Aquatic Invasive Plants
Species of concern, impacts and control

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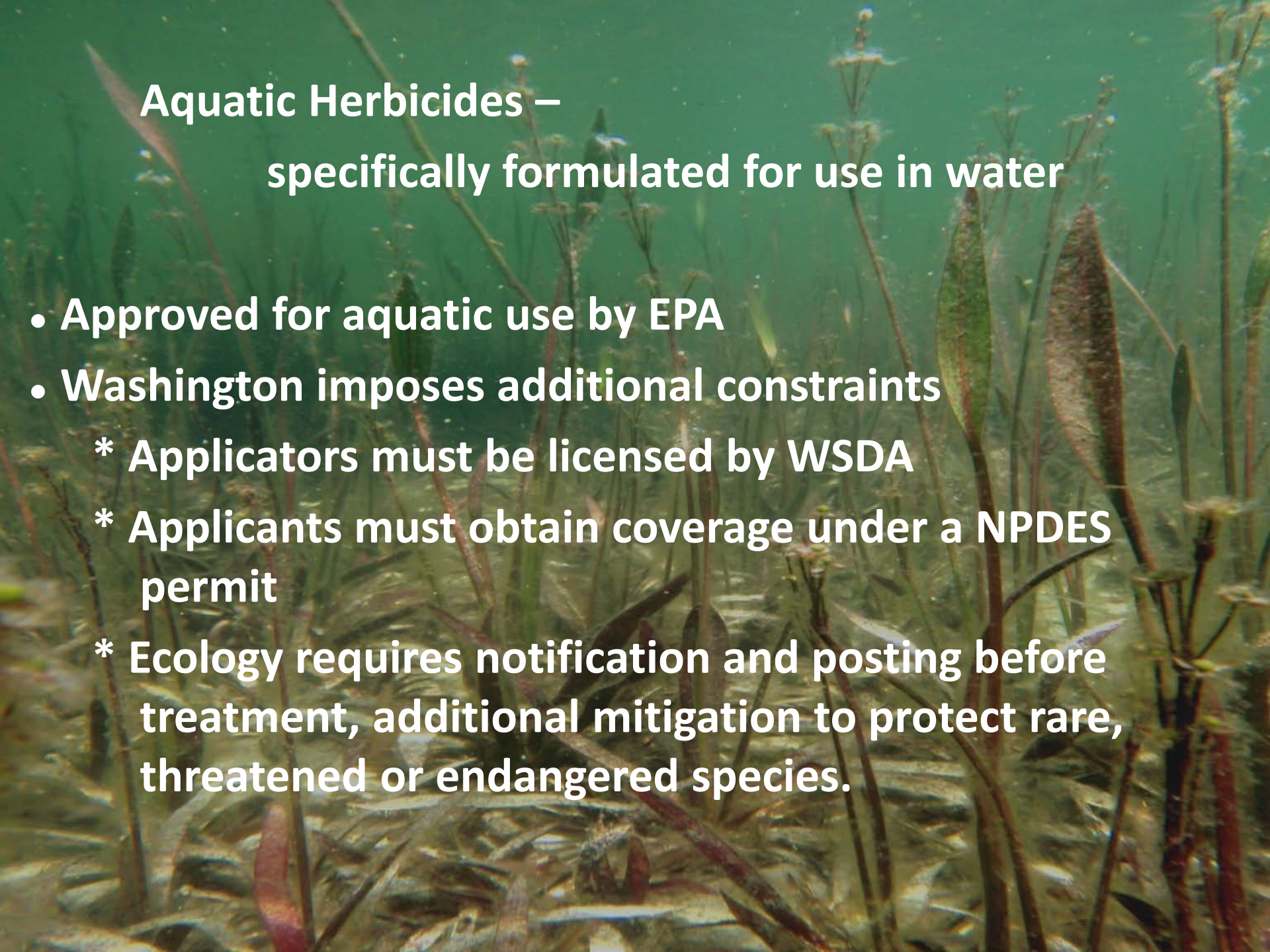


Aquatic Herbicides –
specifically formulated for use in water

- Approved for aquatic use by EPA
- Washington imposes additional constraints
  - * Applicators must be licensed by WSDA
  - * Applicants must obtain coverage under a NPDES permit
  - * Ecology requires notification and posting before treatment, additional mitigation to protect rare, threatened or endangered species.

Ecology issues permits for 12 herbicides and 3 algaecides

Herbicide	Trade name(s)	Selection	Formulation
Glyphosate	Rodeo,AquaMaster,	Broad spectrum	Systemic
Fluridone	Sonar, Whitecap	Broad spectrum	Systemic
2,4-D	AquaKleen, Navigate	Selective – dicot	Systemic
Endothall	Aquathol, Hydrothal	Broad spectrum	Contact
Diquat	Reward	Broad spectrum	Contact
Triclopyr TEA	Renovate, Garlon	Selective – dicot	Systemic
Imazapyr	Habitat	Broad spectrum	Systemic
Imazamox	Clearcast	Selective – monocots	Systemic
Flumioxazin	Clipper	Broad spectrum	Contact
Penoxsulam	Galleon SC	Broad spectrum	Systemic
Carfentrazone-ethyl	Stingray	Selective – grass sp.	Contact
Bispyribac-Sodium	Tradewind	Selective – dependent	Selective

Herbicide	Exposure	Advantages	Disadvantages
Glyphosate	NA	Few label restrictions, focus spray to target plants	Slow action, no submersed control, repeated app. needed
Fluridone	30-60 days	Low dose req., few label restrictions, submersed sp.	Long contact time, slow acting 6-12 weeks, not great - spot treatments
2,4-D	18-72 hours	Inexpensive, fast acting	Public perception, 2,4-D ester not for use in salmon bearing waters
Endothall	12-36 hours	Rapid action, limited drift, good for spot treatments	does not impact below-ground biomass, short term
Diquat	12-36 hours	Rapid action, limited drift,	≠ below-ground biomass, short term, ≠ turbid water, algae bloom
Triclopyr TEA	12-60 hours	Fast acting, spot treatments, selective - EWM,	≠ on water body with outlet or moving water
Imazapyr	NA	Slow acting, emergent sp., focus spray to target plants	Not for underwater sp.
Imazamox	short	Rapidly taken up, growth inhibition w/in 24 hrs.	
Flumioxazin		Fast acting, best early in season, limited biomass	Light dependent, ≠ on water body with outlet
Penoxsulam	45-90 days	Immediate growth inhibition,	Need 2nd "bump" treatment to maintain concentrations
Carfentrazone-ethyl		Slow moving water bodies, emergent and submersed sp.	Not for water body w/irrigation
Bispyribac-Sodium		Selectivity = by adsorption, translocation & metabolism	Need 2nd "bump" treatment to maintain concentrations

Determining method and herbicide:

Condition of the system – monoculture of invasives?

Invasive species of concern? Rare species in area?

selective vs. broad spectrum / contact vs. systemic

Water body conditions – flowing, inflow, outlet?

contact time - short (12-36 hrs) vs. long (30-60 days)

Used for drinking water, recreation? Rare species?

persistence and safety factors

other restrictions from Ecology and WDFW

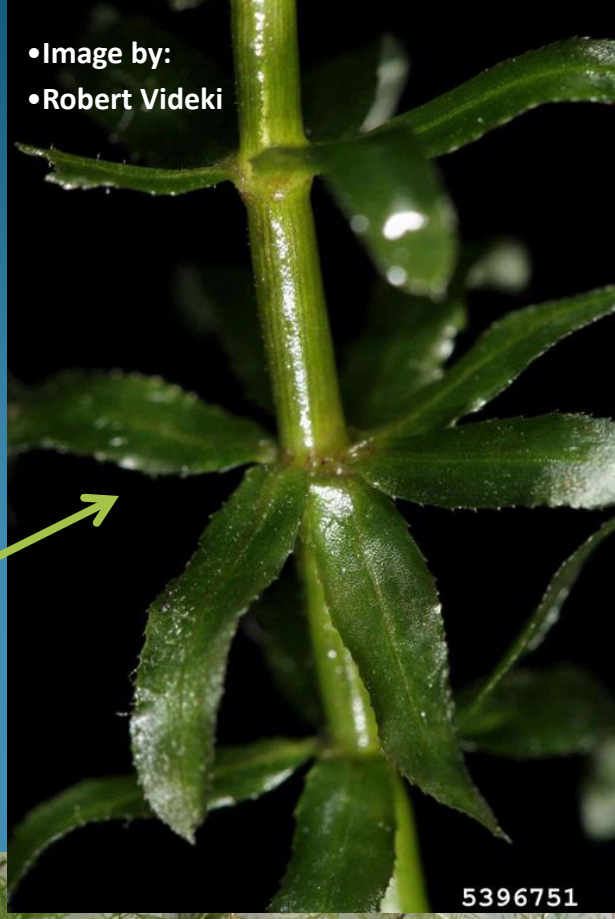
Class A
Submersed and Floating Aquatics and Emergent species

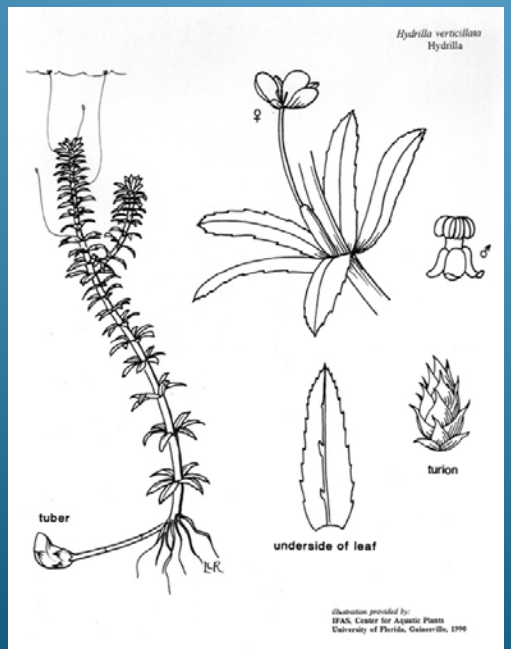
- hydrilla (*Hydrilla verticillata*)
- flowering rush (*Butomus umbellatus)*
- variable-leaf milfoil (*Myriophyllum heterophyllum*)

hydrilla, waterthyme

Distinguishing features include:

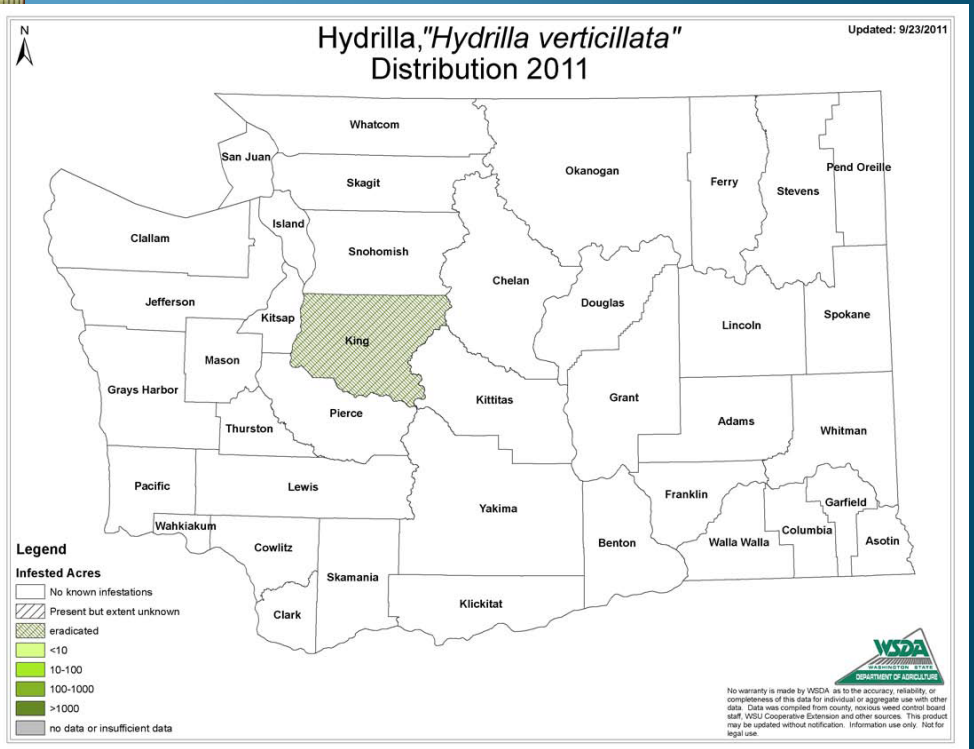
- Presence of tubers (.2-.4 inch long, off white to yellow, pea like structure buried in sediment)
- Leaves in whorls of generally 5 leaves per whorl
- **Serrations or small spines along leaf edges**
- Midrib of leaf often reddish when fresh





- Production of turions on stems and tubers at the end of roots, mainly in the spring
- Female flowers with 3 translucent small petals, attached at leaf axils, float at surface
- Male flowers have 3 white to red narrow petals

- Spreads primarily via rhizomes, stolons, tubers and turions
- Stem fragments with as few as 2 nodes or whorls of leaves can produce a new plant
- Fragments of rhizomes and root crowns can also produce a new plant!



hydrilla, waterthyme

Control options:

- diver hand pulling
- benthic barrier
- biocontrol – (*Hydrellia* sp., *Bagous* sp.)
- Fluridone (systemic) (broad spectrum)
- Endothall (contact) (broad spectrum)
- Diquat (contact) (broad spectrum)
- Penoxsulam (systemic) (broad spectrum)

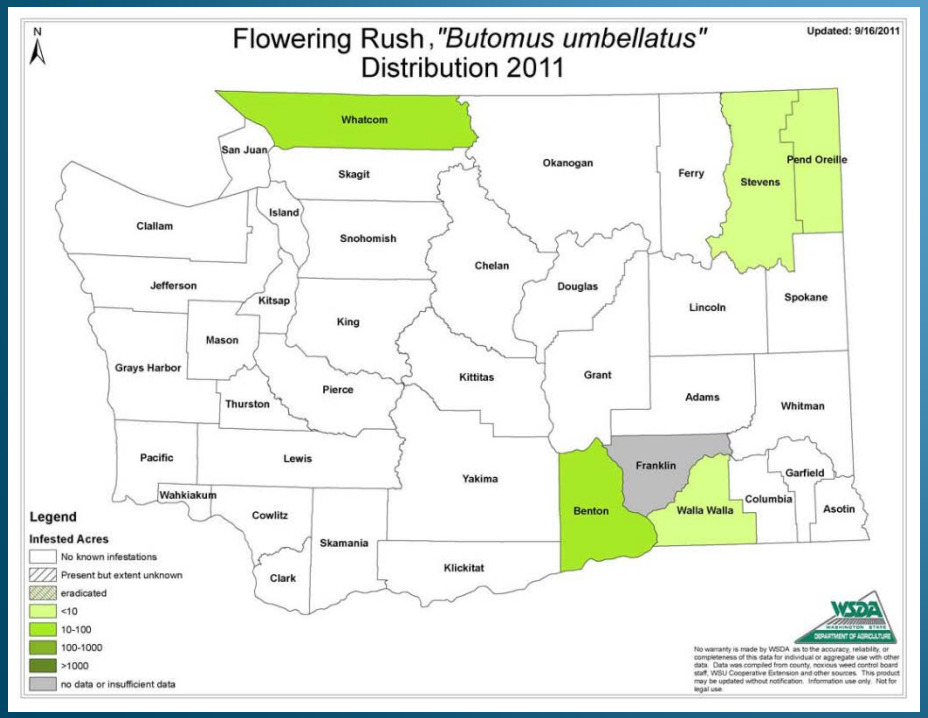
Flowering rush, *Butomus umbellatus*

- Native to Europe, Asia and N. Africa
- Former pond ornamental
- Submersed or emergent, freshwater, perennial
- Stout rhizomes, can form bulbils
- Leaves submersed or emergent, up to 3 feet
- Leaf blades triangular proximally, flattened distally
- Can have twisted/spiral growth

•Image by: Ben Legler

Flowering rush

- Umbellate pink flowers with 3 petals and 3 sepals
- Hard to find when not flowering
  - Sporadic flowering
- Distribution
  - freshwater shorelines and riverbanks and in standing water, irrigation canals and ditches

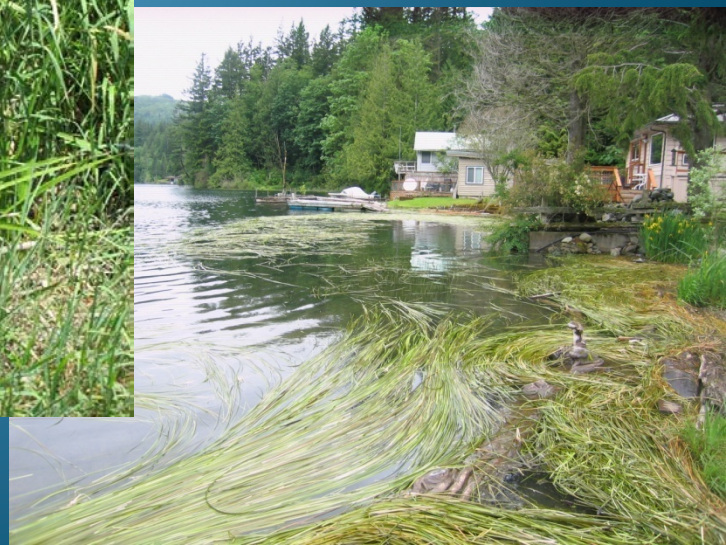


Yakima River

Control options:

- hand pulling
- biocontrol – (CABI research)
- herbicide?

Pend Orielle River



Variable-leaf milfoil (*Myriophyllum heterophyllum*)

- Broad leafy emergent bracts
- Submersed leaves outside whorls

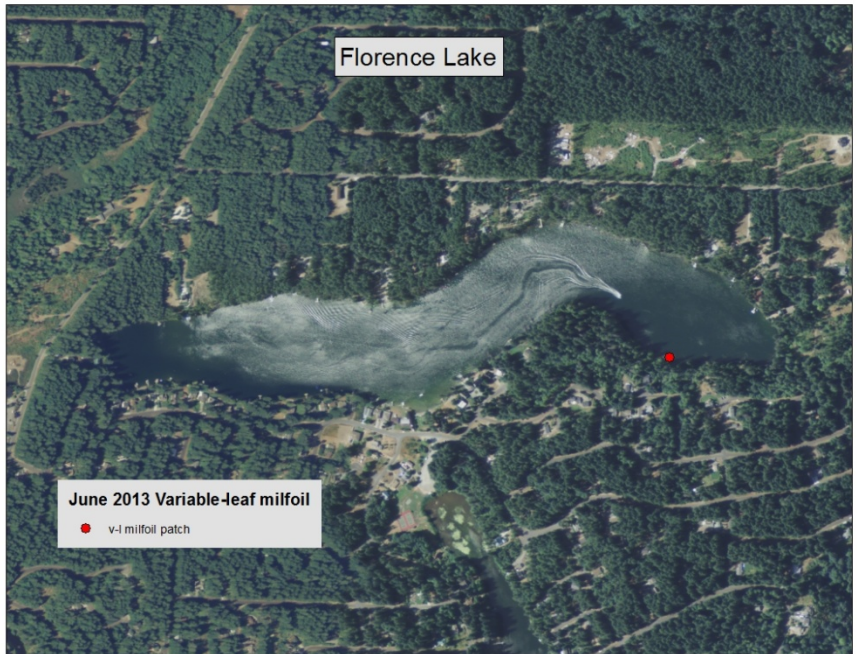
Native water-milfoils

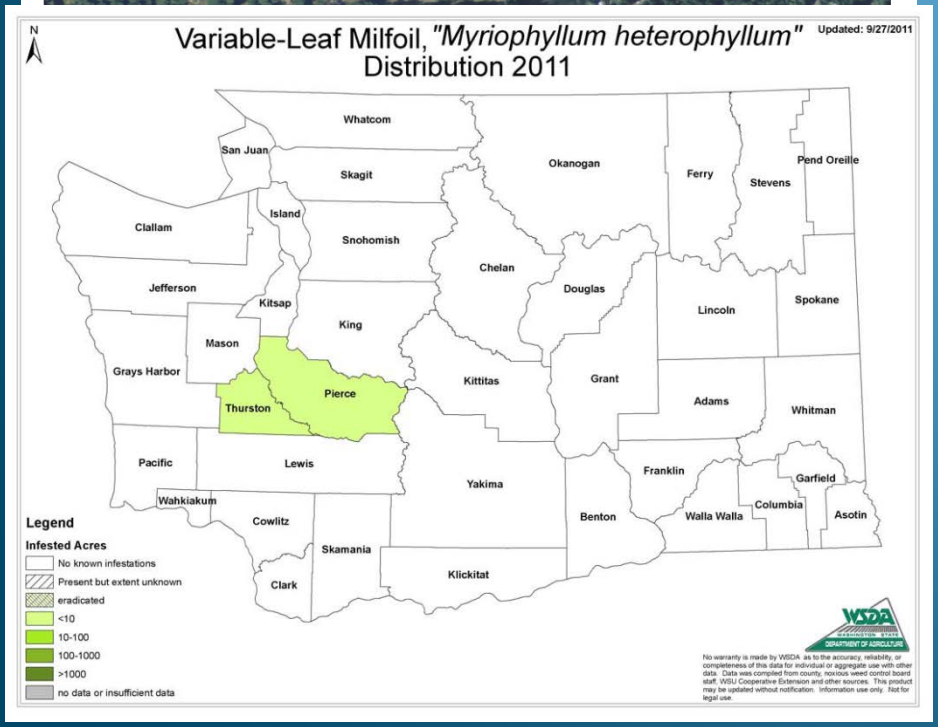
whorled watermilfoil
(*M. verticillatum*)

western watermilfoil
(*M. hippuroides*)

Andean watermilfoil
(*M. quitense*)

northern watermilfoil
(*M. sibiricum*)





Control options:

- hand pulling
- Diquat (contact) (broad spectrum)
- 2,4-D granular (systemic) (selective)
- Triclopyr TEA (systemic) (selective)

Before treatment in 2011

After treatment in 2011

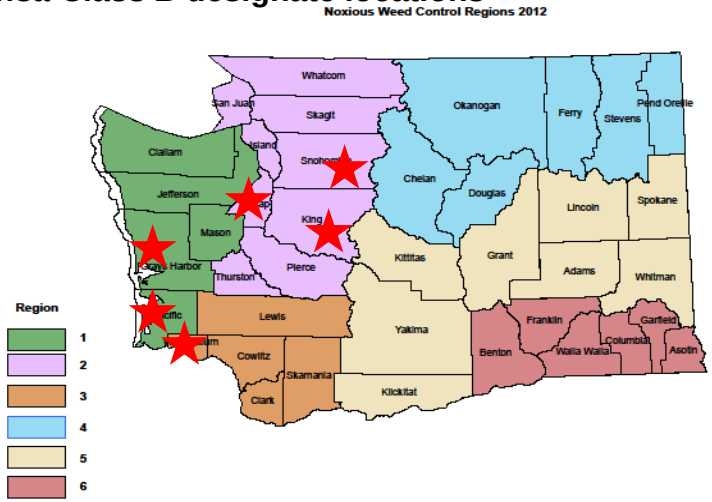
Class B
Submersed and Floating Aquatics and Emergent species

- Brazilian elodea
- Eurasian milfoil
- parrot-feather
- fanwort
- water primrose
- yellow floating heart
- purple and garden loosestrife
- common reed

Brazilian elodea *(Egeria densa)*

- Usually 4 leaves/whorl
- flowers ‘showy’, 3 white petals ~ ¼ in long. Only male plants in U.S.
- Rooted at the bottom, up to 20 feet
- Found in still and flowing waters, lakes, ponds, streams

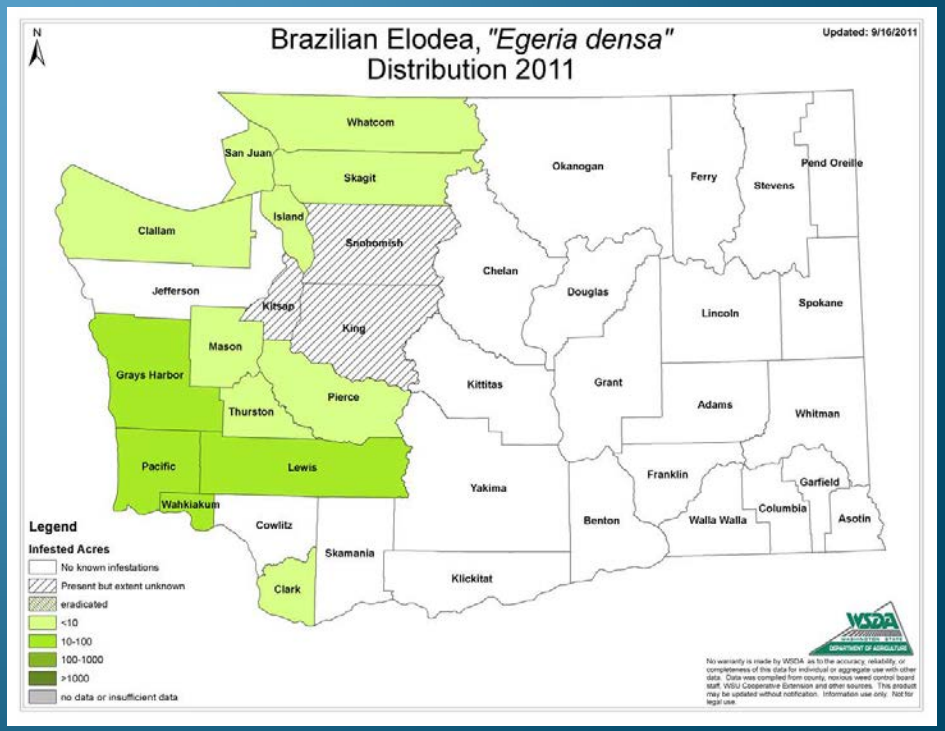
Egeria densa Class B designate locations



Brazilian elodea, *Egeria densa*

Will be a "Class B designate" in all lands lying within:

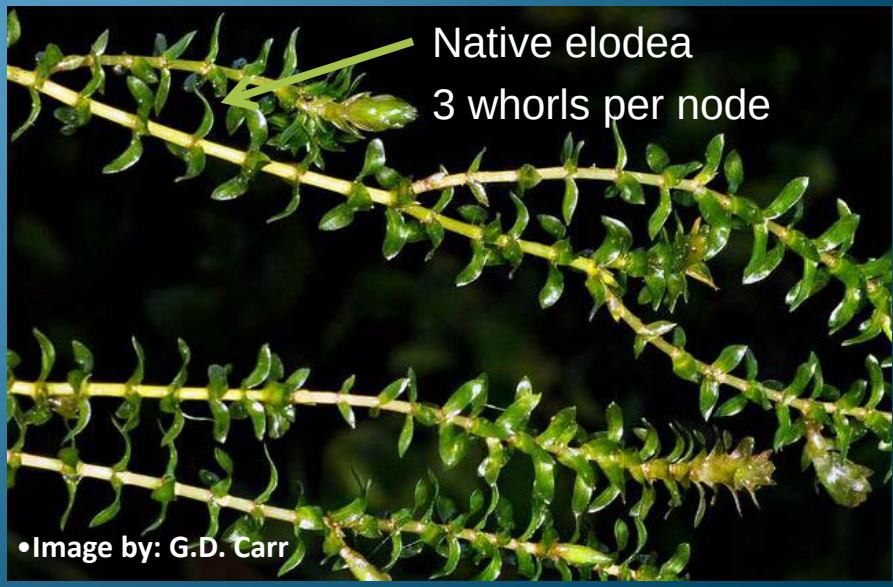
- region 1, except Grays Harbor and Pacific counties
- region 2, except Kitsap and Snohomish counties
- King County of region 2, except lakes Dolloff, Fenwick, Union, Washington, and Sammamish, and the Sammamish River
- region 3, except Wahkiakum County
- regions 4, 5, and 6



Brazilian elodea, *Egeria densa*

How to distinguish from native elodea:

- Larger, more robust and bushy than the native *E. canadensis* (waterweed)
- 1-3 cm long in whorls of 4-8 around the stem
- Bright green leaves
- Stems reach the surface of water forming dense mats
- 18-25 mm white flowers with 3 petals, rise above water surface
- Waterweed smaller and has 3 leaves per whorl, each leaf less than 1 cm long

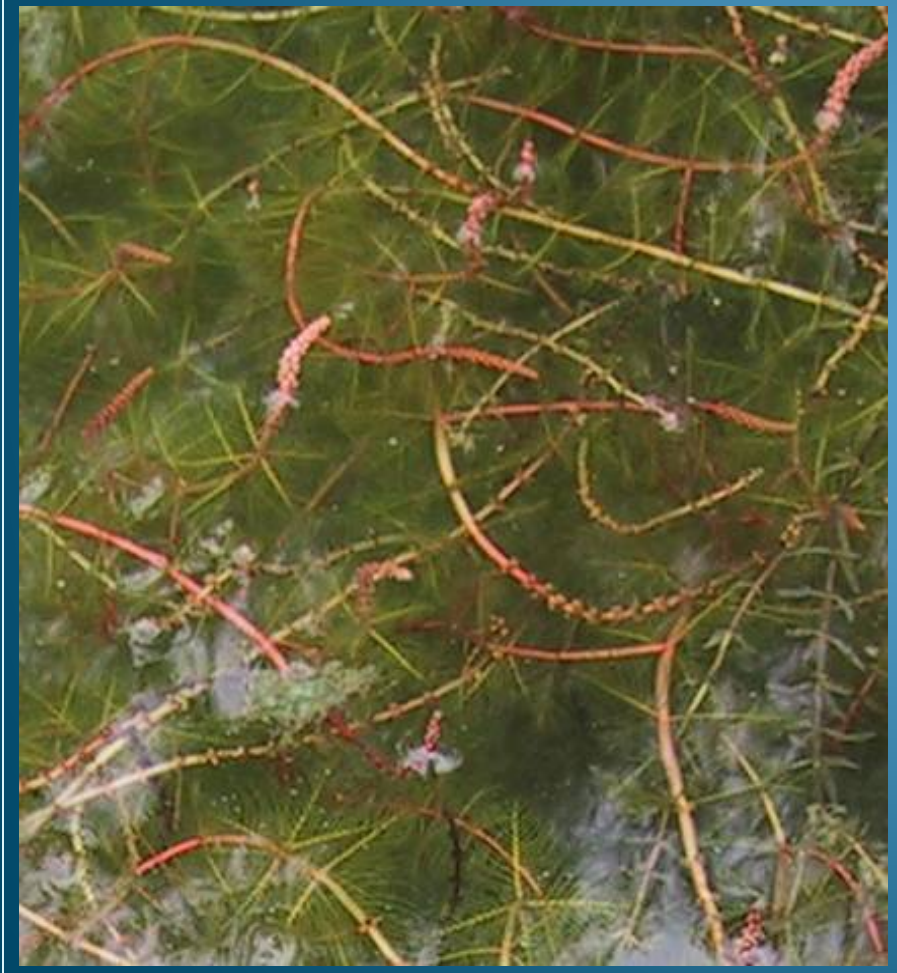


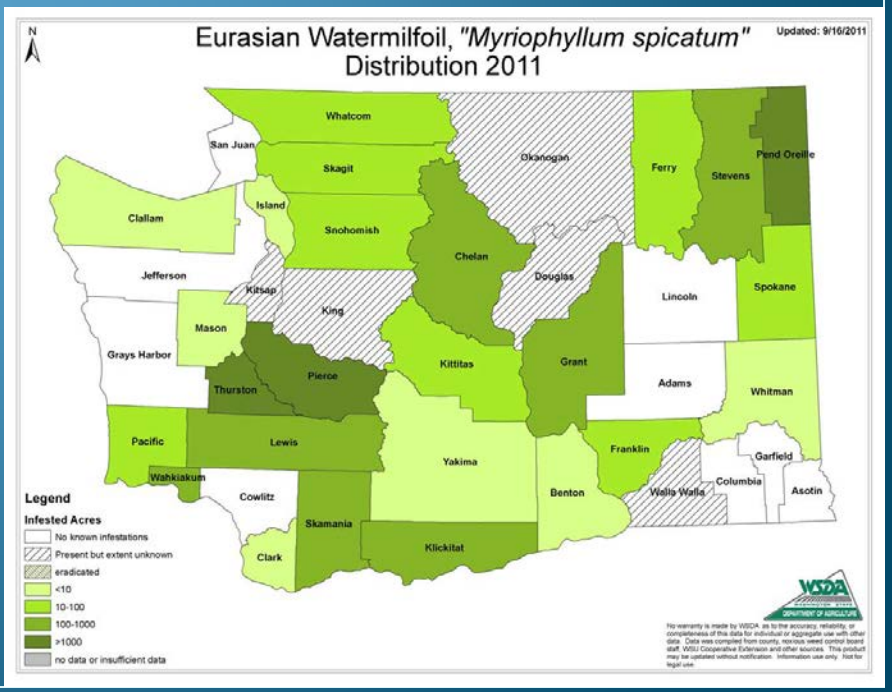
Control options:

- hand pulling
- Diquat (contact) (broad spectrum)
- Fluridone (systemic) (broad spectrum)

Eurasian watermilfoil

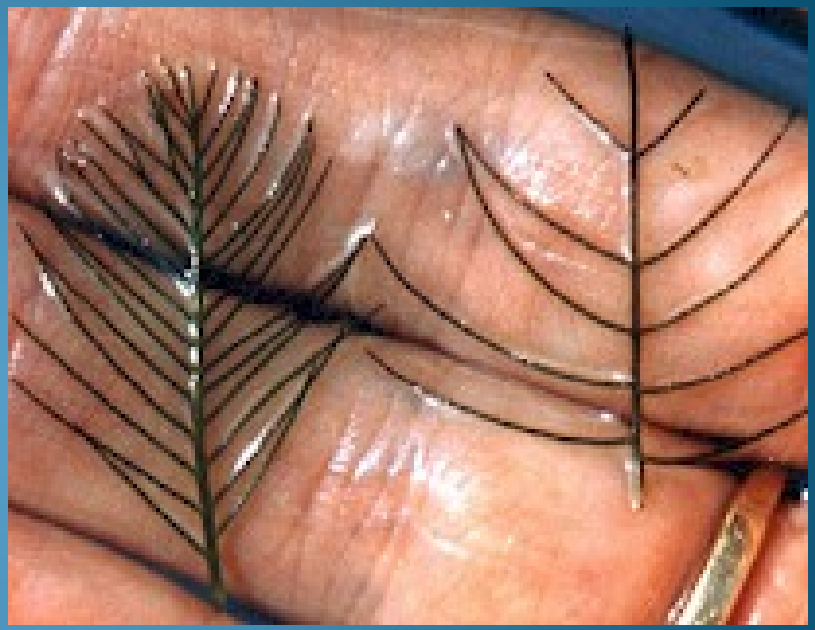
Myriophyllum spicatum





Identification of Eurasian milfoil

- 4 leaves per whorl
- 14 or more leaflet pairs
- leaves more square in outline
- collapse more when out of the water



Eurasian milfoil

northern milfoil
(Myriophyllum sibiricum)

Control options:

- diver hand pulling
- benthic barrier
- biocontrol – (North American weevil – *Euhrychiopsis lecontei*)
- 2, 4-D Amine & Ester (systemic) (selective, dicot)
- Fluridone (systemic) (broad spectrum)
- Endothall (contact) (broad spectrum)
- Diquat (contact) (broad spectrum)
- Triclopyr TEA (systemic) (selective, dicot)
- Penoxsulam (systemic) (broad spectrum)
- Bispyribac-Sodium (systemic) (selective, differential metabolism of sp.)

Parrotfeather, *Myriophyllum aquaticum*

- Bright green, fir tree like emergent leaves and stems
- Leaflets arranged in whorls of 4-6 around the stem in feather like arrangement
- Only reproduce vegetatively
- No tubers or turions
- Spreads exclusively by plant fragmentation and does not auto-fragment
- Tenacious rhizomes allow for spread via boats and trailers even long distances


•Image by: Richard Old


•Image by: John Randall

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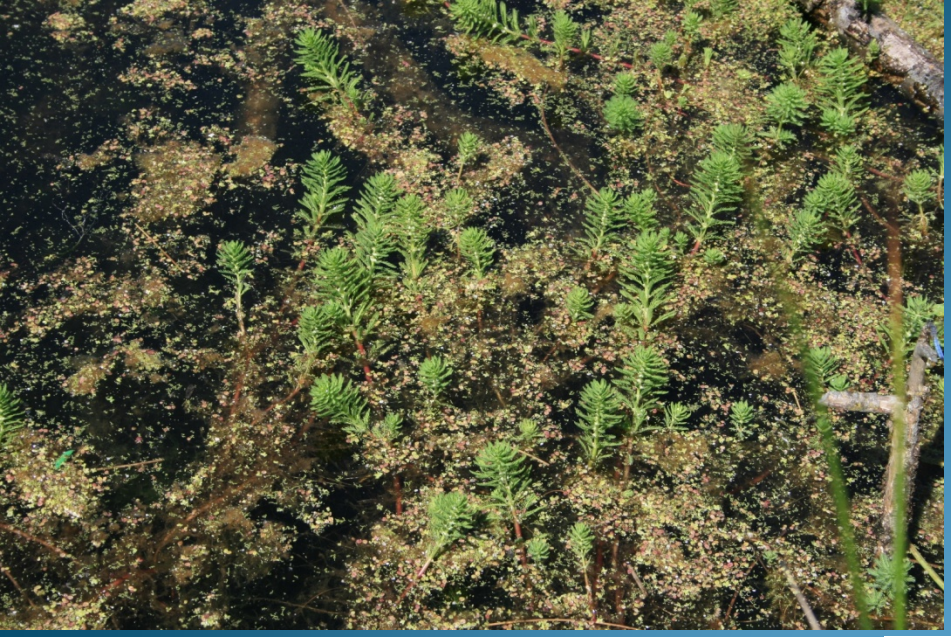

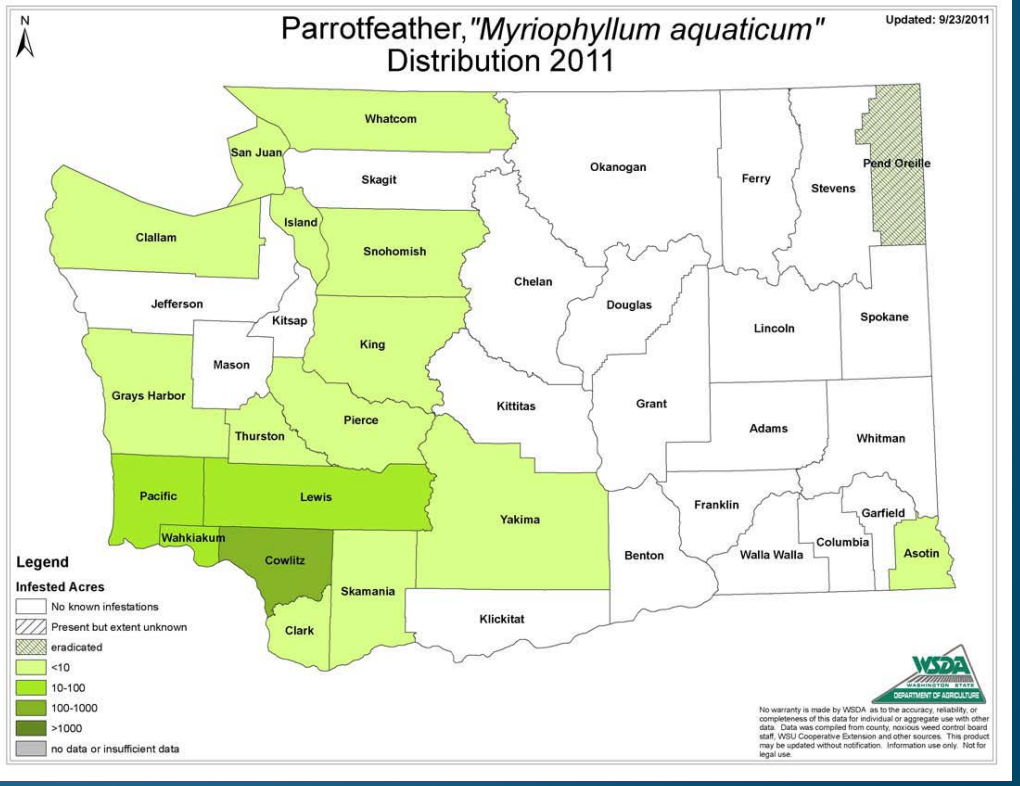
Parrotfeather, "Myriophyllum aquaticum"
Distribution 2011
Updated: 9/23/2011
N
Whatcom
San Juan
Skagit
Okanogan
Ferry
Stevens
Pend Oreille
Island
Clallam
Snohomish
Chelan
Douglas
Lincoln
Spokane
Jefferson
Kitsap
King
Mason
Grays Harbor
Kittitas
Grant
Adams
Whitman
Thurston
Pierce
Pacific
Lewis
Yakima
Franklin
Garfield
Wahkiakum
Cowlitz
Benton
Walla Walla
Columbia
Asotin
Skamania
Klickitat
Clark
Legend
Infested Acres
No known infestations
Present but extent unknown
eradicated
<10
10-100
100-1000
>1000
no data or insufficient data
WSDA
WASHINGTON STATE
DEPARTMENT OF AGRICULTURE
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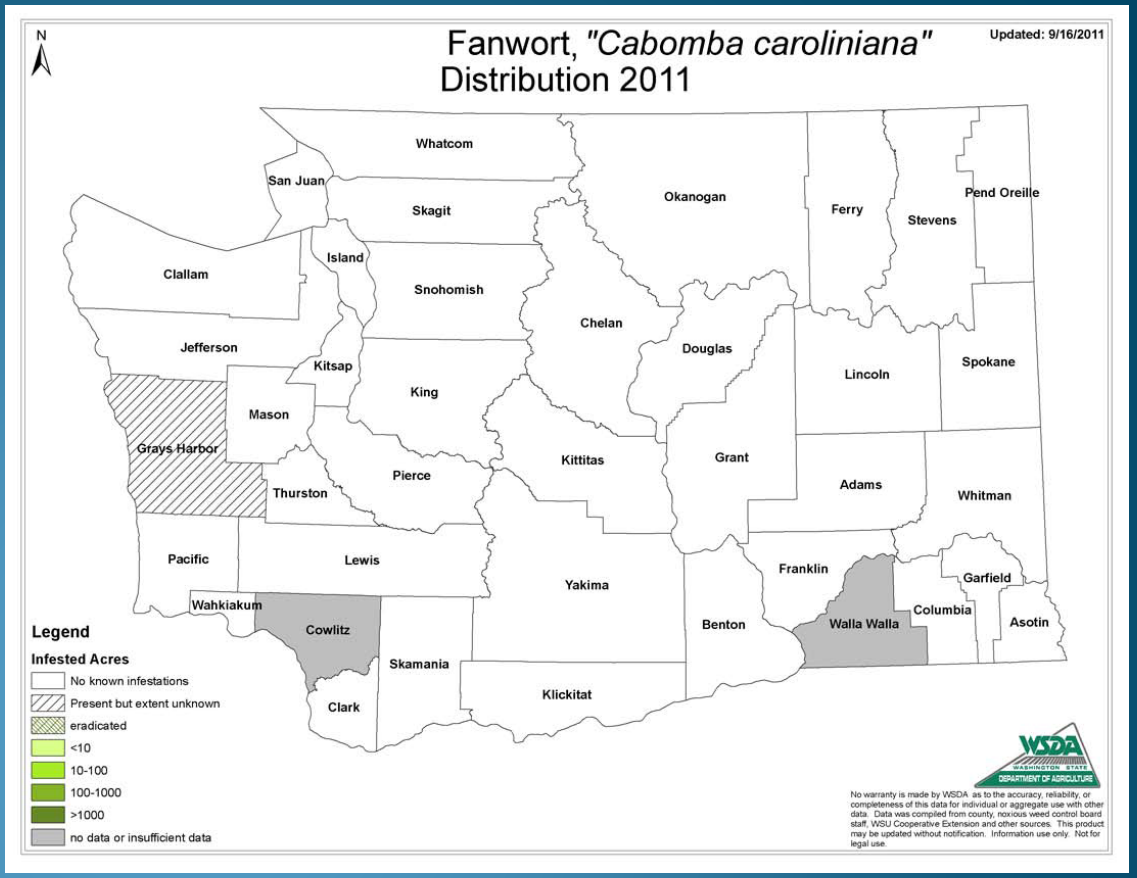
Control options:

- hand pulling
- 2,4-D Amine (systemic) (selective, broad-leaves)
- Diquat (contact) (broad spectrum)
- Endothall (contact) (broad spectrum)
- Triclopyr TEA (systemic) (selective, broad-leaves)
- Imazapyr (systemic) (broad spectrum)

fanwort
(Cabomba caroliniana)

- submersed leaves fan-shaped, opposite, on stalks
- small floating leaves arrow or diamond shaped
- showy flowers
- 3 white petals
- 3 similar sepals



Control options:

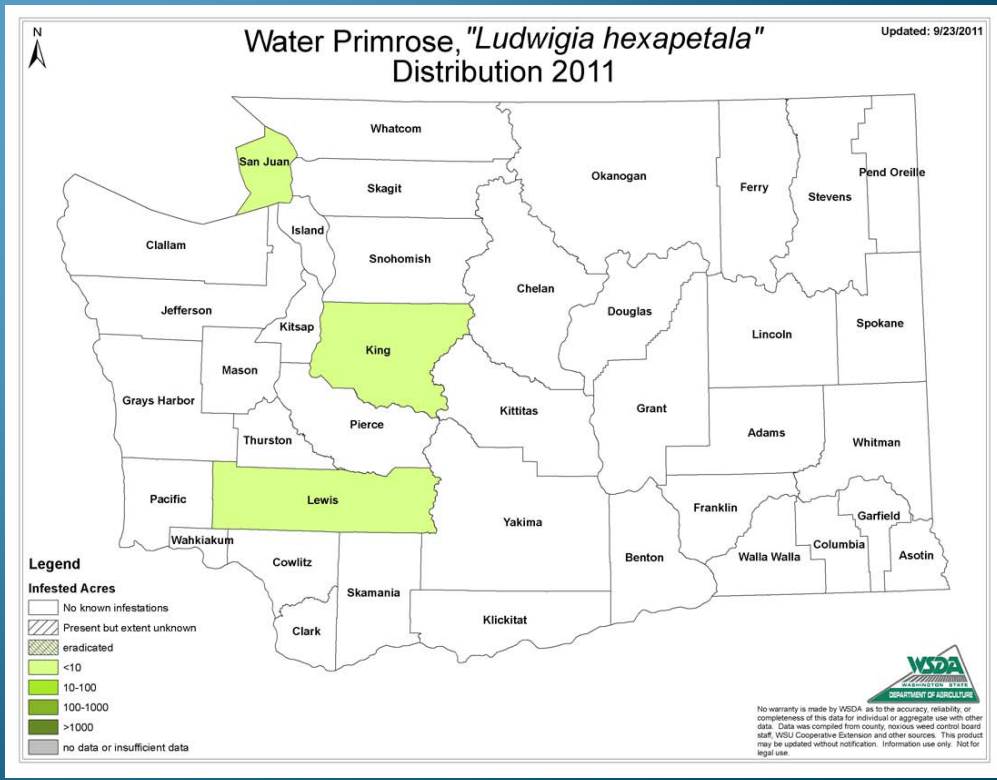
- hand pulling
- Diquat ?
- Fluridone? (systemic) (broad spectrum)
- Endothall? (contact) (broad spectrum)
- 2,4-D?

water primrose *(Ludwigia hexapetala)*

- native to South America
- young leaves rounded, mature leaves pointed
- 5 yellow petals

Control options:

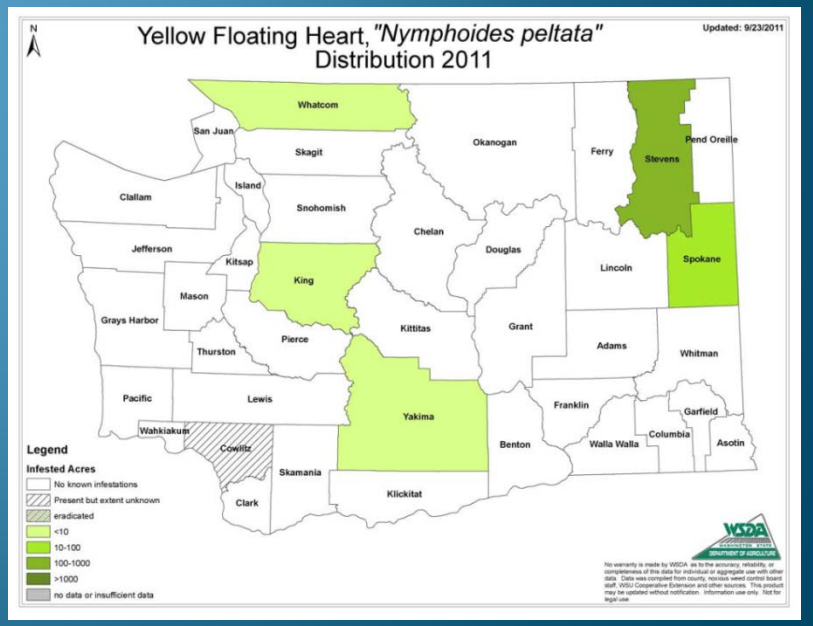
- hand pulling
- 2,4-D Amine (systemic) (selective, dicot)
- Triclopyr TEA (systemic) (selective, dicot)



Yellow floating heart (*Nymphoides peltata*)

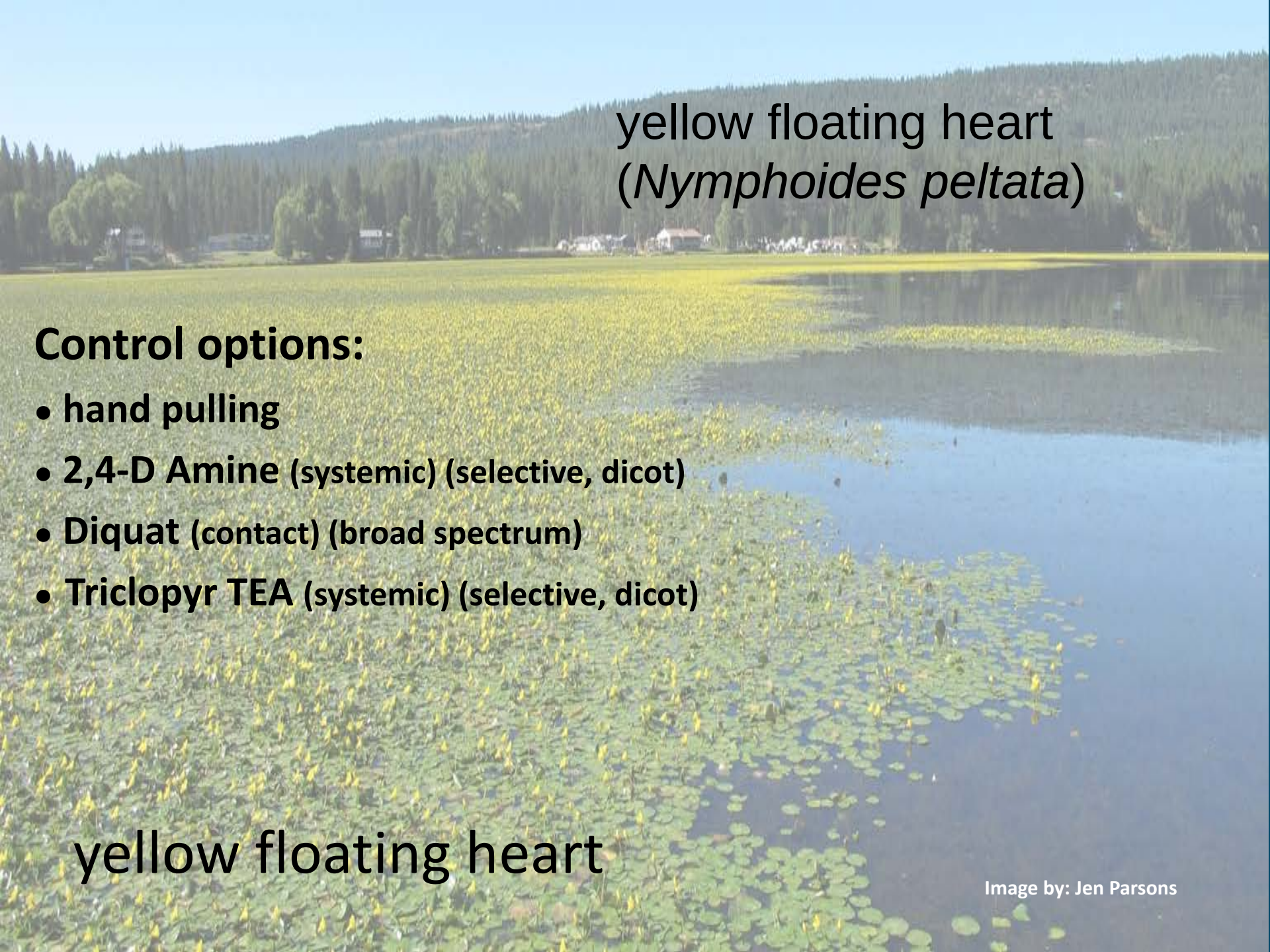
- Flowers on stalks that rise a few inches above the surface
- Flowers an inch in diameter
- Five petals per flower with a distinctive fringe, arranged like the spokes of a wheel
- Heart shaped leaves on long stalks
- Leaves have slightly wavy margins and purplish undersides


•Image by: Jen Parsons



Native look-alike species:
Nuphar polysepala
(spatterdock)


•Image by: Max Licher



yellow floating heart (*Nymphoides peltata*)

Control options:

- **hand pulling**
- **2,4-D Amine (systemic) (selective, dicot)**
- **Diquat (contact) (broad spectrum)**
- **Triclopyr TEA (systemic) (selective, dicot)**

yellow floating heart

Image by: Jen Parsons

Purple loosestrife, *Lythrum salicaria*

- Perennial herb with square stems, 2-9 ft.
- Leaves opposite, or whorl of 3, lanceolate
- Flowers in dense spike


•WSNWCB

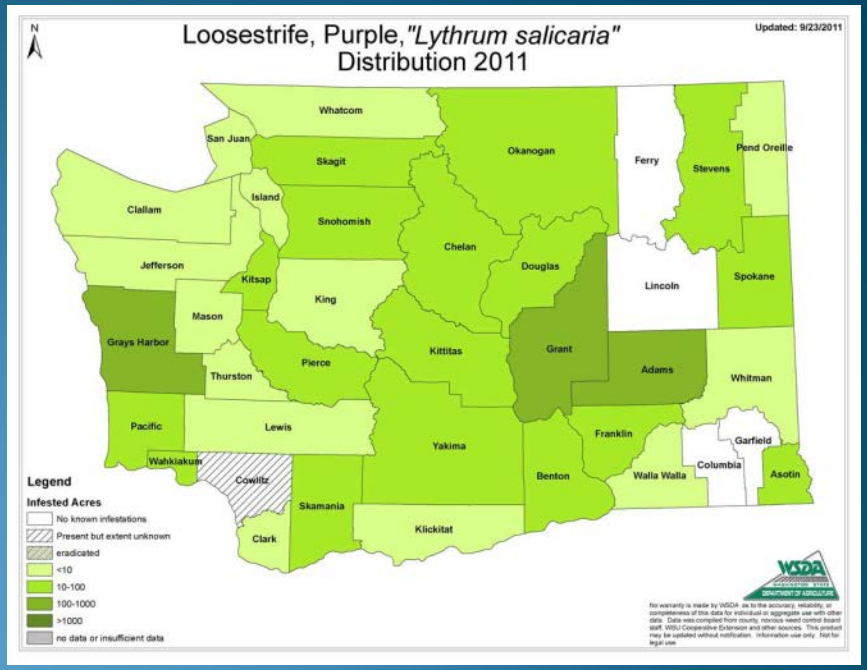

•WSNWCB


•Jenn Andreas, WSU Extension


•Jenn Andreas, WSU Extension

Purple loosestrife

- In wetland environments including ponds, rivers, meadows, roadside ditches, gardens and irrigation canal
- Thrives in both freshwater and brackish water



Control options:

- Biocontrol - *Galerucella calmariensis* and *G. pusilla, Hylobius transversovittatus and Nanophyes marmoratus*
- Imazapyr (systemic) (broad spectrum)
- Glyphosate (systemic) (broad spectrum)
- Triclopyr TEA (systemic) (selective, dicot)
- 2,4-D (selective)

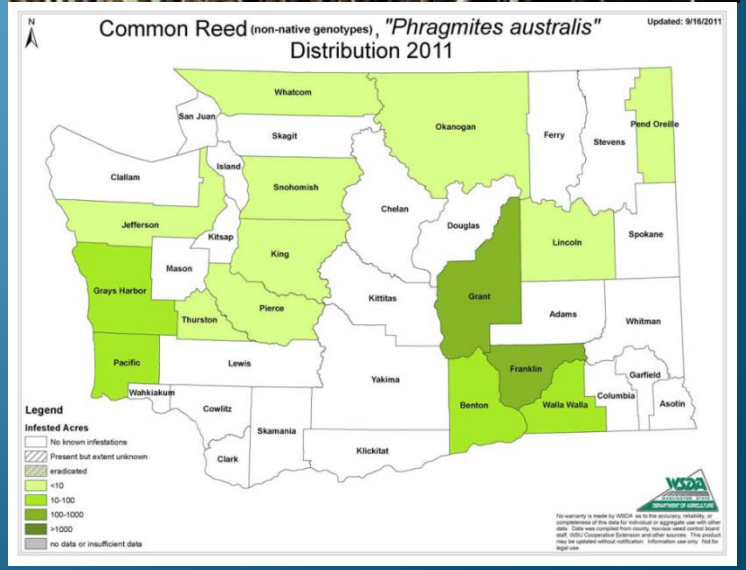
Common reed, *Phragmites australis*

- Large perennial grass with creeping rhizomes
- Stems are woody, rough, hollow and can reach 12 ft +
- Leaves are alternate, lance-shaped and 8 to 16 inches long and 1/5 -1.5 inches wide

Common reed, *Phragmites australis*

- Feathery, plume-like inflorescence (panicle)
  - crowded, silky-hairy spikelets
- Typically found in or near wetlands
- Habitats: disturbed and non-disturbed sites that hold water, including roadside ditches and depressions, ponds, irrigation canals
- Invasive and native form

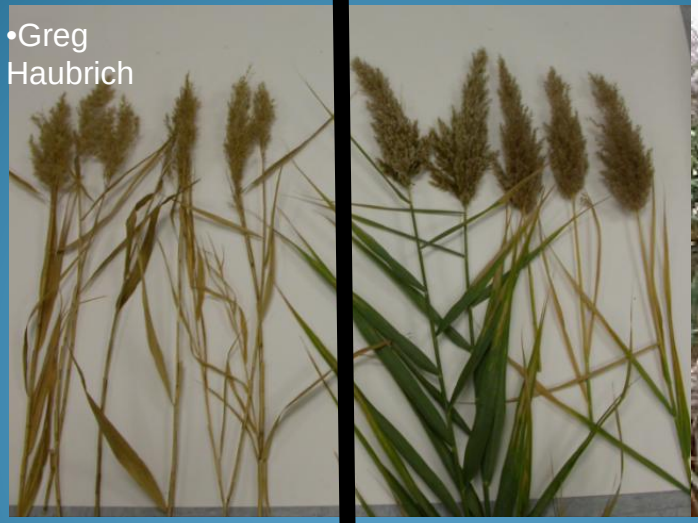
•Greg Haubrich



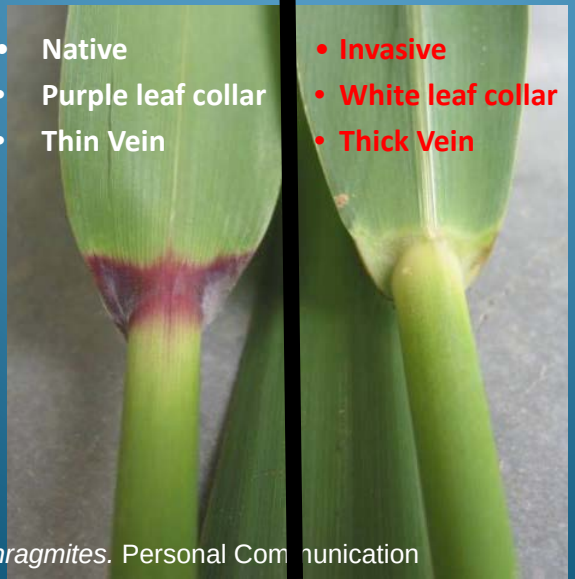
Native vs. Invasive Form

Less bushy

Bushier flowers



- Fewer Leaves
- Lighter Color Leaves (yellow-green)
- Less bushy flowers
- Tends to drop leaves during winter



- More Leaves
- Darker Leaves (blue-green)
- Denser Growth
- Bushier flowers
- Tends to hold onto leaves during winter

•Meadows and Saltonstall 2003. *Native Phragmites.* Personal Communication

Control options:

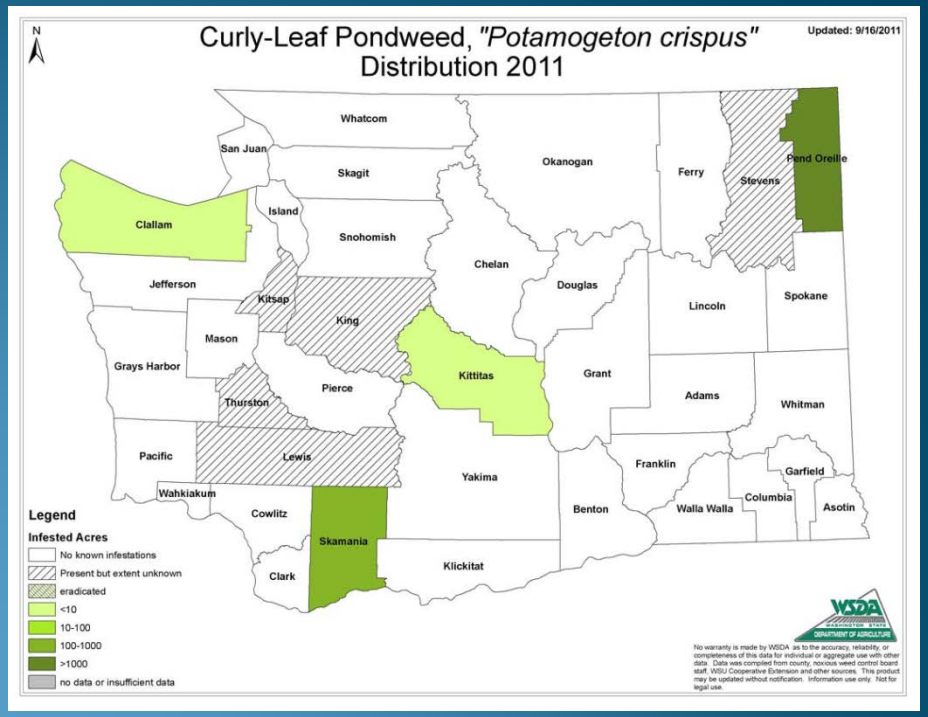
- Biocontrol
- Imazapyr (systemic) (broad spectrum)
- Glyphosate (systemic) (broad spectrum)

Class C
Submersed and Floating Aquatics and Emergent species

- curly-leaf pondweed
- fragrant waterlily
- yellow flag iris

curly leaf pondweed *(Potamogeton crispus)*

- submersed
- wavy, serrated leaf margins, parallel sides
- bur-like turions



Control options:

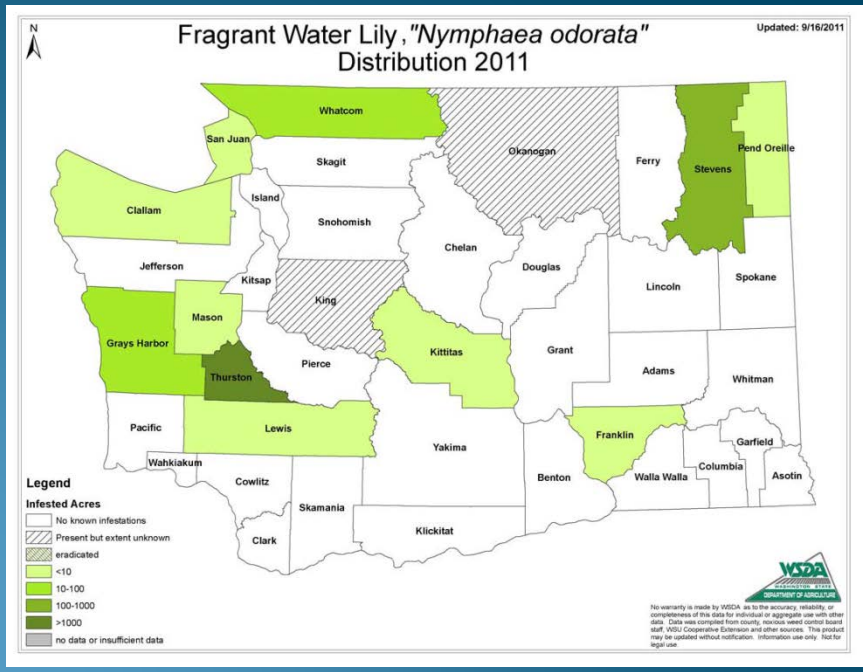
- Fluridone (systemic) (broad spectrum)
- Diquat (contact) (broad spectrum)
- Imazamox (systemic) (selective-monocots more sensitive)
- Endothall (contact) (broad spectrum)
- Flumioxazin (contact) (broad spectrum)

fragrant waterlily
(Nymphaea odorata)

- Large, showy white or pink flowers
- almost circular floating leaves, 11 inches
- stem attached to center of leaf, deep cleft to stem
- underside of leaf red/purple, veins

Control options:

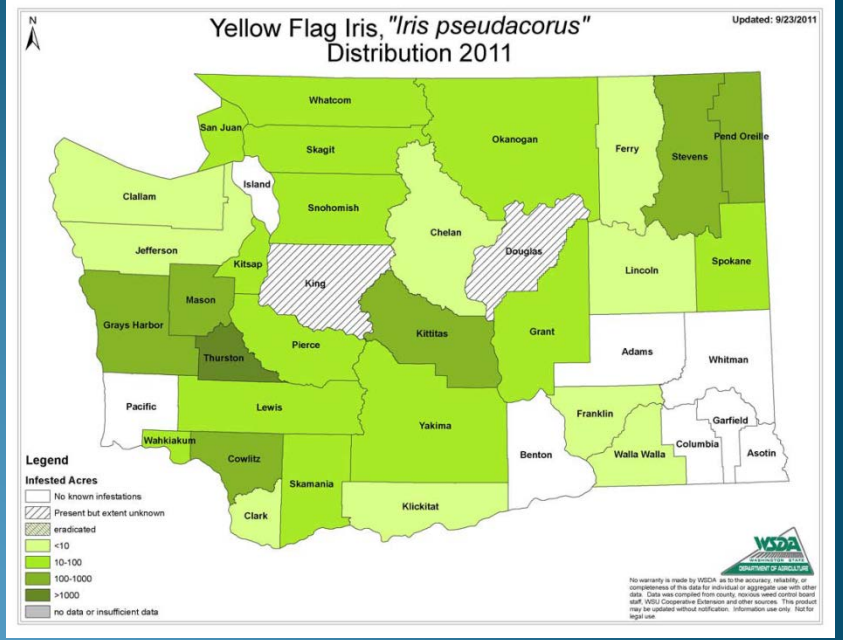
- Harvesting
- Diquat (contact) (broad spectrum)
- Glyphosate (systemic) (broad spectrum)
- Imazapyr (systemic) (broad spectrum)
- Imazamox
- 2,4-D

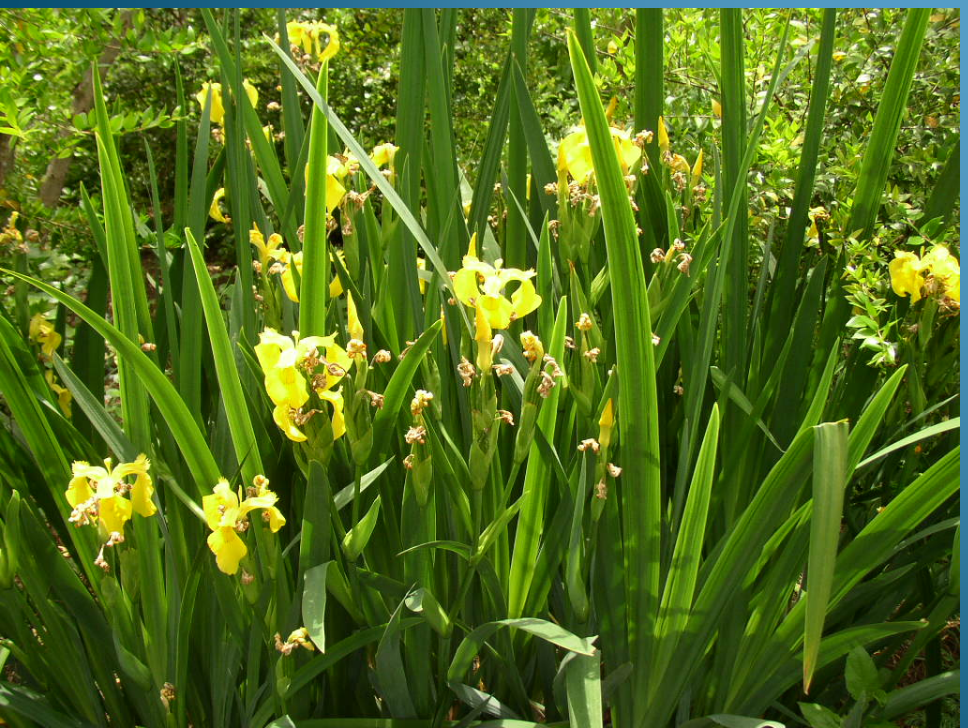


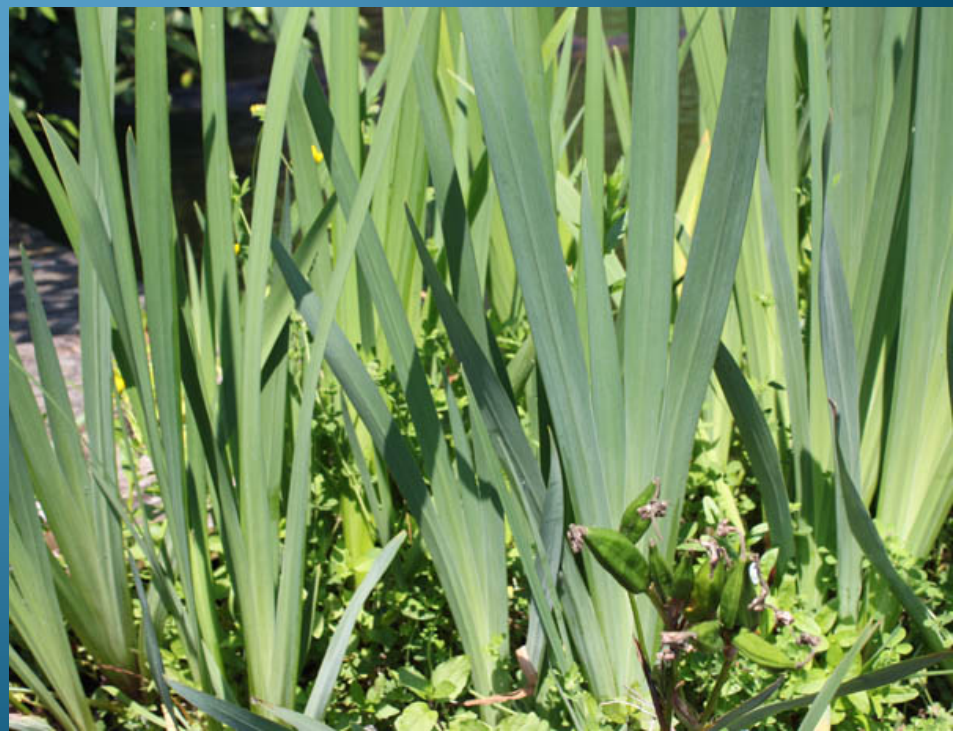
Yellow flag iris
(Iris pseudacorus)

Control options:

- Pulling / digging
- Imazapyr (systemic) (broad spectrum)
- Glyphosate (systemic) (broad spectrum)
- 2,4-D Amine (systemic) (selective, dicot)







Non-chemical control options

Method	Description	Advantages	Disadvantages	Systems used
Dredging	mechanical sediment removal	long term results	very expensive, non-selective	shallow small ponds/lakes
Drawdown	de-water	effective, depending on sp.	environmental impacts, non-selective	man made small lakes
Benthic barrier	material to cover plants	effective, last several seasons	expensive, small scale, nonselective	around docks, boat launches, intensive use, small areas,
Hand cutting/pulling	tools or hand pulling	selective	labor intensive, expensive	localized areas or sites with few populations
Harvesting	mechanical cutting , collection	removes biomass	expensive, sediment issues, short term , non-selective	highly infested sites with little native populations
Diver suction harvester	vacuum lift for entire plant	selective, few sediment issues, longer term	slow and costly	localized areas or sites with few populations
Rotovating	cultivator on long arm, tills sediments	intermediate results	sediment suspension, spread fragments	highly infested sites with little native populations
Biocontrol	insects, fish, pathogens	selective, long term	expensive	heavy, expansive infestations

For more info

- Aquatic Plant ID
  - An Aquatic Plant Identification Manual for Washington's Freshwater Plants; publication # 01-10-032; 360-753-6820
  - Aquatic and Riparian Weeds of the West by J. DiTomaso and E. Healy. 800-994-8849
  - http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html

Remember to decontaminate!

Questions?