Using Phenological Events of Flowering Rush to Improve Chemical Control Strategies

Kurt Getsinger
US Army Engineer Research & Development Center
Environmental Laboratory
Vicksburg, MS

John Madsen
USDA – Agricultural Research Service
University of California
Davis, CA
Research Objectives

**Link:** Flowering Rush phenological data with chemical control strategies – against submersed and emergent growth forms

- Grow plants under mesocosm conditions to determine weak points in life cycle – e.g. distribution of biomass, partitioning of carbohydrate reserves, etc.
- Verify mesocosm results in field populations
- Utilize results for improved herbicide efficacy in field
Flowering Rush (*Butomus umbellatus* L.)

- Aggressive exotic in littoral zone habitats
- Grows from shoreline to 3 meters deep
- Reproduction - seeds, rhizomes, buds, bulbils
- Thrives in quiescent and high-flow environments
- Water-level fluctuations facilitate colonization
Flowering Rush Taxonomy

- *Butomus umbellatus* L.
- Flowering rush
- Member of its own family, the Butomaceae
- Order Alismatales, or the same order as the arrowhead family
Flowering Rush

- Introduced from Europe and Asia
- Both a diploid and triploid biotypes
- Diploid biotype undergoes sexual reproduction and produces > 20,000 seeds per plant
- Diploid biotype also produces > 100 of vegetative bulbils per plant
- Triploid biotype produces few seeds and relies on vegetative growth for spread
Distribution of Flowering Rush

Spreading in reservoirs and river systems

Diploid – eastern Great Lakes, ID (??); Triploid – MN, MT, ID, WA
Modes of Spread

- Rhizomes and rhizome buds
- Seed (in diploid)
- Bulbils (in diploid)
- Boating
- Wave action / drift
- Waterfowl
Monoculture stands
Flowering Rush Impacts

- Dense stands exclude native plant species
- Reduces biodiversity in aquatic systems
- Degradation of fish and wildlife habitat
- Reduction of critical habitat for listed species
- Obstructs flow in irrigation ditches
- Interferes with navigation and recreation
- Obstructs use of waterfront
- Reduces the value of waterfront property
Flowering Rush Management Problem

- Information gaps in life cycle events
  Phenological** approach used to improve the management of other aquatic plants
  ** phenology - study of periodic life cycle events influenced by seasonal variations in climate

- No reliable long-term control strategies
  - including use of herbicides
Growth Forms of Flowering Rush

Submersed form has an epidermis, unlike most other submersed plants.
Production of Propagules
Rhizome Buds

Management must be directed at population of rhizome buds:

- Reducing number of rhizome buds
- Preventing the production of new buds
- Any technology (biological, chemical, mechanical, physical) must address rhizome buds

Figure 6A. The rhizome of flowering rush with two rhizome buds, indicated by the yellow arrows. Rhizome buds initiate new shoots and are the main form of vegetative propagation in flowering rush. Photo by J. Madsen, GRI.
Seasonal Timing

- Growth stage
- Production of propagules
- Carbohydrate allocation
Carbohydrate Allocation

- Photosynthesis produces sugars
- Excess sugars are translocated to the rhizome
- In rhizome, sugars converted to starch for storage

- In rhizome, starch is converted to sugar for movement
- Sugars are used in leaves to increase leaf length and build structures

Movement in phloem is always from source to sink
Seasonal Dynamic

Spring
- High in rhizome
- Low in leaves
- Movement upwards

Early summer
- Low in rhizome
- Low in leaves
- PS balances needs

Late summer
- High in leaves
- Low in rhizome
- Movement downward

Fall/Winter
- PS Stops
- High in rhizome
- No movement
Carbohydrate Low Point

![Graph showing the relationship between starch content and month of the year, with a low point indicated.](image)
Flowering Rush Phenology
Mesocosm Evaluations
Flowering Rush Phenology
Field Verification
Management with Herbicides

- Depth of inundation of shoots

- Limited, short-term success with submersed applications using contact products – primarily diquat

- Water-exchange processes reduce success with longer acting systemic products in submersed applications

- Applications to plants in de-watered littoral sites show promise – quantification in progress
Depth of Inundation

- Emergent treatment should work
- Emergent treatment likely to work
- Emergent treatment may not work, submersed treatment instead or in addition
- Submersed treatment required
Research Approach

Field Evaluations – herbicides – build on results of other studies
Lake Pend Oreille, ID
Flowering Rush Sites

Lake Pend Oreille
Flowering Rush 2012

Flowering Rush Locations

Innovative solutions for a safer, better world
Lake Pend Oreille Dewatered Herbicide Trials -2015

Drift Yard Area
Lake Pend Oreille Dewatered Herbicide Trials

**Five Treatments**: 3 reps each, plots = 0.25 acre each

- Imazapyr, 3 qt/ac (Polaris, Nufarm)
- Imazamox, 2 qt/ac (Clearcast, SePRO)
- Imazapyr, 3 qt/ac + 2,4-D, 1 qt/ac (Weedar 64, Nufarm)
- Imazamox, 2 qt/ac + 2,4-D, 1 qt/ac
- untreated control (reference)
- all chemical treatments included surfactant, 1 qt/ac
Lake Pend Oreille Dewatered Herbicide Trials

April 2015 Plot Lay-out
Lake Pend Oreille Dewatered Herbicide Trials

- Applied prior to re-flooding of littoral zone: 24-28 April 2015
- Used ATV and spray boom
- Plant shoots 1-2 inches above sediment surface
Lake Pend Oreille Dewatered Herbicide Trials

2015 Plots
Lake Pend Oreille Dewatered Herbicide Trials

**Vegetation Assessments:** Pretreatment, 12 and 52 wks post

- 10 biomass samples each plot, each event
Lake Pend Oreille Dewatered Herbicide Trials

Preliminary Results – 12 weeks posttreat - July 2015
Lake Pend Oreille Dewatered Herbicide Trials

Preliminary Results – 16 weeks posttreat - Aug 2015
Lake Pend Oreille Dewatered Herbicide Trials

Biomass Sample – 12 weeks posttreatment
Lake Pend Oreille Dewatered Herbicide Trials

Mean (+ SE) Estimated Cover – 12 weeks posttreatment

![Bar graph showing Flowering Rush Bareground Treatments with visual estimates of percent cover for different herbicide treatments including Ref, IX, IX+D, IZ, and IZ+D. The graph indicates the percentage of cover with error bars for each treatment.]
Lake Pend Oreille Dewatered Herbicide Trials

Preliminary Results: 12 wk post – Native Plants - July 2015
Benefits of Work

- Phenological studies will benefit all flowering rush management techniques
- Chemical control – application techniques, evaluation of products, timing of applications
- Cost-effectiveness -- linking weak points in FR life cycle to application parameters – less herbicides, consistent and prolonged control
- Restore native vegetation; improve fish and wildlife habitat, etc.
- Provide guidance to resource managers for improving control of flowering rush
Flowering Rush R&D Cooperators

- CE Aquatic Plant Control Program - ERDC
- CE Districts -- Seattle, Walla Walla, Portland, Omaha
- CE Albeni Falls Project – Lake Pend Oreille
- USDA-ARS – Davis, CA
- Idaho State Department of Agriculture
- Bonner Co, ID
- Washington State Department of Ecology
- Pend Oreille Co, WA
- Avista Utilities (WA, ID, MT)

- Others being sought …