A Summary of the Monoecious Hydrilla Symposium:

Identifying Research, Management, and Regulatory Priorities

M.D. Netherland, US Army ERDC
Hydrilla verticillata L.f. Royle

- Hydrilla is a monocot - Hydrocharitaceae family
  - Elodea, Egeria, and Vallisneria
  - Early detection will be difficult?

- Native to SE Asia
  - Found on 6 Continents (Poland)
  - Multiple Biotypes / Cryptic speciation?

- Dioecious and Monoecious Biotypes
  - Separate Introductions to the US
  - Worldwide – Monoecious = tropical & Dioecious = temperate
Monoecious Hydrilla

- Delicate plant
- Subterranean turions sprout in spring
- Temperate plant
- Moderate temperature optimum
- Produces large numbers of axillary and subterranean turions
What is a Biotype?

- Biotypes are distinct reproducing populations of the same species that exhibit different reproducible characteristics.

Ryan et al. 1995

Figure 2. Leaves and stems of monoecious (left) and dioecious hydrilla (right), collected in the same area of Lake Gaston.

Coexistence of Monoecious and Dioecious Hydrilla in Lake Gaston, North Carolina and Virginia

Frederick J. Ryan, C. R. Coley, and S. H. Kay

J. Aquat. Plant Manage. 35: 9-12
Monoecious Hydrilla Symposium

- In September 2012 ERDC hosted a Symposium on Monoecious Hydrilla in Syracuse, NY
  - 1.5 day meeting
- 40 invited attendees
  - 7 state agencies, 5 Universities, 3 Federal Agencies
    - Private industry, applicators, Lake Cayuga
- Theme – focus on “our ignorance” regarding monoecious hydrilla
  - Determine what we don’t know and what we need to know
A 150 acre infestation in Lake Cayuga, NY was an impetus for this workshop

- Eradication Plan using herbicides implemented in fall 2011 & summer 2012
- Eradication efforts likely to continue for at least 5 years
Why is this relatively small infestation on Lake Cayuga Important?

Potential for spread throughout the region is significant.
To Complicate Matters: Hydrilla was Positively Identified on 13 miles of the **Erie Canal** in Sept 2012

- Plant I.D. was confirmed at the Hydrilla Symposium

![Map of the Erie Canal and Lake Erie with locations marked]
Why Did We Hold a Symposium to Focus on a Specific Biotype Of Hydrilla?

The movement of the monoecious biotype into northern tier lakes is the most significant Future Research & Management challenge in APM.
Hydrilla in the US

- Two separate introductions
  - Monoecious – Korean lineage (38th parallel)
    - Adapted to Northern Latitudes?
  - Dioecious – SE Asian lineage – Southern strain
- Both are **polyploids**
- Both exhibit **heterosis** (hybrid vigor)
- Biotypes “might as well be two different species”
Monoecious Hydrilla

- Search of the UF Center for Aquatic and Invasive Plant Library
  - “Hydrilla” = 5099 records
  - “Monoecious Hydrilla” = 197 records
    - 45% of these titles are from Oral Presentations

- Bottom Line
  - Very few published articles focusing on the Monoecious Biotype in the US
Myths about Monoecious Hydrilla — From John Madsen - MSU

- It can’t grow in the North
  - It is circumboreal
- It’s just like dioecious hydrilla
  - There are distinct differences
- It’s a wimpy plant and not a real competitive weed
  - Different type of competitor?
- What we don’t know about Mhydrilla can’t hurt us
Hydrilla found between 45 and 55 degree N. Latitude In China

US Monoecious Hydrilla from Korea
Hydrilla Growth in a 160 acre Lake (pond) in Maine, suggests the plant can grow to high densities in the North.
Hydrilla in China

- Recent proliferation of Chinese articles on hydrilla
- Lori Benoit (CT) – PhD Dissertation
  - Hydrilla in China is highly invasive but genetically distinct and highly differentiated from both US populations
  - Research Relevance to Monoecious Biotype?
- Irony – Chinese are using hydrilla for vegetation restoration projects
  - Restoring degraded habitat and heavy metal uptake
Hydrilla in Europe

- Single introduction of a **diploid** plant
- Not an “Aggressive Invader”
- Valued, but “rare component” of aquatic plant community
  - How would our polyploid hydrilla perform in Europe?
- European or Chinese Literature may not be useful in predicting behavior of US polyploids
Hydrilla in the Midwest and NE

- There is no worldwide analogue to the natural lakes in this region of the United States
  - Well established native submersed vegetation
  - Heavy human utilization and value placed on Lakes
  - Well established aquatic plant management industry

- Do we want to add hydrilla to this mix?
Monoecious Hydrilla - the “Wimpy Cousin” of the Dioecious Biotype?

OR

Monoecious Hydrilla - an Insidious Invader?
## Spread of Dioecious Biotype in US

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<thead>
<tr>
<th>Year</th>
<th>Number of States</th>
<th>States</th>
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<tbody>
<tr>
<td>1960 – 1969</td>
<td>1</td>
<td>FL (1950’s)</td>
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<tr>
<td>1970 –1979</td>
<td>5</td>
<td>AL, CA, GA, LA</td>
</tr>
<tr>
<td>1980 – 1989</td>
<td>9</td>
<td>CT ?, MS, SC, TX</td>
</tr>
<tr>
<td>1990 – 1999</td>
<td>11</td>
<td>AR, TN</td>
</tr>
<tr>
<td>2000 – 2011</td>
<td>14</td>
<td>ID, OK, KS</td>
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## Spread of Monoecious Hydrilla

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<td>1</td>
<td>DE</td>
</tr>
<tr>
<td>1980 – 1989</td>
<td>6</td>
<td>CA, (CT ?), MD, NC, VA</td>
</tr>
<tr>
<td>1990 – 1999</td>
<td>8</td>
<td>PA, WA</td>
</tr>
</tbody>
</table>
Myth #2: It’s just like dioecious hydrilla (from J. Madsen)

- In biology, life history, physiology, environmental amplitude, and phenotype the two biotypes might as well be two different species
- Monoecious hydrilla is temperate –
  - call it Mhydrilla
- Dioecious hydrilla is tropical –
  - call it Dhydrilla
Unkn0wns for Mhydrilla in the North

- What is the greatest environmental constraint to hydrilla growth in Northern waters?
  - Seasonal Extremes (temp, flow, etc.)
    - Remember: Variable milfoil and cabomba are southern imports
  - Water Clarity, Alkalinity, Sediments

- Will hydrilla colonize/proliferate in deep water?
  - Will it spread to unvegetated areas (e.g. FL?)

- Will hydrilla be competitive?
  - Limited and Conflicting Literature
Monoecious Hydrilla is Colonizing and Spreading in Areas that Were Predicted to be “Low Probability” Sites for Invasion
Significant stretches of the Ohio River Now Support Monoecious Hydrilla (OH to PA)

Spread in other Rivers: e.g. Potomac, Chesapeake Bay, Abermarle Sound, etc.
Monoecious Hydrilla in Odd Places

Wild and Scenic Rivers in TN and NC

- Considered a threat to unique macroinvertebrate and fish communities

Management Options?
Colonizing Unique Stream Habitat

- **Hydrilla** grows well in a variety of substrates –
  - Poorly adapted to bedrock and large slabs
  - Rooted between large boulders in sand-filled crevices

- **Hydrilla** withstands a variety of water depths and early spring flows up to 50,000 CFS
  - Commonly observed waters a few inches to 8 feet
  - Unique stream communities at potential risk

Found in 54 river miles
Monoecious Hydrilla in Reservoirs

- Significant infestations in SC, NC, and VA (AL, TN, GA)
- Why don’t we hear more about it in this region?
  - **HEAVY USE OF STERILE GRASS CARP**
    - (Duke Energy, Santee Cooper, Corps of Engineers)
- Adapted to drawdown, high spring flow, turbidity
  - Tuber sprouting synchronized w/ favorable growth conditions
    - Reduced flow/fluctuation, rapid warm up and clear water
Extensive Shoreline Infestations are Characteristic in SE Reservoirs that are Not Stocked with Grass Carp

Co-occurrence of Monoecious and Dioecious Hydrilla On Lake Guntersville, AL
- over 25,000 acres estimated in 2012
- suspect that monoecious is becoming dominant biotype

Does this represent a re-invasion by monoecious hydrilla?
Why Be Concerned in North?

- Reliance on Grass Carp – Highly unlikely
- Eradication Programs = 6++ years
- Disjunct Introductions will be common/likely
  - Cayuga and Erie Canal were simply lottery winners
- Riverine/Stream Establishment = > chance of natural lake introduction
Symposium Discussions

- Further spread of Mhydrilla is highly likely
- Are current eradication strategies sustainable?
- Tuber longevity is a significant impediment to eradication strategies
  - Ongoing eradication programs 6 to 10 years
- Are humans the only vector for spread?
  - Waterfowl, seeds?
Monoecious Hydrilla produces prolific fruits

Germinating Seed

Role of Seeds is generally unknown?

We thought milfoil seeds were unimportant, but hybridity suggests otherwise
What do we need to Know?

- How competitive and invasive is Mhydrilla?
  - Simulate northern conditions
  - We think it could be very bad, but really can’t say

- No consensus on current value of predictive models
  - Latitudinal impacts on growth and spread?
    - MN/WI vs. OH/IN
    - Natural Lakes vs. Reservoirs
  - Is biology information adequate for modeling/prediction?
What Do We Need to Know

- Plant Phenology - poorly understood in the North
  - Tuber sprouting, tuber formation, plant senescence
    - E.g. hydrilla formed tubers into late Nov. in Cayuga
- Publications on herbicide efficacy are limited
  - Support of eradication programs
- Etc. etc. etc.
Final Thoughts

- Does evidence support hydrilla being invasive enough in the north to sustain eradication programs?
- If not eradication, then what?
  - Containment?
- Prevention vs. Preparation?
  - You are as likely to find hydrilla in a high profile lake as in a pond
- A White Paper summarizing the Symposium presentations and discussion is being prepared
  - Good guidance document for Midwestern Managers