Aquatic Weed Control Techniques

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Nonindigenous vs. Native Community

Alternanthera philoxeroides
Alligatorweed

Nelumbo lutea
American lotus

Getting a Good Plant ID:

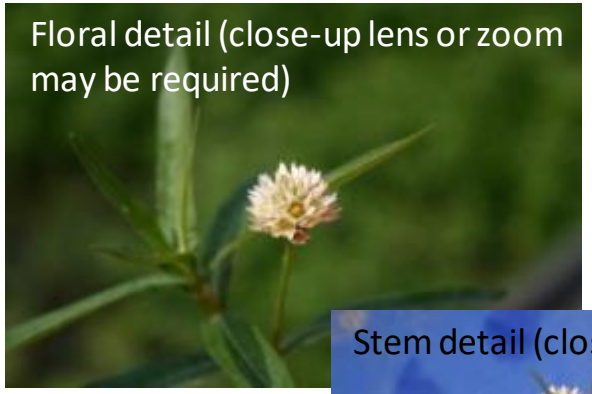
- This is first step in Management:
  - Publication Guides
  - Online Keys
- Experts - Send Photos or Live plant
- A number of people can identify aquatic plants in your region
  - Your Extension agent or specialist likely knows who they are

Applicator preparing to treat a storm water retention pond overgrown with water lettuce

Getting a Good Plant ID:

- Live Plant
  - Wrap in damp paper towel
  - Place in Ziploc bag
  - Ship on ice overnight to MSU

- Sending good quality digital photos are best way to get a good ID
  - Flower
  - Close-Up
  - Habitat



Getting a Good Plant ID:

- Proper identification is critical to selecting the correct herbicide
  - E.g., Aquathol K (endothall) is excellent for egeria, good for hydrilla, poor for elodea
  - They are in the same family

- Proper identification will also indicate if there is an invasive problem or a localized native nuisance

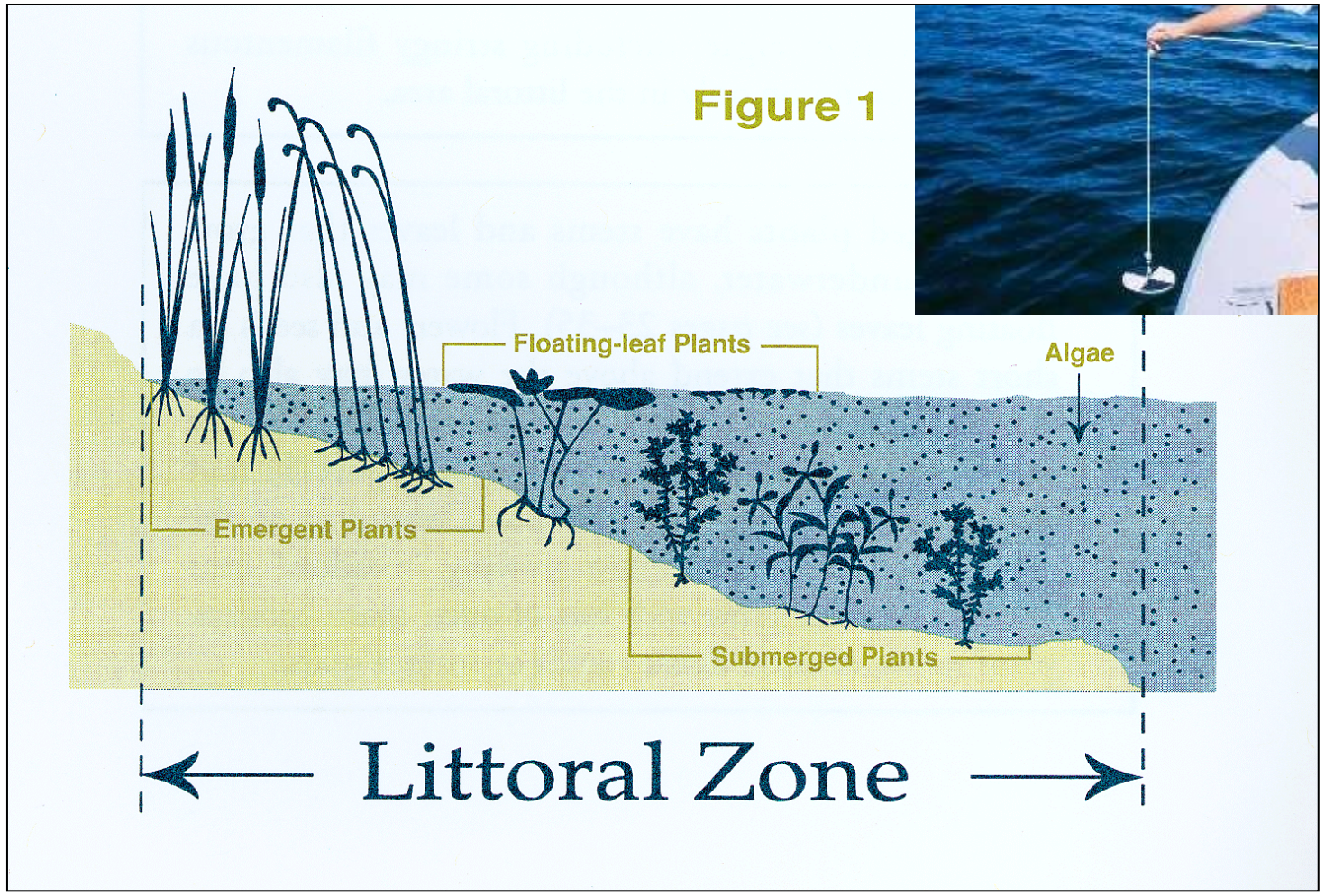
Hydrilla verticillata *Elodea canadensis*

Growth Form:

- Growth form is key step in plant ID

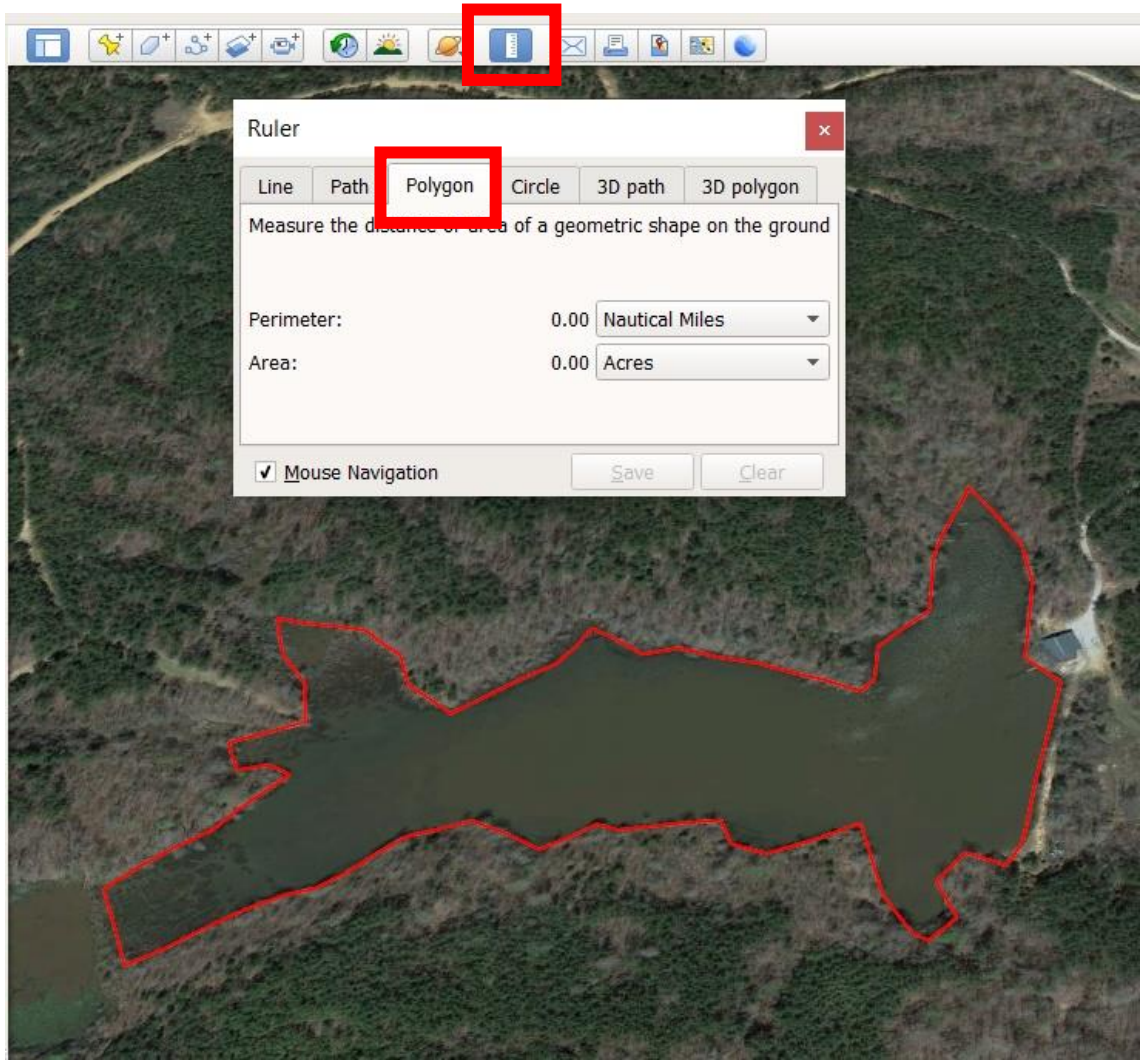
- Littoral zone is that area of lakebed that receives enough sunlight for aquatic plants to grow

- Changes seasonally as water clarity changes
  - 3X Secchi Depth
  - Free-floating plants and algae not restricted to littoral zone



How Big is Your Problem?

- For emergent and floating leaf plants, the AREA is the critical calculation needed (with a few exceptions)
- For submersed plants and algae, water VOLUME is the critical calculation needed (some exceptions)
- Software can help with this
  - Google Earth Pro



How Big is Your Problem?

- Spend the time to take 20 or so depth soundings with a rod or sonar across the surface area of a pond
  - Or infested area
- Average these measurements for the avg depth
- Volume = area x avg. depth
  - Ac-ft.

Develop a Management Plan

- Identify problem
- Define management goals
- Select management technique
  - Assess logistics and budget
  - Identify alternatives
- Monitor…monitor some more
- Switch tactics if needed

Develop a Management Plan

- Useful metrics (Collect every 3-4 months):
  - Littoral depth
  - Water temperature
  - Water hardness/alkalinity
  - Plant community
    - %-cover or relative abundance of each spp.
  - Fish harvest/stocking rates
  - Fish feeding rates

- Start collecting before management begins

Aquatic Plant Management Approaches:

- Prevention is Best!
- Biological Control
- Mechanical Control
- Physical Control
- Chemical Control
- Integrated Control

Invasion Process:

- Lag Phase
  - Plants may go unnoticed
  - Eradication possible
- Exponential Growth Phase
  - Usually when management begins
  - Maintenance Management is target
- Carrying Capacity
  - Invasive spp. start to form large monocultures

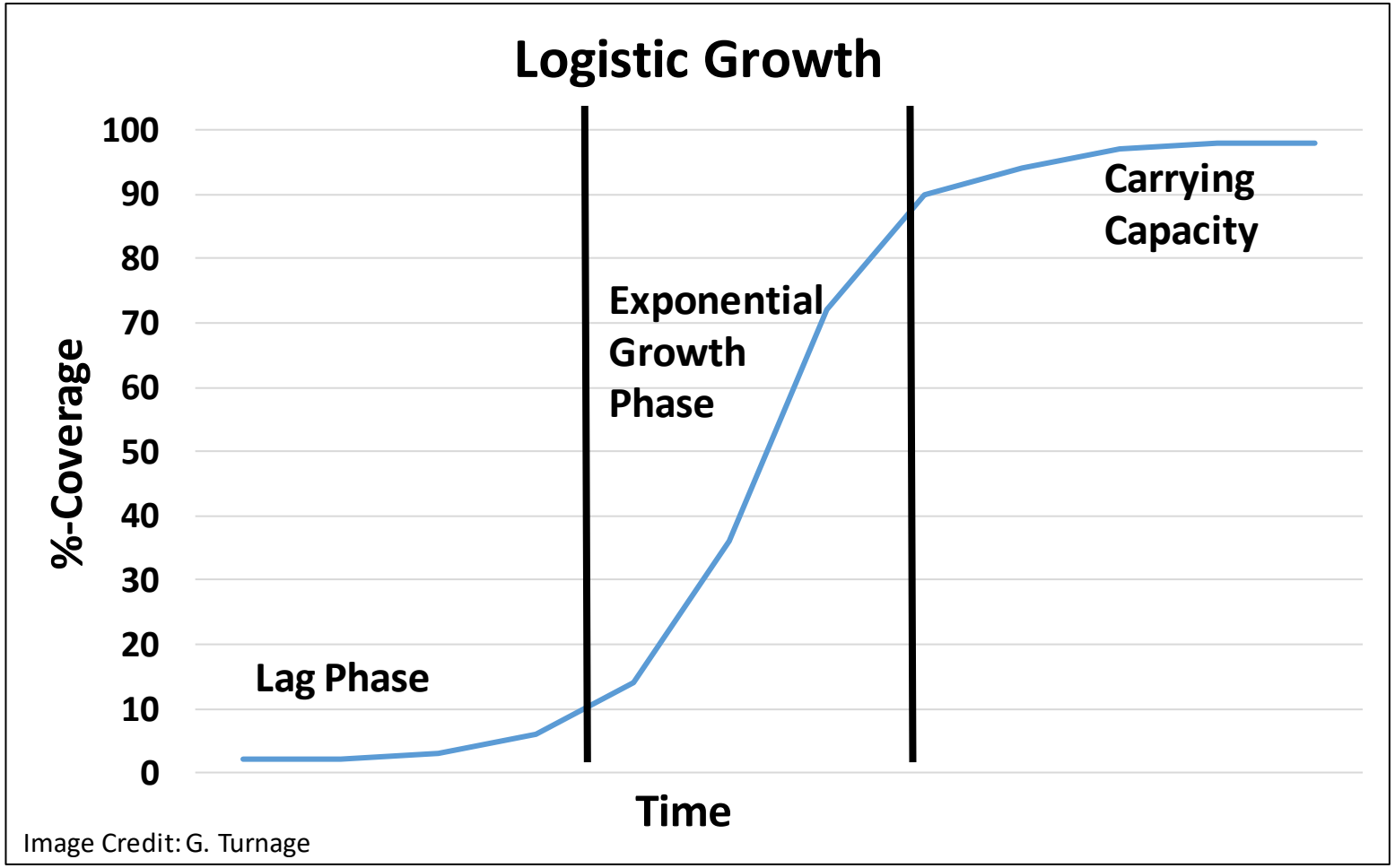


Image Credit: G. Turnage

Prevention:

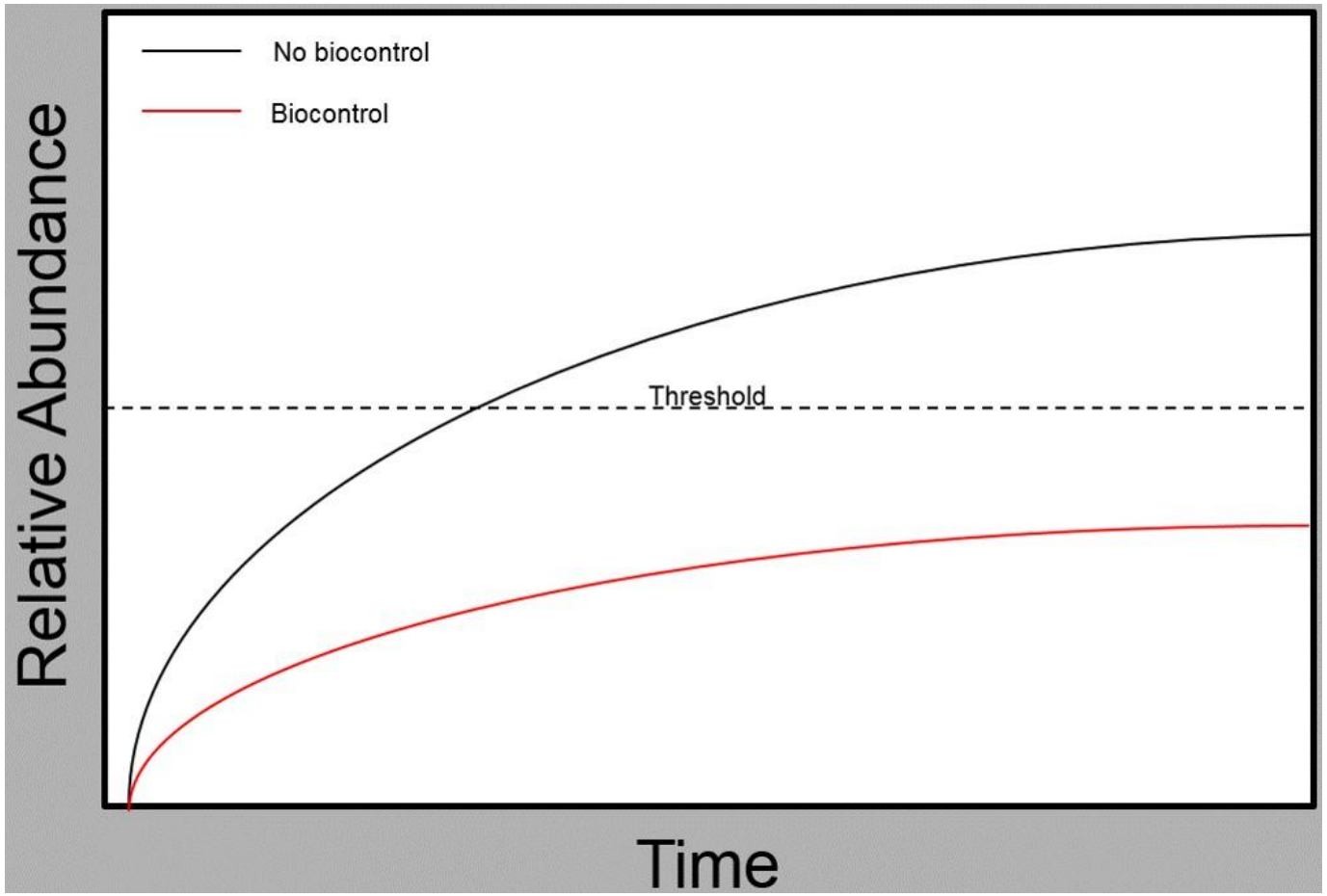
- Prevention is the best plant control technique

- Multiple vectors for invasion
  - Boats and boat trailers
  - Hunting gear (duck decoy rigging)
  - Fishing gear
  - Bait buckets

- Know what's coming into and leaving your pond
  - Inspect gear

Biological Control:

- Purpose is to maintain plant population below nuisance levels
  - Not an elimination technique
- In MS, specific biocontrol agents released for:
  - Alligatorweed
  - Giant salvinia
- General biocontrol agent (grass carp) released for numerous species



Biological Control:

- Grass carp effective on some species
  - Hydrilla
  - Southern naiad
  - Leafy pondweed

- Natural feeding preference
  - “All or none” effect
  - Tends to roam downstream

- Must be restocked after 4-5 yrs.


Photo credit: G. Turnage.

Mechanical Control:

- Purpose is physical destruction or removal of plants

- Destruction
  - Cutting
  - Rotovating

- Removal
  - Hand Pulling
  - Harvesting
  - Diver-operated suction harvesting

Physical Control:

- Purpose is environmental alteration
- Dredging – also mechanical control
- Drawdown
  - Total ecosystem “reset”
- Benthic barrier and dyes
  - Shading
- Nutrient inactivation

Drawn down lake; kayaker is in central lake channel, surrounding sediment is normally underwater.

Chemical Control:

- Purpose is induction of phytotoxic effects for plant death
- Only use EPA approved herbicides with aquatic use language on the label
  - THE LABEL IS THE LAW
  - Only use aquatic approved additives
    - NIS, MSO, & COC
- Off label use is illegal!!
  - Buyer beware when talking to county co-ops

- Systemic:
  - 2,4-D (Amine)
  - Bispyribac-sodium
  - Fluridone
  - Glyphosate
  - Imazamox
  - Imazapyr
  - Penoxsulam
  - Triclopyr
  - Topramezone
  - Florpyrauxifen-benzyl
- Contact:
  - Carfentrazone-ethyl
  - Copper
  - Diquat
  - Endothall
  - Flumioxazin
- Algae Specific:
  - Peroxidases

Chemical Control:

- Foliar Applications
  - Emergent and Floating Plants
- Calculate the area of the infestation, not the area of the waterbody
- Application to leaves above the surface of the water
- Use aquatic-approved surfactant

Chemical Control:

- Submersed Applications
- Herbicides are applied to water, and plants take up herbicide from water
- Water movement, residence time, and concentration are critical for effective treatment
  - Water flow
  - Tides
  - Wind
  - Temperature
  - Herbicide formulation

Chemical Control:

- Submersed Applications
- Concentration-Exposure Time Relationships critical for herbicide selection in moving water
- Higher rate = less contact time needed
- Dyes study usually done first

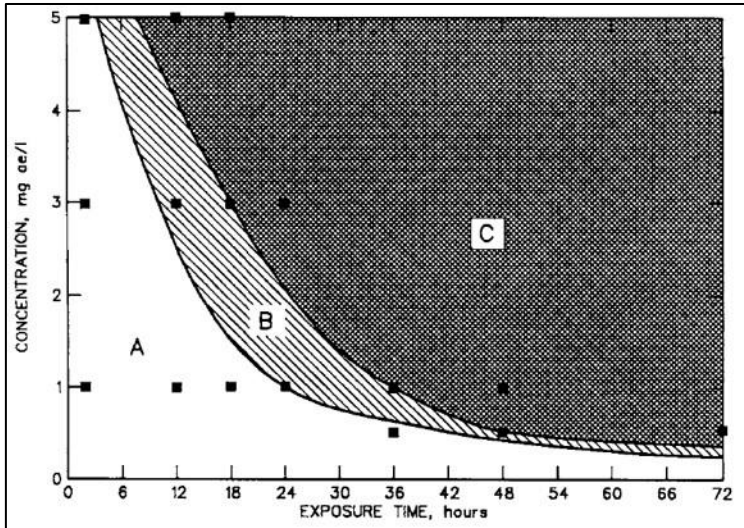


Figure 5. Endothall concentration and exposure time relationships for control of Eurasian watermilfoil. Solid squares represent actual endothall concentration/exposure time (CET) test coordinates. Zones A, B, and C were estimated using these test coordinates. Zone A represents CET combinations that should provide < 70% milfoil control along with a high probability of rapid regrowth within 1 week posttreatment; Zone B represents CET combinations that should provide between 70 and 85% milfoil control with regrowth beginning approximately 3 to 4 wks posttreatment; and Zone C represents CET combinations that should provide 85 to 100% milfoil control with very limited regrowth up to 4 weeks posttreatment.

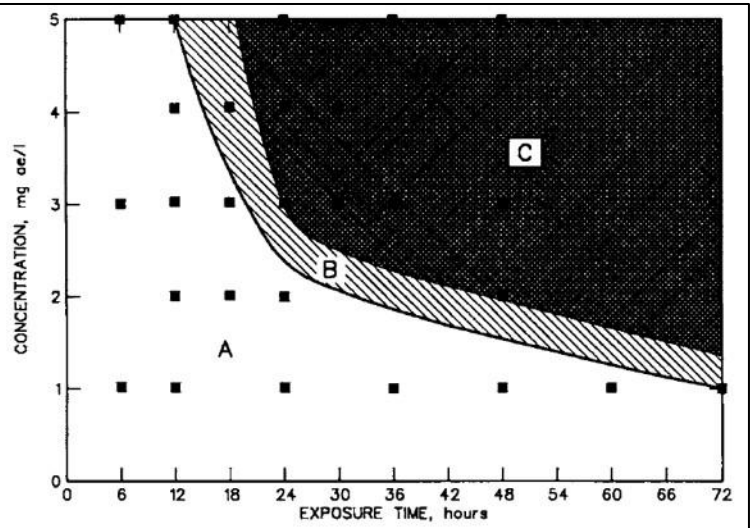


Figure 6. Endothall concentration and exposure time relationships for control of hydrilla. Solid squares represent actual endothall concentration/exposure (CET) time test coordinates. Zones A, B, and C were estimated using these test coordinates. Zone A represents these CET combinations that should provide < 70% hydrilla control and a high possibility of rapid regrowth within 1 to 2 weeks; Zone B represents CET combinations that should provide between 70 and 85% hydrilla control with regrowth beginning at 4 to 6 weeks posttreatment; and Zone C represents CET combinations that should provide 85 to 100% hydrilla control with very limited or no regrowth up to 6 weeks posttreatment.

Chemical Control:

- Herbicide Issues
  - Selectivity and activity
  - Use restrictions
  - Herbicide resistance
  - Herbicide stewardship
  - Regulation—NPDES
- Tank Mixes often used to avoid/mitigate issues above
- Use appropriate rates
  - Don’t cut corners on rate calculations

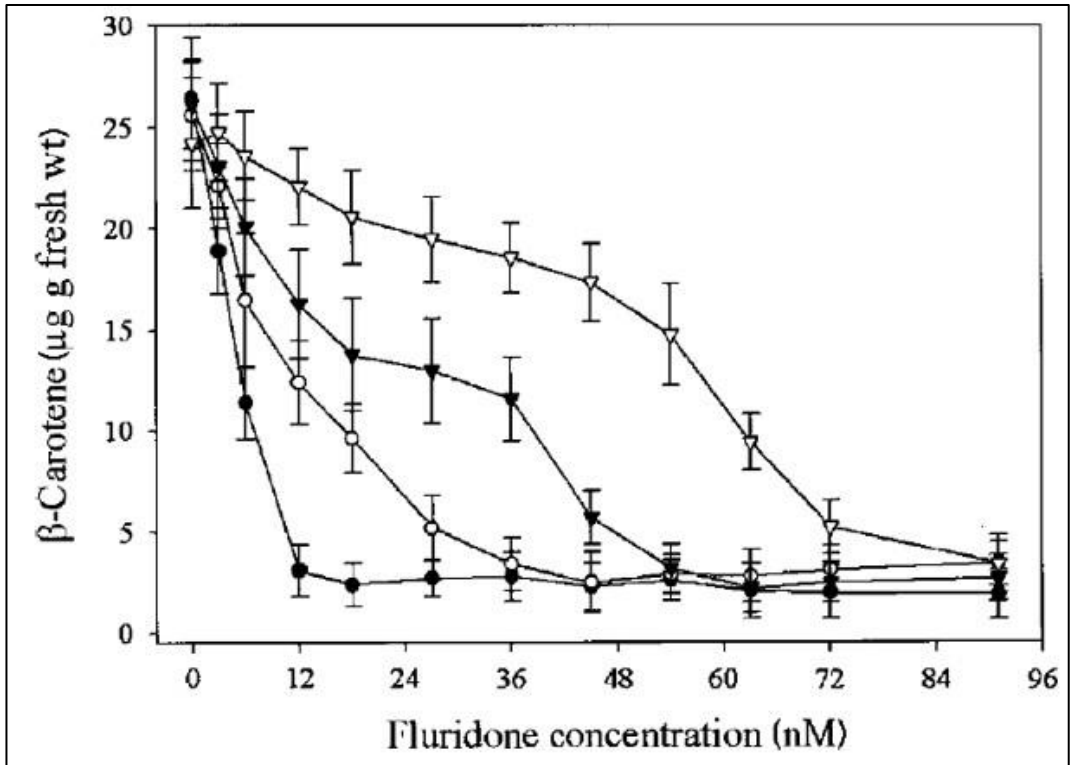


Figure 2. Mean and standard deviations obtained from laboratory assays of the β-carotene content of hydrilla shoot apices following a 14-day exposure to fluridone concentrations ranging from 0 to 91 nM. Phenotypes: ●: susceptible (179 lakes); ○: low resistance (8 lakes); ▼: intermediate resistance (7 lakes); ▽: high resistance (5 lakes) (reprinted with permission of Blackwell Publishing from Michel *et al*[5]).

Integrated Control:

- Combines techniques from 4 control categories
  - Can be cheaper but not always
- Usually attain better, longer lasting control
  - Plant is stressed from multiple directions
- Not always needed or appropriate

Chemical Control:

- Herbicide Selection
- See the most recent Weed Control guidelines for your state
- Herbicide formulation and rate can affect control efficacy
- Plants may not respond immediately
  - Learn time of symptomology
  - Ask Extension specialist if not sure

CONTROL OF SOME COMMON AQUATIC WEEDS WITH HERBICIDES.

	2,4-D	Bispyribac-sodium	Carfentrazone-ethyl	Copper Complexes Copper Sulfate[1]	Diquat	Endothall	Flumioxazin	Fluridone	Glyphosate	Hydrothol 191	Imazamox	Imazapyr	Penoxsulam	Sodium Carbonate Peroxyhydrate	Triclopyr	Acid Blue # & Yellow #23
Algae																
green algae				•												•[2]
blue-green algae (Cyanobacteria)				•										•		•[2]
filamentous and water net				•	•		•			•						
Chara and Nitella				•						•						
Floating Weeds (not attached to bottom)																
duckweed		•	•		•		•	•				•	•			
common salvinia		•	•		•		•		•				•			
giant salvinia		•	•		•		•		•				•			
watermeal			•		•		•	•				•	•			
waterhyacinth	•	•	•		•				•		•	•	•			
water lettuce		•	•		•		•		•		•	•	•		•	

Intro to Chemical Control:

- Rivers and Harbors Act – 1890'S
  - Water hyacinth
- 2,4-D – 1940's
- 16 general use herbicides in aquatics
  - 1 is a dye
  - Peroxides - algae
- 100'S of terrestrial use herbicides - 2023

Intro to Chemical Control:

- Herbicide Physico-Chemical Properties Differ
- pH sensitive
- Turbidity
- Temperature sensitive
- Systemic vs. contact
- Short vs. long CET
- Foliar vs. submersed activity

Photo credit: J.D. Madsen, used with permission.

Intro to Chemical Control:

- Systemic Herbicides:
  - 2,4-D
  - Bispyribac sodium
  - Florpyrauxifen-benzyl
  - Fluridone
  - Glyphosate
  - Imazamox
  - Imazapyr
  - Penoxsulam
  - Topramezone
  - Triclopyr
- Contact Herbicides:
  - Carfentrazone-ethyl
  - Copper
  - Diquat
  - Endothall
  - Flumioxazin
- Dyes
- Peroxides (algae)
- Adjuvants:
  - Non-ionic surfactants (NIS)
  - Buffering agents
  - Stickers
  - Sinkers
  - Methylated seed oils (MSO)
  - Crop oil concentrate (COC)
  - Markers
  - De-foamers

Environmental Fate:

- Environmental Fate – life cycle of a chemical (herbicide) or pollutant after release.

- Why is this important?
  - Can affect human health
  - Paraquat & organ weakening

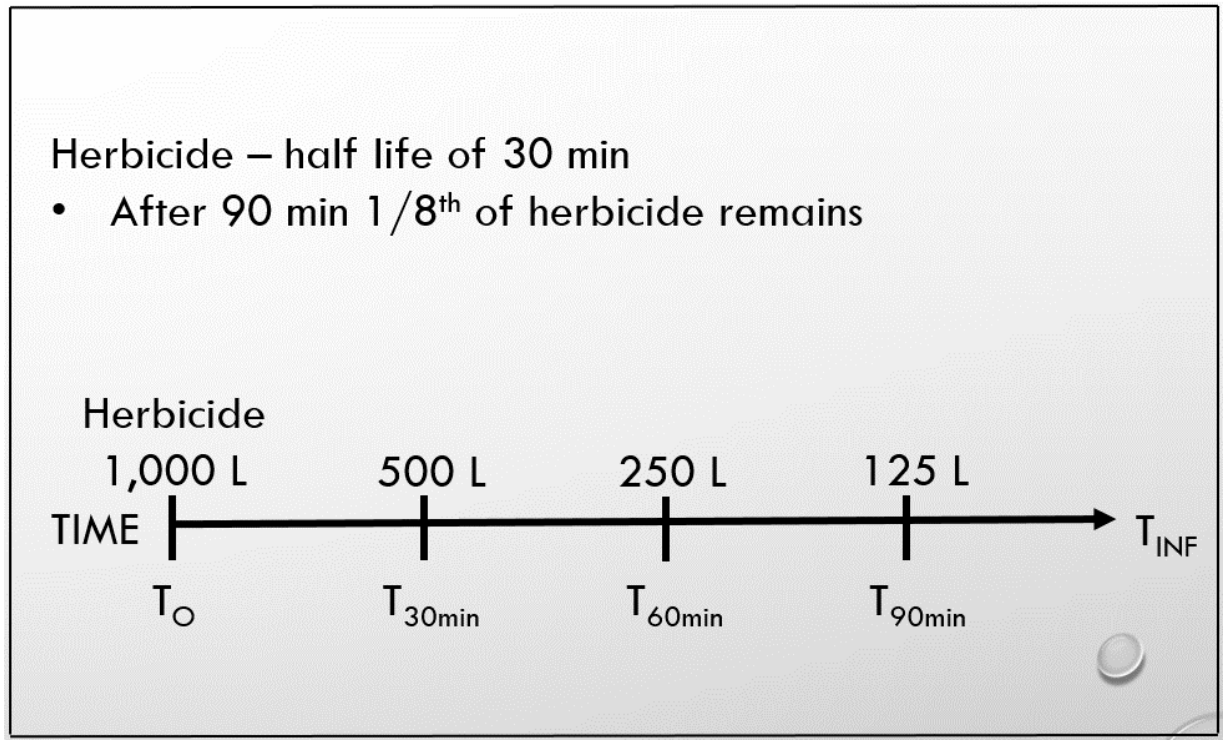
- Can affect microflora
  - Microbes in soil and water

- Can affect non-target plants


Photo credit: B. Alcott, used with permission.

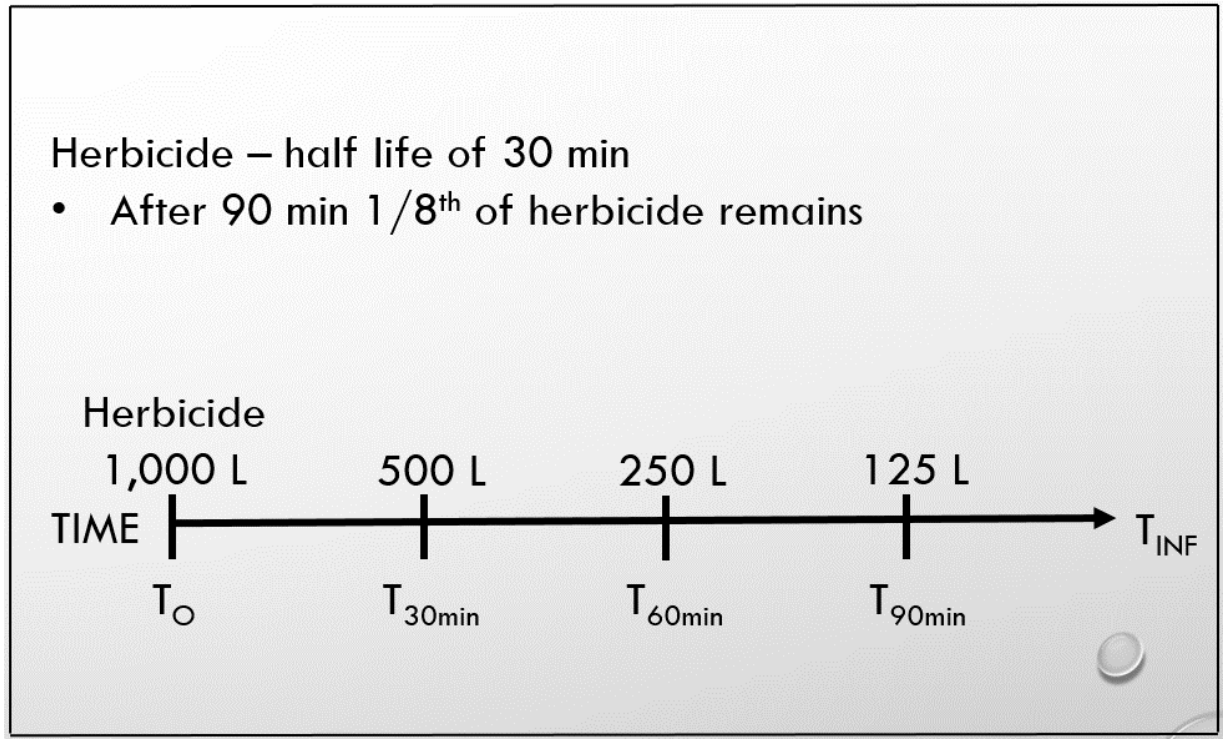
Environmental Fate:

- Factors affecting herbicide fate in environment
  - Water solubility
    - Solubility <-> Adsorption <-> Mobility
    - KOW – partition coefficient
      - High = hydrophobic
    - pKa – log of dissociation constant of acid
    - Microbial degradation
  - Adsorptive potential
    - KOC - measure of attraction of ions/molecules to solid surface (or organic material).
  - Half Life
    - Time to reach one half of original dose.



Environmental Fate:

- Factors affecting herbicide fate in environment (cont)
  - Photodecomposition
    - Latitude
    - Season
    - UV light
  - Volatility – occurs when herbicide goes from liquid to gas state.
    - Vapor pressure
    - Soil moisture (wetlands)
    - Temperature
  - Soil/water chemical properties



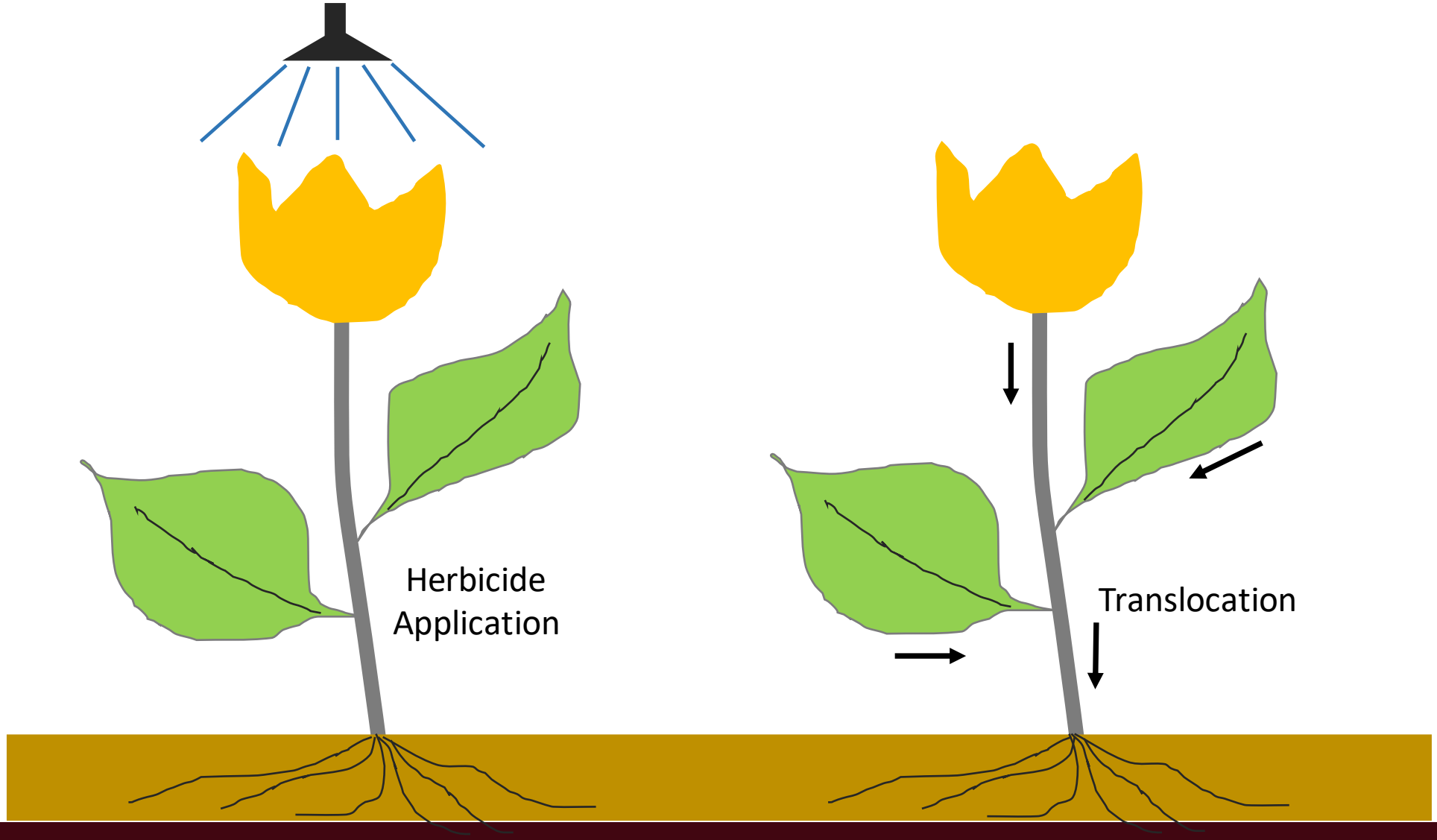
Definitions:

- Adsorption – attraction, adhesion, or accumulation of herbicides to a substance.
- Photodegradation (photolysis) – broken down by sunlight.
- Microbial degradation – broken down by microbes (bacteria).
- Hydrolysis – broken down by interactions with water.
- Plant uptake – taken in by pores on plant tissues (roots, leaves, etc.).
- Sequestration – occurs when herbicides placed in a location (usually vacuoles) w/in plants that inhibits phytotoxicity due to herbicides.

Definitions:

- Site of Action – location in plant where herbicide acts to cause damage.
- Chlorosis (chlorotic) – loss of green color in plants (yellowing).
- Necrosis (necrotic) – death of plant cells.
- Bleaching – plants take on a white color.
- Systemic Herbicide – herbicide that translocates (moves) from the site of entry through the plant to the site of action.
- Contact Herbicide – herbicide that does not translocate, but rather affects plants at or near the site of entry into the plant.

Systemic Herbicides:



Systemic Herbicides:

2,4-D – (2,4-dichlorophenoxy)acetic acid

- Selective for dicots, although 'leaky.'
- Submersed or foliar applications.
- Auxin mimic.
- Acid and ester formulations:
  - Acid – root uptake better
  - Ester – foliage uptake better
- Symptomology – twisting/bending, chlorosis, necrosis, plant death.

2,4-D	
Typical Use Rate (ppm)	0.5 – 4.0
Selectivity	Selective (dicots)
Degradation	Microbial, Photolysis
Half-Life (days)	7 – 48
Mode of action	Auxin mimic, growth regulation
Time to symptomology	Days to weeks
K_{OC} (mL/g)	20 (salt), 100 (ester)
K_{OW}	NA
pKa	2.7

* Check labels for herbicide use restrictions.

Systemic Herbicides:

Bispyribac-sodium – 2,6-bis [(4,6-dimethoxy-2-pyrimidinyl]oxy) benzoic acid

- Submersed or foliar application.
- Stable at pH 5-9.
- Symptomology: growth stops, chlorosis, necrosis, and plant death.

Bispyribac-sodium	
Typical Use Rate (ppm)	0.015 – 0.045
Selectivity	Broad spectrum
Degradation	Microbial
Half-Life (days)	~30
Mode of action	Enzyme inhibitor (ALS)
Time to symptomology	Weeks
K_{OC} (mL/g)	852-1793
K_{OW}	-1.03 (logP)
pKa	3.05

* Check labels for herbicide use restrictions.

Systemic Herbicides:

Florpyrauxifen-benzyl – 2-pyridinecarboxylic acid, 4-amino-3-chloro-6-(4-chloro-2-fluoro-3-ethoxy-phenyl)-5-fluoro-, phenyl methyl ester

- Submersed or foliar application.
- SC Form: 1 PDU = 10 ppb
  - Labeled in SE states of U.S.
- Symptomology: twisting/bending, chlorosis, necrosis, plant death.

Florpyrauxifen-benzyl	
Typical Use Rate (ppm)	0.01 – 0.05
Selectivity	Broad spectrum
Degradation	Hydrolysis (pH dependent)
Half-Life (days)	111 (pH 7); 1.3 (pH 9)
Mode of action	Auxin mimic, growth regulation
Time to symptomology	Days
K_{OC} (mL/g)	34,200
K_{OW}	NA
pKa	NA

* Check labels for herbicide use restrictions.

Systemic Herbicides:

Fluridone – 1-methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4(1H)-pyridinone

- Submersed or foliar application.
- Long CET required at lower rates.
- Symptomology – bleaching, chlorotic, plant death.
  - Usually takes weeks to months to gain control of problematic species

Fluridone	
Typical Use Rate (ppm)	0.005 – 0.030
Selectivity	Broad spectrum
Degradation	Microbial, Photolysis
Half-Life (days)	20+
Mode of action	Inhibits pigment synthesis
Time to symptomology	Days to weeks
K_{OC} (mL/g)	1,000 (avg), ~250 – 2,460
K_{OW}	74
pKa	None

* Check labels for herbicide use restrictions.

Systemic Herbicides:

Glyphosate – N-(phosphonomethyl)glycine

- Foliar application.
- 3 formulations:
  - All salts
- Symptomology – growth stops, chlorosis, necrosis, and plant death.
  - Witch's broom

Glyphosate	
Typical Use Rate (%)	2 – 5
Selectivity	Broad spectrum
Degradation	Adsorption, Microbial
Half-Life (days)	14+
Mode of action	Enzyme inhibitor (ESPS)
Time to symptomology	Days to weeks
K_{OC} (mL/g)	24,000
K_{OW}	0.0006 – 0.0017
pKa	2.6, 5.6, and 10.3 (diff forms)

* Check labels for herbicide use restrictions.

Systemic Herbicides:

Imazamox – 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazole-2-yl]-5-(methoxymethyl)-3-pyridinecarboxylic acid

- Foliar or submersed application.
- Active in soil.
- Symptomology – chlorosis, necrosis, and plant death.

Imazamox	
Typical Use Rate (ppm)	0.050 – 0.075
Selectivity	Broad spectrum
Degradation	Microbial, Photolysis
Half-Life (days)	7 – 14
Mode of action	Enzyme inhibitor (ALS)
Time to symptomology	Days to weeks
K_{OC} (mL/g)	Weak
K_{OW}	5.36
pKa	2.3, 3.3, & 10.8 (pH 5-9)

* Check labels for herbicide use restrictions.

Systemic Herbicides:

Imazapyr – (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo1H-imidazole-2-yl]-3-pyridinecarboxylic acid

- Foliar application.
- Active in soil.
- Symptomology – growth stops, chlorosis, necrosis, and plant death.

Imazapyr	
Typical Use Rate (%)	2 – 5
Selectivity	Broad spectrum
Degradation	Microbial, Photolysis
Half-Life (days)	2 – 4
Mode of action	Enzyme inhibitor (ALS)
Time to symptomology	Days to weeks
K_{OC} (mL/g)	Weak, reversible
K_{OW}	1.3
pKa	1.9 and 3.6

* Check labels for herbicide use restrictions.

Systemic Herbicides:

Penoxsulam – 2-(2,2-difluoroethoxy)-6-(trifluoromethyl)-N-(5,8-dimethoxy[1,2,4]riazolo-[1,5c]pyrimidin-2-yl)benzenesulfonamide

- Foliar or submersed application.
- Active in soil.
- Symptomology – chlorosis (possible reddening of veins), necrosis, and plant death.

Penoxsulam	
Typical Use Rate (ppm)	0.01 – 0.04
Selectivity	Broad spectrum
Degradation	Microbial, Photolysis
Half-Life (days)	15+
Mode of action	Enzyme inhibitor (ALS)
Time to symptomology	Days to weeks
K_{OC} (mL/g)	104
K_{OW}	-0.354
pKa	NA

* Check labels for herbicide use restrictions.

Systemic Herbicides:

Topramezone – [3-(4,5-dihydro-isoxazolyl)-2-methyl-4-(methylsulfonyl) phenyl](5-hydroxyl-1-methyl-1H-pyrazol-4-yl)methanone

- Foliar or submersed application.
- Active in soil.
- Symptomology – bleaching, chlorosis, necrosis, and plant death.

Topramezone	
Typical Use Rate (ppm)	0.005 – 0.050
Selectivity	Broad spectrum
Degradation	Photolysis
Half-Life (days)	72
Mode of action	Enzyme inhibitor (4-HPPD)
Time to symptomology	Weeks
K_{OC} (mL/g)	22.3 – 172.4
K_{OW}	1.52
pKa	4.06

* Check labels for herbicide use restrictions.

Systemic Herbicides:

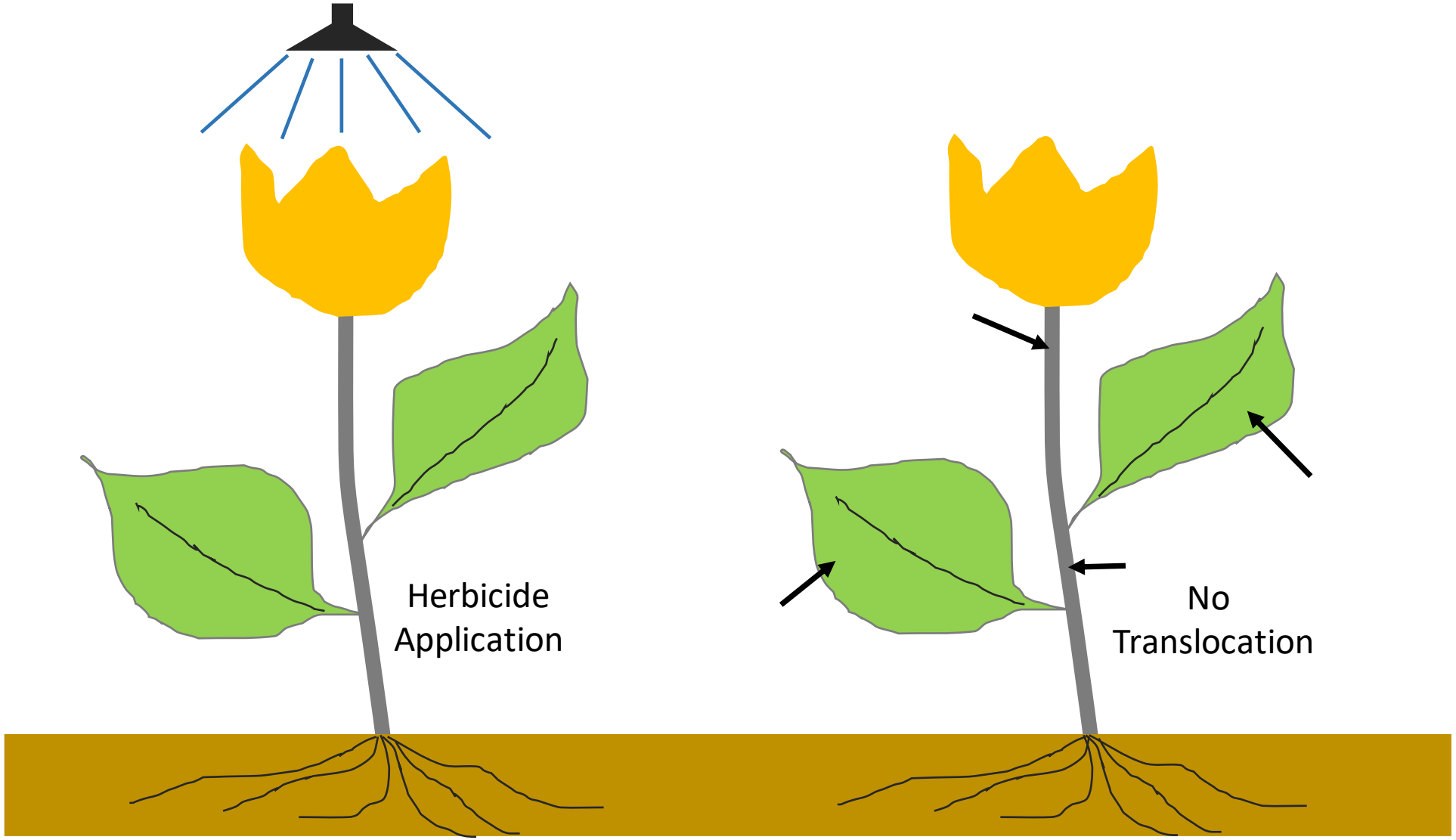
Triclopyr – [(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid

- Foliar or submersed application.
- Active on woody vegetation.
- Symptomology – twisting & bending, growth stops, chlorosis, necrosis, and plant death.

Triclopyr	
Typical Use Rate (ppm)	0.75 – 2.5
Selectivity	Selective (dicots)
Degradation	Microbial, Photolysis
Half-Life (days)	0.5 – 3
Mode of action	Auxin mimic, growth regulation
Time to symptomology	Days to weeks
K_{OC} (mL/g)	20
K_{OW}	2.64, 0.36, & 0.11 (pH 5, 7, 9)
pKa	2.68

* Check labels for herbicide use restrictions.

Contact Herbicides:



Contact Herbicides:

Carfentrazone-ethyl – ethyl 2-chloro-3-[2-chloro-4-fluoro-5-[4-(difluoromethyl)-4,5-diydro-3-methyl-5-oxo-1h-1,2,4- trizol-1-yl)phenyl]propanoate

- Foliar or submersed application.
- Early morning applications better.
- Symptomology – necrosis and plant death.

Carfentrazone-ethyl	
Typical Use Rate (ppm)	0.2
Selectivity	Broad Spectrum
Degradation	Microbial, Photolysis
Half-Life (days)	3 – 8 (pH dependent)
Mode of action	Enzyme inhibitor (PPO)
Time to symptomology	Days
K_{OC} (mL/g)	750
K_{OW}	3.36
pKa	None

* Check labels for herbicide use restrictions.

Contact Herbicides:

Copper – copper chelate or sulfate

- Foliar or submersed application.
  - Chelates active longer in water
  - Only use in water alkalinity >50 ppm
- Many formulations.
- Symptomology – cells become chlorotic, plant/algal death.
  - Commonly used as an algaecide.

Copper	
Typical Use Rate (ppm)	0.2 – 1.0
Selectivity	Broad spectrum
Degradation	Chemically bound
Half-Life (days)	3 – 8 (pH dependent)
Mode of action	Inhibits photosynthesis
Time to symptomology	Hours to Days
K_{OC} (mL/g)	Moderate (chel), strong (sulf)
K_{OW}	NA
pKa	4.23 (Tri form)

* Check labels for herbicide use restrictions.

Contact Herbicides:

Diquat – 6,7-dihydrodipyrido[1,2-α:2',1'-c]pyrazinediium ion

- Foliar or submersed application.
  - Do not use in very turbid water
- Some resistance in Landoltia.
  - Reduced uptake likely
- Symptomology – rapid wilting, necrosis, plant death.

Diquat	
Typical Use Rate (ppm)	0.1 – 0.37
Selectivity	Broad spectrum
Degradation	Adsorption, photolysis
Half-Life (days)	1 – 7
Mode of action	Inhibits photosynthesis
Time to symptomology	Hours to Days
K_{OC} (mL/g)	1,000,000
K_{OW}	0.000055
pKa	None

* Check labels for herbicide use restrictions.

Contact Herbicides:

Endothall – 7-oxabicyclo[2.2.1]heptane-2,3 dicarboxylic acid

- Submersed or foliar application.
- Recently reclassified as a systemic:
  - Short CET
- 2 formulations:
  - Both salts
- Symptomology – defoliation and browning, plant death.

Endothall	
Typical Use Rate (ppm)	0.3 – 3.0
Selectivity	Broad spectrum
Degradation	Microbial
Half-Life (days)	3 – 7
Mode of action	Inhibits photosyn and cell resp.
Time to symptomology	Days
K_{OC} (mL/g)	20 (pH 7), 110-138 (pH 7.8)
K_{OW}	NA
pKa	3.4 & 6.7

* Check labels for herbicide use restrictions.

Contact Herbicides:

Flumioxazin – 2-[7-fluoro-3,4-dihydro-3-oxo-4-(2-propynyl)-2H-1,4-benzoxazin-6-yl]-4,5,6,7-tetrahydro-1H-isoin-dole-1,3(2H)-dione

- Foliar or submersed application.
- Very sensitive to high pH waters.
- Symptomology – rapid wilting, necrosis, plant death.

Flumioxazin	
Typical Use Rate (ppm)	0.1 – 0.4
Selectivity	Broad spectrum
Degradation	Microbial, photolysis, hydrolysis
Half-Life (days)	3 – 5 (pH 5), 14 – 22 m (pH 9)
Mode of action	Enzyme inhibitor (PPO)
Time to symptomology	Hours to Days
K_{OC} (mL/g)	13,000
K_{OW}	2.55
pKa	None

* Check labels for herbicide use restrictions.

Dyes:

- Only 2 registered with EPA for control of aquatic vegetation.
- > 2-3 ft depth needed.
- Absorbs and/or reflects sunlight thus inhibits photosynthesis.
- Need to re-apply monthly

Dye	
Typical Use Rate (ppm)	1 - 2
Selectivity	Broad spectrum
Degradation	NA
Half-Life (days)	Variable
Mode of action	NA (inhibits photosynthesis)
Time to symptomology	Days
K_{OC} (mL/g)	NA
K_{OW}	NA
pKa	NA

* Check labels for herbicide use restrictions.

Adjuvants:

- Non-ionic (NI)/ NI + N/ Organosilicon surfactant
- Crop/vegetable/methylated seed oil concentrates
- Deposition/Spreader/Stickers/ Sinking agents
- Activators
- Buffering/conditioning agents
- Anti-foam agents
- Tank cleaners

Final Thoughts:

- Develop a management plan
  - “Measure twice, cut once”
- Define management goals
  - Think twice if management is irreversible or long-term
    - Grass carp, fertilizer
- MONITOR!!
  - Change tactics if techniques don’t work

Web Sites

- **FEDERAL GOVERNMENT**
  - Aquatic Plant Control Research Program
    - www.wes.army.mil/el/aqua/aqua.html
  - USDA Plants
    - www.plants.usda.gov
- **STATE GOVERNMENT**
  - Mississippi Department of Agriculture and Commerce
    - www.mdac.state.ms.us
  - Mississippi Department of Wildlife, Fisheries and Parks
    - www.mdwfp.com
- **UNIVERSITY**
  - Center for Aquatic and Invasive Plants
    - aquat1.ifas.ufl.edu
  - Mississippi State University Extension
    - msucares.com
- **PROFESSIONAL SOCIETY**
  - MidSouth Aquatic Plant Management Society
    - www.msapms.org
- **FOUNDATION**
  - Aquatic Ecosystem Restoration Foundation
    - www.aquatics.org

Questions

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