Managing Invasive Aquatic Plants and Stakeholder Expectations Using Herbicides

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Who/What is a Stakeholder

- Resource Agency (e.g. MI DEQ)
  - Responsible for permitting
- Managers (applicators/consultants)
  - Responsible for submitting permit
- Lakefront property owners
  - In MI the property owners fund the applications
- Resource users and NGO’s
  - Fishing/hunting interests, pleasure boating
  - Nature conservancy, DU,
A Personal / Agency History in MI

- Foundational research on use of low rates of fluridone for EWM Control
- AERF-sponsored research on 8 MI Lakes using low-rate, whole-lake fluridone
- Studies and stakeholder meetings allowed for permitting fluridone at “6 + 6 ppb (National Impact)
- Multiple key findings
  ▶ Value of concentration sampling, selective control, thermoclines/economics, whole-lake strategies
Small-scale testing followed by field validation of results: AERF has been integral in helping develop multiple use patterns.
Operational Guidance

Unexpected Results Can Occur Anywhere in Process

Research Hypothesis: Observation Or Insight

Improved Small-Scale Study Design

Improved Field Study Design

Field Monitoring

Asking Better Research Questions

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Respect for Agency Resource Managers

- Make decisions that will make someone unhappy
  - Even no decision = unhappy stakeholders
- Nexus between science, public expectations, political & internal agency pressure
- Make decisions with imperfect information
  - Research support is a critical function
Stakeholders = A Social Dimension:
Treat where people live & recreate

Milfoil is foiled by herbicide on Minnetonka bays
As milfoil spread, so does interest in using chemicals to control it on Lake Minnetonka.
By LAURIE BLAKE, Star Tribune
Respect for Applicator/Managers

- Decisions must make customers, stakeholders, and regulators happy
  - A Difficult Feat
- Create & then try to meet customer expectations
  - This is vetted through a permitting process
  - Research is sometimes viewed as “interfering”
- Treatments impacted by environmental variables
  - most treatments provide acceptable control
    - Margin for error
14 Herbicides Labeled for Aquatic Use
(~223 labeled for terrestrial use)

Copper (1900’s)
Endothall (1960)
Glyphosate (1977)

2,4-D (1950’s)
Diquat (1962)
Fluridone (1986)

Triclopyr (2002)
Imazapyr (2003)

Carfentrazone (2004)
Imazamox (2008)
Bispyribac (2011)

Penoxsulam (2007)
Flumioxazin (2010)
Topramazine (2013)

Blue = Plant Enzyme Specific Inhibitors
Invasive Wetland Plants – Largely controlled by Glyphosate & Imazapyr throughout the United States

Phragmites

Invasive Grasses

Cattails- MN invasive cattail mgmt.

Habitat and Access

ERDC

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Key Mgmt. Issues in MI

- The most problematic species are curlyleaf pondweed and Eurasian watermilfoil
  - Hybrid watermilfoil
  - Starry Stonewort
- MI DEQ – primary reliance on 5 herbicides
  - Diquat, endothall, fluridone, triclopyr, and 2,4-D
  - Increased reliance on Copper for Stonewort
- Long-running debate regarding too much control of native vegetation
Management Strategies and Emerging Issues
EWM and CLP

- Different life histories and invasive strategies
- This impacts mgmt. strategies
  - Addressing 50 yr old weed problems with 50 yr old tools
    - CAN WE STILL INNOVATE?

- Morphology impacts response to mgmt.

Scale and Product Dictate Strategy and Herbicide

Easy to Control
But
Easier to Manage

Harder to Control
But
Harder to Manage
Large-scale Mgmt.

- Multiple strategies developed and refined
  - EWM - Fluridone (MI), 2,4-D (WI), Triclopyr (MN)
  - CLP - Endothall for long-term mgmt. (MN, WI)
- Irony: more refined strategies & predictability for large-scale vs. small-scale treatments
- Selectivity?
  - We have largely determined individual species that are sensitive to each strategy/product
  - Can provide flexibility in strategies
Developing Tools to Reconcile Plant Data with Stakeholder Observations

Biomass (g dry wt.) – June 2012

<table>
<thead>
<tr>
<th>Bay</th>
<th>N Obs (total)</th>
<th>Sum (total)</th>
<th>N Obs (Native)</th>
<th>Sum (Native)</th>
<th>N Obs (Invasive)</th>
<th>Sum (Invasive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grays</td>
<td>101</td>
<td>1018.3</td>
<td>73</td>
<td>356.8</td>
<td>26</td>
<td>661.5</td>
</tr>
</tbody>
</table>

98% EWM Reduction

Biomass (g dry wt.) – August 2012

<table>
<thead>
<tr>
<th>Bay</th>
<th>N Obs (total)</th>
<th>Sum (total)</th>
<th>N Obs (Native)</th>
<th>Sum (Native)</th>
<th>N Obs (Invasive)</th>
<th>Sum (Invasive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grays</td>
<td>77</td>
<td>527.0</td>
<td>75</td>
<td>515.6</td>
<td>4</td>
<td>11.3</td>
</tr>
</tbody>
</table>

18% EWM
Mapping is a tool that helps us visualize pre and post-treatment conditions - patterns of recovery, Density of native SAV.

This tool is available to Applicators to Incorporate into surveys.
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Spot Treatments Remain a Technical Challenge

- Often – small treatments = bigger challenges
  - More difficult for EWM vs. CLP
- Makes Early Detection and Rapid Response a Difficult Proposition
- Generally a simple matter of challenges in “keeping the product in place”
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BUILDING STRONG®

Liquid or granular
Bottom placement
Innovative solutions for a safer, better world

BUILDING STRONG®

Observed [2,4-D] vs. Hours After Treatment
Liquid vs. Granular Small Scale Treatments ≤ 10 Acres

Target Concentration

2,4-D Conc. (ppm)

Hours After Treatment (HAT)

1 3 6 12 24 48 72
n=53 n=78 n=66 n=27 n=49 n=29 n=20
n=46 n=67 n=55 n=18 n=57 n=51 n=37
Thermocline Considerations – Not for Whole Lake Only

Mixed Lake (early)

Stratified Lake (late)

Herbicide is partitioned

Economics, Total Amount of Herbicide Used, Timing, Timing, Timing
Carman’s Bay- MN - 300 acre bay treated in 2011 and 2012

- 96 acres treated in 2010 –
  - Triclopyr 1.0 mg/L
- 83 acres treated in 2011
  - Triclopyr 1.25 mg/L

2010 – Milfoil frequency in Sep = 67%
2011 – Milfoil frequency in Sep = 2%

WHY THE DIFFERENCE?

1.
2.
3.
Early March Trmt.

15 WAT

EWM & Timing – Whole-Lake
Or whole bay Triclopyr or 2,4-D

Early season – highly effective
Late season – highly effective

Selectivity differences are small

Mid-April Trmt.

12 WAT

EWM and Timing – small or spot

Early season – less effective
Late season – more effective

More Tissue Available for Uptake

Netherland and Glomski (2014)
Comparative Application Techniques

- It is difficult to generate useful field comparison data for different application techniques?
  - Herbicides are good at killing target plants
  - When a treatment works, it may or may not be related to the application strategy
    - Field data is often confounding
    - It’s all about the CET
  - When the scale gets big enough, just about every technique works
Emerging Issues in APM
Hybrid Milfoils:

A Look Into Our Future / Present
Does it Matter if this is EWM or Hybrid?
Change in Biomass of Townline MI Hybrids compared to 6 Other Milfoil Populations (2 other hybrids)

-Graph explains how a hybrid can become Dominant

SUBTLE CHANGES CAN DRIVE SELECTION OF HYBRIDS!
Watermilfoil DNA Analysis

Zuelling & Thum, 2012
Some believe that only “whole lake treatments” can result in selection pressure

- Treat a 15 acre block (5 feet deep) on a 150 acre lake (10% of the lake)
- 2,4-D or Triclopyr at 2 ppm or 2000 ppb
- Thermocline = 10 feet - Lakewide avg. concentrations of ~125 ppb
  - 125 ppb strong impacts to EWM
  - 125 ppb - impacts on Hybrid?

Higher Rate Spot Treatments may create a Stronger Selection Pressure for Hybrids Outside the Treatment Zone

Whole-lake treatment strategy
Vs
Whole-lake impacts
Are Higher Rates the Answer?

- Convince permitting agencies that there is **Science** behind asking for higher rates?
  - Agency concerns = native plant selectivity and fear that we will select for even more tolerant strains

- Product combinations?
  - Large-scale auxin-mimics + endothall
  - May impact selectivity patterns

- Regulators - long memories when it comes to products/strategies that reduce overall SAV
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Hybrids – Can minimize your margin for error

- You must think in terms of both concentration and exposure time

<table>
<thead>
<tr>
<th>2,4-D 1.5 mg/L</th>
<th>6 hr % control</th>
<th>12 hr % control</th>
<th>24 hr % control</th>
<th>96 hr % control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minnetonka EWM</td>
<td>56</td>
<td>92</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Frog, WI Hybrid</td>
<td>13</td>
<td>43</td>
<td>59</td>
<td>100</td>
</tr>
<tr>
<td>English, WI Hybrid</td>
<td>16</td>
<td>28</td>
<td>64</td>
<td>100</td>
</tr>
<tr>
<td>Townline, MI Hybrid</td>
<td>48</td>
<td>89</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
Conclusions

- These hybrids should be considered invasive
  - Possibly more invasive than EWM
  - Treatments can select for more tolerant hybrids
- Differences in herbicide susceptibility are subtle, but meaningful
- The Good News – Multiple products work on Milfoils - Rotation
Other Emerging Issues
Endangered Species Issues

Will become more prevalent as EPA and FWS work to reconcile disagreements regarding impacts of herbicides on Endangered species

AERF Initiative
Algae as Invasive Plants?

Starry Stonewort

AVM – linked to bird deaths

Limited Management Alternatives - #1 use of Copper-based products

Golden Algae

Massive Fish Kills in TX

Toxin

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Starry Stonewort

- Currently viewed as a Michigan problem
- Limited background information on biology
  - how invasive is it likely to be?
  - Why is the problem currently limited to Michigan?
- Need to formalize the research process
  - AERF & MI DEQ
  - Find funding to address the problem
- Starry stonewort issue vs. other species
  - Numerous Invasive Plants and Animals
In the Current World of Invasive Species Science, There is Always “a Worse Threat Around the Corner”

Key Tenet of Prevention
Monoecious Hydrilla in the Midwest and NE

- There is no worldwide analogue to the 1000’s of natural lakes in this region of the US
  - Well established and diverse native SAV
  - Heavy human utilization & value placed on Lakes
  - Well-established APM industry
    - Significant pressure to implement management

- Do we want to add hydrrilla to this mix?
  - Eradication projects – IN, NY
Mhydrilla - showing up in Odd Places

Wild and Scenic Rivers in TN and NC

- Considered a threat to unique macroinvertebrate and fish communities

Management Options?
Does Mhydrilla Pose a Greater Threat to Northern Waters Than Other Invasive Plants?

Hydrilla | Eurasian Milfoil | Curlyleaf Pondweed

We Don’t Know & We Can’t Know without Letting Hydrilla Spread and Compete

Hydrilla will test our commitment to Prevention and EDRR
Observations on Managers

- Get too excited when something works
- Too negative when something fails
- What did you learn and was it documented?
  - Can you apply this to other sites?
  - Can you repeat the success across a broad range of scenarios?
South Twin Lake, 2010

2,4-D Herbicide Concentrations

Days after treatment

Concentration (µg/L ae)

Mean Treated
Mean Untreated
Lakewide Target
Irrigation Limit
Lessons Learned with CLP

- Highly sensitive to Herbicides at a wide scale under a broad range of exposures
  - Early-season Endothall is highly effective
  - Killing a plant growing from a single turion
- We don’t know when it is okay to stop managing
  - Is objective seasonal control or long-term mgmt.
- The plant can be highly variable in density/nuisance levels in the absence of management
Need to Understand Target Plant Biology

- E.g. Curlyleaf pondweed –
  - Rapid early growth, senescence in summer - algae blooms
  - Turions - quiescent and viable for 3+ years (role of sediment burial)
    - Sprout in Fall, dormant in winter, bolt in spring

- Management strategies – take turions into account
  - 1 treatment = seasonal control & limited impact next year
  - Once turions have formed – Plant is ready for next year
  - Treat prior to turion formation