



# **Integrated Weed Management: Mechanical, Biological, Chemical Control**

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# General Perception of Stormwater Ponds

## Multiple Uses

# Prevention

- **Proper pond location**
- **Pond design**
- **Regular Maintenance**
- **Avoidance of weed introductions**

# Aquatic Weed Management Techniques

- Hand removal
- Cultural (physical)
- Mechanical
- Biological
- Chemical
- Revegetation

*The most cost-effective approach is a combination of two or more tactics into an integrated management effort.*

# Weed Management Decisions

- **Plant identification**
- **Budget and Equipment**
- **Control Period - Speed and Duration**
- **Use of the body of water (irrigation, potable water, livestock, fishing, etc.)**
- **Physical, environmental & economic constraints**
- **Water quality**
- **Fish and wildlife populations (including threatened and endangered species)**

# Physical Removal

- Pros
  - Chemical free
  - Provides fast results
  - Generally doesn't require permitting or licensing
- Cons
  - Can spread weeds
  - Time and labor intensive
  - Can be very expensive



# Mechanical Removal

- Harvesters
  - Expensive
  - Rental?
  - What will you do with harvested weeds



# Mechanical Removal

- Land Based Machinery
  - Expensive
  - What to do with harvested weeds



# Mechanical Removal

- Hand Tools
  - Great option for small ponds
  - Compost harvested weeds
  - Relatively inexpensive



# Mechanical Removal

## Advantages

- Complete, immediate vegetation removal
- No herbicide residues to cause concern
- Nutrients are removed from the system
- More aesthetically appealing, no dead plant eyesores
- No decaying vegetation to cause odors, oxygen depletion, and fish kills
- Considered environmentally benign by the public

# Mechanical Removal

## Disadvantages - I

- Accessibility may be limited by obstructions (trees, stumps, boulders), depth, or launching limitations.
- Disposal of vegetation necessary: plants have high water content, transportation may be required to carry them to the shore and then to a landfill.
- Equipment is expensive, slow, inefficient (only a few acres can be harvested per day), and susceptible to frequent breakdowns.

# Mechanical Removal

## Disadvantages - II

- Cost per acre is very high, particularly around docks and piers (may exceed \$2,000 per acre per cutting, with 2 or more cuttings per season).
- Vegetative fragments may spread to new areas within the same body of water or be carried on equipment to infest another body of water.
- Fish, turtles, frogs, snakes, and aquatic invertebrates associated with the vegetation also *MAY* be removed.

# Equipment Used for Mechanical Weed Removal

- Chains pulled by shore-based vehicles
- Hand-held or small, boat-mounted cutter bars
- Specialized cutter boats (which cut trails, but throw the vegetation back into the water).
- Backhoes, draglines, dredging equipment
- Specialized, barge-mounted weed harvesters

# Biological Control

- Species Available
  - Tilapia
  - Triploid Grass Carp

## Pros

- Permanence (classical or inoculative approach)
- Low maintenance costs, not necessary to repeat every growing season
- No chemical residues for concern
- Minimal environmental damage
- Desirable species usually unaffected (classical)
- Usually perceived by the public as acceptable

## Cons

- Effective control may require several growing seasons, even under the best circumstances.
- Initial costs are relatively high (when amortized over the long term, costs usually are low, compared with other methods of aquatic weed management).
- Biological control agents are susceptible to a wide variety of human and environmental interferences.



# Biological Control

- Tilapia
  - Blue (*Oreochromis aureus*)
  - Nile (*Oreochromis niloticus*)
  - Red-Bellied (*Tilapia zillii*)
- Stocking
  - April-May @ 200-400/acre
- Cold Tolerance
  - Lethal Limit  $\approx 50^{\circ}\text{F}$



**A Permit from SCDNR is  
REQUIRED in South Carolina**

# Biological Control

## Blue Tilapia

### *Oreochromis aureus*

- Most cold tolerant species available.
- Primarily feeds on algae
- Minimal consumption of vascular plants
- Capable of filter feeding on planktonic algae
- Spawn begins when waters reach 68°F and continues throughout summer and fall.
- Mouth brooders



# Biological Control

## Nile Tilapia

*Oreochromis niloticus*

- Moderate cold tolerance
- Feed primarily on planktonic algae
- Will consume filamentous algae
- Spawning begins at 66-68°F and may continue into Fall
- Mouth brooders



# Biological Control

## Red-Bellied Tilapia

*Tilapia zillii*

- Low cold tolerance
- Primarily feed on aquatic macrophytes
- Will consume filamentous algae
- Spawning begins at 72°F and last throughout summer into fall.
- Nest guarders



# Biological Control

## Triploid Grass Carp

*Ctenopharyngodon idella*

- Overwinter well
- 5 years of quality service
- May live 20 years and reach weights in excess of 30lbs
- Primarily feed on aquatic macrophytes
- Preferred plants include: Spikerush, Chara, Pondweeds, and Naiads



# Use of Grass Carp in Aquatic Weed Management

- Grass carp may live 10 years or longer and grow to more than 50 lbs. in size.
- Grass carp may provide effective, long-term control of macroalgae and most species of submersed weeds.
- Only the triploid sterile grass carp are permitted in South Carolina (some states do not permit grass carp).
- Stocking usually is limited to ponds and larger impoundments with little outflow.
- Stocking in open systems usually is not permitted.

# Stocking Recommendations for the Tripliod Grass Carp

- SC requires a **permit** from SCDNR before grass carp may be purchased. Vendors generally furnish it.
- Stocking rates vary but generally are 5 fish per acre for prevention or 20-25 fish per **vegetated** acre when aquatic weeds are present.
- Fish should be 10" to 12" long to reduce predation.

# Weeds Usually Controlled by the Triploid Grass Carp

- American elodea
- Bladderwort
- Brazilian elodea
- Brittle naiad
- Creeping rush
- Coontail
- Fanwort
- Hydrilla
- Muskgrass (*Chara*)
- Pondweed
- Proliferating spikerush
- Southern naiad
- Stonewort (*Nitella*)
- Widgeongrass

All of these plants are submersed; all except muskgrass are vascular, flowering plants

# Introduction to Chemical Control

- Chemical control involves the application of EPA registered aquatic herbicides and algaecides as a management tool for noxious aquatic vegetation.
- Proper handling and use of these herbicides poses no significant threat to the aquatic environment or human health.
- All aquatic weed management techniques have some impact on the environment.
- The impacts of aquatic weed management activities, including herbicide and algaecide application are usually short in duration.

# Advantages of Chemical Control

- Relatively easy to use
- Fairly broad-spectrum activity
- Fairly quick kill of target weeds (most cases)
- Most herbicides effective for spot treatments (prevent spread of new weeds)
- Less expensive and labor intensive than hand removal or mechanical control
- Gives longer control than with hand removal or mechanical control

# Disadvantages of Chemical Control

- Accessibility sometimes limited (obstructions, etc.)
- Limited choice of products (some very expensive)
- May damage desirable vegetation as well as weeds
- Limited contact time due to dilutions and flow
- Off-target movement of chemicals with water flow
- Localized oxygen depletion may occur
- Nutrient release from dying and decaying weeds
- Damaged weeds may float away and root elsewhere
- Herbicide persistence and toxicity problems

# Chemical Control

- NPDES Requirements
- Pesticide Licensing
- Herbicide Labeling
- Effective Chemistries
- Water Use Restrictions
- Selecting the Right Herbicide
- Herbicide Additives
- Tank Mixes
- Application Techniques



# Chemical Control

## National Pollution Discharge Elimination System (NPDES)

- **Federal Law**
  - Marriage of Clean Water Act and Federal Fungicide, Insecticide, and Rodenticide Act
  - EPA Regulations
  - Administered by SCDHEC
- **Permit Requirements**
  - General Permit
    - Less than 200 acres or 20 miles of shoreline.
- **Above Thresholds**
  - **Notice of Intent (NOI)**
    - Submit notification 15 days prior to application.
  - **Integrated Pest Management**
    - You may be required to implement IPM
  - **Pesticide Discharge Management Plan**
    - Required to develop and submit pesticide usage documentation



# Chemical Control

## Pesticide Licensing

- **Private Applicator License**
  - Required for purchasing Restricted Use Pesticides for Personal Use.
  - Requires 5 hours continuing education per cycle.
- **Commercial Aquatic Applicator License**
  - Required for all for hire aquatic herbicide application activities. Required for multi-owner ponds (HOAs).
  - Required to carry 50/100K insurance.
  - Requires 10 hours continuing education, 3 aquatic specific.
- **Non-Commercial Aquatic Applicator License**
  - Required for government employees who make aquatic applications to government property.
  - No insurance requirement.
  - Requires 10 hours continuing education, 3 aquatic specific.



# Chemical Control

## Herbicide Labeling

- **Always read the label!**
- Labels will tell you which species the product controls.
- The label will tell you how to apply and how much to apply.
- Always follow the directions and never over apply.
- **The Label is the Law!**

The image shows a detailed view of a pesticide label, divided into several numbered sections:

- 4) PRECAUTIONARY STATEMENTS HAZARDS TO HUMANS (ACUTE AND CHRONIC) DANGER**
- 5) ENVIRONMENTAL HAZARDS**
- 6) PHYSICAL OR CHEMICAL HAZARDS**
- 7) DIRECTIONS FOR USE**  
It is a violation of Federal law to use this product in a manner inconsistent with the directions.
- 8) RE-ENTRY STATEMENT**
- 9) CATEGORY OF APPLICATION**
- 10) STORAGE AND DISPOSAL**  
STORAGE: \_\_\_\_\_  
DISPOSAL: \_\_\_\_\_
- 7) CROP**
- 11) RESTRICTED USE PESTICIDE**  
FOR RETAIL SALE TO AND APPLICATION ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION
- 1) PRODUCT NAME**
- 2) ACTIVE INGREDIENT** \_\_\_\_\_ %
- 3) INERT INGREDIENTS** \_\_\_\_\_ %  
TOTAL \_\_\_\_\_ 100.0%
- THIS PRODUCT CONTAINS \_\_\_\_\_ OZS OF \_\_\_\_\_ PER GALLON
- KEEP OUT OF REACH OF CHILDREN**
- 12) DANGER — POISON**
- 13) **
- 14) STATEMENT OF PRACTICAL TREATMENT**  
IF SWALLOWED: \_\_\_\_\_  
IF INHALED: \_\_\_\_\_  
IF ON SKIN: \_\_\_\_\_  
IF IN EYES: \_\_\_\_\_
- SEE SIDE PANEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS
- 15) MFG BY** \_\_\_\_\_  
**TOWN, STATE** \_\_\_\_\_
- 16) ESTABLISHMENT NO.** \_\_\_\_\_  
**EPA REGISTRATION NO.** \_\_\_\_\_
- 17) NET CONTENTS** \_\_\_\_\_
- WARRANTY STATEMENT**

# Chemical Control

## Application Rates and Cautions

- Labels provide information on amount of herbicide to apply based on either SURFACE ACRES or WATER ACRES/ACRE FEET.
  - **Surface Acres** – 2 dimensional measurement, depth not considered. Area of pond.
  - **Water Acres/Acre Feet** – 3 dimensional measurement, depth included. Area of pond x average depth.
- Alkalinity and Hardness concerns
  - Certain chemistries may be toxic to fish or ineffective on plants in relation to water alkalinity or hardness. Labels will provide information on concerns pertaining to alkalinity and hardness.



# Chemical Control

## Effective Aquatic Chemistries

- 2,4-D
- Bispyribac
- Carfentrazone
- Copper
- Diquat
- Endothol
- Flumioxazin
- Fluridone
- Glyphosate
- Imazamox
- Imazapyr
- Penoxsulam
- Sodium Carbonate Peroxyhydrate
- Triclopyr



# Chemical Control

## Water Use Restrictions

- Herbicides may require a waiting period before treated waters may be used for various activities.
  - Irrigation
  - Fish Consumption
  - Watering Livestock
  - Swimming



# Chemical Control Herbicide Selection

- E** = Excellent Control (90 to 100%)
  - G** = Good Control (80 to 89%)
  - F** = Fair Control (70 to 79%)
  - P** = Poor Control (<70%)
- \* A blank space indicates weed response is not known

[\\*Click for list of available herbicides\\*](#)

[\\*Click for Application Rates\\*](#)

[\\*Click for Water Use Restrictions\\*](#)

Weed	Copper complexes, copper sulfate (various)	2,4-D (various) Navigate®	Diquat (various) Reward®	Endothal		Fluridone Sonar®	Glyphosate AquaMaster®	Triclopyr Renovate®	Imazapyr Habitat®	Sodium Carbonate Peroxyhydrate Greenclean®
				Aquathol K Aquathol G	Hydrothol G Hydrothol 191					
<b>ALGAE</b>										
Filamentous	E	P	P		G					E
Planktonic	E	P	G		G					E
Branched (Chara)	E	P	G		G					
Nitella	E	P	G		G					
<b>FLOATING PLANTS</b>										
Bladderwort	P	P	E			E				
Duckweeds	P	G	G	P	P	E	P		E	
Water Hyacinth	P	E	E			P	G	E	E	
Watermeal	P	P	P			G	P			
<b>SUBMERSED PLANTS</b>										
Broadleaf watermilfoil	P	E	E	E	E	E	P	E		
Coontail	P	G	E	E	E	E	P			
Egeria	P	P	G	F	F	E	P			
Elodea	P	P	E	F	F	E	P			
Eurasian watermilfoil	P	E	E	E	E	E	P	E		
Fanwort	P	F	G	E	E	E	P			
Hydrilla	F	P	G	G	G	E	P			
Naiads	P	F	E	E	E	E	P			
Parrotfeather	P	E	E	E	E	E	F	F	E	
Pondweeds (potamogeton)	P	P	G	E	E	E	P			
<b>EMERGENT PLANTS</b>										
Alders	P	E	F	P	P	P	E			
Alligatorweed	P	F	P	P	P	G	E	E	E	
American lotus	P	E	P	P	P	F	G	E	E	
Arrowhead	P	E	G	G	G		E		E	
Buttonbush	P	E	F	P	P	P	G		E	
Cattails	P	G	G	P	P	F	E		E	
Common Reed	P	P	P	P	P	P	G		E	
Fragrant & white waterlily	P	E	P	P	P	E	E	E	E	
Frogbit	P	E	E					E	E	
Maidencane	P	P	F			F	E		E	
Most grasses	P	P	P	P	P	P	G		E	
Pickeralweed	P	G	G			P	F	E	E	
Pond edge annuals	P		G			E	E		E	
Rush	P	P	F	P	P	F	E		E	
Sedges and rushes	P	F	F	P	P	P	G		E	
Slender spikerush	P		G			G	P			
Smartweed	P	E	F			F	E	E	E	
Spatterdock	P	E	P	P	P	E	E	E	E	
Southern watergrass	P	P				G	E			
Torpedograss	P	P	P			F	G		E	
Watershield	P	E	P			G	G			
Water pennywort	P	G	G	P	P	P	G	E	E	
Water primrose	P	E	F			F	E	E	E	
Willows	P	E	F	P	P	P	E		E	

# Chemical Control

## Herbicide Additives

- Surfactants
  - Cut the waxy cuticle on plants.
  - Allow herbicide to penetrate the plant.
  - Help herbicides stick to plants.
  - Help herbicides sink.
  - Provide a visual trail for submerged applications



# Chemical Control

## Tank Mixes

- Use of multiple herbicides simultaneously
- Herbicides must be compatible
- Safe chemistry mixes will be discussed on label
- Utilize multiple Modes of Action



***The label is the law!***

# Do I Need A Pesticide License?

- South Carolina Law requires individuals to possess a Commercial Pesticide Applicators License in Category 5, Aquatic Pest Control, before they apply aquatic herbicides if the work is done for compensation on the property of another.
- A license is also required, regardless of ownership, if the application is made to an area where public access to the treated site is expected.
- Private swimming lakes, where the public would be exposed to the treated waters, are the most obvious example of the latter requirement.
- On all public facilities, such as golf courses, driving ranges, subdivisions, condominium/apartment complexes and mobile home parks, applicators are required to possess a Category 5 License to apply aquatic pesticides.
- Certain aquatic pesticides require an Aquatic Pesticide License for any purchase and application.

# Questions

- **Applicator License?**
- **Water Use Restrictions?**
- **Downstream Uses?**
- **Ownership?**
- **Local Ordinances?**
- **HOA Covenants?**
- **SC DHEC Buffers?**
- **Read and Follow The Label?**

# Available Resources

## Online Sources of Aquatic Weed ID and Control Information

### **Aquaplant**

Aquaplant is an excellent website that provides information on aquatic plant identification, control recommendations, and herbicide specific information. While visiting this site, users can identify the plant they are having trouble with, determine which control methods would be most effective, and print the label for any herbicide they choose to use.

<http://aquaplant.tamu.edu/>



# Available Resources

## Online Sources of Pond Management and Control Information

**Clemson Home and Garden Information Center** <http://www.clemson.edu/extension/hgic/>

The Clemson Home and Garden Information Center offers easily understood factsheets on almost any home and garden information. The pond series includes factsheets on:

Fertilizing Recreational Fish Ponds

Liming Recreational Ponds

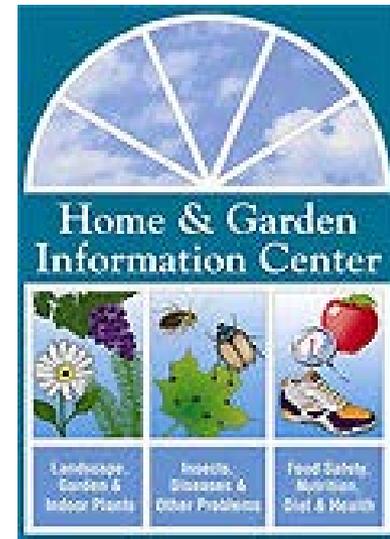
Stocking & Harvesting Recreational Fish Ponds

Use of Rotenone for Management of Fish Populations

Aquatic Weed Control Overview

Biological Control of Aquatic Weeds

Chemical Control of Aquatic Weeds



# Available Resources

## Online Sources of Aquatic Weed ID and Control Information

### Center for Aquatic and Invasive Plants

- This website provides information on aquatic weed identification for hundreds of species. Numerous images can be found for each species contained in the database. The site is not as user friendly as Aquaplant, but it does contain species that are not found on Aquaplant. It is an excellent identification source when Aquaplant fails.

<http://plants.ifas.ufl.edu/>



# Available Resources

## Online Sources of Aquatic Weed ID and Control Information

### South Carolina Department of Natural Resources

<http://www.dnr.sc.gov/water/aquaff/>

- The SCDNR site contains identification information for some of the most commonly occurring aquatic weeds found in the state. The site offers detailed identification information on these plants including descriptions and photographs.



# Available Resources

## Online Sources of Aquatic Weed ID and Control Information

- South Carolina Department of Natural Resources
- The Department maintains online an up to date listing of fish dealers and the types of fish each dealer sells.
- If you are stocking fish for recreational fishing, biological weed control or fish farming, the list is a great help.
- <http://www.dnr.sc.gov/wildlife/publications/pdf/AquaculturistVendorsList.pdf>



# Available Resources

## Mobile Apps

### Clemson University

#### “Calibrate My Sprayer”

- Improperly calibrated pesticide spraying equipment may cause either too little or too much pesticide to be applied. This free mobile app was created to aid in the proper calibration of spraying equipment. Simply select the type of sprayer you want to calibrate (Broadcast or Banded), insert values in each input box, select what you want the app to calculate (Volume/Area or Catch/Nozzle), and tap 'Calculate'. Each input's units can be customized by tapping the units. Sprayers can be saved with user-defined names.
- This free mobile smartphone app is designed for iPhone, iPod Touch, iPad and Android devices

<http://www.clemson.edu/extension/mobile-apps/>



# Available Resources

## Mobile Apps

### Clemson University “Mix My Sprayer”

- Mix My Sprayer was created to aid with quick, accurate calculations of product mixes to be applied with spraying equipment. Users can create custom lists of favorite products by category. Simply add or select a product, insert values in each input box, and the app automatically calculates the amount of product to include in the user-defined mix size. Units for each input can be customized by tapping the unit buttons. Products are saved with the user settings last used.
- This free mobile smartphone app is designed for iPhone, iPod Touch, iPad and Android devices.

<http://www.clemson.edu/extension/mobile-apps/>



# Available Resources

## Mobile Apps

### Texas A&M “Pondcalc”

- **PondCalc** is a comprehensive tool for recreational pond users as well as aquaculture producers. One of the most common problems in pond management is over-estimation of pond size. This tool allows the user to quickly and easily calculate the surface area of any shaped pond and then calculate the number of acre feet, all without having to do any math. These calculations allow the user to determine accurate pond area and volume for the application of chemical treatments and herbicides

<http://aquaplant.tamu.edu/userul-apps/>



# Available Resources

## Mobile Apps

### Texas A&M “AquaRef”

- **AquaRef** – The aquaculture and pond manager quick reference guide is an inclusive set of tables and conversion factors for aquaculture professionals. Conversion factors range from the weight of chemical units that must be added to water to achieve particular concentrations to temperature conversion to volumetric water conversion factors to metric-English conversion for chemicals. This guide is packed full of useful information including pond filling time, pumping rate equivalents, discharge rates from standpipes, net mesh sizes for grading fish, length/weight relationships for fish, oxygen saturation points, pounds of fish that can be hauled at temperature, egg development stages, stocking guides, fertilization rates, and much more. Texas A&M AgriLife Extension’s AquaRef is credited in large part to Larry Dorman with the University of Arkansas at Pine Bluff, as he developed many of these materials for the quintessential Aquaculture Producer’s Quick Reference Handbook. Tables were reproduced with permission.

<http://aquaplant.tamu.edu/useful-apps/>



# Available Resources

## Mobile Apps

<http://aquaplant.tamu.edu/useful-apps/>

### Texas A&M

#### “Aquaplant”

- **AquaPlant** is designed to help pond owners and their advisors in the identification and management of aquatic vegetation. Aquatic vegetation management can be a perplexing problem. The first part of that problem is proper identification. Management of most aquatic plant species depends on properly identifying the desirable or nuisance plant. After identification of the aquatic plant is achieved with the visual index and description pages of AquaPlant, the user can then use the management section for each species to learn the correct treatment options including biological, mechanical, and herbicide controls.



# Available Resources

## Mobile Apps

<http://aquaplant.tamu.edu/useful-apps/>

### Texas A&M “Aquacide”

- **Aquacide** – The Aquatic herbicide selection, effectiveness, and restriction guide is a tool for recreational pond managers as well as aquaculture professionals. This comprehensive visual guide helps you select the most effective herbicides for all aquatic vegetation classes, including the most common North American algae and floating, submerged, and emergent aquatic vegetation. Only herbicides that provide good or excellent control are provided for each species. AquaCide provides the environmental restrictions of all aquatically labeled herbicides, such as restrictions for human use (drinking, swimming, and fish consumption), livestock watering, irrigation (turf and crops), and other general comments pertaining to restrictions and differences in formulation



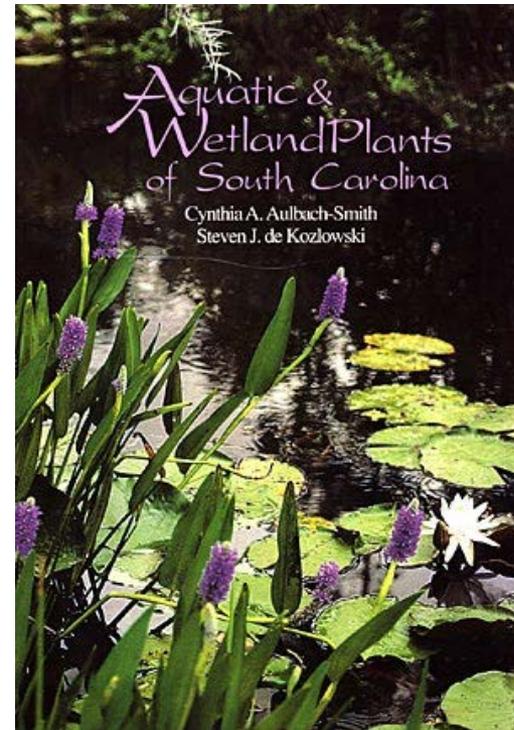
# Available Resources

## Books

### **Aquatic and Wetland Plants of South Carolina**

- This book provides detailed information on aquatic plants found in South Carolina including; descriptions of plants, distributions, and photographs. It is a wonderful resource and field guide to South Carolina's aquatic plants.

Written by  
Cynthia A. Aulbach-Smith and Steven J. de Kozlowski



# Available Resources

## Books

### **A Manual of Aquatic Plants**

- Fassett prepared the data to make the identification of aquatic plants as simple as possible, not only when they are flowering or fruiting, but also in sterile condition. The Manual covers a region from Minnesota to Missouri and eastward to the Gulf of St. Lawrence and Virginia. Originally published in 1940, the Manual was reissued in 1957 with revised nomenclature and other updates by Eugene C. Ogden

Written by  
Norman C. Fassett

