GIS for Aquatic Plant Management

Ryan M. Wersal and John D. Madsen
Mississippi State University Mississippi State, MS
Geographic Information Systems and Aquatic Plant Management

- Geographic Information Systems (GIS) have become the new tool for information management, planning, and presentation for invasive aquatic plant management programs; and is critical in every component of an APM program
Aquatic Plant Management Program Components

- Regional or National Databases
- Prevention
- Early Detection and Rapid Response plans
- Monitoring
- Assessment
- Management operational planning
- Regulatory compliance
- Education and outreach
National or Regional Databases

• Web-based databases that display locations of invasive plants graphically
• Some databases use an Arc-IMS server
• Resource for planning, research, and public education
National Databases

• National Institute for Invasive Species Science
  – http://www.niiss.org

• USGS Nonindigenous Aquatic Species
  – http://nas.er.usgs.gov/

• USDA APHIS NAPIS

• USDA NRCS Plants database

Waterhyacinth in bloom at Lake Columbus, MS
Interactive map
Updated as new data is added
Retrieve collection information
Fact sheets
Regional Databases

- Invasive Plant Atlas of New England
  - www.ipane.org

- Invasive Plant Atlas of the Mid-South
  - www.gri.msstate.edu/ipams

- Used by volunteer networks to input invasive plant information
Invasive Plant Atlas of New England

- Use as tool for
  - Entering volunteer information
  - Directing surveys
  - Early detection and rapid response
  - State or regional planning

Prevention

• GIS is used for planning and implementing surveys for invasive species
• Recording new infestations for control
• Identify likely new infestation points (e.g., boat launches and marinas)
• Identify likely sources of plants for invasion
• Identify boundaries to spread (e.g., watersheds)
Early Detection and Rapid Response

- Directed searches for invasive plants
- Identify exact locations for control
- Identify volunteers, staff to monitor new reports
- Identify likely areas for new infestation
MN DNR Program

- MN DNR uses GIS to identify “outlier” locations of EWM for rapid response
- MN DNR funds cost-share to lakes in “core infestation” area

Eurasian watermilfoil distribution in Minnesota. Source: MN DNR
Monitoring

• Directed surveys
  – Looking for presence of invasive species

• Quantitative surveys
  – Estimate distribution and diversity of all plants

• Remote sensing
  – Aerial
  – Satellite
  – Hydroacoustic

Surveying Ross Barnett Reservoir near Jackson, MS for invasive aquatic plants using an IPAQ and GPS antenna.
# Monitoring and Assessment Techniques

<table>
<thead>
<tr>
<th>Technique</th>
<th>Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover Techniques: Point Intercept</td>
<td>Species composition and Distribution, Whole-lake</td>
</tr>
<tr>
<td>Cover Techniques: Line Intercept</td>
<td>Species composition and distribution, study plot</td>
</tr>
<tr>
<td>Abundance Techniques: Biomass</td>
<td>Species composition Abundance</td>
</tr>
<tr>
<td>Hydroacoustic Techniques: SAVEWS</td>
<td>Distribution, Abundance (no species discrimination)</td>
</tr>
<tr>
<td>Remote Sensing: Satellite, Aircraft</td>
<td>Distribution (near-surface plants only, no species discrimination)</td>
</tr>
</tbody>
</table>
Directed Surveys

• Establish a search pattern or search points

• Navigate to points or along course

• Record observation of invasive species

• Submersed plants may require bottom sampling

Old school – GPS and antenna (above picture) with data recorded in notebook (left). In front of boat, plants are sampled using a plant rake
Mapping

• Can range from very rough to very accurate
• May be done with GPS and depth finder
• Trained layperson to expert
• Can also be done via remote sensing

Remetrix Image www.remetrix.com
Quantitative Surveys

• Generates data on acreage, species distribution, species diversity

• I prefer a point intercept method

• Many other techniques have been used

• Run FarmWorks SiteMate, ArcInfo Application, or other software

Data entry for point intercept survey on a Panasonic Toughbook – better for middle-aged eyes
• Computers and GPS have:
  – Increased survey efficiency
  – Decreased survey time
  – Increased accuracy of sample location
  – Increased accuracy of data management
Ross Barnett Reservoir, MS

- 33,000 acres
- 1423 points
- Conducted the survey in June 2005
- Survey time was approximately 80 hours
Sample Locations for Ross Barnett Reservoir, June 2005
Hydroacoustic Survey

• Accurately maps depth distribution and areal extent of submersed vegetation

• Cannot map topped-out plants

• Cannot differentiate species

• SAVEWS algorithm may misinterpret bottom structure as plants
Hydroacoustics

- Bathymetry
- Vegetation measured as cover and height
- Integrated calculation gives biovolume of plants
- Does not identify species
Acoustic Environment of Submersed Vegetation

Sabol, USAERDC
Spatial Change Analysis

Sabol, USAERDC
Remote Sensing Assessment

2,4-D amine at 1 gallon per Acre
June 7, 2005

Tennessee-Tombigbee Waterway, Columbus, MS
Waterhyacinth Coverage

PreHAC

397 pixels
357,300 m²
88 Acres

PostHAC

255 pixels
229,500 m²
57 Acres
Point Intercept Assessment Methods

• Lake Pend Oreille, ID (94,000 acres)

• 1,614 points surveyed in both 2007 and 2008. Points were on a 250m grid

• Herbicide areas assessed on a 100m grid
Pack River Delta

Treated with fluridone in 2007 with poor success

Treated in 2008 with triclopyr with excellent results

Note: Map only shows the locations of Eurasian watermilfoil, not all points sampled
Cocollala Creek

Scheduled for treatment in 2008

Treatments not done because of lack of EWM

Assessment showed excellent control in 2008 from the 2007 fluridone treatment

Note: Map only shows the locations of Eurasian watermilfoil, not all points sampled
Biomass Assessment

- Sites should be preselected with GIS whether doing whole-lake or plot sampling
- GIS can be used to randomize points
- GIS can be used for data analysis, presentation
Biomass Assessment

- Biomass or abundance is the most accurate method for assessing control
- GIS can be used to select a priori points for sampling
- Core sampler can assess stem biomass
- Also measures seeds, tubers, turions
Big Muskego Lake Biomass Samples

- Fifty-five random points selected from the 300 points in the point intercept grid
- Sampled once per year with 0.1 m² quadrat
Management Operational Planning

- Volumetric calculations for herbicide treatment
- Identification of use restrictions and conflicts
- Staging areas
- Sensitive areas
- Treatment areas
Volumetric Calculations

- Volumetric calculations needed to calculate the amount of herbicide to be added to achieve target concentration
- Important for whole lake or plot treatments
- Measure depth with hydroacoustics or sounding rod
## Volumetric Calculations

www.remetrix.com

### Lake Hortonia (Entire Lake) Water Volume Tables

<table>
<thead>
<tr>
<th>Contour</th>
<th>Volume of Contour (acre-feet)</th>
<th>Cumulative Volume (acre-feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface to 3 Foot</td>
<td>1475.5</td>
<td>1475.5</td>
</tr>
<tr>
<td>3 Foot to 6 Foot</td>
<td>1281.0</td>
<td>2756.5</td>
</tr>
<tr>
<td>6 Foot to 9 Foot</td>
<td>1015.9</td>
<td>3772.4</td>
</tr>
<tr>
<td>9 Foot to 12 Foot</td>
<td>811.5</td>
<td>4584.0</td>
</tr>
<tr>
<td>12 Foot to 15 Foot</td>
<td>655.0</td>
<td>5238.9</td>
</tr>
<tr>
<td>15 Foot to 18 Foot</td>
<td>532.2</td>
<td>5771.1</td>
</tr>
<tr>
<td>18 Foot to 21 Foot</td>
<td>463.8</td>
<td>6234.9</td>
</tr>
<tr>
<td>21 Foot to 24 Foot</td>
<td>438.2</td>
<td>6673.2</td>
</tr>
<tr>
<td>24 Foot to 27 Foot</td>
<td>417.2</td>
<td>7090.4</td>
</tr>
<tr>
<td>27 Foot to 30 Foot</td>
<td>402.0</td>
<td>7492.4</td>
</tr>
<tr>
<td>30 Foot to 33 Foot</td>
<td>382.0</td>
<td>7874.4</td>
</tr>
<tr>
<td>33 Foot to 36 Foot</td>
<td>358.1</td>
<td>8232.6</td>
</tr>
<tr>
<td>36 Foot to 39 Foot</td>
<td>337.7</td>
<td>8570.3</td>
</tr>
<tr>
<td>39 Foot to 42 Foot</td>
<td>325.9</td>
<td>8986.1</td>
</tr>
<tr>
<td>42 Foot to 45 Foot</td>
<td>241.9</td>
<td>9108.1</td>
</tr>
<tr>
<td>45 Foot to 48 Foot</td>
<td>189.2</td>
<td>9297.3</td>
</tr>
<tr>
<td>48 Foot to 51 Foot</td>
<td>144.0</td>
<td>9441.3</td>
</tr>
<tr>
<td>51 Foot to 54 Foot</td>
<td>107.6</td>
<td>9549.0</td>
</tr>
<tr>
<td>54 Foot to 57 Foot</td>
<td>74.4</td>
<td>9623.3</td>
</tr>
<tr>
<td>57 Foot to 60 Foot</td>
<td>49.9</td>
<td>9673.2</td>
</tr>
</tbody>
</table>
Identification of Use Restrictions and Conflicts

• Locate drinking water intakes for humans and livestock

• Locate irrigation water intakes

• Locate swimming beaches or areas of contact

• Locate unusual bottom types, substrates, or areas incompatible with specific management techniques
Regulatory Compliance

- Distance to locations of water intakes, swimming beaches, or other areas of exposure
- Define and comply with treatment permit or guidelines
- Locate required sampling locations
Drinking Water

• Many aquatic herbicides have a specified setback

• Illustration of setback for triclopyr around drinking water intake in Sandpoint, ID

• Within this zone, a limited number of approaches could be used
  – Few herbicides
  – Mechanical or physical techniques
Federal Nexus

• Federal lands have a restricted list of herbicides allowed for use
• Varies by region
• Controlled under US FWS by endangered species issues
• This location is limited as potential bull trout habitat (though the land next to it is not?)
Staging areas

• Locate public or private boat launches that may be used for mobilizing management activity

• Locate off-load areas for harvest material, dump sites, or disposal areas

• Locate aid stations or other areas for emergencies
Sensitive areas

• Areas of rare, threatened, or endangered species habitat

• Areas of exceptional fish spawning habitat or wildlife resources

• Areas identified by resource managers as protected
Endangered Species (WA Species of Concern)

- Myriophyllum spicatum (green) is target species
- Sagittaria platyphylla (orange) is a new invasive
- Carex comosa (blue) is a protected state rare plant species
Treatment Areas

• Mark off areas for herbicide treatment, biocontrol release sites, mechanical control, or other activities

• Preplan routes for activity for GPS to follow for perfect “swath”

• Automate release of chemical based on speed and depth
2007 Treatment Locations for Lake Pend Oreille

Treatment Type
- Diver Dredge
- Triclopyr
- Fluridone

Kilometers
Map of Proposed Management Activity
Precision Application in Lakes

- Application of precision agriculture equipment to aquatic systems
- Metered application of herbicide combined with GPS and depth
- Similar capabilities also deployed in helicopters and airboats
LITTLINE

Littoral Zone Treatment Technology

- On-board computer with pre-loaded data controls exact placement depth and rate of aquatic herbicides
- Flow of product varies with change in speed to maintain consistent application rate per acre-foot

Dual Application Lines permit two products to be applied at one time
• LittLine is a system with two separate pumps, valves, and controllers.
• So two products can be applied at the same time (in the pictures, you can see two sets of pumps and control valves, one behind each tank)
On-board Controls

- Furuno Chart/depth plotter
- Herbicide rate and track computer
- Backup computer for bathymetric mapping
- Hose reel controls, hose in/out
- Pump on/off & valves controls
Treatment Documentation

Post application reporting

• Date & Time of application
• Conditions
• Rate delivered at pre-set data points
• Total amount of product used
• Total amount of active ingredient applied
Water Exchange and Off Target Herbicide Movement

0 HAT
3 HAT
20 HAT

Pack River-1
8-1-2008
Upper Half of Water Column
20 HAT

Pack River-1
8-1-2008
Bottom Half of Water Column
20 HAT
Summary

• GIS is a very important tool for aquatic plant management projects

• GIS can be used in all stages of the project
Education and Outreach

- Present information on invasive plants present
- Present information on proposed management
- Present information on management results
- Combine with photos from a GPS camera for time-and-location stamped photos
- Openness is a major issue with management in waters
Volunteer Monitors

- Provide search sites or patterns for volunteers
- Provide GPS equipment, even handheld computers, for data entry
- Encourage ownership of project for stakeholders
Aquatic Plant Restoration Goal

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

• Clean Lakes, Inc.
  – Thomas McNabb

• North Carolina State Univ.
  – Bridget Lassiter, Gail Wilkerson, Jenny Johnson, Justin Nawrocki and Robert Richardson

• Remetrix
  – Doug Henderson

• US Army Engineer Research and Development Center
  – Kurt Getsinger, Michael Netherland, Bruce Sabol, and John Skogerboe

• Washington DOE
  – Kathy Hamel and Jenifer Parsons
Contact Information

Ryan M. Wersal
Mississippi State University
Geosystems Research Institute
662-325-4595
rwersal@gri.msstate.edu

Dr. John D. Madsen
Mississippi State University
Geosystems Research Institute
Ph. 662-325-2428
jmadsen@gri.msstate.edu