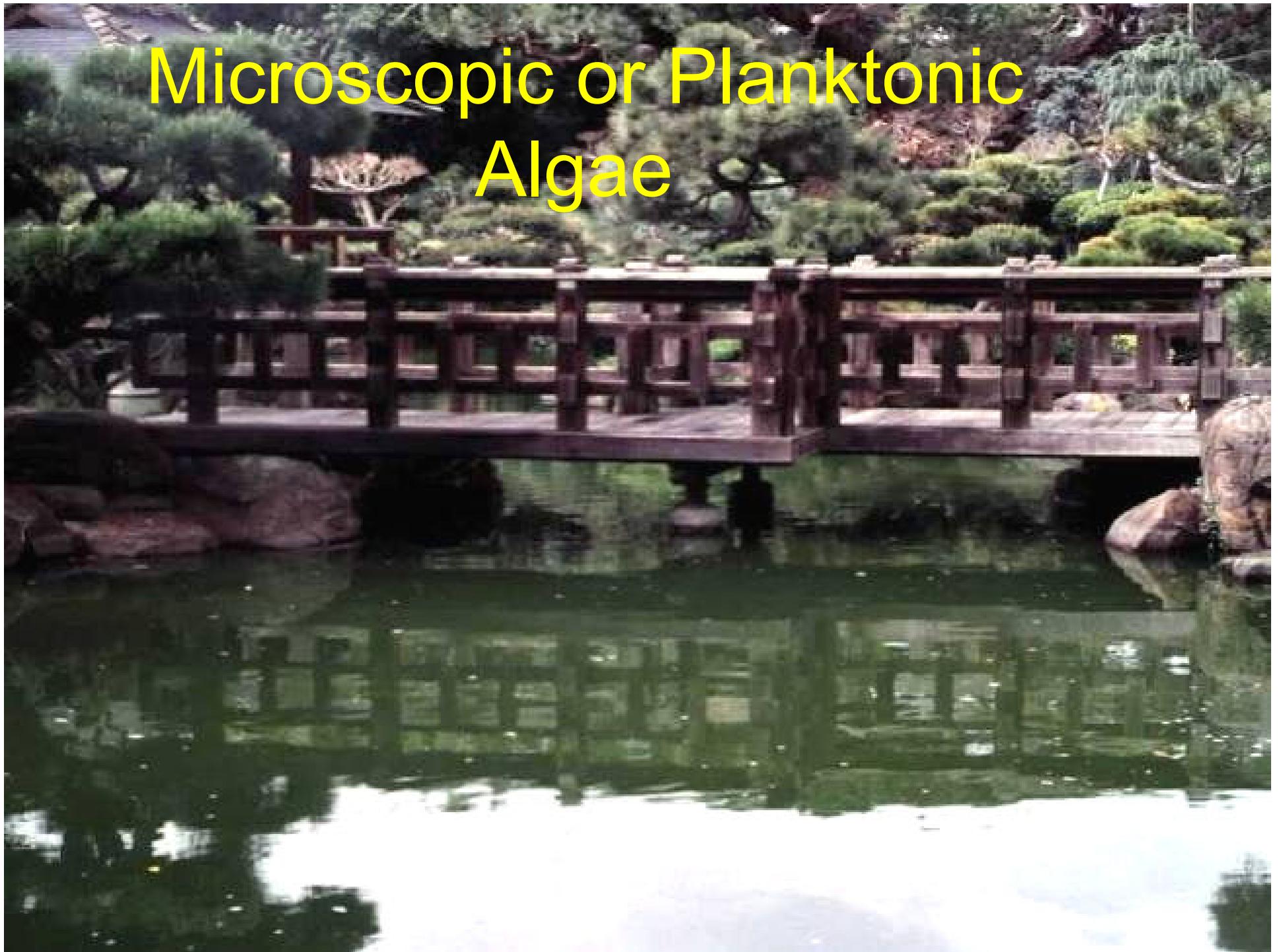
Pond Workshop & Maintenance
January 29th, 2010
Cathey's Valley

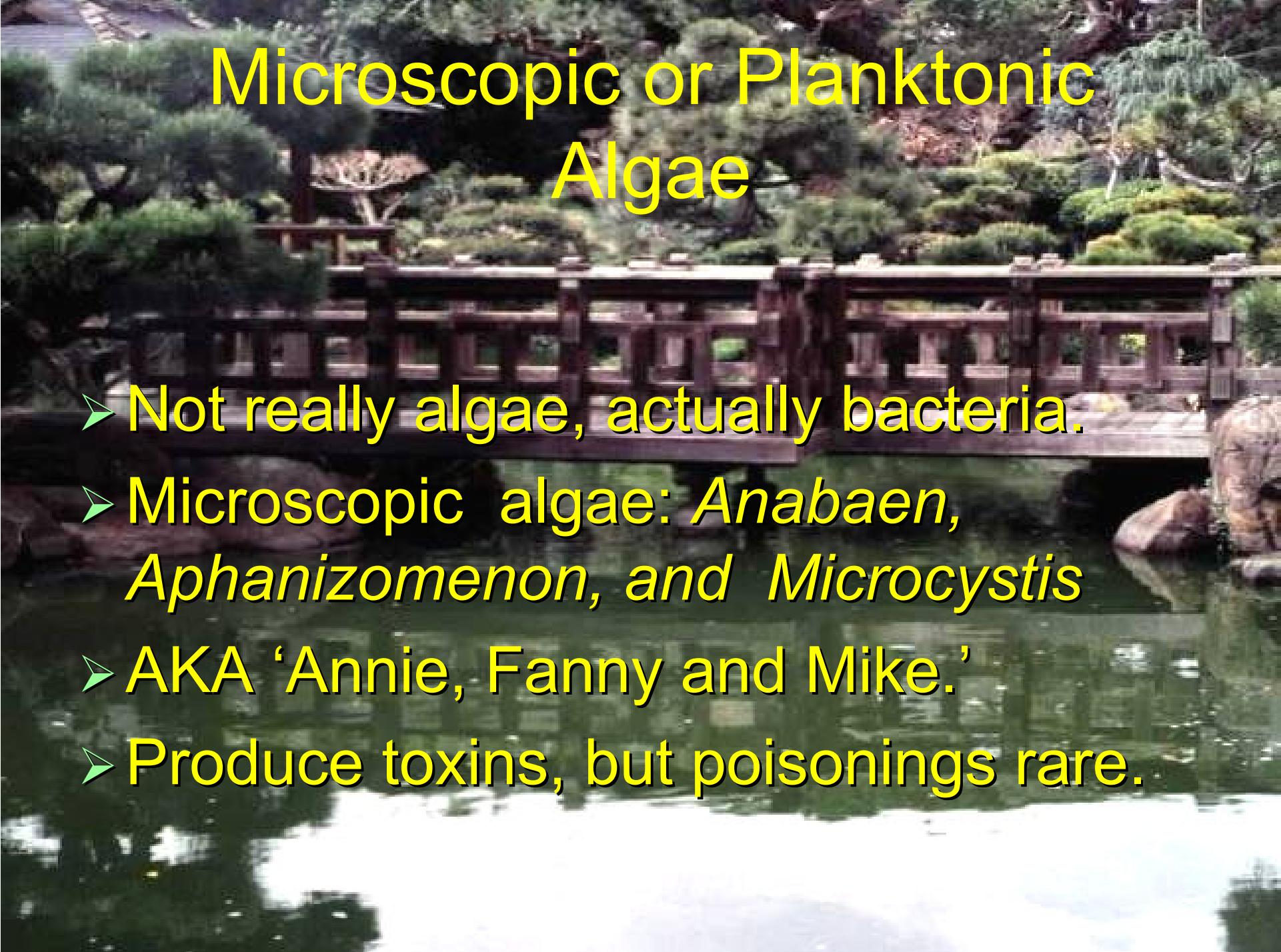


Algae



Microscopic or Planktonic Algae



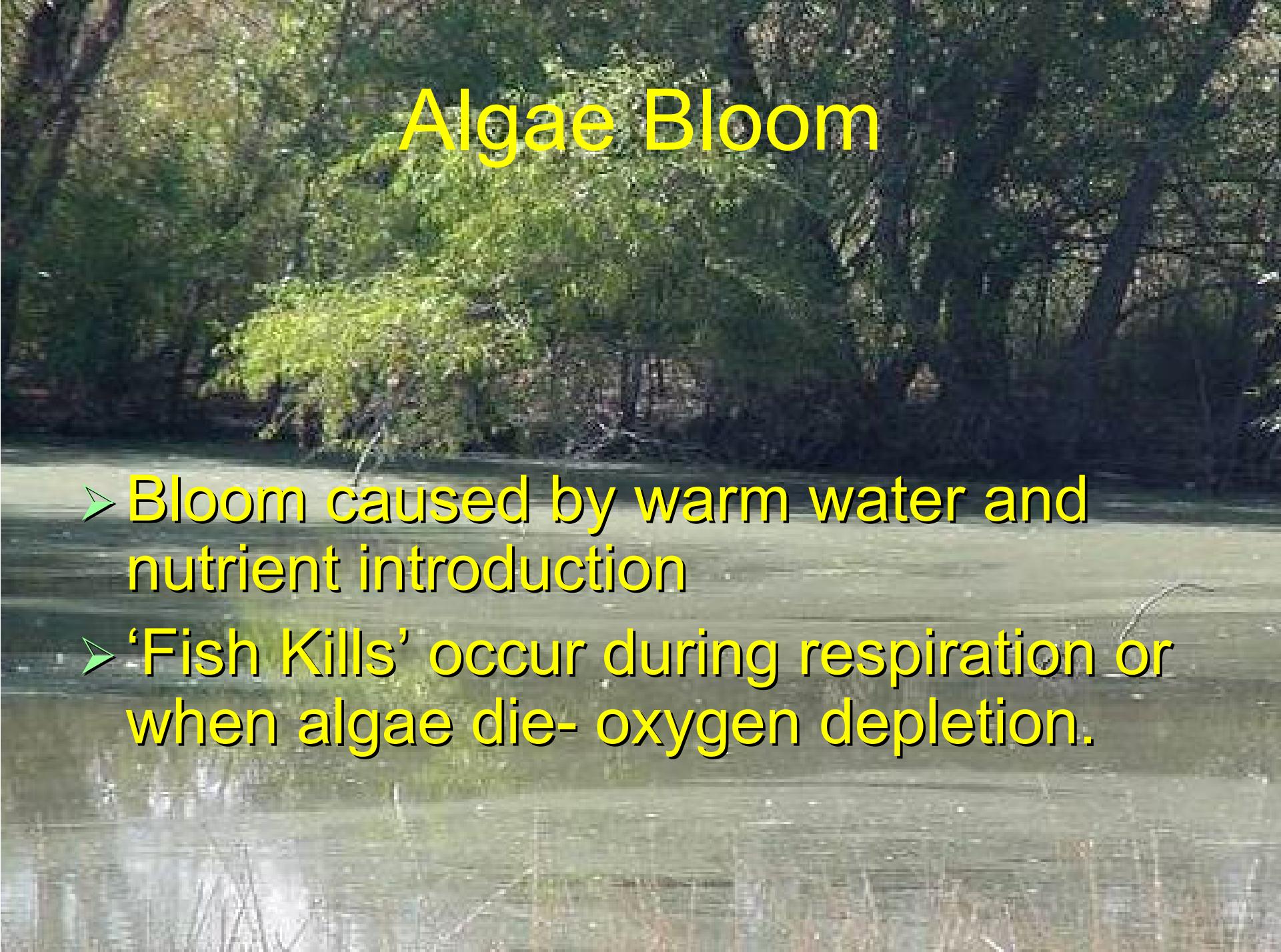


Microscopic or Planktonic Algae

- Not really algae, actually bacteria.
- Microscopic algae: *Anabaen*, *Aphanizomenon*, and *Microcystis*
- AKA 'Annie, Fanny and Mike.'
- Produce toxins, but poisonings rare.



Algae Bloom



Algae Bloom

- Bloom caused by warm water and nutrient introduction
- ‘Fish Kills’ occur during respiration or when algae die- oxygen depletion.



Filamentous Algae- Floating Mats





Filamentous Algae- Floating Mats

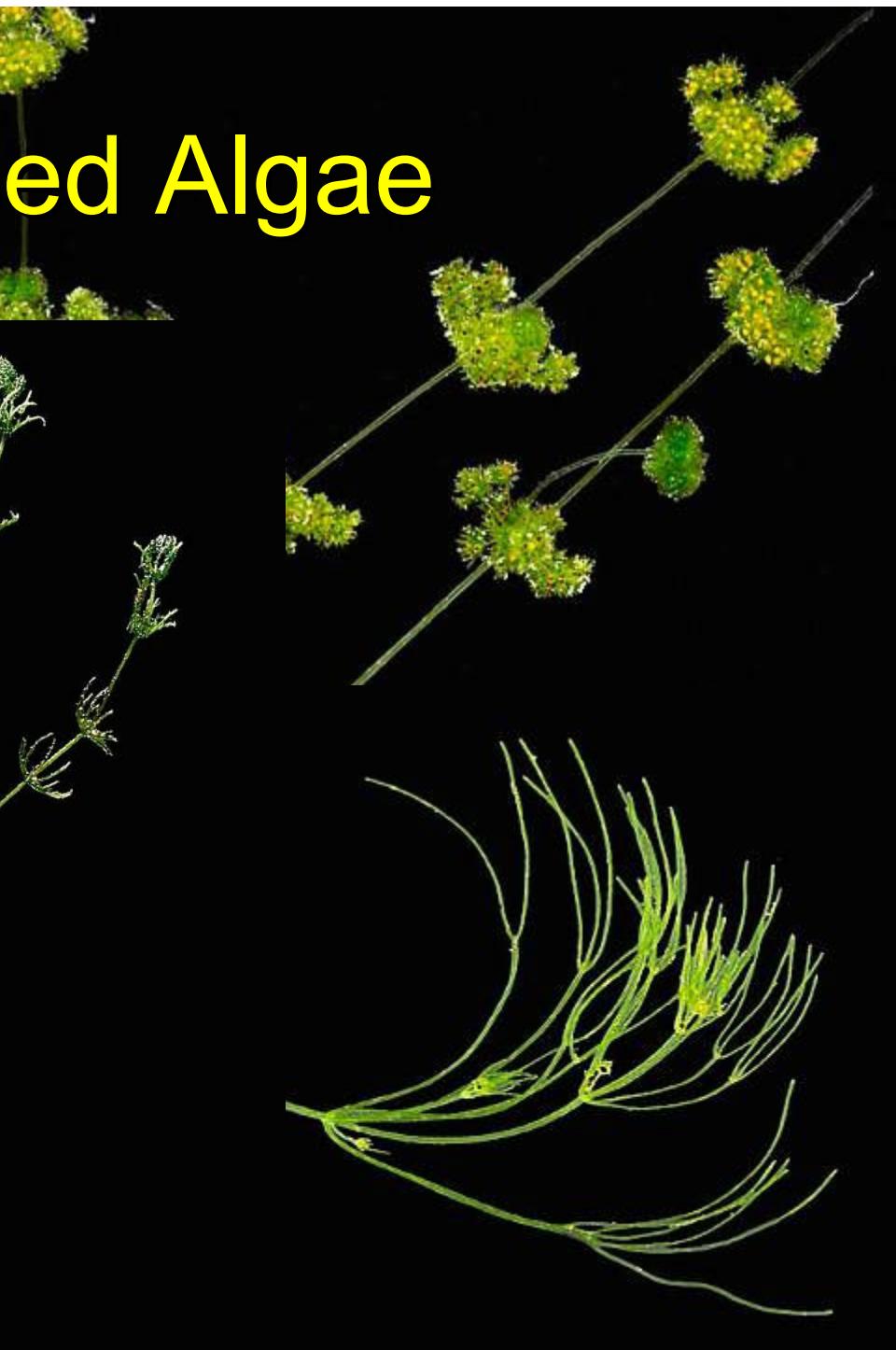
- Often incorrectly called 'moss'
- Growth usually starts on edges and bottoms of pond in spring

Filamentous Algae- Floating Mats

- Often incorrectly called 'moss'
- Growth usually starts on edges and bottoms of pond in spring
- Segments are single cells.
- Common Species: *Cladophora*, *Rhizoclonium*



Submersed Algae



Chara-stonewort



Chara-stonewort

- Usually grows in very hard water
- Often confused with flowering plant
- Rough feel and distinctive musky smell
- Where it is low growing it is voluble habitat for fish



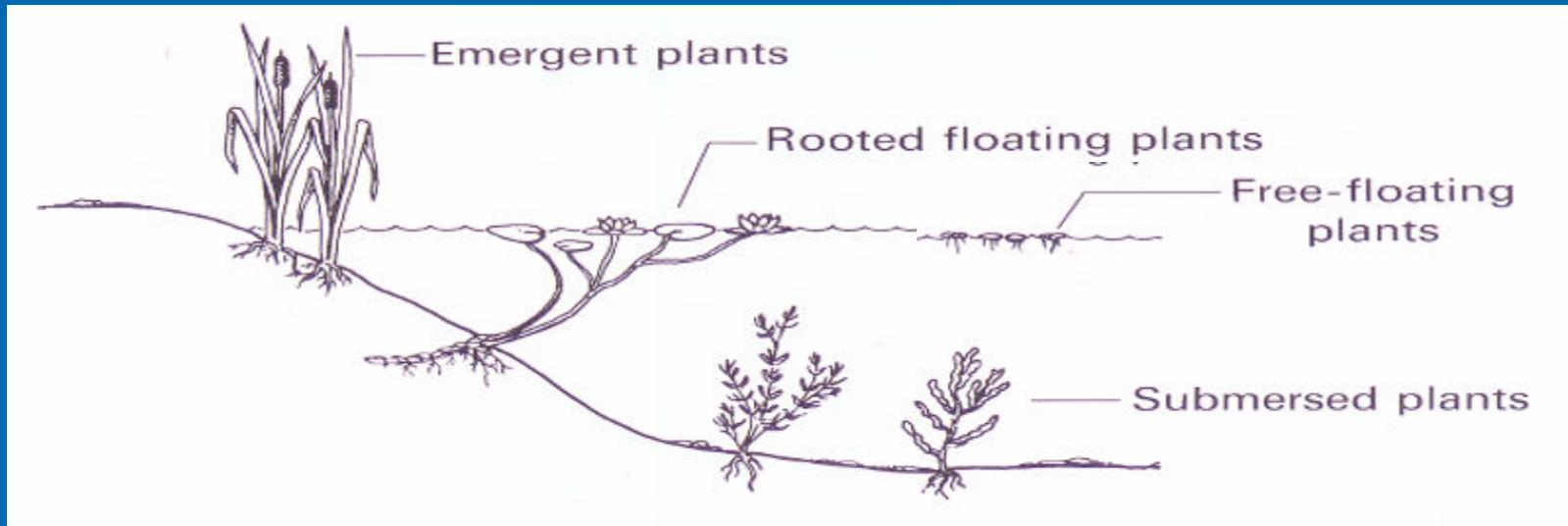


Nitella

- Native- very similar to Chara
- No rough feel



Types of Aquatic Plants



Free-floating plants

Each of the four types of aquatic plants favors a certain water depth. Typically the growth areas are not sharply divided. Expect to see overlap in growth—submerged plants interspersed among floating-leaf varieties.





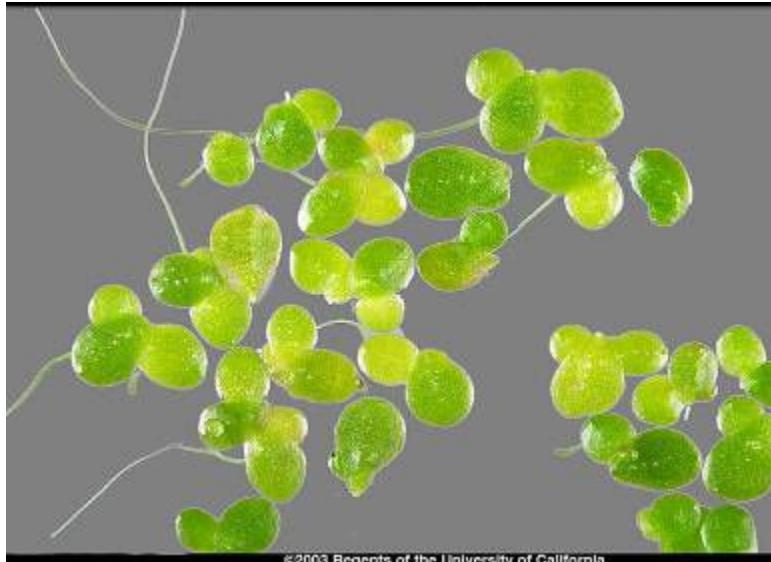
Pacific mosquitofern
Azolla filiculoides

Pacific mosquitofern

Azolla filiculoides

- Fern- reproduces by spores and stem fragments
- Desirable native species in natural habitat
- Often grow in eutrophic water-
- Still sold in aquarium trade- careless disposal of water may introduce into new areas.





Common duckweed

Lemna minor

Common duckweed

- Very small floating perennial native
- In high fertility site can double in number every 3 days
- Reproduces by budding (daughter plant)
- One root per frond

Water hyacinth

Eichhornia crassipes



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Water hyacinth

Eichhornia crassipes

- Noxious floating perennial introduced from Brazil
- Floating mats connected by stolons clog water ways
- Heavy infestations can alter water oxygen content, temperature, pH, and displace native plants and wildlife.



Water hyacinth

Eichhornia crassipes

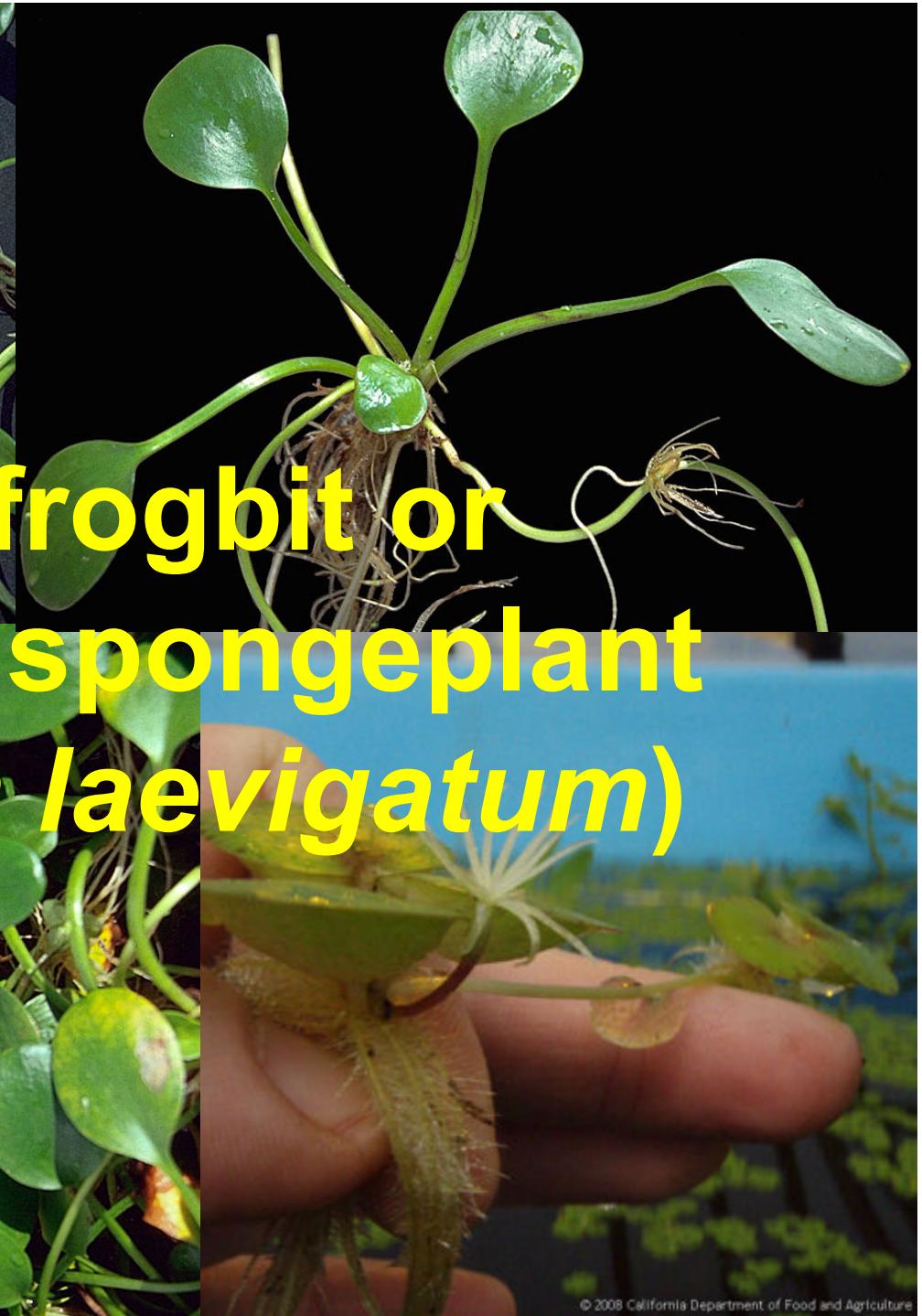
- Linked to other plants by stolons
- Frost may kill foliage, but stem bases often survive and develop new foliage in Spring.
- Reproduces by stolon or seed. Honey bees are main pollinators
- Insect biocontrol (2 weevils, 1 moth) have been ineffective

Weed Alerts 2004!

Joe DiTomaso
UC Davis



Smooth frogbit or West Indian spongeplant (*Limnobium laevigatum*)





Smooth frogbit or West Indian spongeplant (*Limnobium laevigatum*)

- Hydrocharitaceae-Same family as Hydrilla
- Native to Central and South America
- First infestation in Redding (2002). Found in 2007 in scattered patches along 10-15 miles of the San Joaquin River in Fresno.
- Later it appeared in the Sacramento Delta and
- near the Kings River southeast of Fresno.



Smooth frogbit or West Indian spongeplant (*Limnobium laevigatum*)

Floating to rooted stoloniferous perennial.

Very different from hydrilla and Brazilian egeria -
resembles a smaller version of water hyacinth

. The bottom of its leaves have a diagnostic
honeycomb-like spongy tissue.



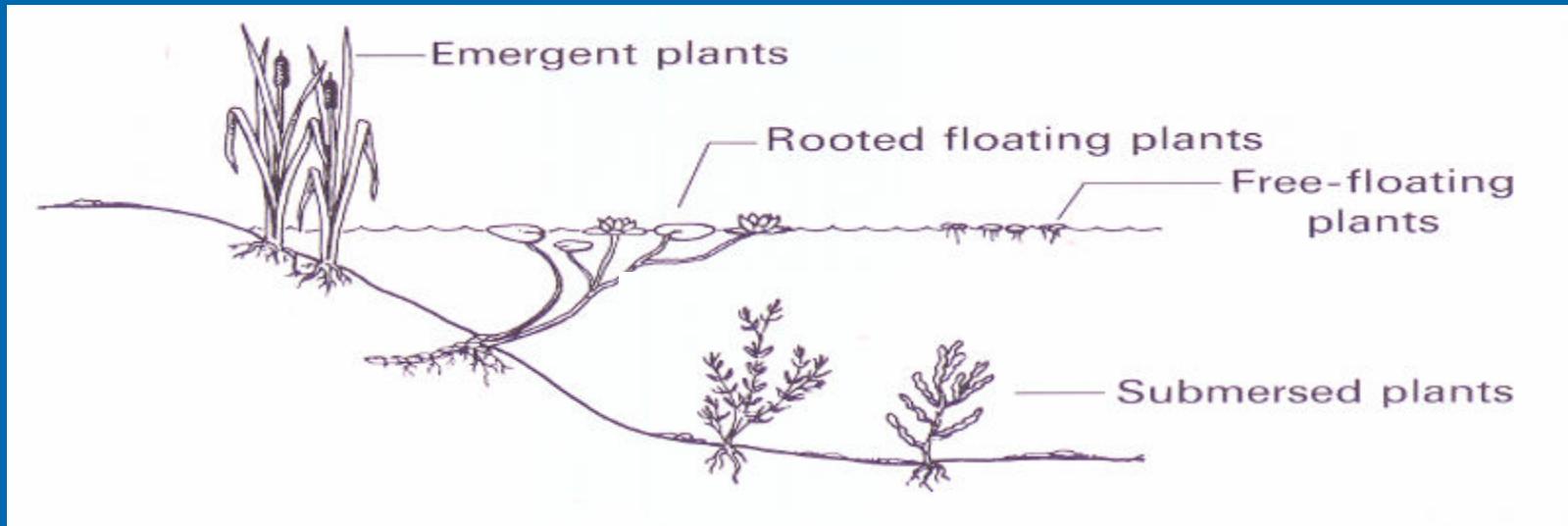


Placed on CDFA Noxious Weed Q-list

Juvenile form of partly submersed rosettes with thick floating leaves develop into much larger mature clumps



Types of Aquatic Plants



Submersed plants

Pondweeds

- All *Potamogeton* and *Stuckenia* species are native to the Western US, except *Potamogeton crispus*-curlyleaf pondweed (Eurasia)
- Important components of wildland aquatic habitats-
- Perennials-most with rhizomes
- Curlyleaf produces turions and Sago produces tubers

Sago pondweed

Stuckenia pectinatus

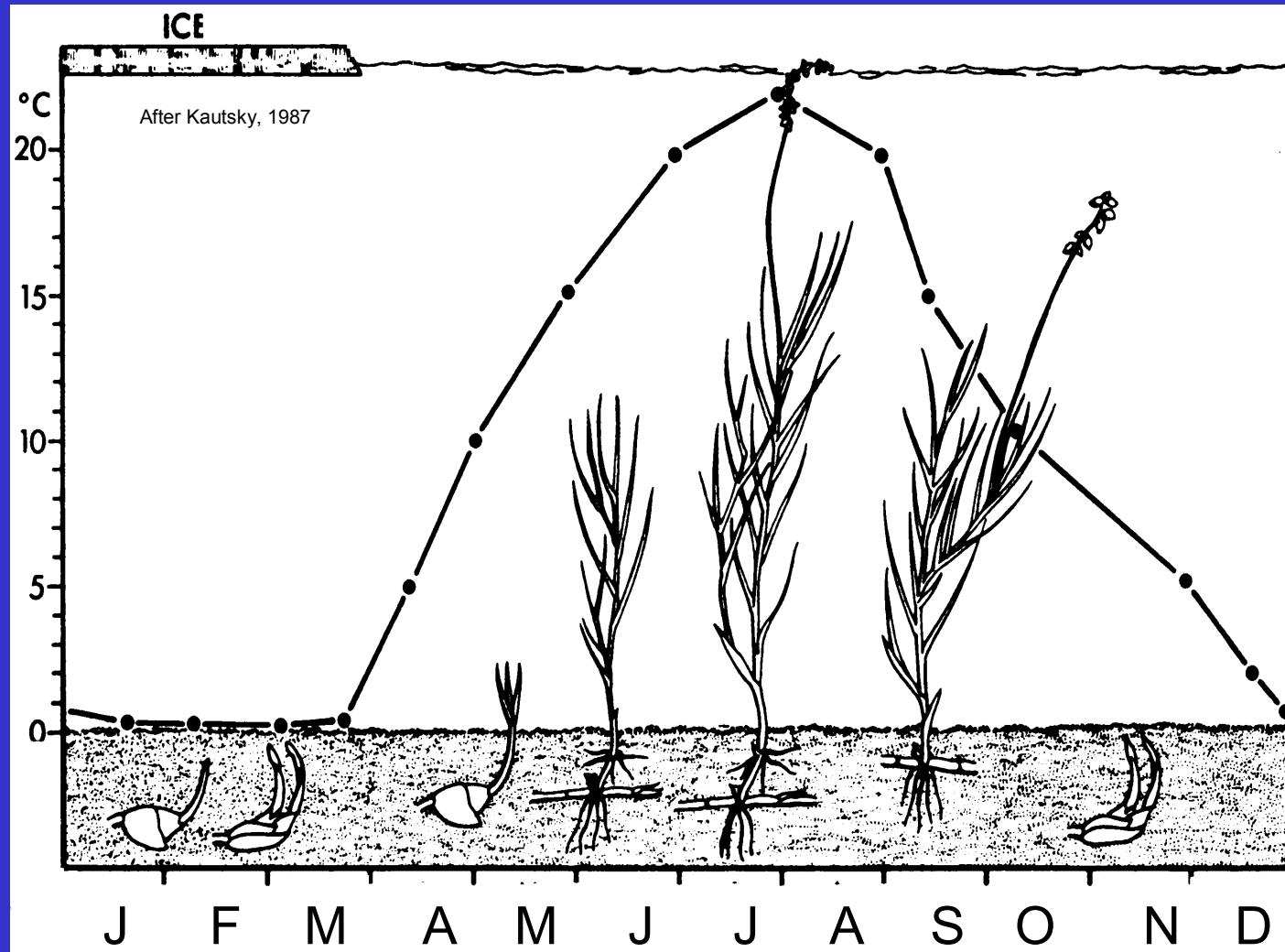


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Seasonal Development of Sago Pondweed



Curlyleaf pondweed

Potamogeton crispus



Leafy pondweed

Potamogeton foliosus



Floatleaf pondweed

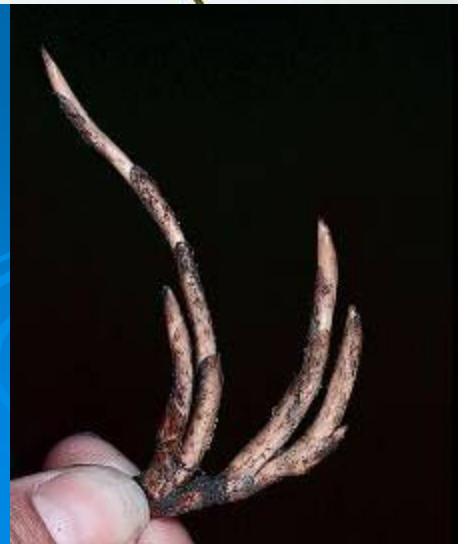
Potamogeton natans





American Pondweed

Potamogeton nodosus

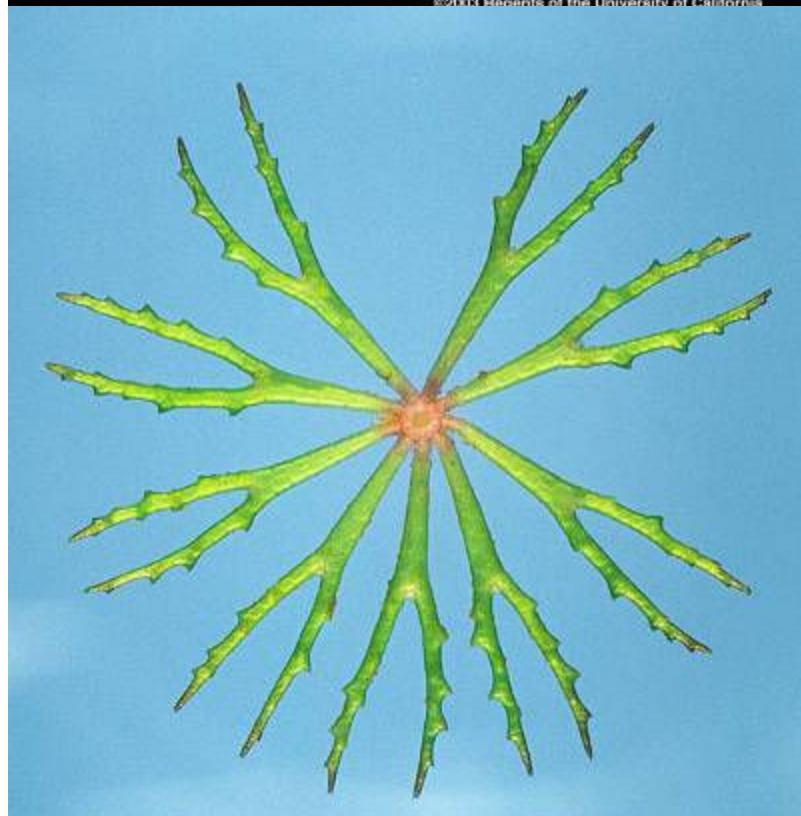


Coontail, Parrotfeather and Milfoils





Coontail
Ceratophyllum demersum





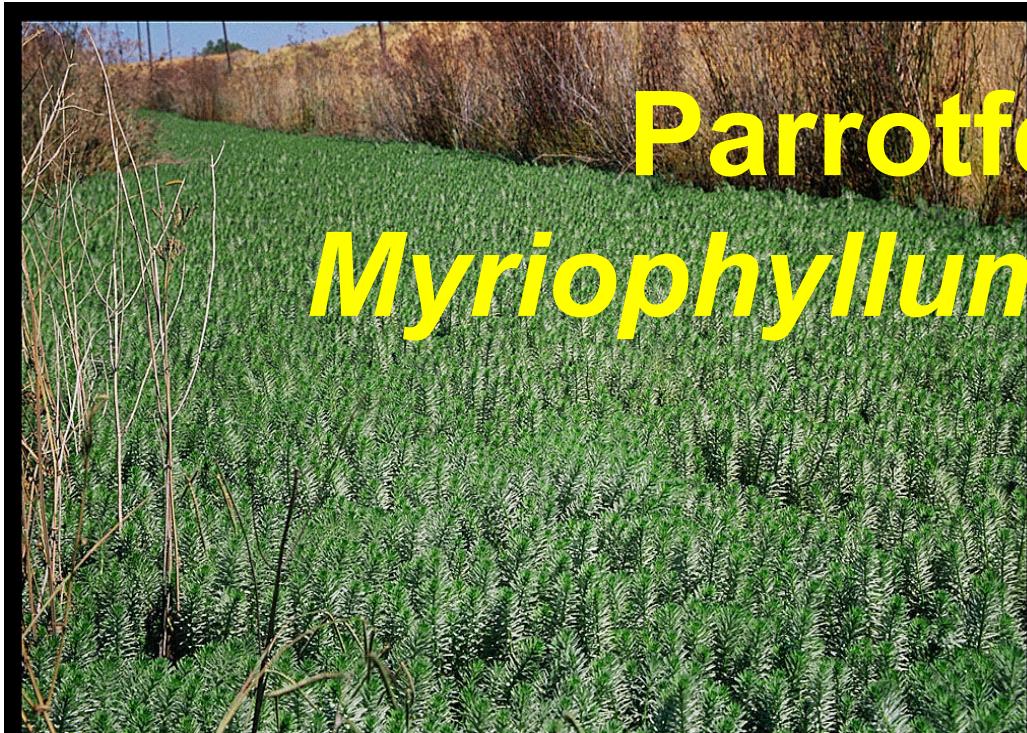
Coontail

Ceratophyllum demersum

- Native-annual to perennial
- Cross section- leaves look like “bumpy tuning fork”
- Modified stem-not roots lightly hold plant- easily dislodged



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Parrotfeather

Myriophyllum aquaticum

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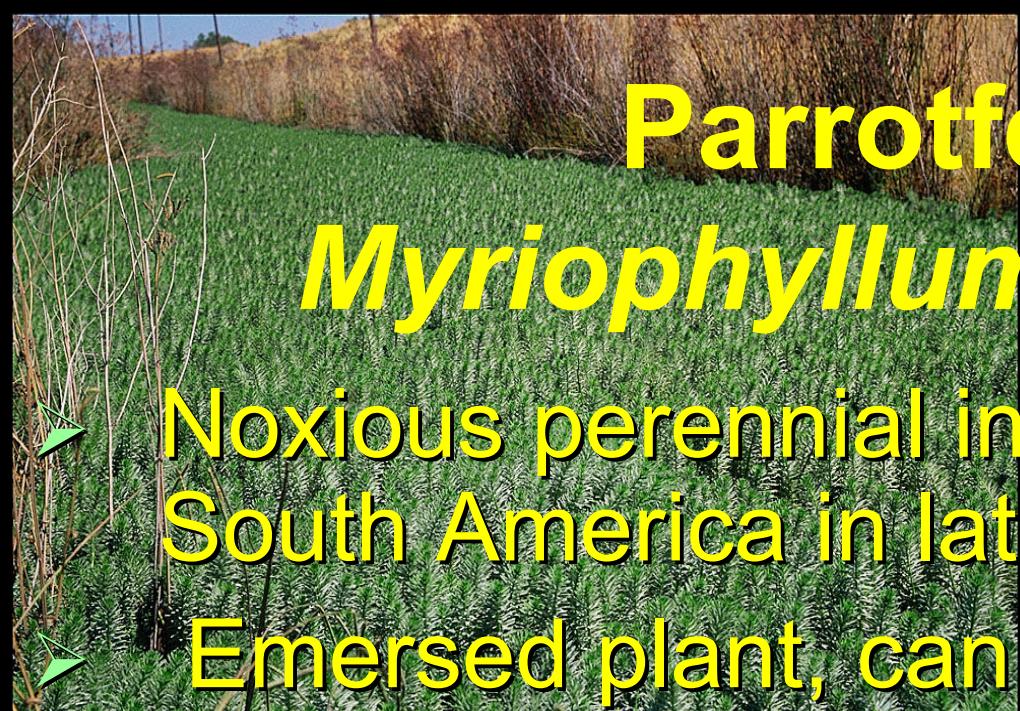


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Parrotfeather

Myriophyllum aquaticum

- Noxious perennial introduced from South America in late 1800's
- Emerged plant, can become semi-terrestrial
- Typically only female plants found in Calif.
- Reproduces vegetatively only- by rhizome and stem fragments

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Western watermilfoil

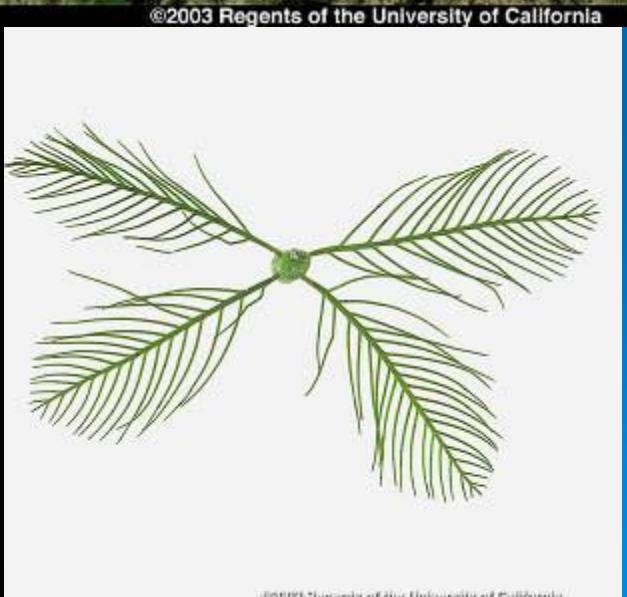
Myriophyllum hippuroides



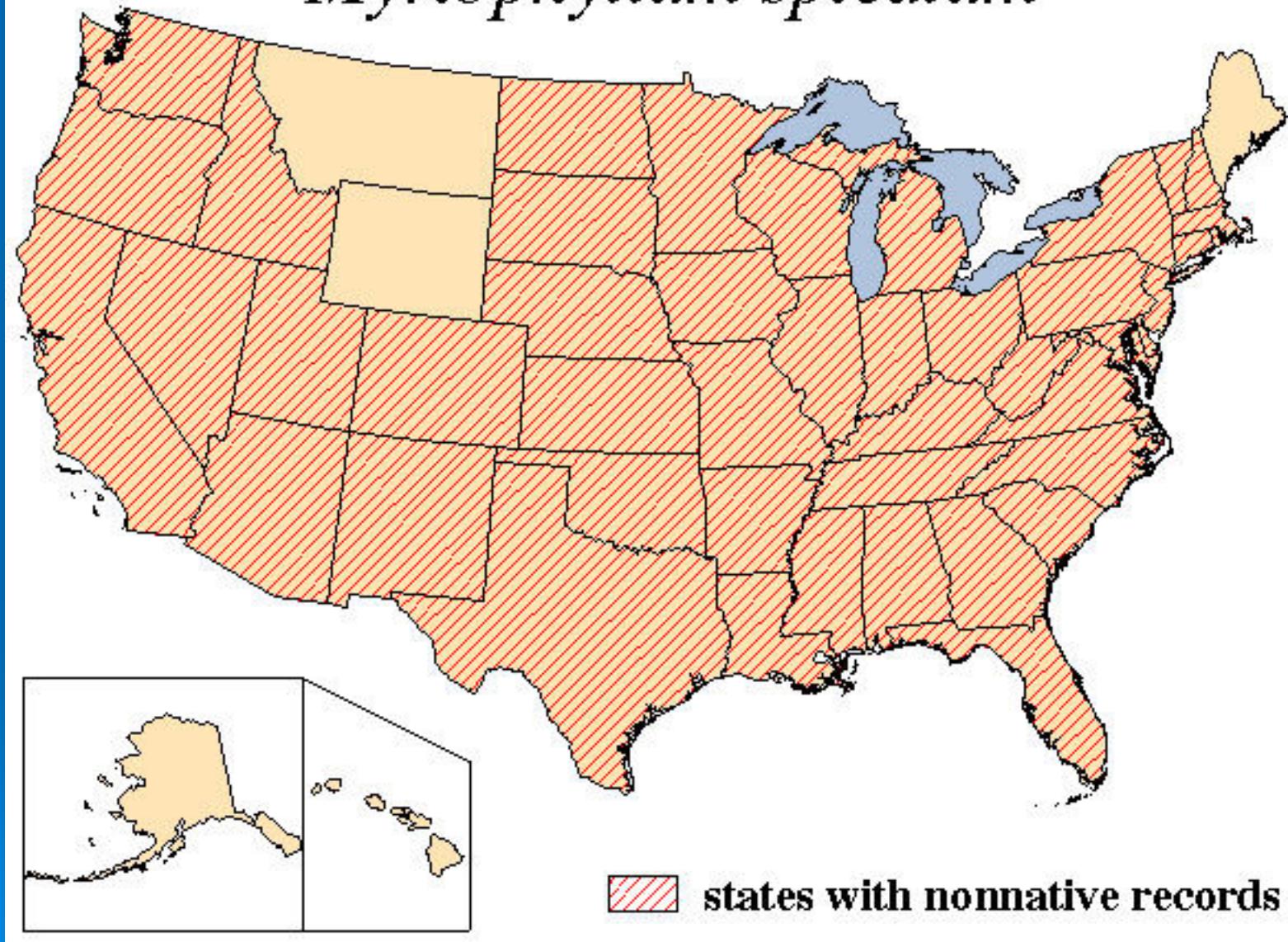
- An uncommon native species
- not considered weedy
- Unlike other milfoil's emerges from water

Eurasian watermilfoil

Myriophyllum spicatum



Myriophyllum spicatum



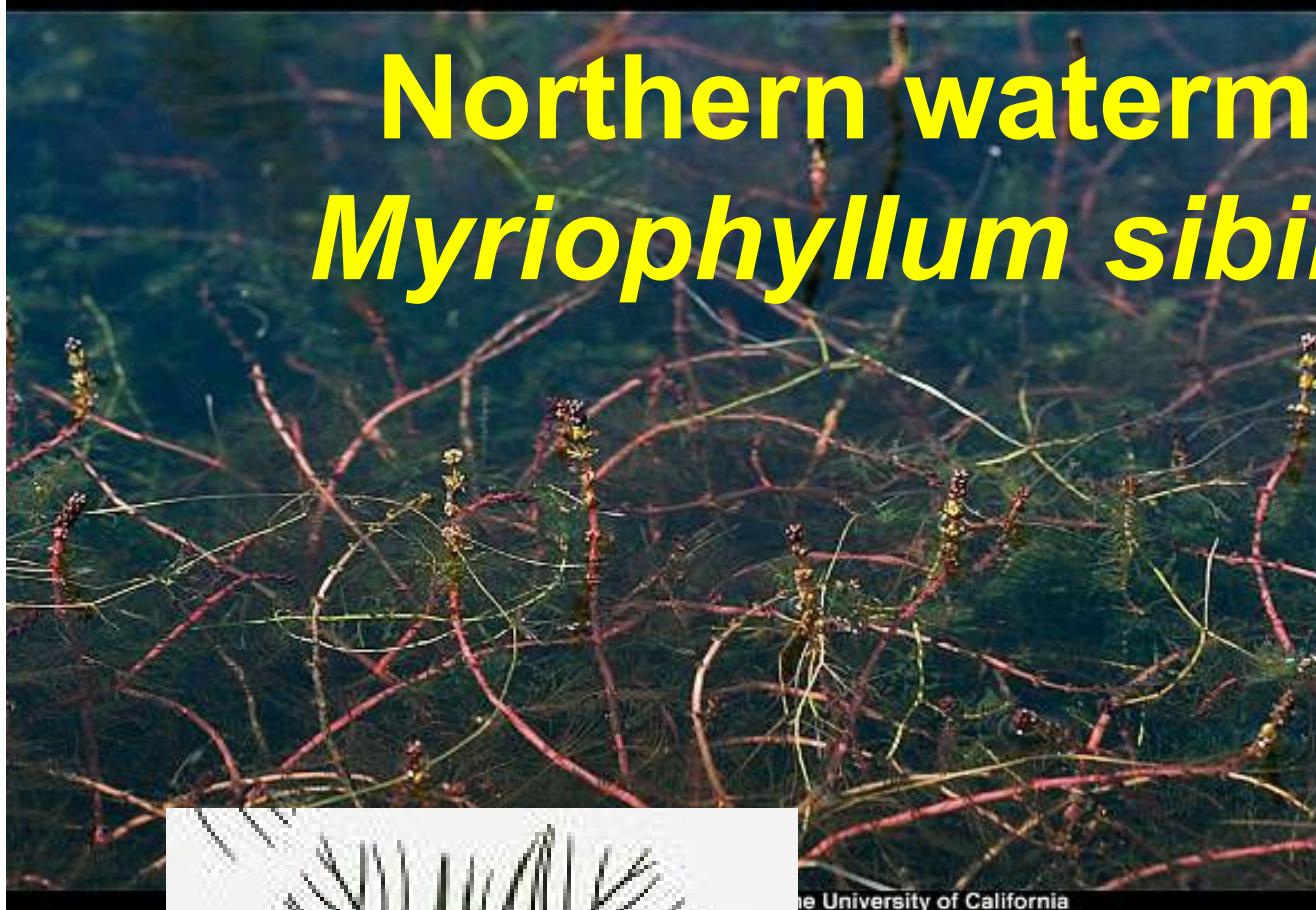
Eurasian watermilfoil

Myriophyllum spicatum

- Noxious perennial propagated by rhizomes, axillary buds and seeds.
- Seeds can survive dormant for 7 years under dry conditions and are eaten and spread by birds.
- Introduced from Eurasia, probably late 1940's in aquarium trade.

Northern watermilfoil

Myriophyllum sibiricum



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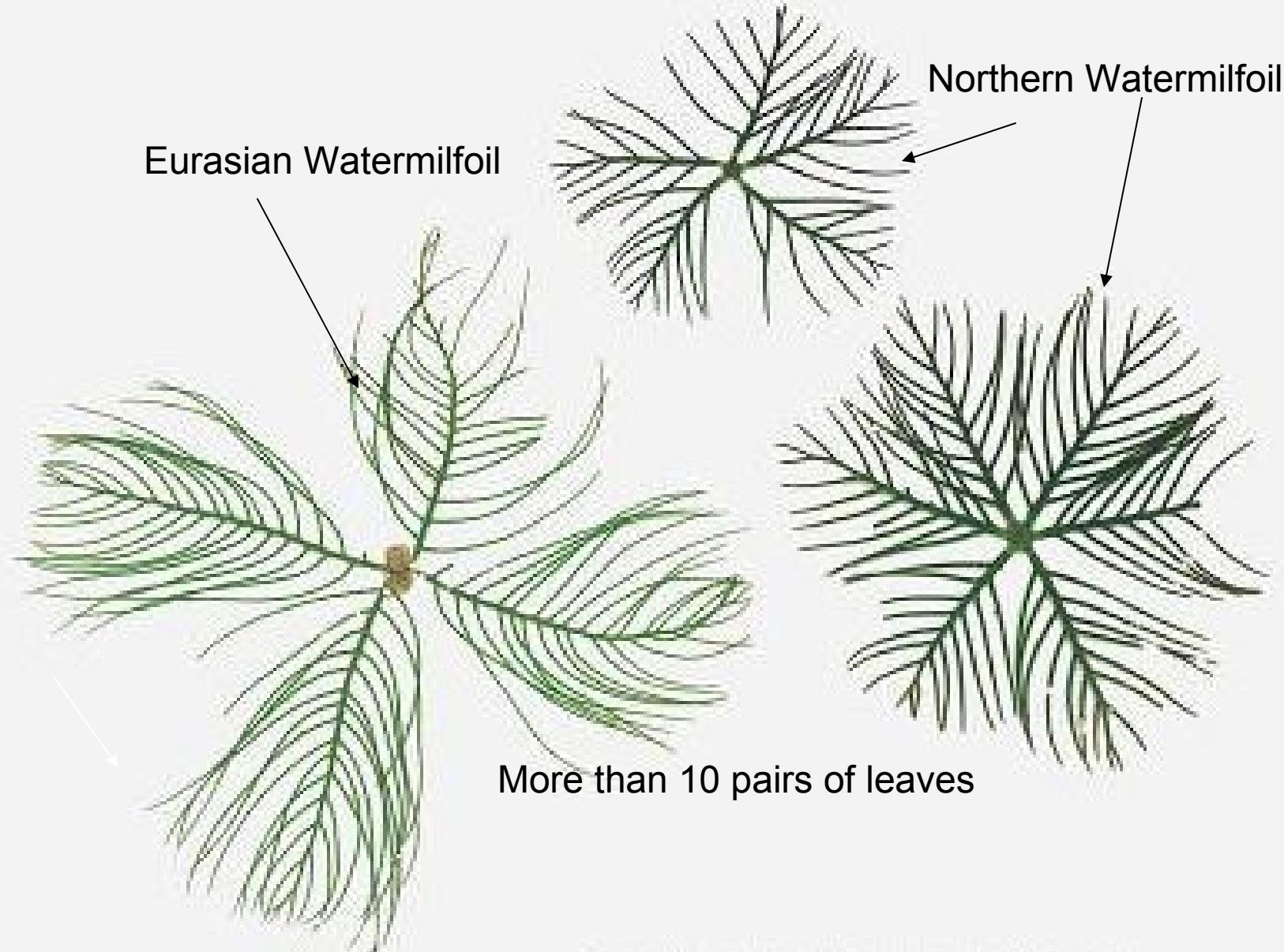




Northern watermilfoil

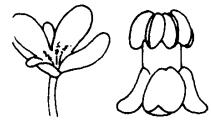
Myriophyllum sibiricum

- Widespread native
- Produces turions-EWM does not
- Looks very similar to EWM- leaf lobes different-

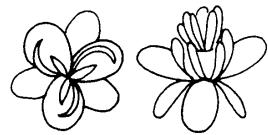


Elodea, Egeria, Hydrilla

HYDRILLA



ELODEA



EGERIA

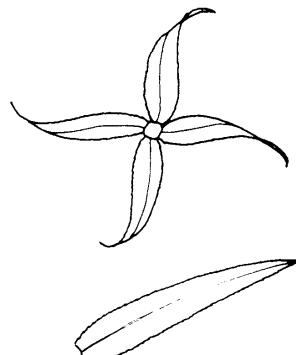
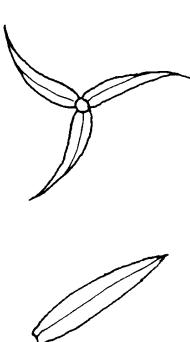
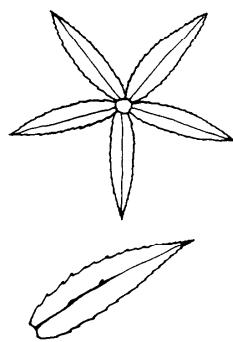
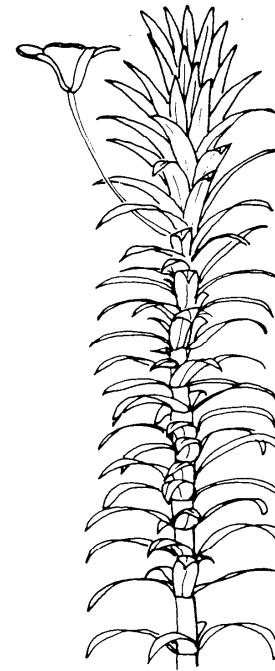
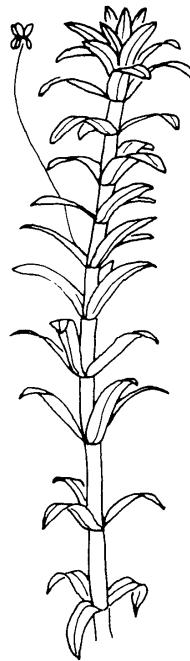
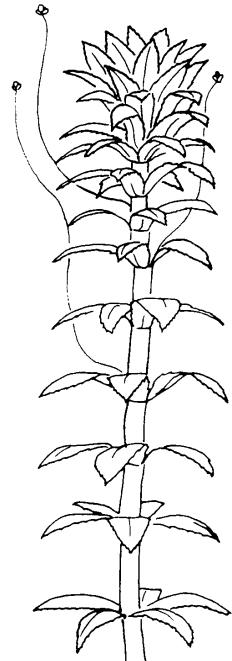
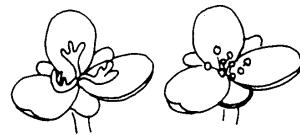
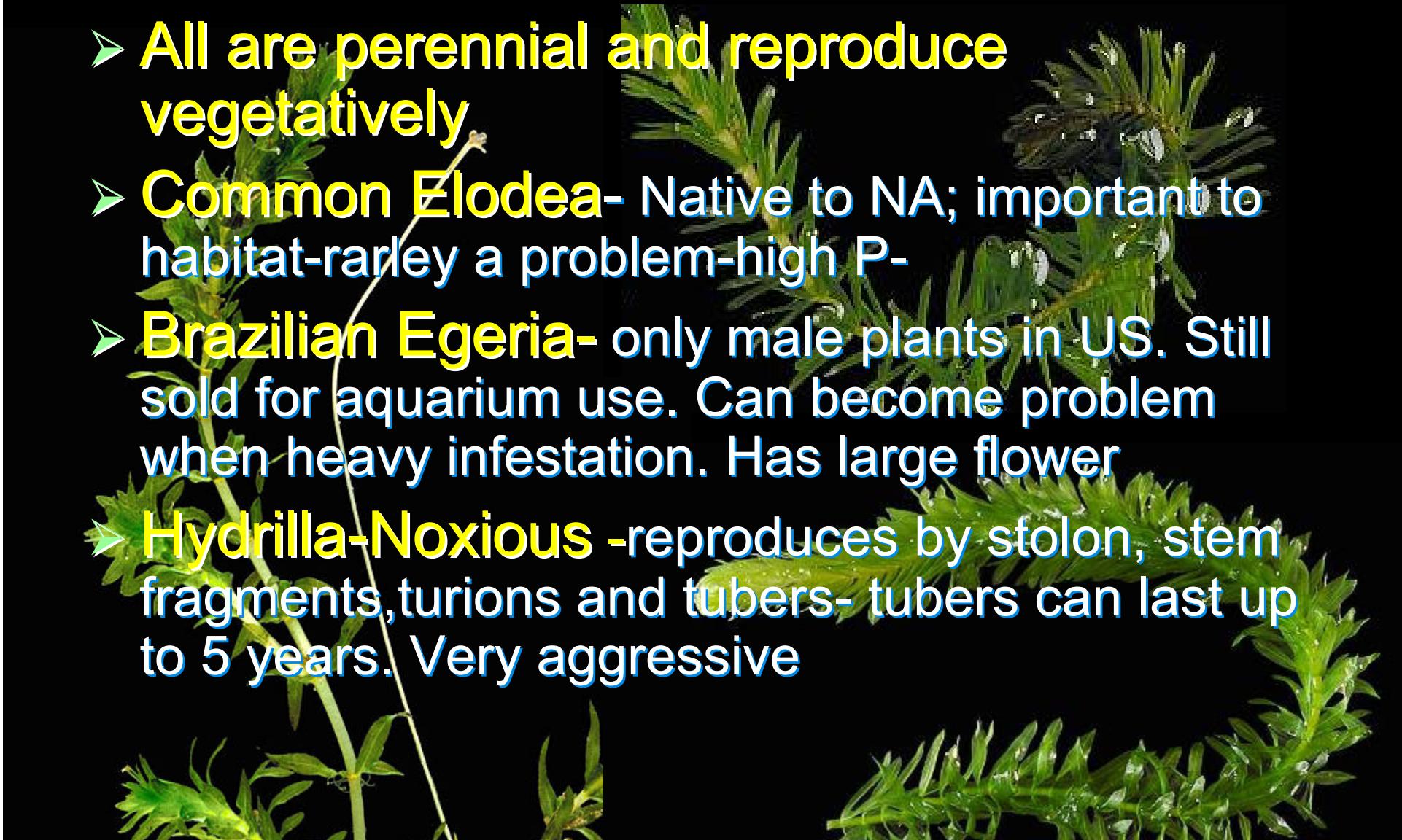


illustration provided by:
IFAS, Center for Aquatic Plants
University of Florida, Gainesville, 1990



Elodea, Egeria, Hydrilla

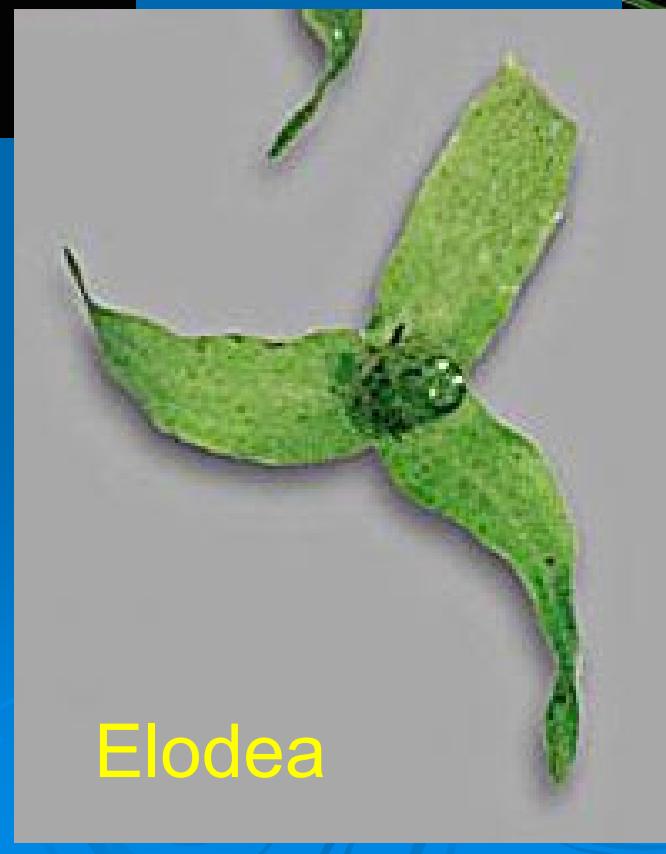
- All are perennial and reproduce vegetatively
- Common Elodea- Native to NA; important to habitat-rarely a problem-high P-
- Brazilian Egeria- only male plants in US. Still sold for aquarium use. Can become problem when heavy infestation. Has large flower
- Hydrilla-Noxious -reproduces by stolon, stem fragments,turions and tubers- tubers can last up to 5 years. Very aggressive



Hydrilla



Egeria



Elodea

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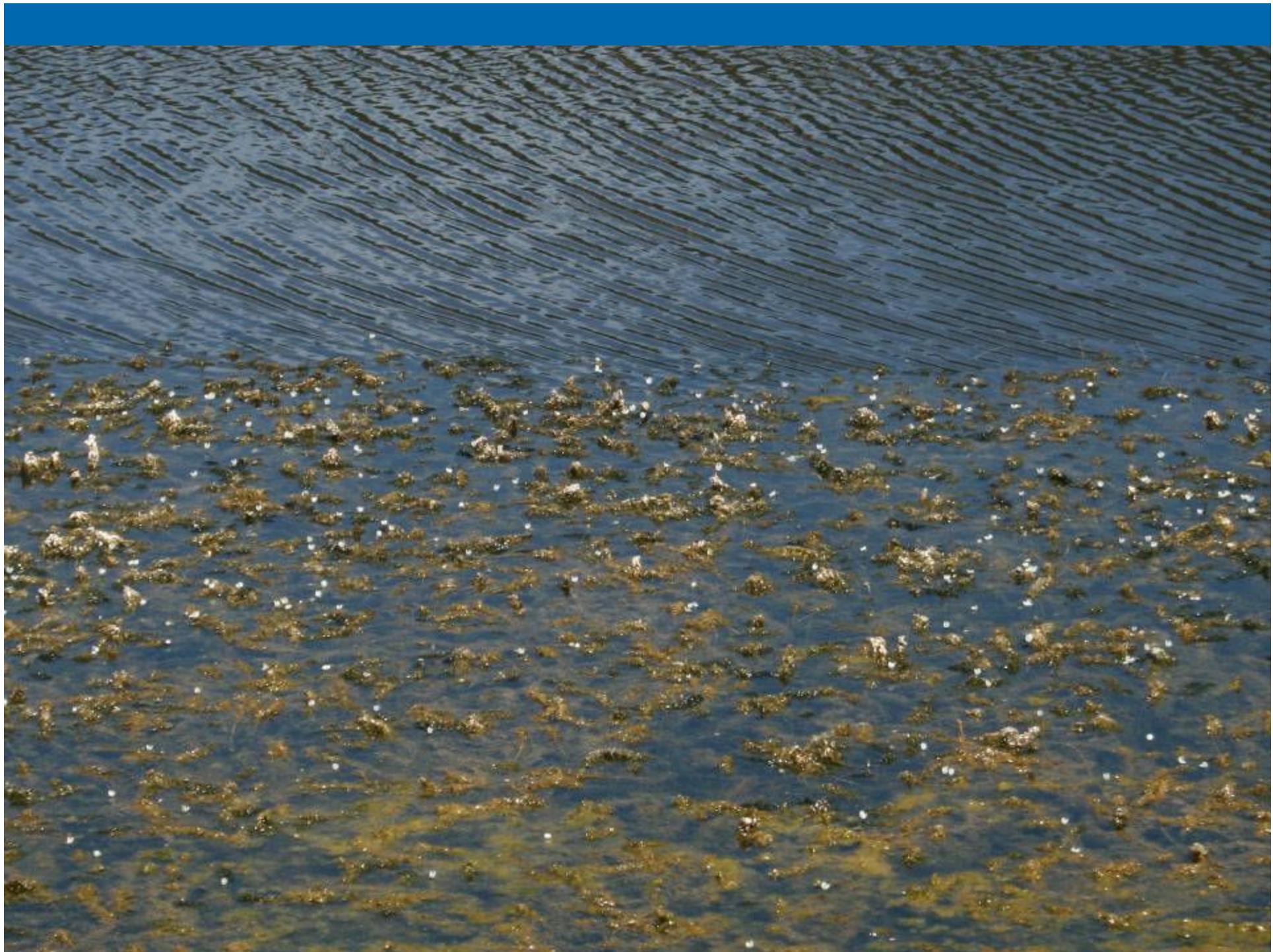
Common Elodea
Elodea canadensis

Brazilian Egeria

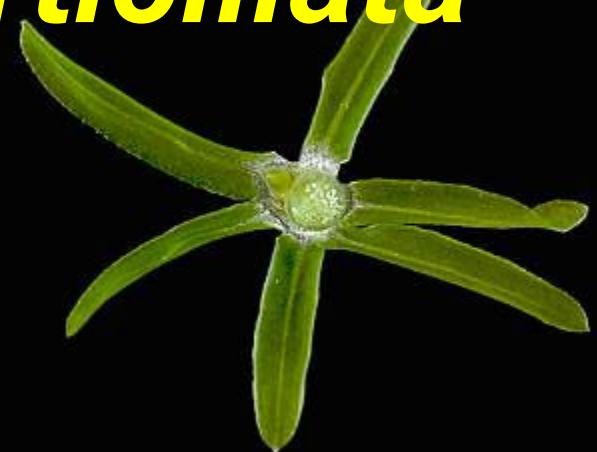
Egeria densa

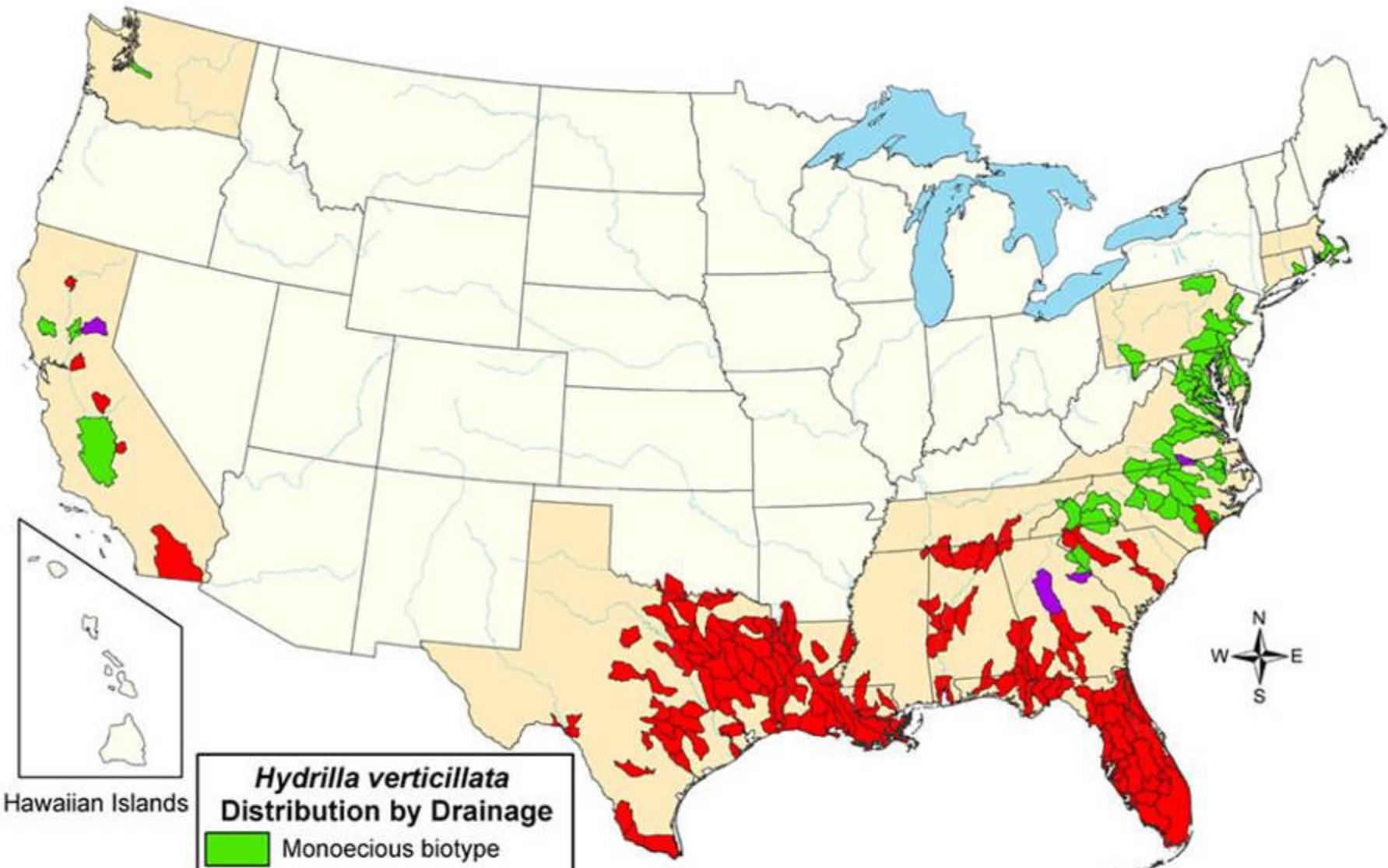






Hydrilla-Hydrilla verticillata





Hawaiian Islands



September 2002



Hydrilla at Wakulla Springs, Florida

Hydrilla verticillata

Photo by Vic Ramey

Copyright 1998 Univ. Florida



Hydrilla

Hydrilla verticillata

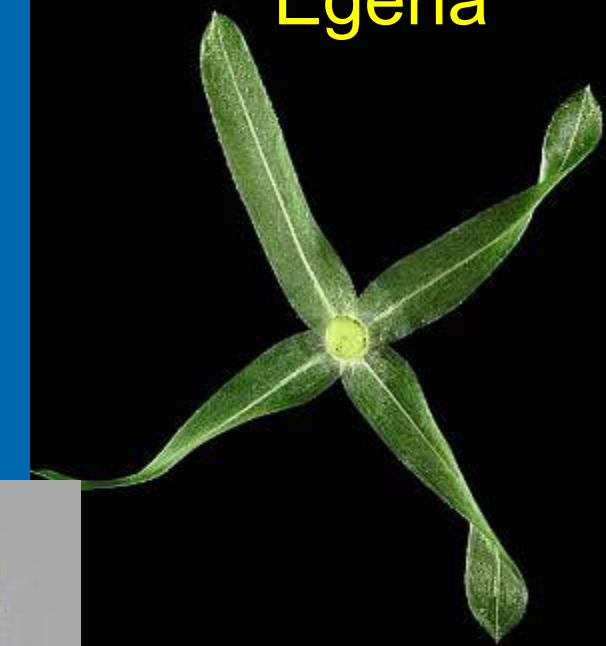
Photo by Ann Murray

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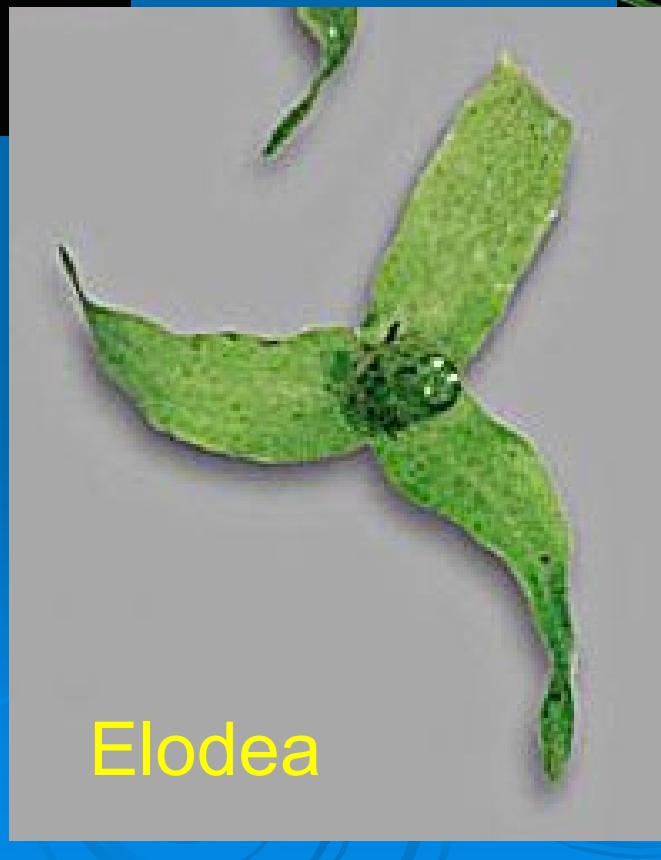
Hydrilla



Egeria



Elodea



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Najas guadalupensis

Southern Naiad

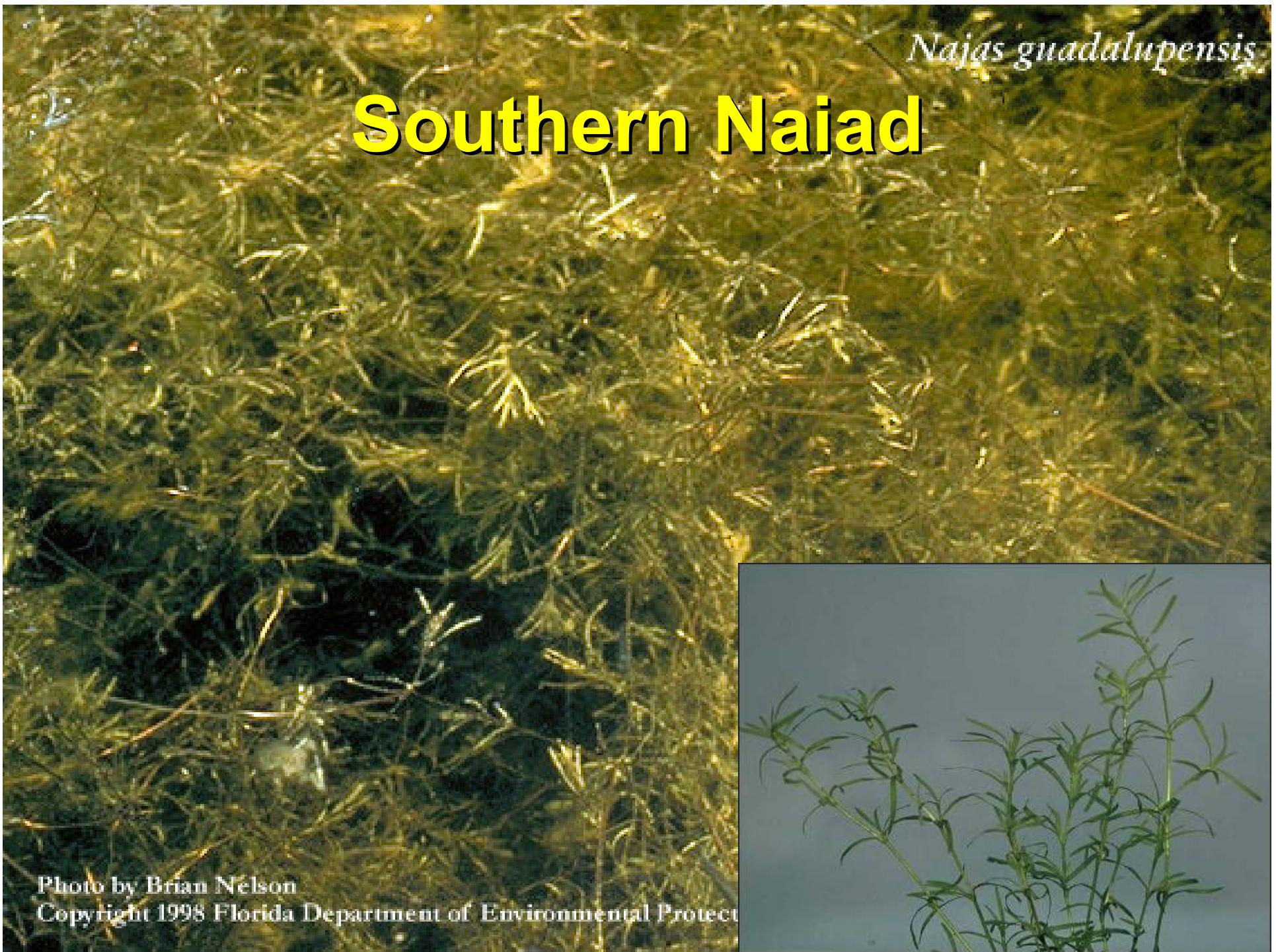


Photo by Brian Nelson

Copyright 1998 Florida Department of Environmental Protection



Najas guadalupensis

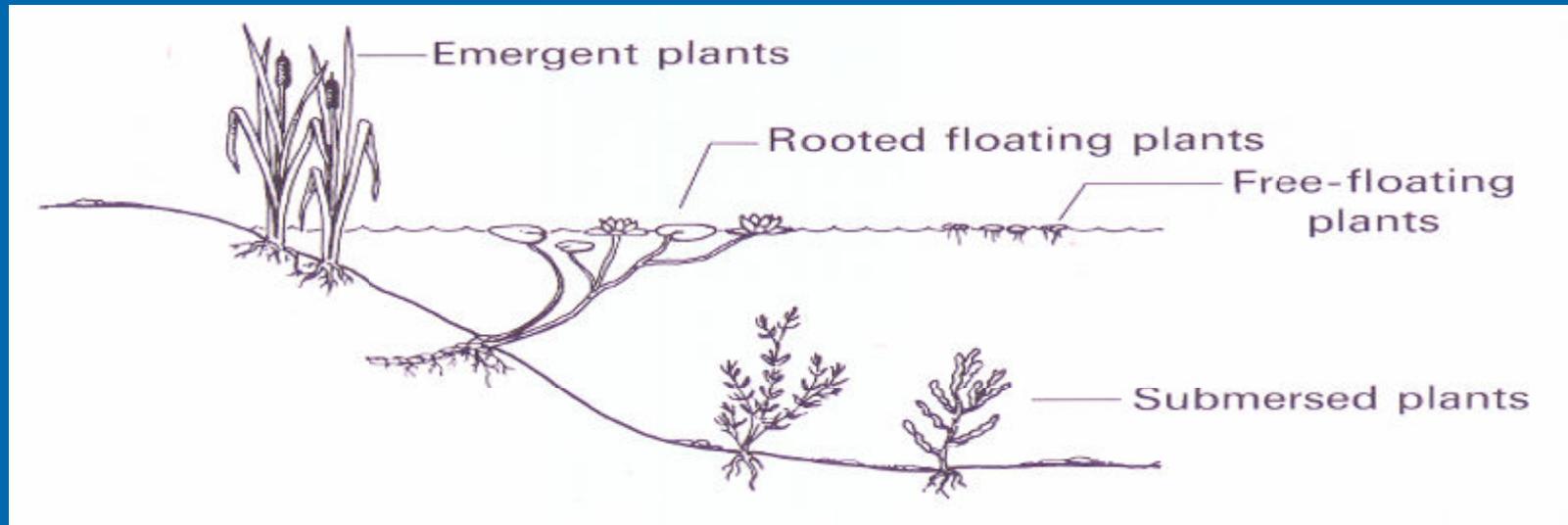
Southern Naiad

- Same Family as Hydrilla, Egeria, and Elodia
- Annual- Spreads primarily by seed
- Seeds and foliage important food source for Birds
- Not usually considered a weed in natural habitat
- Will tolerate polluted water

Photo by Brian Nelson

Copyright 1998 Florida Department of Environmental Protection

Types of Aquatic Plants



Rooted floating plants

Creeping waterprimrose

Ludwigia peploides





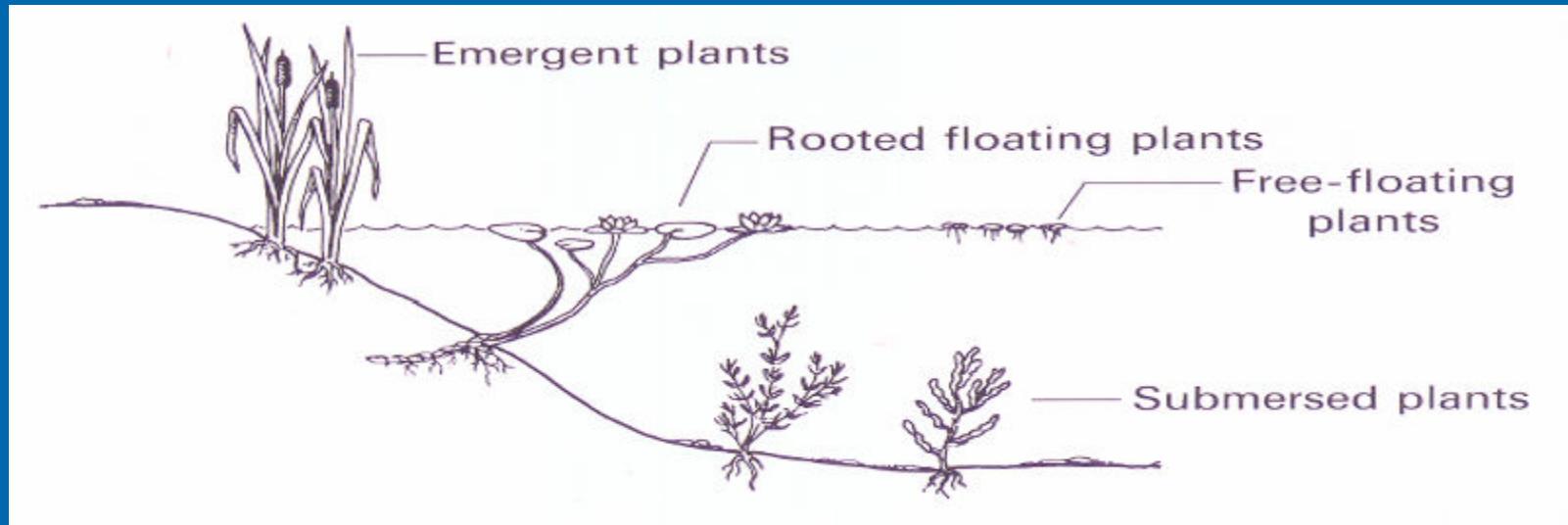
Creeping waterprimrose

Ludwigia peploides

- 3 species- one native to California
- Can develop thick mats that interfere with water flow
- Rooted in side of pond or canal
- Reproduces by seed, creeping stems and stem fragments



Types of Aquatic Plants



Emergent plants

Purple loosestrife

Lythrum salicaria



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Purple loosestrife

- Escaped cultivated ornamental and medicinal plant
- Perennial- spreads by slowly spreading crown-to 2 ft diameter.
- Can replace natives- Monotypic stands in Northeast have been around 20 years
- Reproduces by seed- large plant can produce 2 MILLION SEEDS!





Giant horsetail
Equisetum telmateia ssp. *braunii*



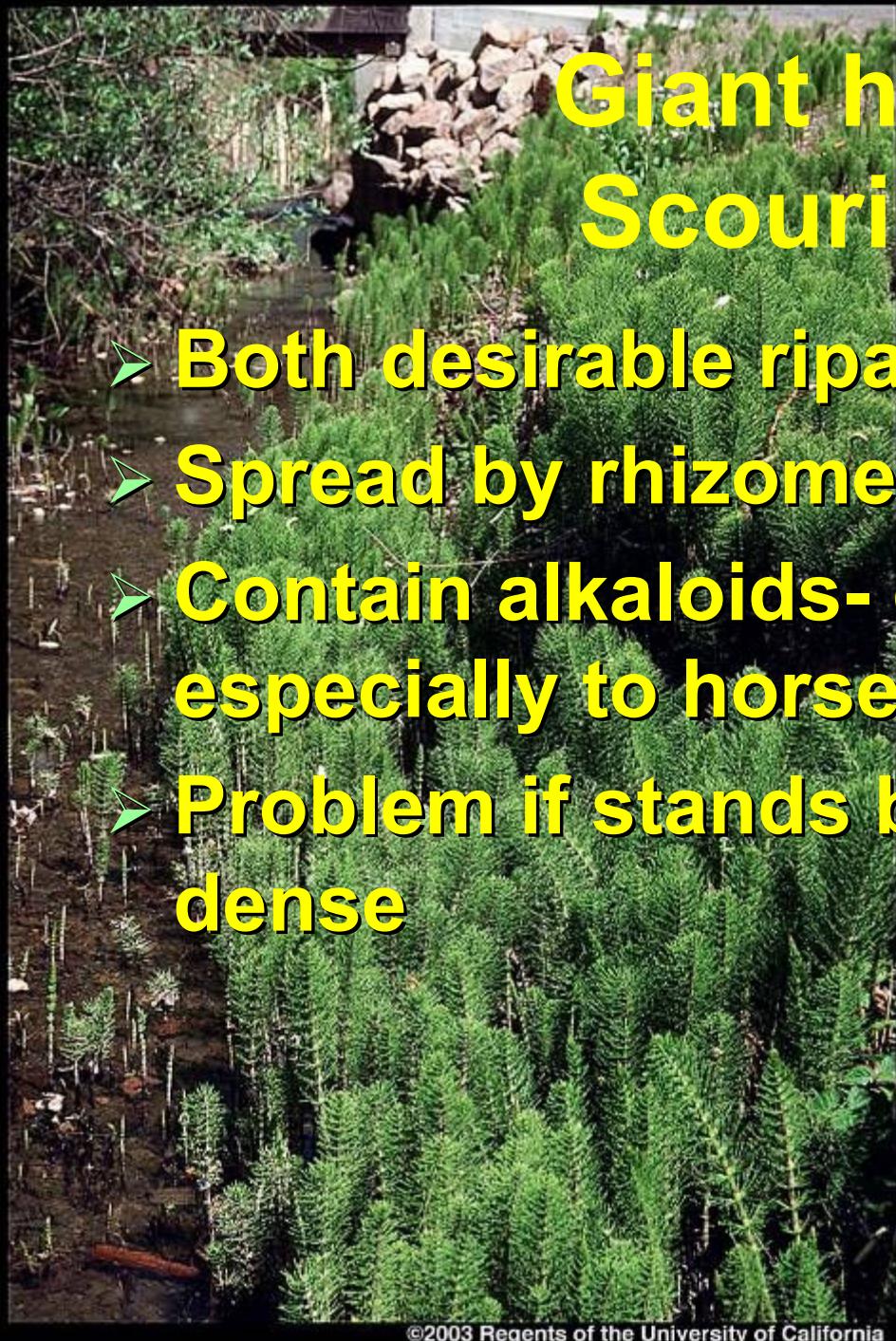
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Scouringrush
Equisetum hyemale
ssp. *affine*



Giant horsetail Scouringrush

- Both desirable riparian native-
- Spread by rhizome
- Contain alkaloids- can be toxic- especially to horses
- Problem if stands become excessively dense



Giant reed

Arundo donax



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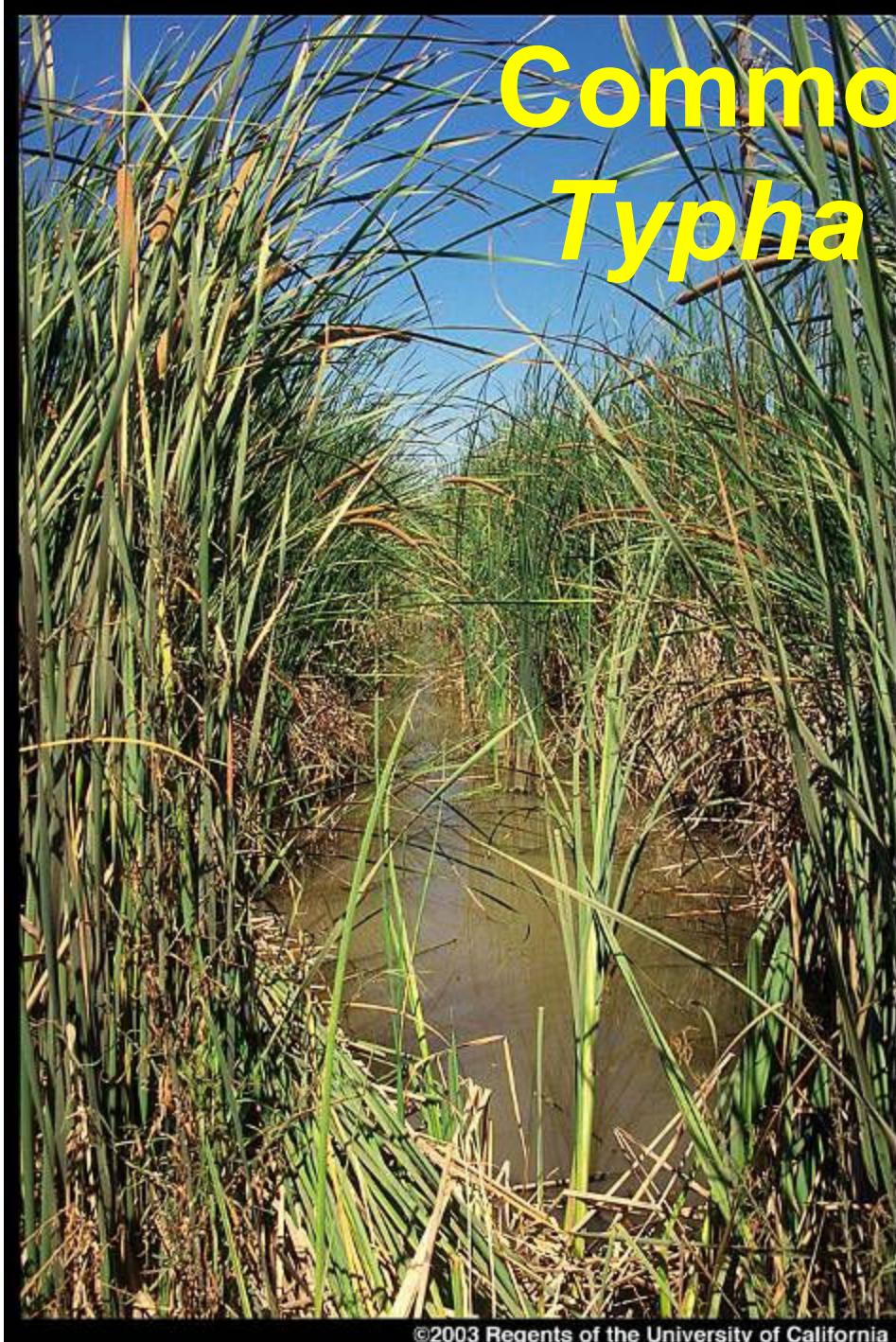
Giant reed

Arundo donax

- Robust perennial grass- grows 6-30 feet high-spreads by rhizome- no viable seeds
- Brought to Los Angeles in 1820's used for roofing and fodder material
- Used for erosion control- now causes floods
- Displaces native plants and wildlife because of the large stands and monopolization of soil moisture-

Common cattail

Typha latifolia





Common cattail

Typha latifolia

- Widespread desirable native – valuable source of food and shelter for wildlife- prevent shoreline erosion, and help remove excess nutrients from water.
- Spreads by seed and extensive rhizome system-
- “Everybody wants 2 feet of cattail- nobody wants 10 feet!”

Perennial pepperweed

Lepidium latifolium



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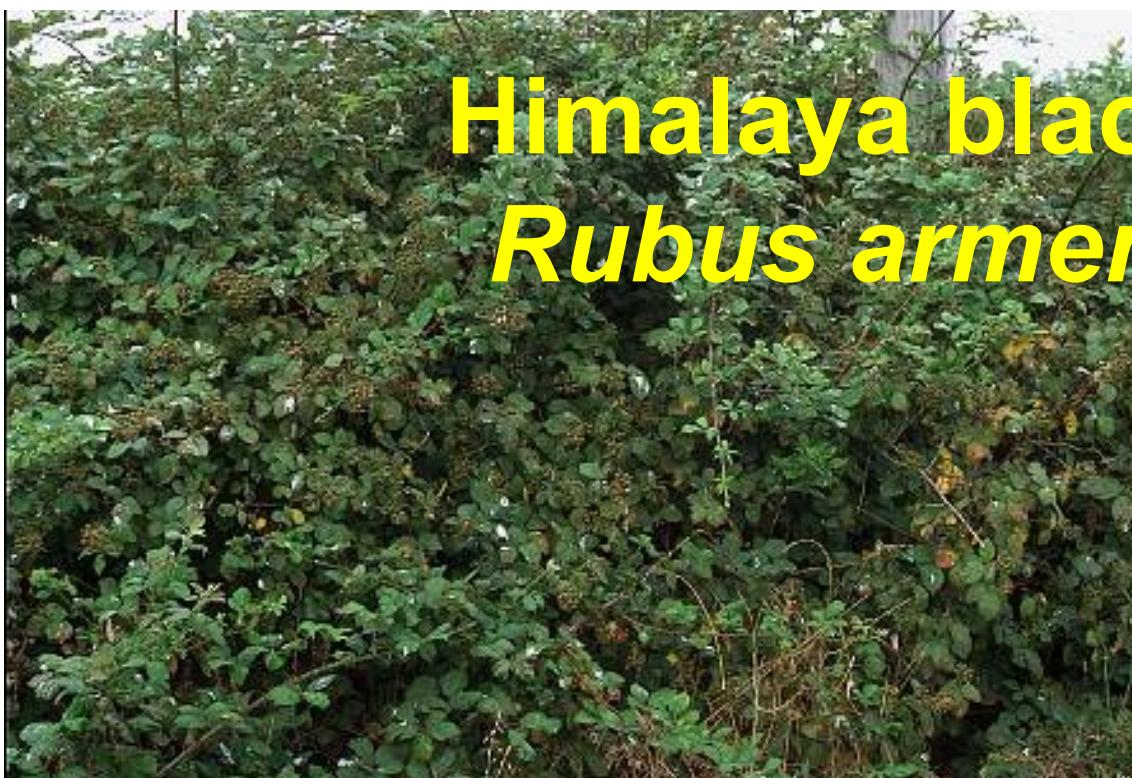
Perennial pepperweed

Lepidium latifolium

- Perennial spreads by root and seed
- Forms dense stands in brackish or alkaline wetlands- and other areas
- Introduced from Europe found in all counties in CA, except Del Norte, Humboldt and Imperial.

Himalaya blackberry

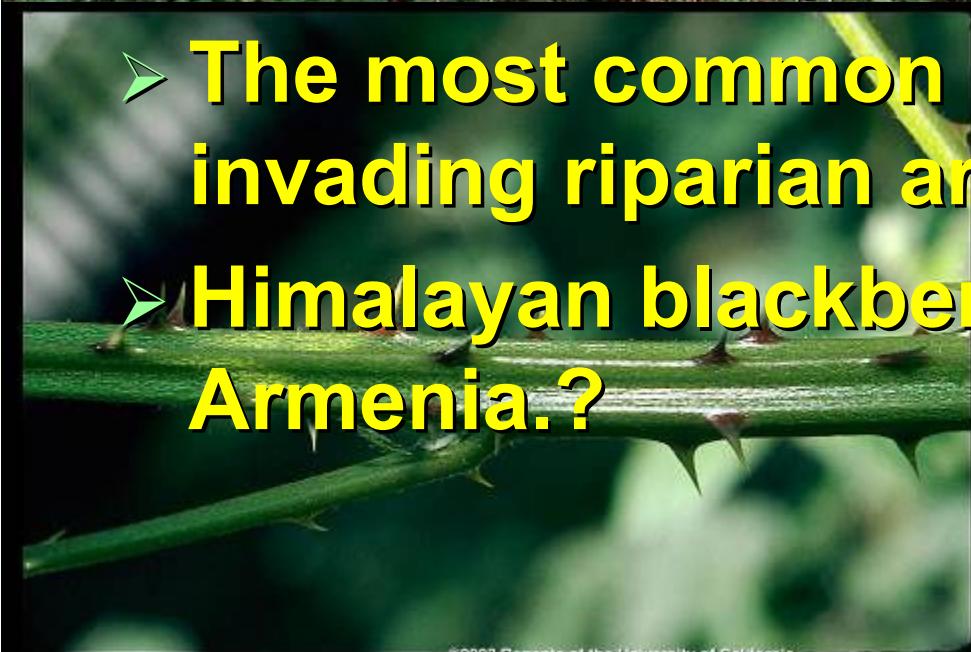
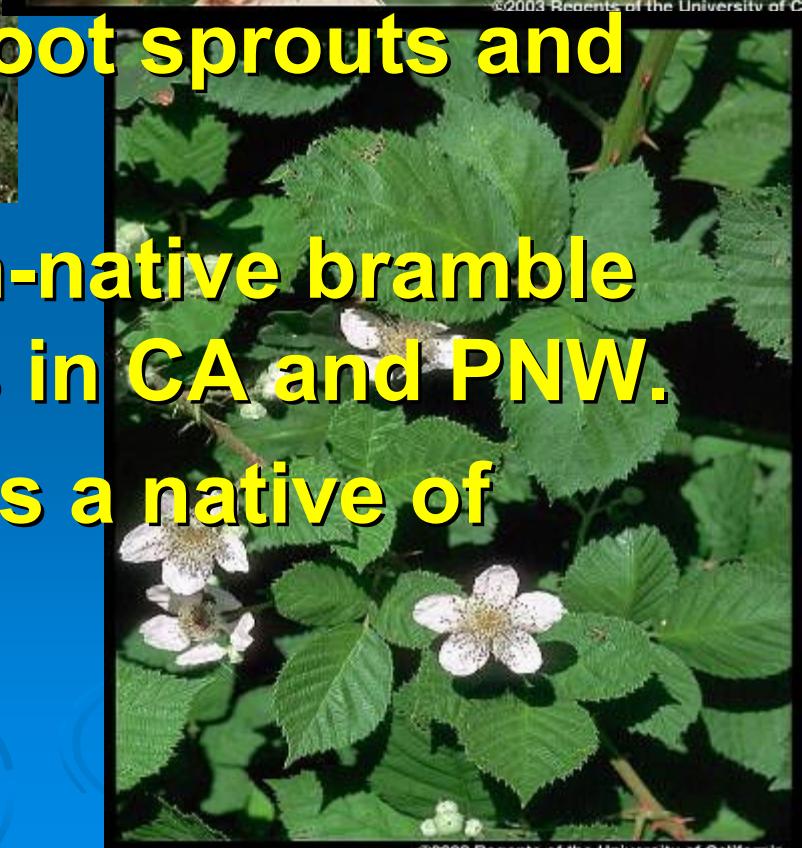
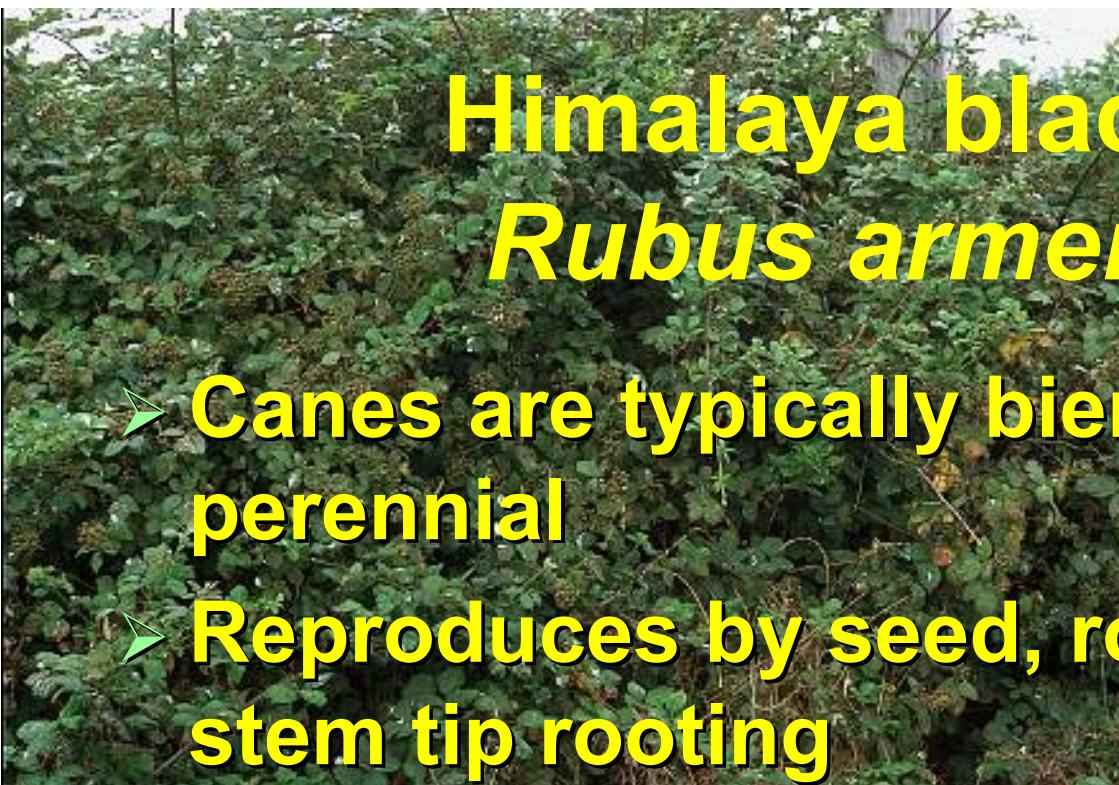
Rubus armeniacus



Himalaya blackberry

Rubus armeniacus

- Canes are typically biennial- roots are perennial
- Reproduces by seed, root sprouts and stem tip rooting
- The most common non-native bramble invading riparian areas in CA and PNW.
- Himalayan blackberry is a native of Armenia.?

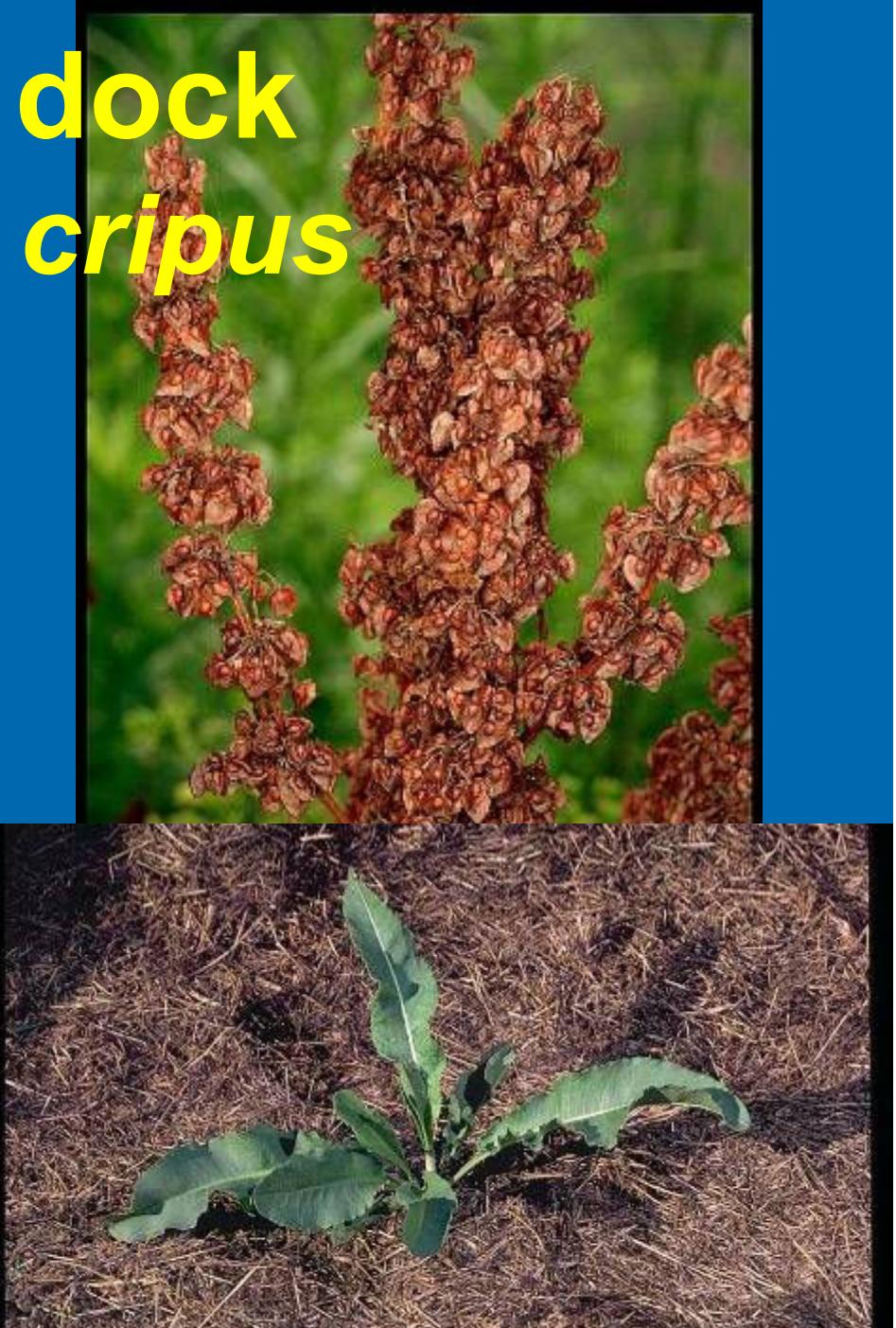


Curly dock

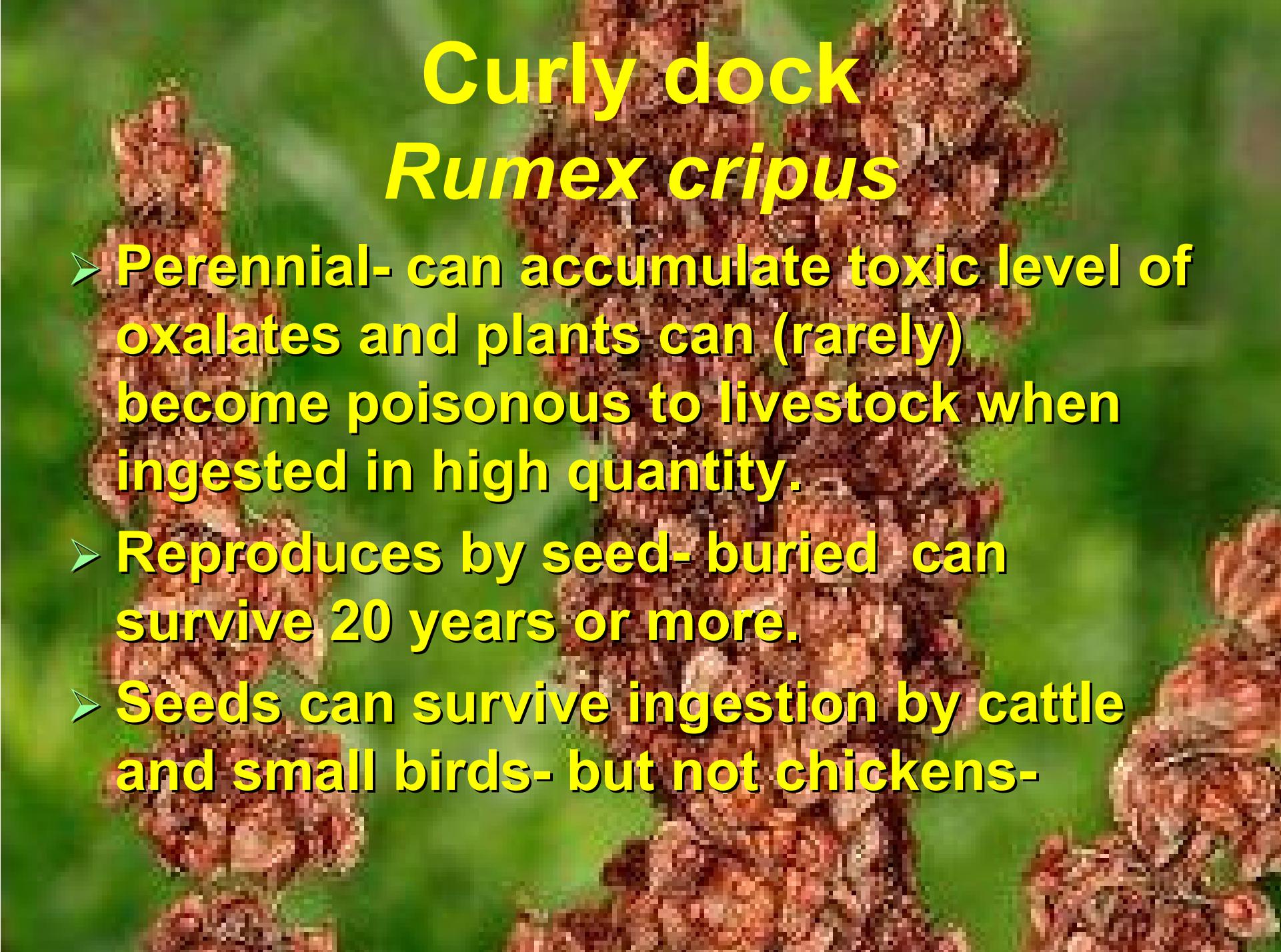
Rumex cripus



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Curly dock

Rumex cripus

- Perennial- can accumulate toxic level of oxalates and plants can (rarely) become poisonous to livestock when ingested in high quantity.
- Reproduces by seed- buried can survive 20 years or more.
- Seeds can survive ingestion by cattle and small birds- but not chickens-



Pale smartweed

Polygonum lapathifolium





Pale smartweed

Polygonum lapathifolium

- Desirable annual native that produces seeds that are an important food source for birds
- Can impede water movement when population becomes large and dense



Questions?





Aquatic Weed & Algae Control



Aquatic Systems: Multiple uses

- Fishing
- Swimming
- Boating
- Aesthetics
- Drinking Water
- Wildlife
- Flood Control
- Irrigation
- Frost Protection
- Hydroelectric

Aquatic Plant Management Plan

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



Aquatic Plant Management

❖ Prevention

- ❖ Educational signs at boat launches, marinas
- ❖ Volunteer Plant Survey to watch for invasive plants in pond

❖ Identify plant species

❖ Site Considerations

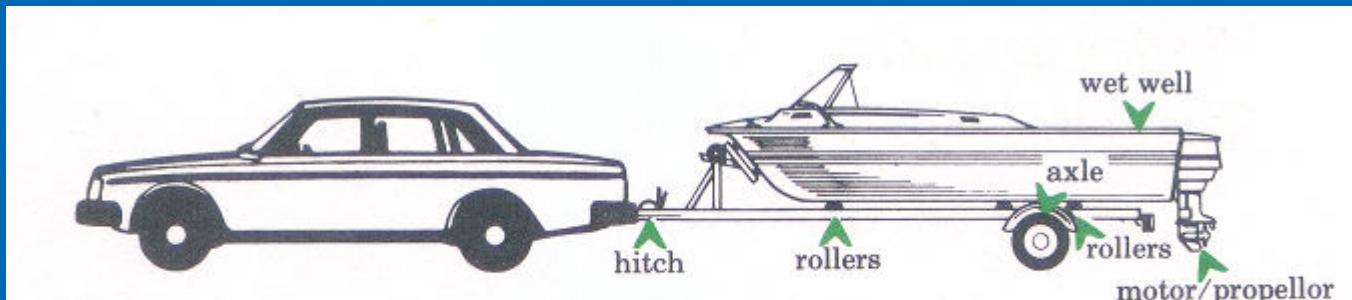
❖ Select Management Approach

mechanical
biological
herbicides

❖ Monitor / Follow Up Application



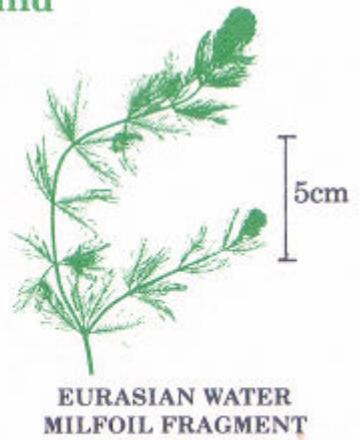
Prevention: Educational materials, signs, inspections at boat ramps.

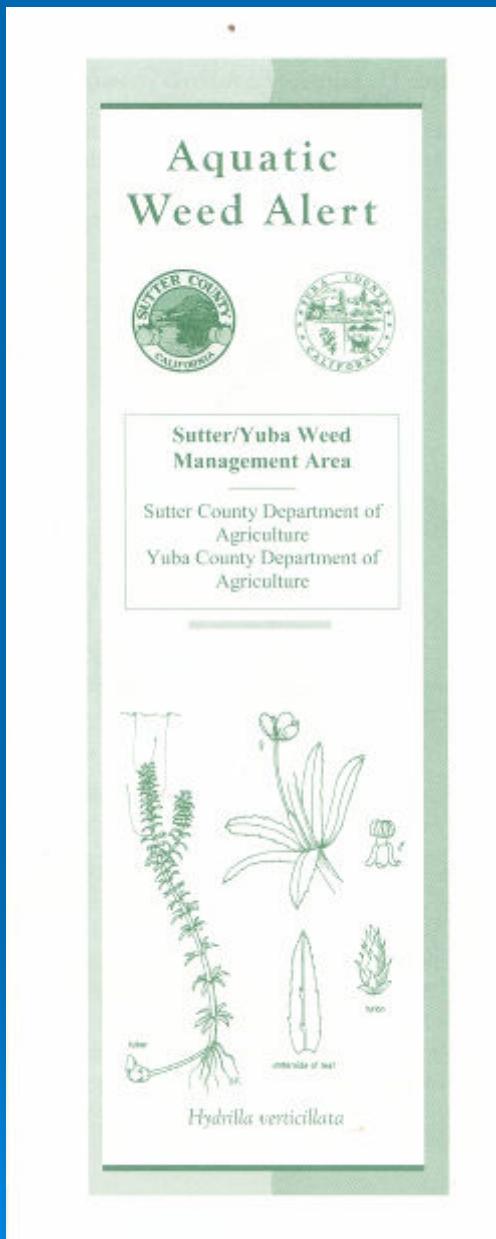


◀ Locations where aquatic weeds are often found

Boaters can help prevent the spread of Eurasian water milfoil by removing all aquatic weeds from **trailer, boat, motor/propellor** and **anchors** before launching and after leaving water. Special care should be taken to remove aquatic weeds from the wet wells of trailered boats and the interior of cartop boats and canoes.

80447/1



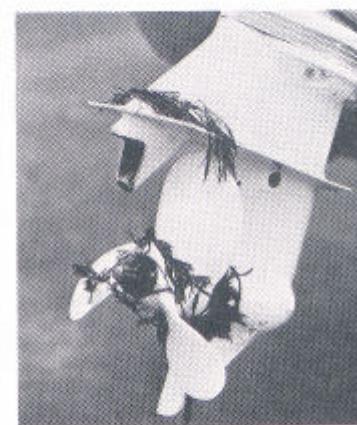


Awareness can prevent the introduction of weedy aquatic plants.

STOP Spread of Eurasian Water Milfoil

Eurasian water milfoil is an aquatic weed which interferes with boating, swimming, waterskiing, and fishing in southern British Columbia and on Vancouver Island.

Fragments of Eurasian water milfoil may survive if transported on boating equipment and can initiate new colonies if introduced to noninfested lakes. It has not yet been found north of Shuswap Lake and in most of the Kootenay Regions.



Do not transport aquatic weeds!



Province of
British Columbia

Ministry of
Environment

Prevention

Eliminate shallow areas during construction
> 3 feet deep, except in designated
swimming areas.

Prevent nutrients from entering the pond
point sources
use 10 - 20 foot wide grass buffer strips
fertilize areas adjacent to pond sparingly
prevent livestock from entering the pond directly
reduce the number of waterfowl

Management Goals



- Management approach will depend on your goals for the site:

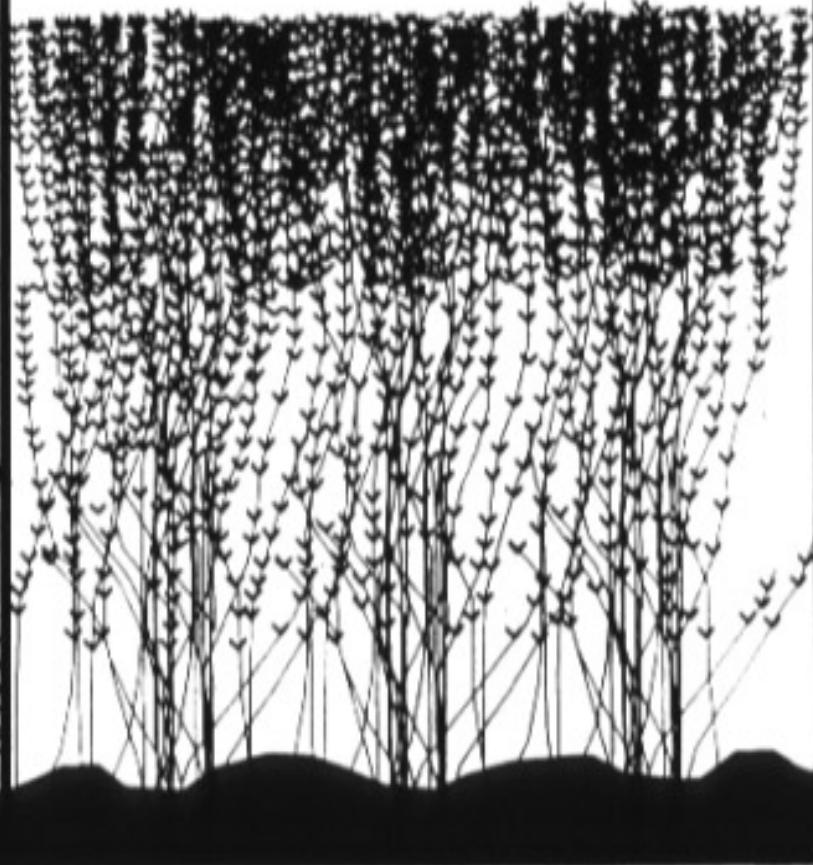
Site Considerations

- ❖ Pond Dimensions
- ❖ Average Depth
- ❖ Inflows / Outflows
- ❖ Location in the Floodplain
- ❖ Types of Fish
- ❖ Water Uses

A. Diverse native community



B. Monospecific non-indigenous population



Which is more desirable?

Costs of aquatic weed management

- Ranges from \$500 to \$3,000 per acre
- Ranges from \$500 to \$5,000 per mile of canal

Costs of aquatic weed management

- Ranges from \$500 to \$3,000 per acre
- Ranges from \$500 to \$5,000 per mile of canal

What are the costs associated with?

- Consumable Materials (e.g. herbicides, fuel)
- Equipment (sprayers, harvesters, trucks, boats, safety gear)
- Personnel (salaries, training, insurance, benefits)
- Regulatory: NPDES-monitoring and compliance (sampling equipment, training, analysis, documentation, record storage)

Aquatic Plant Management

- Mechanical Control
- Cultural Control
- Biological Control
- Chemical Control

Mechanical Control



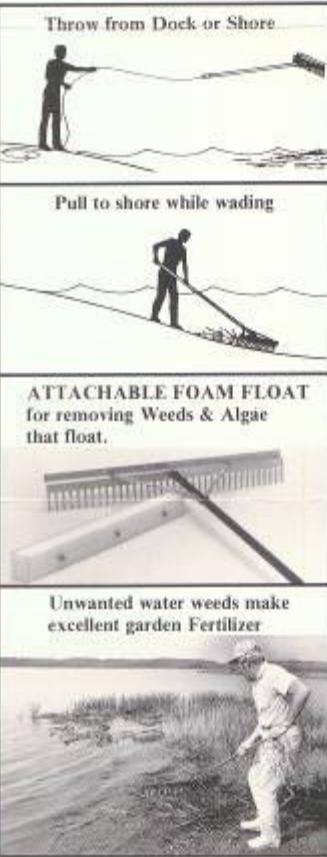
- Hand pulling and raking
- Cutting and harvesting
- Shredding
- Dredging
- Chaining
- Diver-operated suction harvesting
- Rotovating

Hand operated tools

AQUA WEED RAKE™



Just Throw it out and Rake in the weeds



- Fun and Easy because it's **LIGHT WEIGHT!**

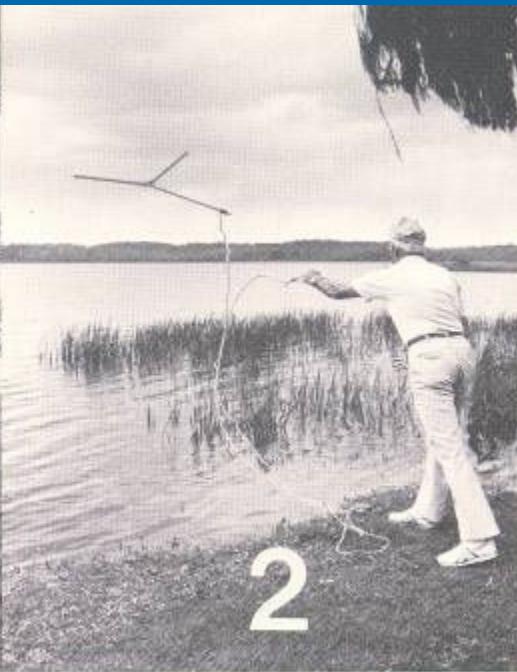
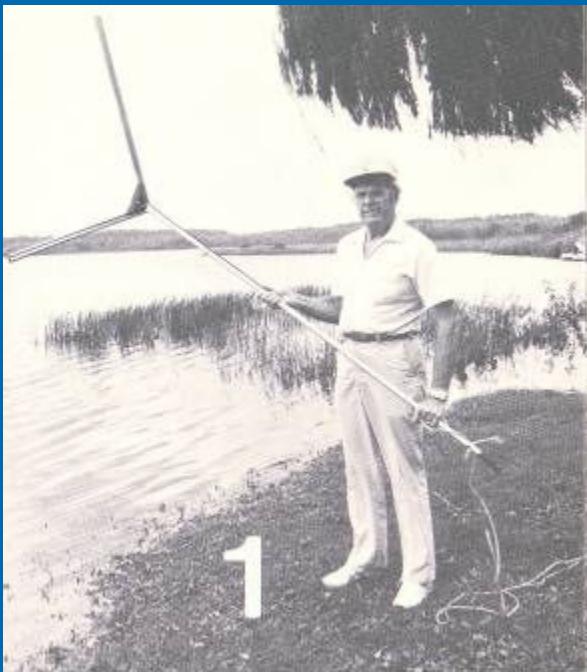


Safe, Simple, Economical, and Effective

Environmentally safe. SWIM IMMEDIATELY after using—no more concern about toxic effects to fish, wildlife, pets or humans. **SO SIMPLE** any one person can use this lightweight (3½ pound) - 36 inch-5½ foot Magnesium Aluminum Rake. Adjustable extension (6' to 10') allows for removing weeds and debris from lake bottoms. **ECONOMICAL** because it provides many years of weed removal for less than the cost of chemical treatments. Ideal for fast and easy "Shoreline clean-up" or "Sand Raking" beaches or gardens. The Attachable Float makes the rake **MORE EFFECTIVE** for removing weeds that float.

- What could be a better companion tool for "Aqua Weed Cutter" owners?

LAKE WEED- A- WAY INC. PO BOX 132 Caledonia Michigan 49316-0132 616 891-1294



HANDY MARKETING CO.

Dear Friend:

If you have a water weed problem, you already know what a job it is keeping the weed growth under control. Water weeds can greatly affect the use of your water property by inhibiting swimming, fishing and boating. Uncontrolled water weeds can also be an unsightly mess.

The AQUA WEED CUTTER will not only solve your water weed problems, but also help you do your part in preserving our nation's most valuable resource. If for any reason you are not satisfied in 30 days with the operation of the AQUA WEED CUTTER, return it to wherever you purchased it for a full refund. This is a no risk offer on your part.

The AQUA WEED CUTTER is manufactured with the highest degree of workmanship and the highest quality of materials. The AQUA WEED CUTTER is 100% manufactured in the United States. Zinc plating and the stainless steel resharpenable blades offer a high degree of corrosion resistance. We are so sure of the quality of materials and workmanship that goes into each AQUA WEED CUTTER that we have recently extended the limited warranty period from 90 days to 1 year.

Sincerely,

Don Breckenridge
Don Breckenridge,
President

SATISFIED CUSTOMERS

"Does a fantastic job - I figured I cleared more weeds in two hours than I've previously been able to in a whole summer."
-South Haven, MI

"My friend brought his AWC over to my house and I tried it. I thought it was great and I ordered one. The AWC is effective and easy to use."
-Webster, WI

"I like it very much. It does a very good job. I had to put a longer rope on it because I can throw it farther than the rope would permit. It's nice to be able to cut weeds without getting wet, especially when the water is cold."
-Aitkin, MN

"Gentlemen, I wish to inform you that your AQUA WEED CUTTER does a very good job and I am pleased. Several of the neighbors have also ordered them."
-Gowen, MI

"We have tried the AQUA WEED CUTTER and find it does an excellent job of cleaning the weeds in our beach, along the long pier and boat docks. We are very satisfied with the product and would recommend it to anyone who has a need."
-Claypool, IN

**BEACHES • PONDS &
SMALL LAKES CAN BE
WEED FREE!
SAFE, EASY-TO-USE •
HELPS TO CONTROL
WATER WEEDS**

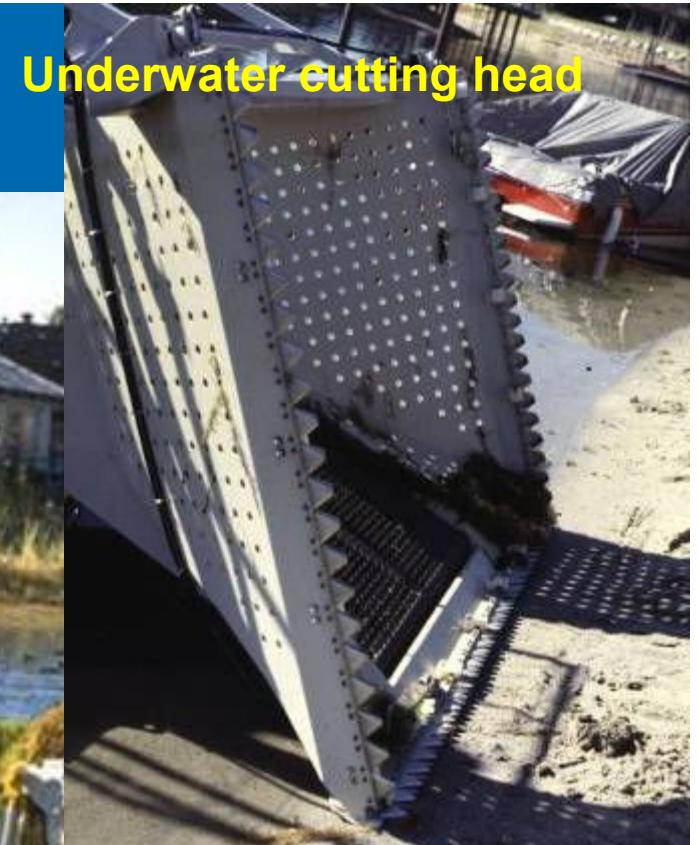
- Cuts a 48" path up to 20' deep (without operator getting wet!)
- Just throw it out and pull it in from Any Dock or Shore!

**Stainless Steel Resharpenable Blades!
30-DAY MONEY BACK GUARANTEE!!**

Cutting/Harvesting



Cutting/Harvesting



The plant material has to be taken to appropriate disposal site.



Small fish and invertebrates become trapped in the plant material.

Not all pieces are captured-
Plant fragments may cause new infestation elsewhere



Shredding



- Shredders chop material in place, pieces too small to clog waterways
- Immediate relief
- A lot of biomass at bottom of canal-





Dredging



Removes nutrient-rich sediments

Exposes nutrient poor layers;

Deepens resulting in less light penetrating to the bottom.



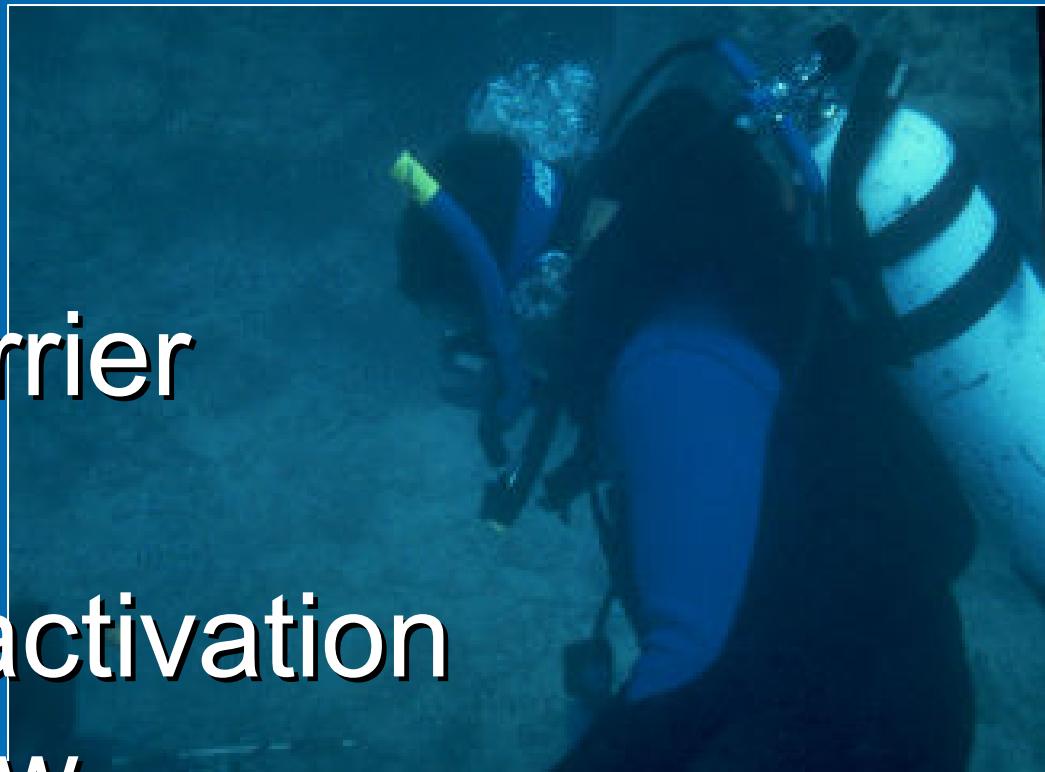
Chaining

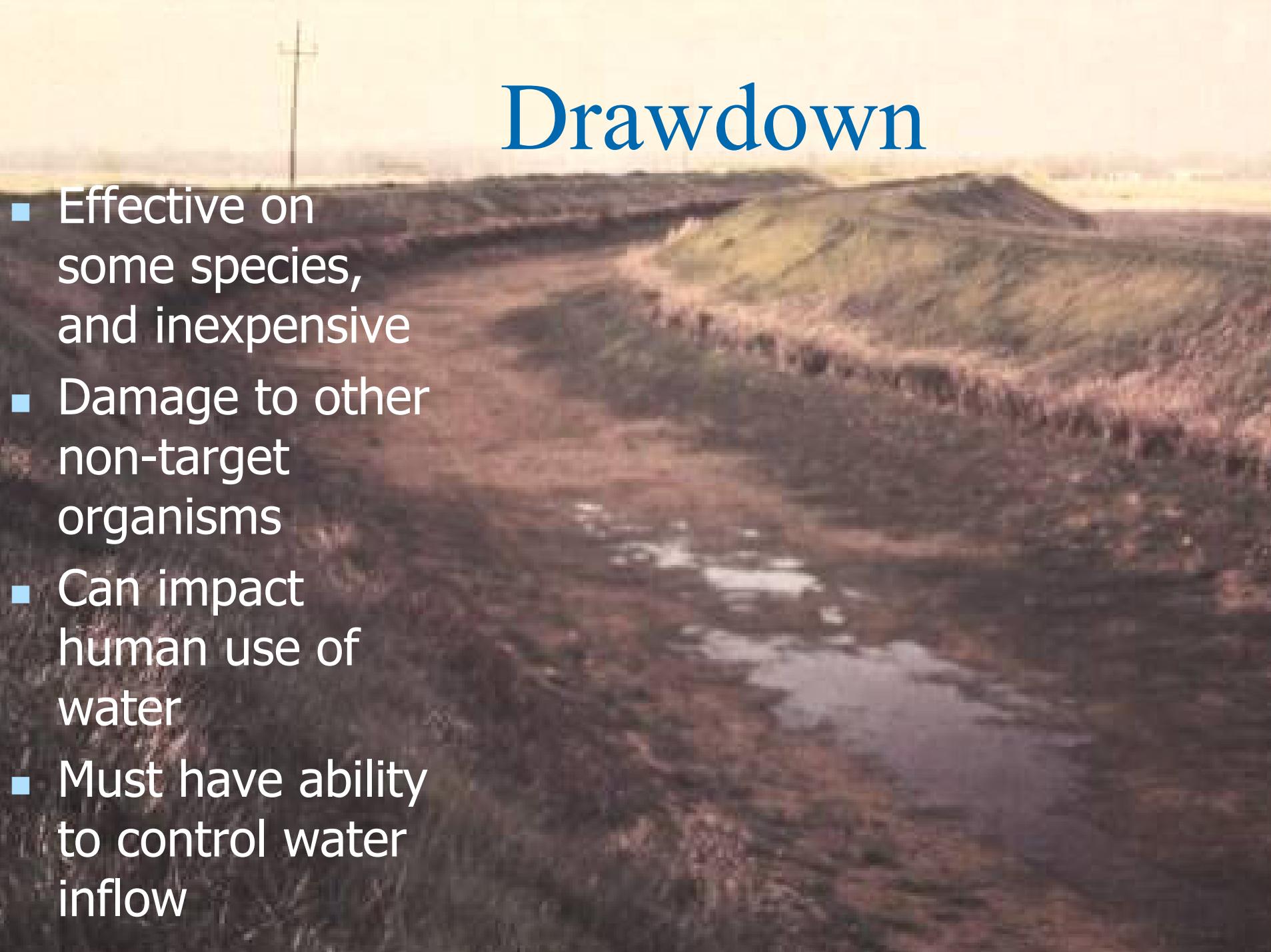


Requires a large chain and two large tractors
Dislodges weeds, and anything else, from
bottom of canal-

Cultural Control

- Drawdown
- Benthic Barrier
- Shading
- Nutrient Inactivation
- Barley Straw





Drawdown

- Effective on some species, and inexpensive
- Damage to other non-target organisms
- Can impact human use of water
- Must have ability to control water inflow

Water Level Drawdown effect on weed populations

↓ Coontail, Egeria, Eurasian watermilfoil,
Southern Naiad, Water Lily, Robbin's Pondweed

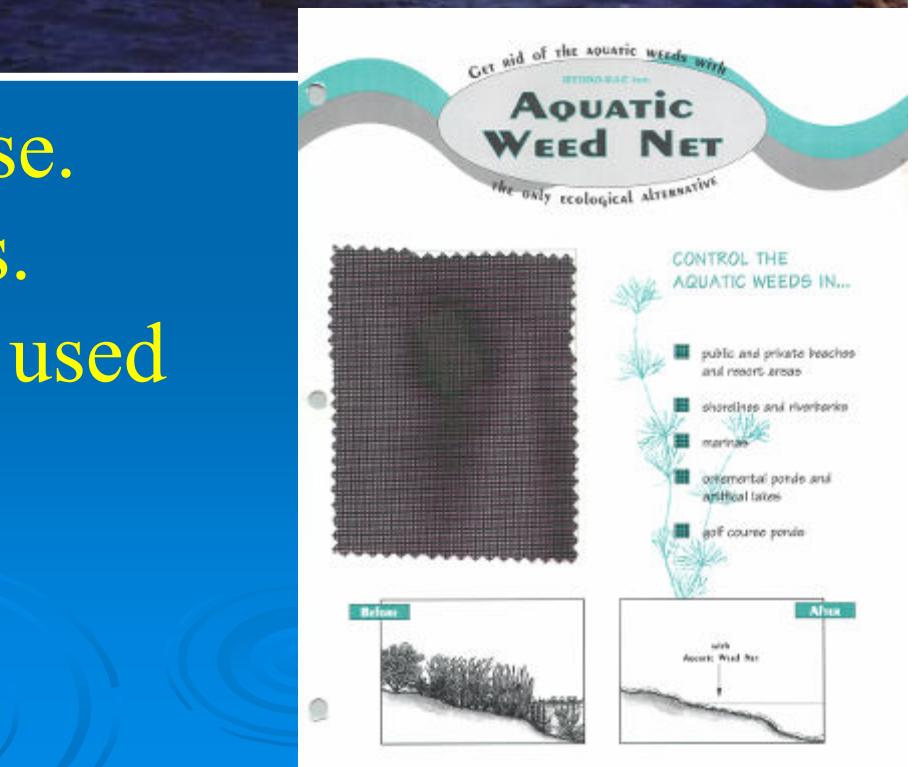
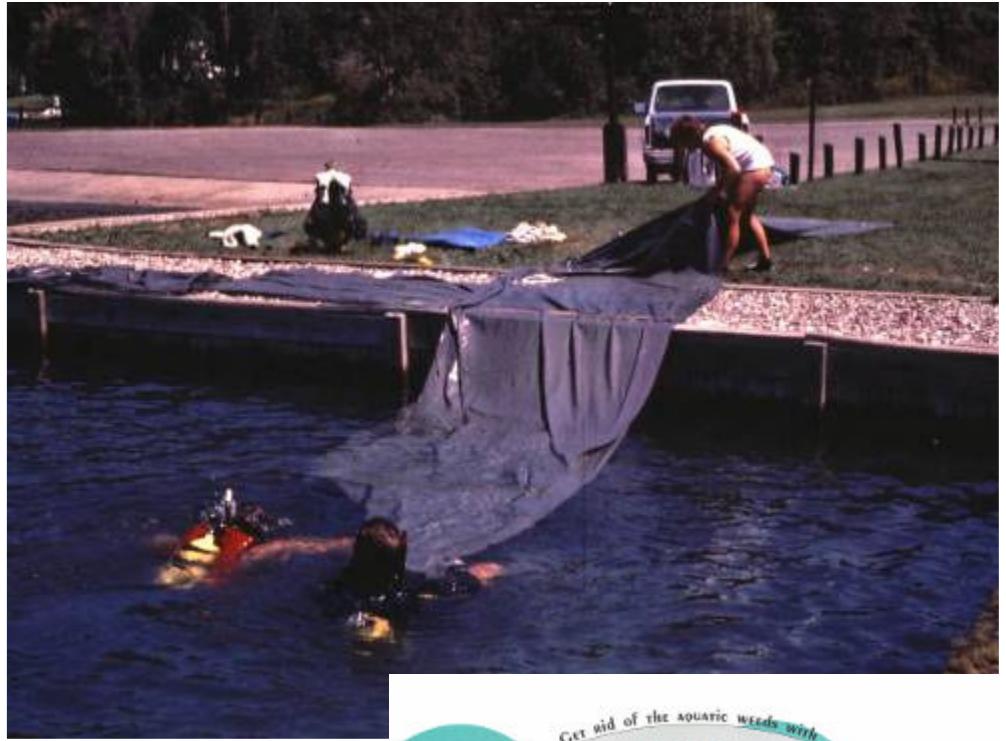
↑ Alligator weed, Hydrilla, Bushy Pondweed

↓ ↑ Waterhyacinth, Elodea, Cattail

Benthic Barrier

Advantages

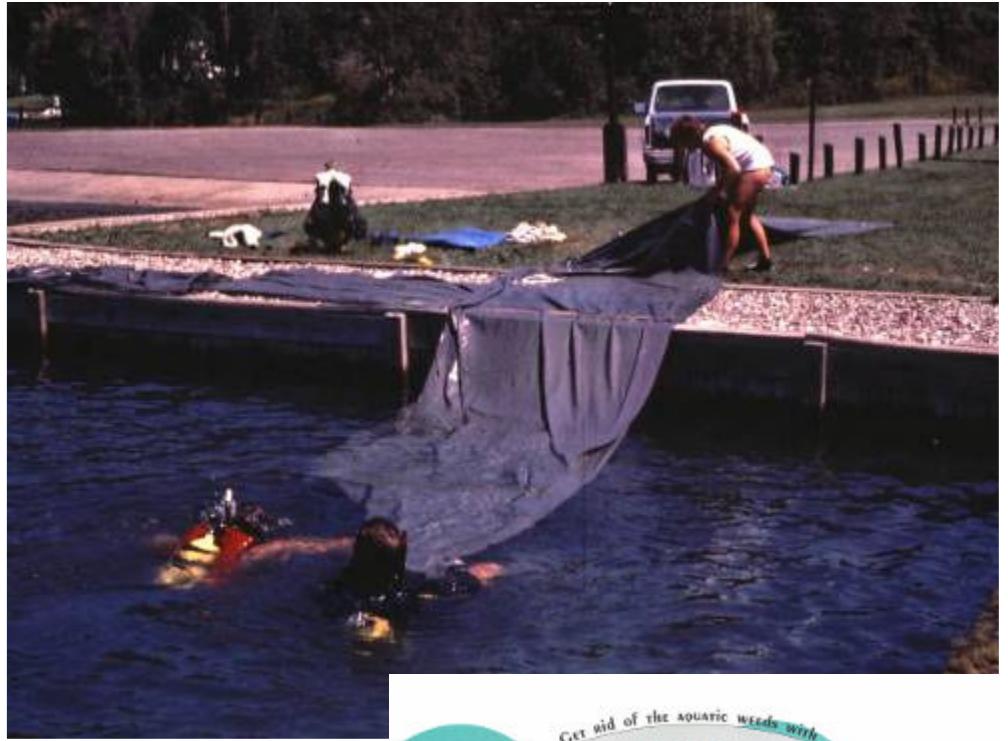
- Last up to 10 years
- Frees areas for immediate use.
- Easy to install in small areas.
- Prevent new plant growth if used early in the spring.



Benthic Barrier

Disadvantages

- Habitat can be eliminated.
- Not suitable for large-scale (expensive)
- Must be removed and cleaned in the fall.
- Too shallow an installation may entangle props.
- Installation may be strenuous especially in deep water!





Light Alteration as a Management Approach

Increase water depth by dredging.

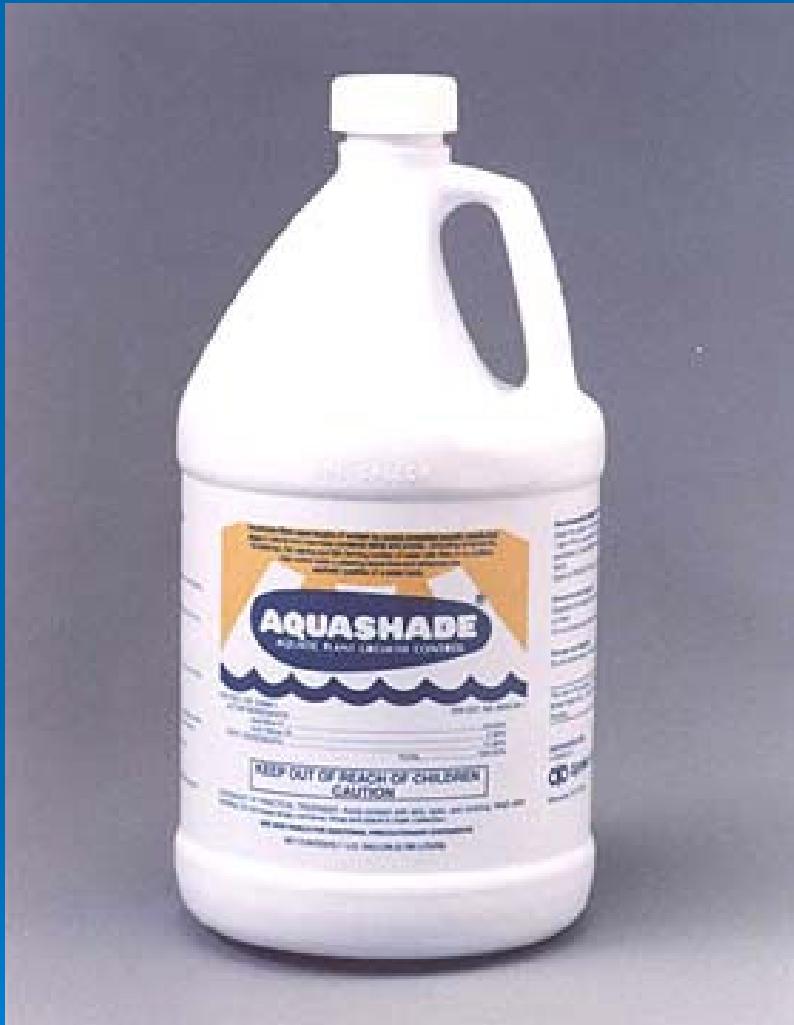
Increase shade from stream banks by planting tall grass, shrubs or trees.

Add nutrients to stimulate algal blooms.

Increase turbidity due to suspended clay.

Use light absorbing dyes.

(slow water turnover, dilution, apply early in growing season, most effective in clear water, require minimum depths of > 0.5 to 2 m)



Shading

- Water-soluble dye
- Inexpensive
- Discoloration appears artificial



AQUASHADE
AQUATIC PLANT GROWTH CONTROL

FOR ALL SEASONS

U.S. Pat. No. 4,042,367

EPA Reg. No. 33068-1

EPA Est. No. 33068-OH-1

AQUASHADE FILTERS WAVE LENGTHS OF SUNLIGHT
TO CONTROL UNWANTED AQUATIC WEEDS AND ALGAE
IN NATURAL AND MANMADE CONTAINED LAKES AND PONDS
INCLUDING ORNAMENTAL, RECREATIONAL, FISH REARING &
FISH FARMING BODIES OF WATER WITH LITTLE OR NO OUTFLOW
ALSO COLORS WATER A PLEASING AQUA
ENHANCES THE AESTHETIC QUALITIES OF A

ACTIVE INGREDIENTS:
Acid Blue 9
Acid Yellow 23
INERT INGREDIENTS:
TOTAL

KEEP OUT OF REACH OF CHILDREN
CAUTION
STATEMENT OF PRACTICAL TREATMENT
Avoid contact with skin, eyes, and clothing. Wash thoroughly with soap and water if contact occurs. Do not reuse empty container. Wrap and place in a closed container for disposal.
DIRECTIONS FOR USE
It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
GENERAL CLASSIFICATION
M
WHERE TO APPLY
Natural and manmade contained Ponds, Lakes & Fountains including Ornamental, Recreational, Fish Rearing and Fish Farming Ponds with little or no outflow, Golf Course Ponds and Watering Tubs.
Do Not apply directly to streams, other natural bodies of water or any body of water not under total control of the user.
Do Not apply to water that will be used for human consumption.
HOW TO APPLY
Pour from the container near shoreline into water. It will mix throughout. For an early control, pour onto the ice in a meter diameter circle. It will melt a hole & disperse underneath.
WHEN TO APPLY
For best results, apply before growing season starts, or when growth is on the bottom. Less effective when growth is near surface (2 ft.), in that case, physical removal or chemical killing of growth already above surface may be done before AQUASHADE is applied. When using an aquatic herbicide, follow all label restrictions, precautions and directions for use.

NET CONTENTS: 1 GALLON (3.785 L)

applied biochem
MILWAUKEE, WISCONSIN 53218

800 11982

1-800-558-5106



TRUE BLUE™
LAKE & POND DYE



PRECISION
PRODUCTS FOR GROWTH

TECHNICAL BULLETIN

DESCRIPTION:

TRUE BLUE™ is a dark aqua blue, odorless, non-toxic liquid formulated to impart an attractive blue coloring to natural and man-made ponds, lakes, fountains and waterfalls.

Designed to turn water blue without producing an artificial appearance, TRUE BLUE aids in beautifying parks, corporate campuses, golf courses, campgrounds and retention ponds.

ADVANTAGES:

- Non-toxic. Tested by independent agencies.
- Harmless to fish, wildlife and other aquatic species.
- Non-toxic, natural-looking color.
- Easy to use.
- Long-lasting.
- Colorless.
- Economical.
- Highly concentrated!

DIRECTIONS FOR APPLICATION:

Apply TRUE BLUE at a rate of one gallon (3.785 L) per four acre feet of water. Note: one acre foot is the quantity of water (43,560 cubic feet) that would cover one acre to a depth of one foot. One gallon of TRUE BLUE will treat up to 1,250,000 gallons of water, depending on water quality.

Recommended application method: TRUE BLUE may be applied with a hand-held pressure sprayer (use caution if windy conditions exist), but can also be poured from a slow-moving boat or directly from the container along the shoreline. Following application, TRUE BLUE will be evenly dispersed and mixed throughout the entire body of water by wind and water currents.

For best results, apply in early spring and throughout the season depending on the desired level of color intensity.

PACKAGING:

TRUE BLUE is available in one gallon containers, packaged six gallons per case.

PROPERTIES:

Form	Liquid
Odor	None
Color	Dark blue
Storage Stability	Excellent
Cold Stability	Stable
Chemical Stability	Stable
Flammability	None
Flame Point	None
Solubility in Water	100%
Boiling Point	212°F
pH	5.4
Specific Gravity	1.045
% Volatile by Weight	70.75%
Evaporation Rate	Same as water
Weight per Gallon	8.7 lbs.

IMPORTANT NOTE:

Do NOT apply this product to water intended for human consumption. Do NOT use this product for streams, rivers or other bodies of water not under control of the user. Do NOT use in water that has been or will be chlorinated.

HEALTH HAZARD AND FIRST AID INFORMATION:

Avoid contact with skin, eyes or clothing. If accidentally ingested, drink large volumes of water. Do not induce vomiting. If skin contact occurs, wash skin with soap and water. If eye contact occurs, flush eyes with water for fifteen minutes. If irritation persists, obtain medical attention. Material Safety Data Sheet available on request.

STORAGE AND DISPOSAL:

Store above 32°F. Do NOT reuse empty container. Dispose of container in a safe manner in accordance with federal, state and local regulations. Do not use product in a manner inconsistent with labeling.

INFRINGEMENT INFORMATION:

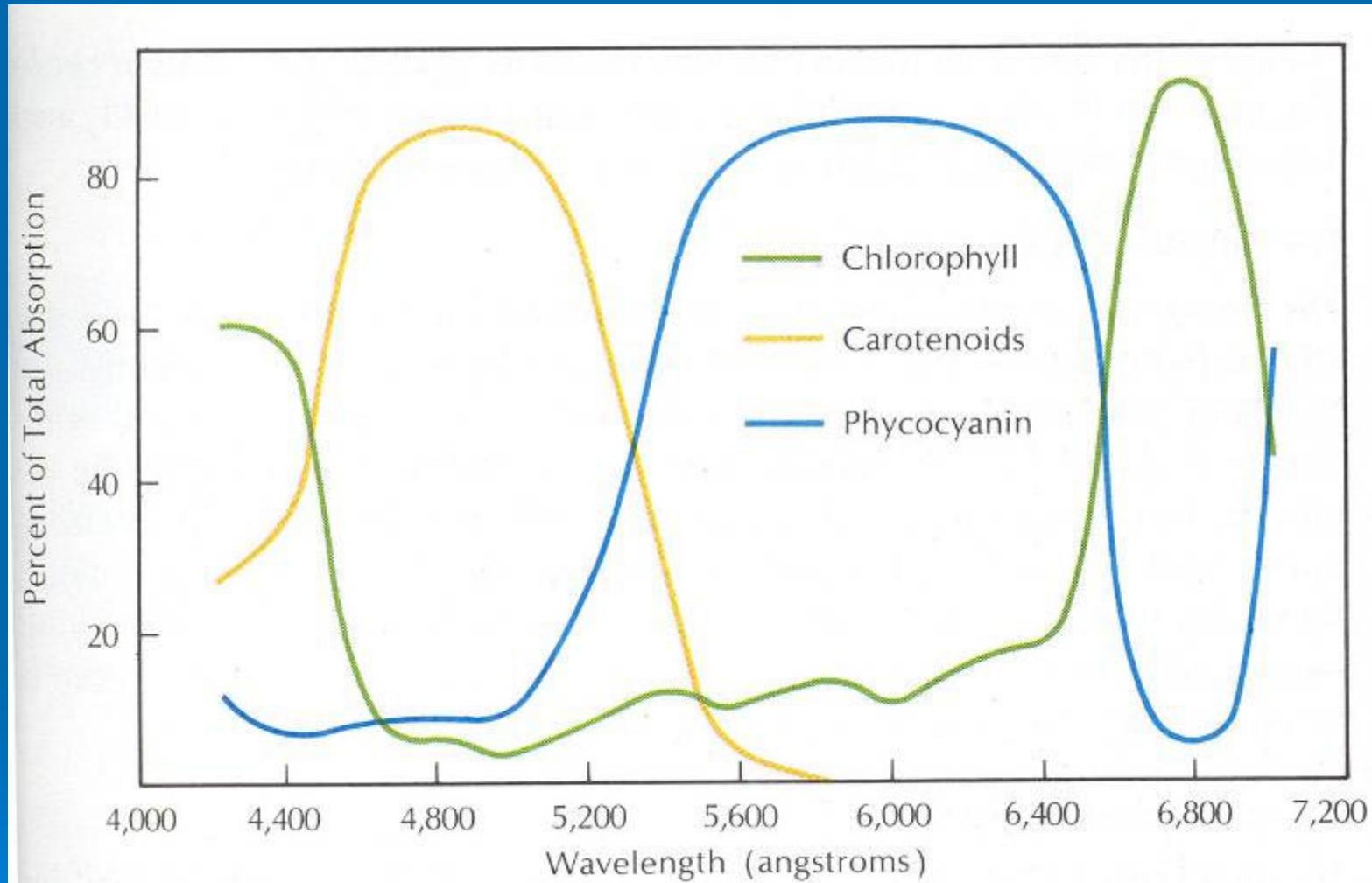
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YOUR LOCAL DEALER IS:

PRECISION LABORATORIES, INC.
PO Box 157
Naperville, IL 60565
800-323-6280 • 312-488-0890
Fax: 312-488-1176

TRUE BLUE is a trademark of Precision Laboratories, Inc. ©1998 Precision Laboratories, Inc.

How colorants work



Block light wavelengths that plants need for growth

Nutrient Inactivation

- Complex P with
 - Alum
 - Iron
 - Other
- Controls algae relatively inexpensively and can clarify water
- May not effect plants, particularly rooted ones
- Can adversely effect fish and other organisms

Barley straw

Algae control agent?- conflicting results



Biological Control



- Insects
 - Classical
 - Native
- Pathogens
 - Classical
 - Native
- Herbivorous Fish
 - Grass carp

West Indian Manatee



Water hyacinth control in Florida

Grass Carp

■ Advantages

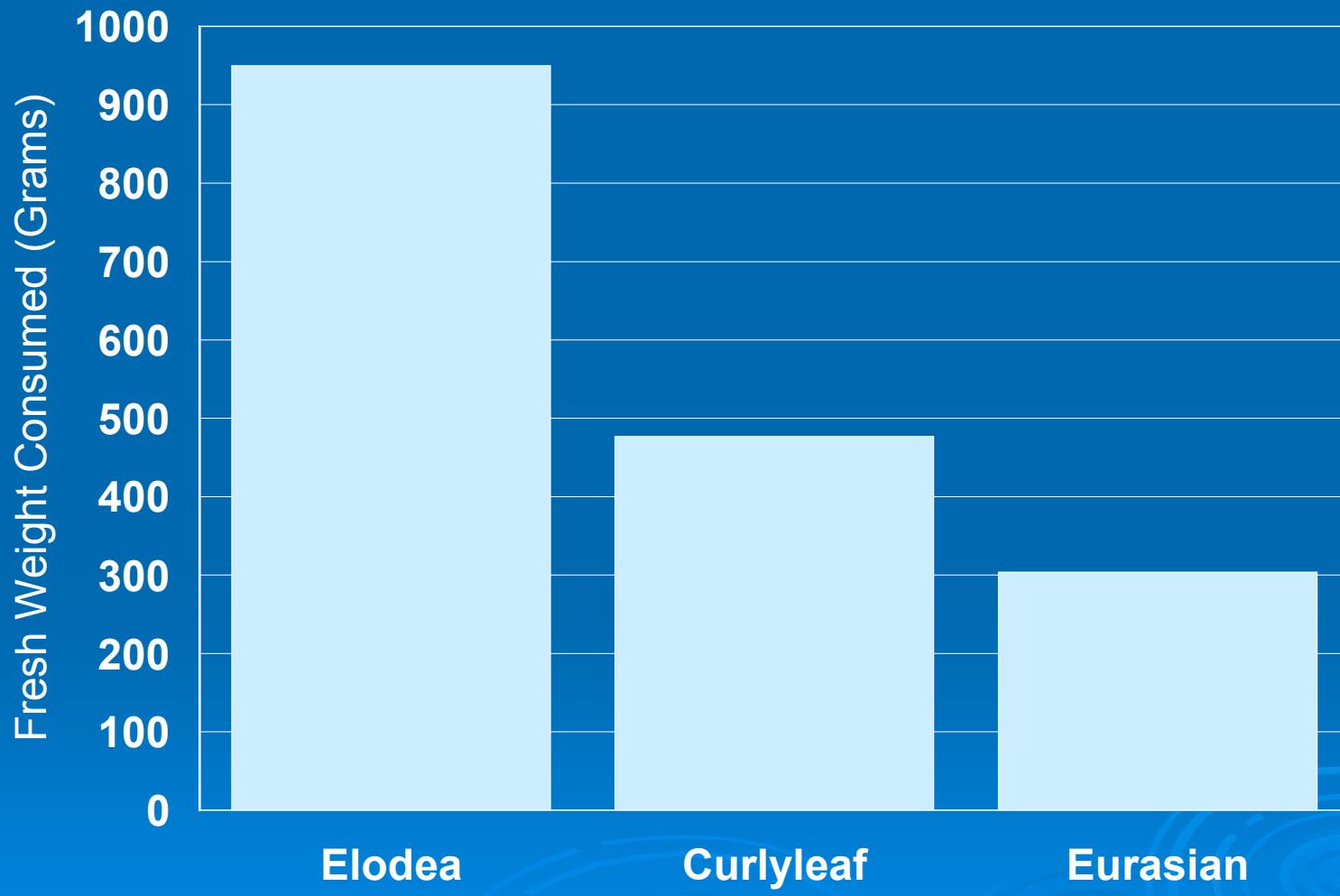
- Effective
- Inexpensive
- Long-term

■ Disadvantages

- “All-or-none” response
- Not selective
- Cannot control feeding sites
- Cannot stop fish
- Difficult to contain
- Reproduction?



Triploid Grass Carp Prefer Other Species



Pine *et al.* 1990

Classical Insect Control

■ Advantages

- Public perception
- Low cost after R&D
- Long-term



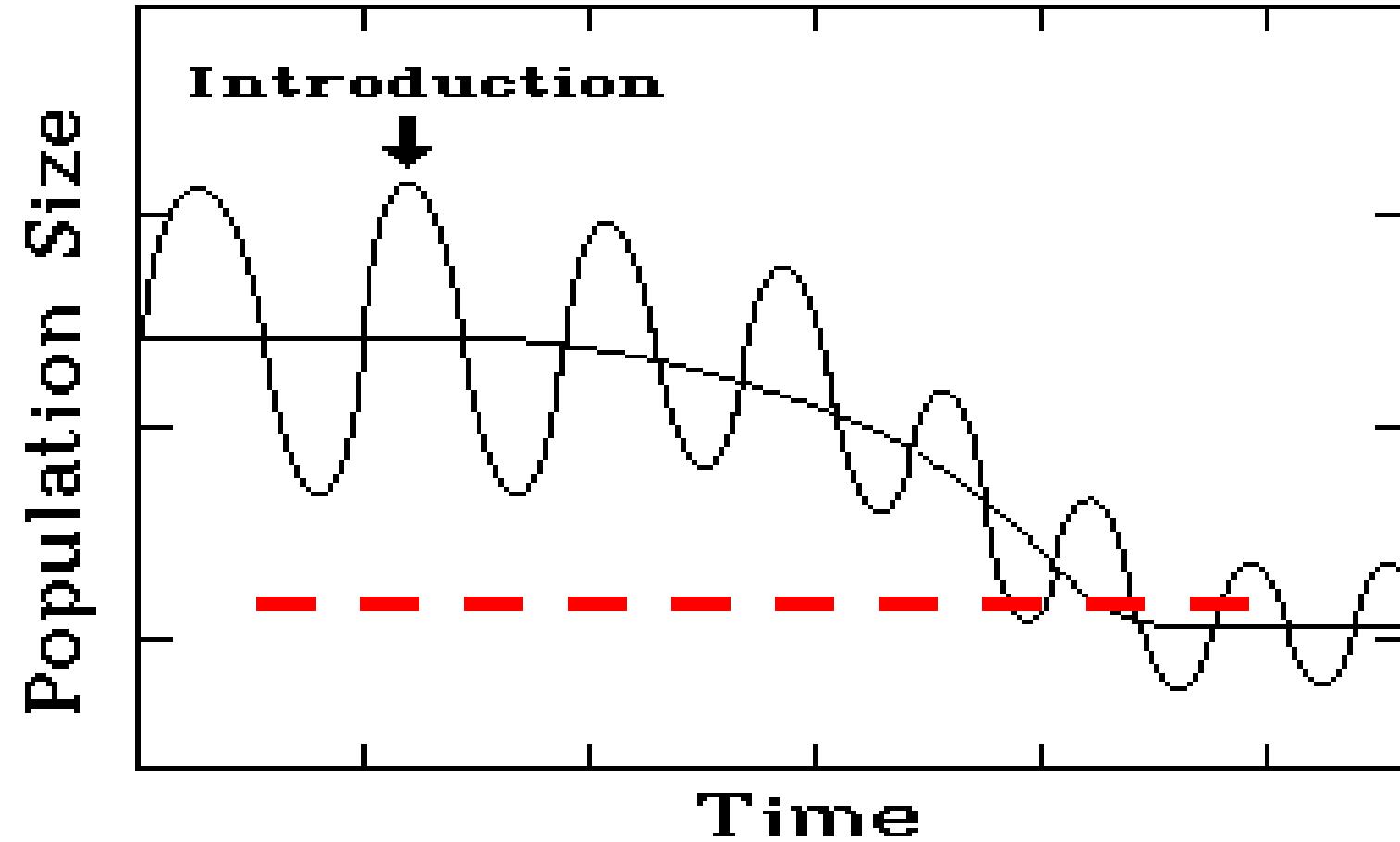
■ Disadvantages

- No agents for several target nonindigenous plants
- Long time for R&D
- Unpredictability of results

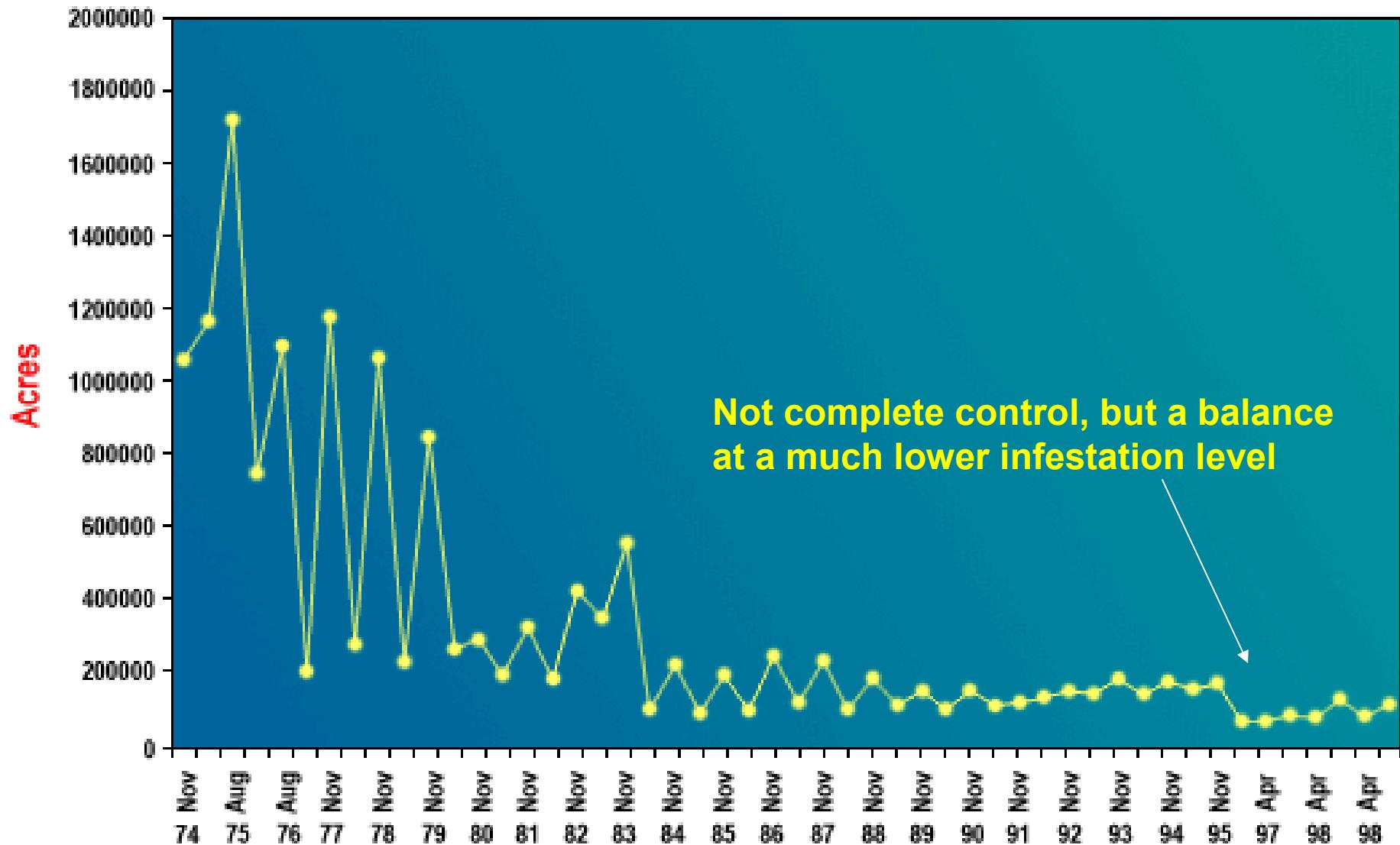
Agasicles hygrophila – Alligatorweed Flea Beetle



Goal of a Classical Insect Biological Control Program – Long term balance



Louisiana Waterhyacinth Data





**Before biological agent release-
monoculture of weedy species**

**After- long term balance-
some weedy species with a lot of natives**



Chemical control to submerged or floating leaf aquatics

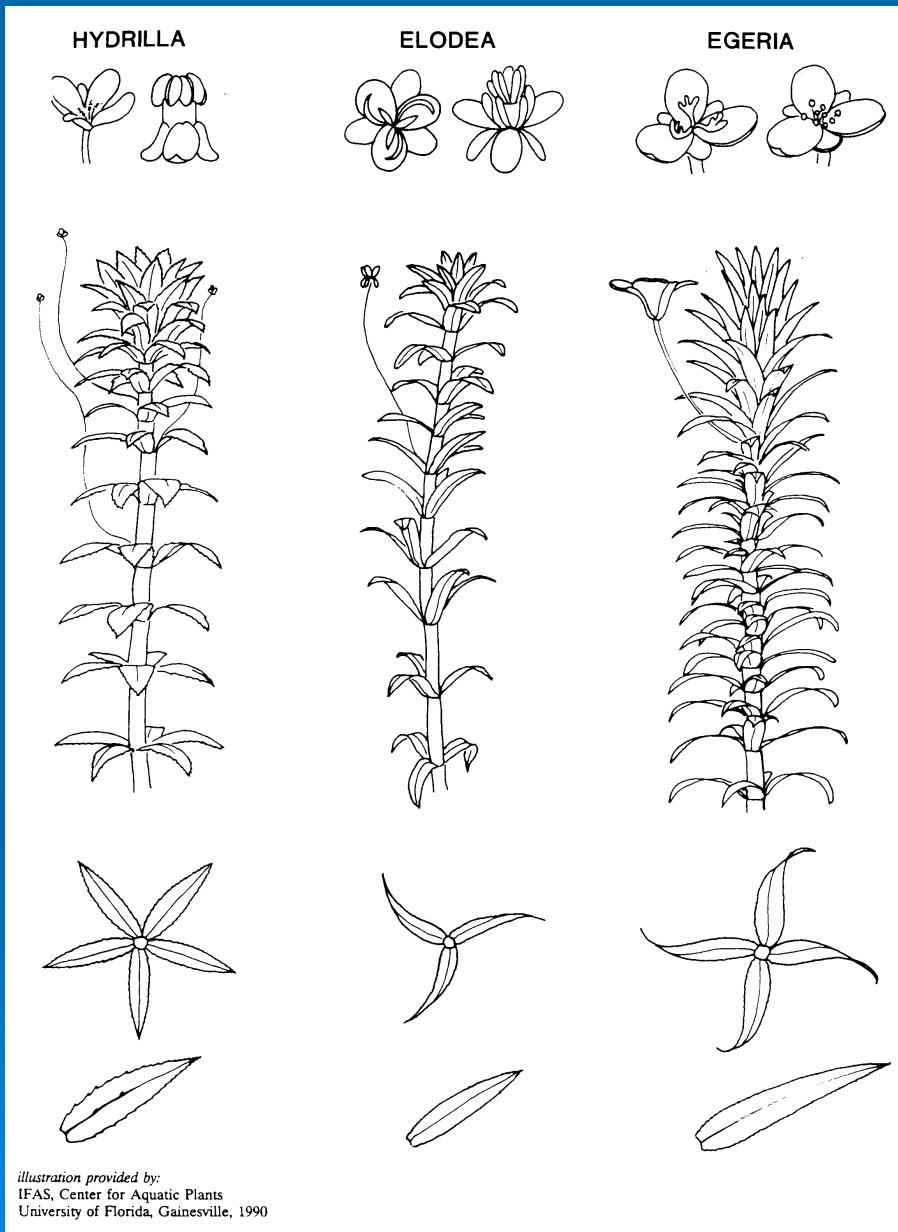


■ Contact

- Complexed copper
- Diquat
- Endothall

■ Systemic

- 2,4-D
- Fluridone
- Glyphosate
- Triclopyr

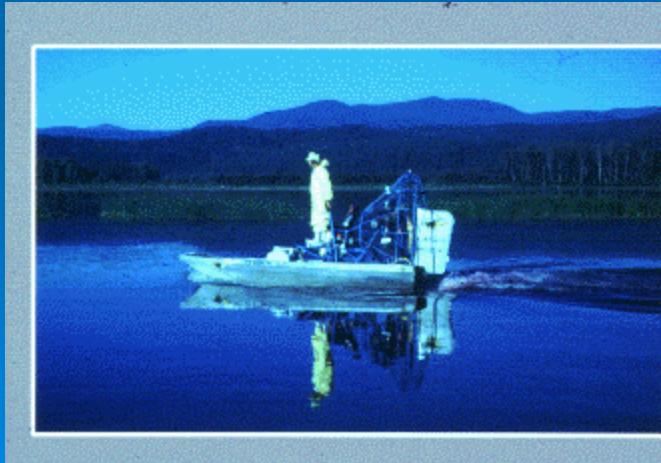


Target Species

- Proper identification of the target species of plant (or algae) is critical for optimal control
- For instance, herbicide selection:
 - Aquathol-K works well on hydrilla
 - Aquathol-K does not work well on egeria

Submersed Application Techniques

- Helicopter, Boat, Airboat
- Surface spray, Subsurface injection, granular spreader



Aquatic Herbicides

Read and follow the label!

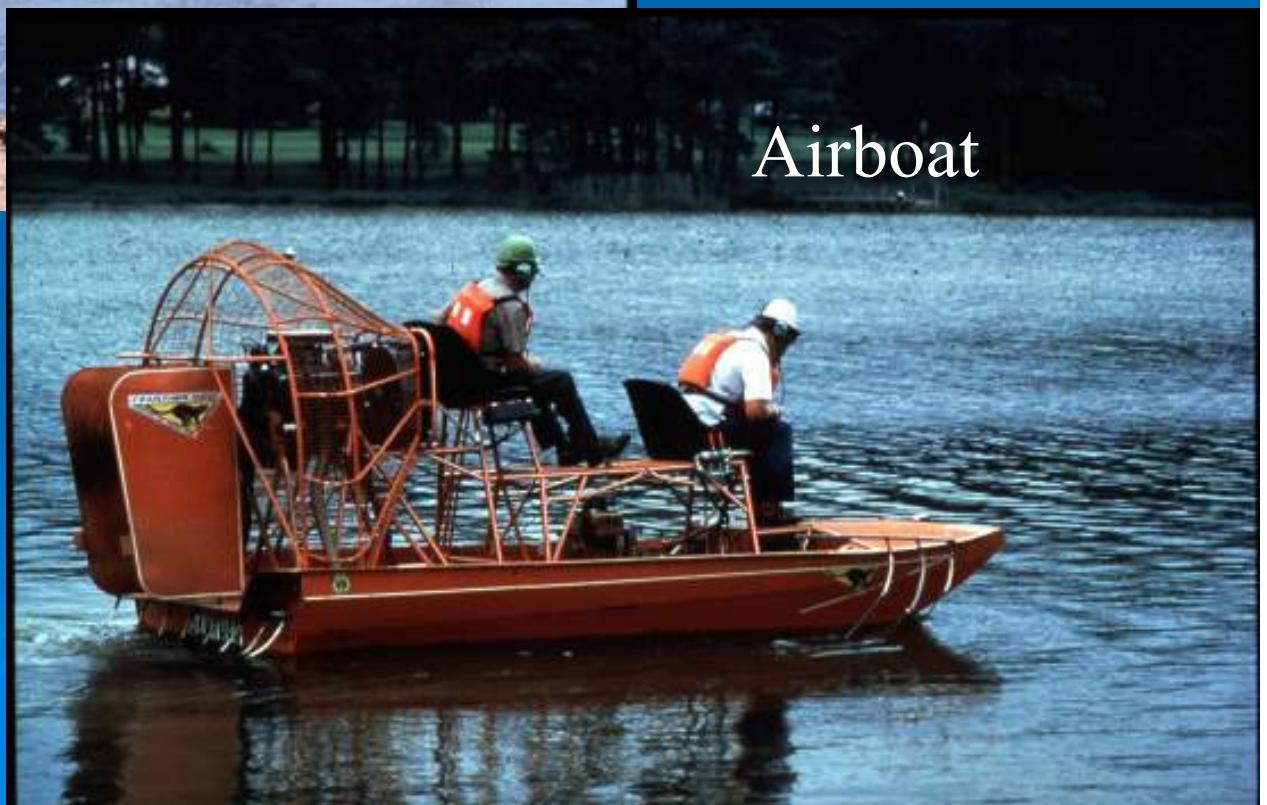


Check with Ag
Commissioner for
local use restrictions.

Application Methods



Airplane



Airboat

Adding Copper Sulfate to an Irrigation Canal



SUBMERSED TREATMENT

WATER EXCHANGE

- FLOW
- TIDES
- WIND
- TEMP

LIQUID

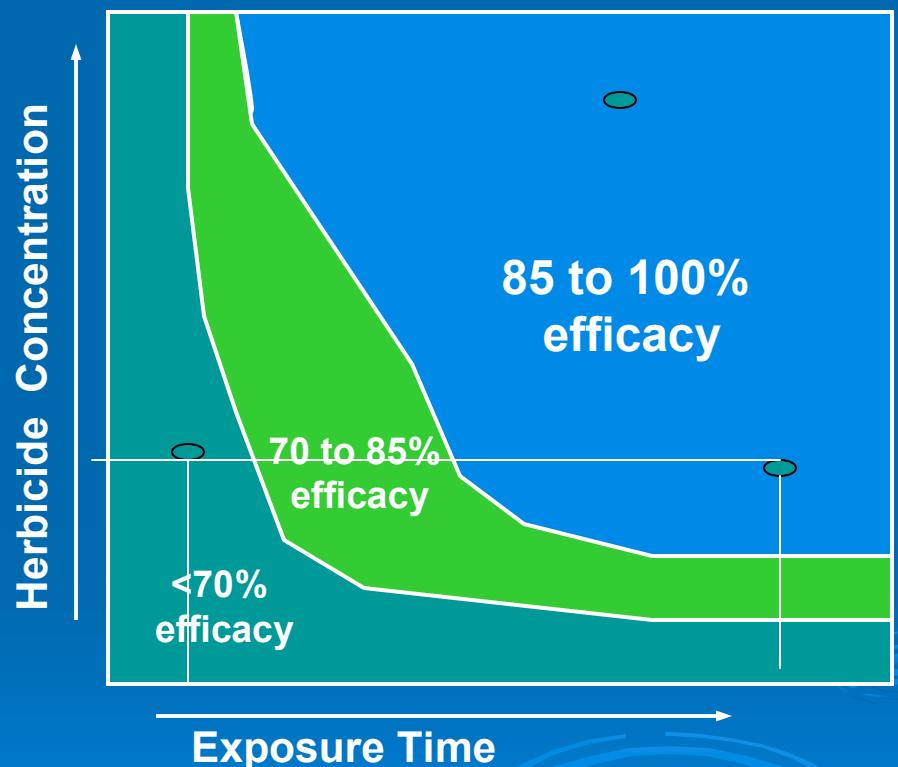
GRANULES

UPTAKE

UPTAKE

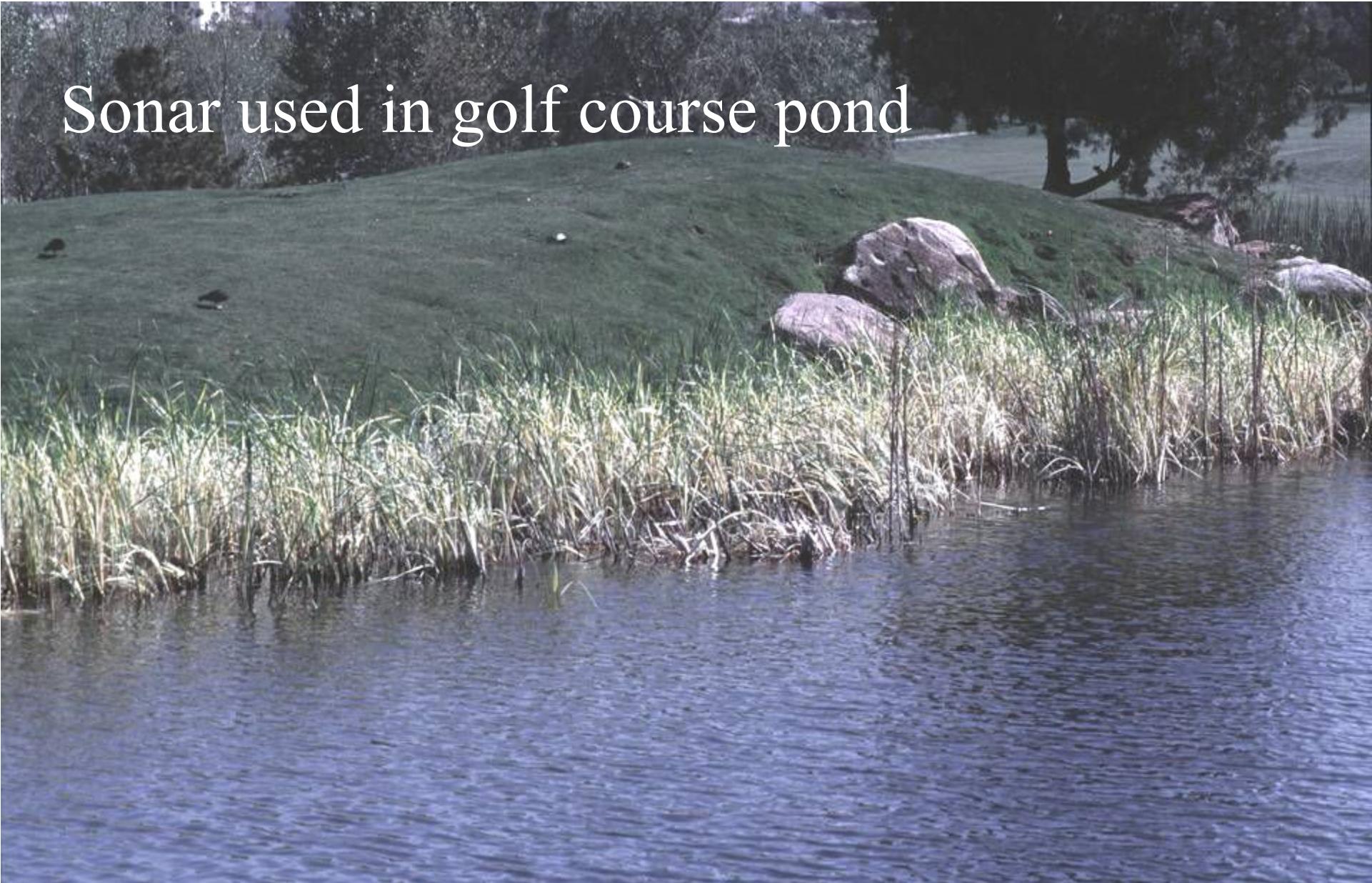
Submersed Plants: Dose & Exposure

- Herbicide efficacy and selectivity dependent on dose and length of exposure to target plant
- Relationships identified for hydrilla and milfoil
 - 2,4-D
 - Endothall
 - Fluridone
 - Triclopyr



Herbicides Used for Submersed Weed Control in Lakes and Reservoirs

Herbicide	Uptake	Half-life (days)	Use
Diquat	FAST	1-7	Spot applications
Copper	FAST	1-5	Spot applications
Endothall	Fast	4-7	Spot applications
Triclopyr	Fast	1-4	Spot applications
Fluridone	Slow	20-90	Only large areas, except for pelleted formulation



Sonar used in golf course pond

Undesired effect –White Cattails

Management Goals and Plans

- The Question:

- What's the best method to control plant X?

- The Answer:

- The best method depends on your management goals given your acceptable economic, environmental, and regulatory limitations

Example of Goals and Management Selection

Target Plant	Your limitation or goal is:	Technique
Eurasian watermilfoil Growing in a small farm pond. You have the ability to drain and add water	Funds	Drawdown or backhoe
	Maintain plant diversity	Triclopyr
	No fishing restriction	Fluridone (SONAR)
	Fish production pond	Shading



Summary of biological management methods for aquatic plants.

Management Method	Description	Advantages	Disadvantages	Systems where used effectively	Plant species response
Grass Carp / White Amur	Herbivorous Fish	Long-term (decades), relatively inexpensive	Cannot control feeding sites, difficult to contain in water body, tendency for "all or none" community response, persistent	Isolated water bodies, effective against hydrilla and other preferred species. Operational.	Fish have strong preference for hydrilla and some native plants, avoid Eurasian watermilfoil, generally do not prefer floating plants
<i>Neochetina</i> spp.	Waterhyacinth weevils	Species selective	Not effective in reducing areal coverage in many situations	Released in Florida, Gulf Coast states. (Developmental)	Leaf scars, some reduction in growth
<i>Hydrellia</i> spp. <i>Bagous</i> spp.	Hydrilla fly, hydrilla stem weevil	Species Selective	Has not yet been established	Released in Florida, Alabama, Texas. (Research)	Limited
<i>Euhrychiopsis lecontei</i> and other native insects	Weevil - native or naturalized	Already established in U.S.	Less selective, currently under R&D	Currently under study in Vermont, Minnesota (Research)	Plants loose buoyancy, weevil interferes with transfer of carbohydrates
<i>Mycoleptodiscus terrestris</i> (Mt)	Fungal pathogen; acts as a contact bioherbicide	Low dispersion, fairly broad spectrum	Expense, cross-contamination, inconsistent viability and virulence of formulation	Under R&D for both Eurasian watermilfoil and hydrilla	"Contact Bioherbicide", plants rapidly fall apart, but regrow from roots
Native Plant Community Restoration	Planting of desirable native plant species or community	Provides habitat, may slow reinvasion or initial invasion	Expensive, techniques still under development	Under R&D around the country	Native plants provide ecosystem benefits, slow invasion

Characteristics of physical management techniques.

Management Method	Description	Advantages	Disadvantages	Systems where used effectively	Plant Species Response
Dredging/ Sediment Removal	Use mechanical sediment dredge to remove sediments, deepen water	Creates deeper water, very long-term results	Very expensive, must deal with dredge sediment	Shallow ponds and lakes, particularly those filled in by sedimentation	Often creates large usable areas of lake, not selective
Drawdown	"De-water" a lake or river for an extended period of time	Inexpensive, very effective, moderate-term	Can have severe environmental impacts, severe recreational/ riparian user effects	Only useful for manmade lakes or regulated rivers with a dam or water control structure	Selective based on perennation strategy; effective on evergreen perennials, less effective on herbaceous perennials
Benthic Barrier	Use natural or synthetic materials to cover plants	Direct and effective, may last several seasons	Expensive and small-scale, nonselective	Around docks, boat launches, swimming areas, and other small, intensive use areas	Nonselective, plant mortality within one month underneath barrier
Shading / Light Attenuation	Reduce light levels by one of several means: dyes, shade cloth, plant trees (rivers)	Generally inexpensive, effective	Nonselective, controls all plants, may not be aesthetically pleasing	Smaller ponds, man-made waterbodies, small streams	Nonselective, but may be long-term
Nutrient Inactivation	Inactivate phosphorus (in particular) using alum	Theoretically possible	Impractical for rooted plants limited by nitrogen	Most useful for controlling phytoplankton by inactivating water column P	Variable

Characteristics of mechanical management techniques.

Management Method	Description	Advantages	Disadvantages	Systems where used effectively	Plant species response
Hand- Cutting/ Pulling	Direct hand pulling or use of hand tools	Low-technology, affordable, can be selective	Labor-intensive, cost is labor-based	Most of the undeveloped world, volunteer labor pools	Very effective in very localized areas
Cutting	Cut weeds with mechanical device (typically boat-mounted sickle bar) without collection	More rapid than harvesting	Large mats of cut weeds may become a health and environmental problem, may spread infestation	Heavily-infested systems	Nonselective, short-term
Harvesting (Cut and Remove)	Mechanical cutting with plant removal	Removes plant biomass	Slower and more expensive than cutting; resuspension of sediments	Widespread use with chronic plant problems	Like cutting, it is cosmetic, non-selective short-term
Grinder or "Juicer" (Cut and Grind)	Mechanical cutting with grinding of plant material and in-lake disposal	Immediate relief of plant nuisance, no disposal	Resuspension of sediments, decomposition of plants in lake, floating plant material	Useful for chronic plant problems where disposal of plants is problematic	Like cutting and harvesting, it is cosmetic, non-selective short-term
Diver-Operated Suction Harvester	Vacuum lift used to remove plant stems, roots, leaves, sediment left in place	Moderately selective (based on visibility and operator), longer-term	Slow and cost-intensive	Useful for smaller nuisance plant populations in which plant density is moderate	Typically have minimal regrowth for Eurasian watermilfoil; not effective for tuber-setting hydrilla
Rotovating	Cultivator on long arm for tilling aquatic sediments	Disrupts Eurasian watermilfoil stem bases, intermediate-term results	May spread large numbers of fragments; resuspension of sediments	Used extensively in the Pacific Northwest and British Columbia, with mixed results	Effective in disrupting Eurasian watermilfoil dense stands; not selective and only intermediate-term

Use suggestions for US Environmental Protection Agency-approved aquatic herbicides.

Compound	Exposure Time (Water)	Advantages	Disadvantages	Systems where used effectively	Plant species response
Complexed Copper	Intermediate (18-72 hours)	Inexpensive, rapid action, approved for drinking water	Does not biodegrade, but biologically inactive in sediments	Lakes as algicide, herbicide in higher exchange areas	Broad-spectrum, acts in 7-10 days or up to 4-6 weeks
2,4-D	Intermediate (18-72 hours)	Inexpensive, systemic	Public perception	Waterhyacinth and Eurasian watermilfoil control, Lakes and slow-flow areas, purple loosestrife	Selective to broad-leaves, acts in 5-7 days up to 2 weeks
Diquat	Short (12-36 hours)	Rapid action, limited drift	Does not affect underground portions	Shoreline, localized treatments, higher exchange rate areas	Broad-spectrum, acts in 7 days
Endothall	Short (12-36 hours)	Rapid action, limited drift	Does not affect underground portions	Shoreline, localized treatments, higher exchange rate areas	Broad spectrum, acts in 7-14 days
Fluridone	Very long (30-60 days)	Very low dosage required, few label restrictions, systemic	Very long contact period	Small lakes, slow flowing systems	Broad spectrum, acts in 30-90 days
Glyphosate	Not Applicable	Widely used, few label restrictions, systemic	Very slow action, no submersed control	Nature preserves and refuges; Emergent and floating-leaved plants only	Broad spectrum, acts in 7-10 days, up to 4 weeks
Triclopyr	Intermediate (12-60 hours)	Selective, systemic	Not currently labeled for general aquatic use	Lakes and slow-flow areas, purple loosestrife	Selective to broad-leaves, acts in 5-7 days, up to 2 weeks

Characteristics of U.S. Environmental Protection Agency-approved aquatic herbicides.

Compound	Trade Name	Company	Formulation; Contact vs. Systemic	Mode of Action	Bluegill 96 hr. LC ₅₀ (mg/L)
Complexed Copper	Cutrine-Plus Komeen Koplex K-Tea	Applied Biochemists (Cutrine) Griffin Corporation	Various complexing agents with copper, superior to CuSO ₄ Systemic	Plant cell toxicant	1250
2,4-D	Aqua-Kleen Weedar-64 Wee-Rhap A-4D Several Others	Cerexagri Nu-Farm Ag Products Helena Chemical	BEE salt DMA liquid IEE liquid Systemic	Selective plant- growth regulator	1.1-1.3 123-230
Diquat	Reward	Syngenta Professional Products	Liquid Contact	Disrupts plant cell membrane integrity	10-140
Endothall	Aquathol K Hydrothal 191 Aquathol granular	United Phosphorous, Inc.	Liquid or granular Contact	Inactivates plant protein synthesis	125 0.06-0.2
Fluridone	Sonar AS Sonar SRP	SePRO	Liquid or granular Systemic	Disrupts carotenoid synthesis, causing bleaching of chlorophyll	9-12.5
Glyphosate	Rodeo	Monsanto	Liquid Systemic	Disrupts synthesis of phenylalanine	4.2-14
Triclopyr	Garlon 3A Renovate	SePRO, others	Liquid Systemic	Selective plant growth regulator	148

Application restrictions of US Environmental Protection Agency-approved aquatic herbicides.

Compound	Persistence (half-life, in days)	Maximum Application Rate	Maximum water concentration	Safety Factor	Application Notes	WES Recommended for
Complexed Copper	3	1.5 gal/ft/acre	1.0 mg/L	>50	Algicide / Herbicide	Hydrilla, other submersed spp.
2,4-D	7.5	0.5 gal/acre	2.0 mg/L	>25	Some formulations for special permits only	Eurasian watermilfoil, water-hyacinth, and others
Diquat	1-7	2 gal/acre	2 mg/L	5	Binds with particles (suspended solids) in water	All
Endothall	4-7	13 gal/acre	5.0 mg/L	>10 (Aquathol) <1.0 (Hydrothal)	Fish are sensitive to Hydrothal 191 - over 1 mg/L may cause fish kill	All submersed spp.
Fluridone	21	1.1 qt/acre	0.15 mg/L (150 ppb)	>20	Applications have been successful below 10 ppb	Most submersed spp.
Glyphosate	14	2 gal/acre	0.2 mg/L	>20	Aerial portions only - not for submersed plants	Most emergent and floating spp.
Triclopyr	na	na	2.5 mg/L	>50	EUP/Special Needs only - US EPA label expected in 1997	Eurasian watermilfoil, water-hyacinth, others