



# Integrated Pest Management Plan for Freshwater Emergent Noxious and Quarantine Listed Weeds



Revised January 2013





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## Section I. INTRODUCTION

This Integrated Pest Management (IPM) Plan for Freshwater Emergent Noxious Weeds is an update of the July, 2004 IPM Plan. These updates include changes to the National Pollutant Discharge Elimination System NPDES Permit (covered in Section V, PERMITS), and new Plant Profiles or updated Plant Profiles. All Plant Profiles are found in Appendix A. All references and websites are found at the end of each Section and at the end of each Plant Profile.

This 2013 IPM Plan is again a collaborative effort between the Washington State Department of Agriculture (WSDA) and the Washington State Department of Ecology (Ecology). Authors and contributors include Greg Haubrich and Bridget Simon – WSDA; and Jenifer Parsons, Kathy Hamel and Nathan Lubliner – Ecology. Information in the Plant Profiles was mainly collected from the Washington State Noxious Weed Control Board (WSNWCB), the County Noxious Weed Control Programs, Jennifer Andreas (Integrated Weed Control Project), and from statewide research projects, often conducted by Dr. Tim Miller, WSU, Mt. Vernon, and Jenifer Parsons, Ecology.

The Washington State Department of Agriculture holds the Aquatic Noxious Weed Management National Pollutant Discharge Elimination System (NPDES) General permit issued by Ecology under authority of the federal Clean Water Act. More information on the NPDES Permit is covered in Section V of this IPM Plan.

Changes to the 2012 Noxious Weed Management NPDES Permit include:

- Plant species authorized for treatment have been expanded to enable a quicker response to new invaders. Treatment is authorized for non-native and potentially invasive plants not listed on the noxious weed and quarantine lists, as determined by the WSNWCB, WSDA, Ecology or Washington Invasive Species Council (WISC).
- Only covers **indirect** application of herbicide and other products to surface waters of the state when treating emergent freshwater weeds.
- Floating or submersed species requiring direct applications of herbicides into the water are covered under the Aquatic Plant and Algae Management Permit, issued by Ecology.
- Fish timing windows were removed since only incidental overspray should occur.
- Herbicides and adjuvants were updated. Some new herbicides were allowed. Other herbicides that are only suitable for in-water application were removed from this permit, but are still allowed under the Aquatic Plant and Algae Management permit.
- Posting/Notification requirements were simplified.
- Updates by WSDA to the IPM Plan for Freshwater Emergent Noxious and Quarantine Listed Noxious Weeds were required by February 1, 2013.

WSDA allows ‘limited agents’ to operate under this permit. There is no cost to the agencies and individuals who wish to control non-native, invasive plants found growing near water, as long as control measures are in compliance with terms of the permit. As required in the permit, WSDA and Ecology have developed monitoring plans and Integrated Pest Management Plans for these types of applications.

The purpose of this IPM Plan is to provide management information and treatment advice about selected freshwater noxious weeds to contractors and cooperators that seek to treat these weeds, and any additional weeds as approved, under Agriculture’s Noxious Weed NPDES permit. The permit calls for each limited agent to adopt this IPM Plan when treating emergent freshwater weeds. This plan offers clarifying information about the IPM approach and about specific management practices appropriate to noxious weeds found in wetlands, lakeshores, riparian zones, ponds and ditches. It is intended that this plan will be periodically revised based on new research and implementation experience.

It is the intent of the authors that this adaptive document be viewed as a work in progress, to be updated from time to time as new information becomes available. Comments, new information or corrections should be directed to Greg Haubrich, WSDA at 509-249-6973 or via email at [ghaubrich@agr.wa.gov](mailto:ghaubrich@agr.wa.gov)



**Saltcedar at old homestead. Douglas Co.**

**Photo: WSDA**

## **Section II**

### **NOXIOUS WEEDS and WEED LAWS**

#### **NOXIOUS WEEDS**

There are many definitions for a ‘weed’. J.M.Torell’s definition is widely accepted by weed managers as “A plant that interferes with management objectives for a given area of land at a given point in time”. Noxious weeds are different, however, in that they have legal status. In Washington State a noxious weed is defined by law as a plant that when established is highly destructive, competitive or difficult to control by cultural or chemical practices.

For the purpose of this document, the term ‘noxious weed’ will include all species on the Washington State Noxious Weed List, and all species on WSDA’s Quarantine List/*Plants and Seeds Whose Sales are Prohibited in Washington State*.

In addition, plant species authorized for treatment under changes to the 2012 Noxious Weed Management NPDES Permit can be expanded to include non-native, invasive plants not listed on the two lists. These additional species will be determined by the Washington State Noxious Weed Control Board (WSNWCB), Washington State Department of Agriculture (WSDA), Washington State Department of Ecology (Ecology) or the Washington Invasive Species Council (WISC) on a case by case basis.

What all of the plants on these regulatory lists have in common are their impacts to our agricultural base, rangelands, waterways, tidelands, parks, wildlife, property values, public health and safety and the ecological health and diversity of our native ecosystems. While the economic effects of noxious weeds on agriculture are enormous, their effects on the natural resources and ecological diversity of the state compound these losses. Noxious weed infestations are the second leading cause of wildland habitat loss. These resources, once destroyed, are irreplaceable.

Washington’s noxious weeds are non-native, invasive plants that have been introduced to the state mostly through human actions. Many of these species were brought in without any natural enemies, such as insects or diseases that help keep their populations in check in their native range. As a result these plants can multiply rapidly. Introductions of non-native, invasive species have been implicated in many of the natural resource and conservation problems the world faces today.

## **NOXIOUS WEED LAWS**

In recognition of the economic and ecological threats caused by invasive, non-native plants, Washington State has enacted laws to control the introduction and spread of noxious weeds.

The Washington State Noxious Weed Control Board determines and adopts the Washington State Noxious Weed List. The complete list is published annually in Chapter 16-750 WAC. Language in the state's main weed law, Chapter 17.10 RCW, makes it very clear that the duty to control noxious weeds is the responsibility of the landowner. This includes eradicating all Class A noxious weeds, controlling and preventing the spread of all Class B noxious weeds designated for control in that region, and controlling or preventing the spread of all Class B and Class C noxious weeds listed on the county weed lists.

Related websites and links are found at the end of this Section.

The following information is from the Washington State Weed Board, and is an overview of Washington State Weed Law information: [http://www.nwcb.wa.gov/ab\\_weedlaws.htm](http://www.nwcb.wa.gov/ab_weedlaws.htm)

Weed laws establish all property owners' responsibility for helping to prevent and control the spread of noxious weeds. Since plants grow without regard to property lines or political jurisdictions, everyone's cooperation is needed – city gardeners, farmers, government land agencies, foresters and ranchers all have a role to play.

Washington's weed laws spell out these responsibilities, and create the government infrastructure needed to educate citizens and to ensure that the laws are respected. These laws also direct the State Weed Board to create and maintain the state's official list of noxious weeds that landowners may be required to control.

The Washington State Noxious Weed List is organized into three categories: Class A, B and C.

Class A weeds are non-native species with a limited distribution in the state. Eradication of all Class A noxious weeds is required by state law. The goal is to remove any known plants before they establish. Class A List: <http://www.nwcb.wa.gov/searchResults.asp?class=A>

Class B weeds are non-native species that are established in some regions of Washington but are of limited distribution or not present in other regions of the state. In regions where a Class B weed is unrecorded or of limited distribution, prevention of seed production is required. In these areas, the weed is a "Class B designate", meaning it is designated for control by state law. In regions where a Class B species is already abundant or widespread, control is a local option,

decided by county weed control boards. In these areas, the weed is a “Class B non-designate”, with containment, gradual reduction and prevention of further spread being the chief goals. The management goal is to keep these species from spreading to areas where there are not found, or where they are found in very limited sites. Each County Weed Board has information for landowners of that county, describing which weeds are designated for control in which areas.

**County Weed Board Links:** [http://www.nwcb.wa.gov/nwcb\\_county.htm](http://www.nwcb.wa.gov/nwcb_county.htm)

**Class B List:** <http://www.nwcb.wa.gov/searchResults.asp?class=B>

Class C noxious weeds are the common, widespread species that people are probably the most familiar with. These species are already widely established in Washington or are of special interest to the state’s agricultural industry. Requiring ‘control’ as described in our weed laws is often not practical. In this case, the County Weed Boards work with the landowners, offering advice on the most effective control method, or a long term control plan. Please contact your local Weed Board for specific control requirements.

**Class C List:** <http://www.nwcb.wa.gov/searchResults.asp?class=C>

In addition to the State Noxious Weed List, there is a plant quarantine list maintained by WSDA. The plant quarantine list, ‘*Plants and Seeds Whose Sales are Prohibited in Washington State*’, consists of both terrestrial and aquatic plants known to be invasive and damaging. Plant quarantines are a preventative measure to keep noxious weed species from ever being introduced as garden or aquatic ornamental plants. All Class A noxious weeds are on this quarantine list. Some plants are placed on the list to prevent them from ever being imported to our state.

WSDA determines the weed species that are regulated by quarantine under WAC 16-752. These include the *Lythrum* Quarantine (WAC 16-752-400), the Wetland and Aquatic Weed Quarantine (WAC 16-752-500) and the Noxious Weed Seed and Plant Quarantine (WAC 16-752-600). These quarantines also define areas quarantined. For all quarantine laws related to noxious weed control: <http://apps.leg.wa.gov/WAC/default.aspx?cite=16-752>

Under these quarantines it is prohibited, except under certain conditions, to transport, buy, sell, offer for sale, or to distribute plant parts of these regulated plants into or within the state of Washington. It is further prohibited to intentionally transplant wild plants and/or plant parts of these species within the state of Washington. Many, but not all, of the plant species listed in the quarantines are also listed on the State Weed List.

## Websites and Links, Section II

1. **Washington State Noxious Weed Control Board**  
<http://www.nwcb.wa.gov>
2. **Washington State Department of Agriculture**  
<http://www.agr.wa.gov>
3. **Washington State Department of Ecology**  
<http://www.ecy.wa.gov>
4. **Washington Invasive Species Council**  
<http://www.invasivespecies.wa.gov>
5. **Washington State Noxious Weed List**  
<http://www.nwcb.wa.gov/printable.htm>
6. **Quarantine List** by species, with pictures:  
<http://www.nwcb.wa.gov/searchResultsQuarantine.asp>  
**Quarantine List**, download a copy of the Quarantine List:  
<http://www.nwcb.wa.gov/siteFiles/ProhibitedPlants.pdf>
7. Washington State Weed Law information, an overview:  
[http://www.nwcb.wa.gov/ab\\_weedlaws.htm](http://www.nwcb.wa.gov/ab_weedlaws.htm)
8. **RCW17.10** (Revised Code of Washington), the state's basic weed law.  
<http://apps.leg.wa.gov/rcw/default.aspx?cite=17.10>
9. **RCW 17.24** Creation and maintenance of the Plant Quarantine List.  
<http://apps.leg.wa.gov/rcw/default.aspx?cite=17.24>
10. **WAC Chapter 16-750** Rules and regulations to carry out the state weed law. Includes the State Noxious Weed List, and definitions and descriptions of regions/boundaries for Class B weeds, and the schedule of monetary penalties.  
<http://apps.leg.wa.gov/WAC/default.aspx?cite=16-750>.
11. **WAC Chapter 16-752** WSDA's Quarantine Laws, Noxious Weed Control;  
<http://apps.leg.wa.gov/WAC/default.aspx?cite=16-752>

### **Section III**

## **INTEGRATED PEST MANAGEMENT - DEFINITION**

There are at least two definitions of Integrated Pest Management (IPM) in Washington State law. Chapter 16-752 WAC defines IPM as a decision making process which combines all feasible control techniques into a program for managing targeted noxious weeds, including but not limited to: prevention, monitoring, consideration of alternative methods and evaluation.

In 1997, the Washington State Legislature enacted Chapter 17.15 RCW requiring that all state agencies follow the principles of IPM. Please refer to the following website:

<http://apps.leg.wa.gov/RCW/default.aspx?cite=17.15>

Chapter 17.15 RCW defines IPM as “a coordinated decision-making and action process that uses the most appropriate pest control methods and strategy in an environmentally and economically sound manner to meet agency programmatic pest management objectives.” The chapter further defines the elements of IPM to include:

- (a) Preventing pest problems;
- (b) Monitoring for the presence of pests and pest damage;
- (c) Establishing the density of the pest population, that may be set at zero, that can be tolerated or correlated with a damage level sufficient to warrant treatment of the problem based on health, public safety, economic or aesthetic thresholds;
- (d) Treating pest problems to reduce populations below those levels established by damage thresholds using strategies that may include biological, cultural, mechanical and chemical control methods and that must consider human health, ecological impact, feasibility and cost-effectiveness; and
- (e) Evaluating the effects and efficacy of pest treatments.

#### **IPM is not:**

- New. Scientifically based programs are specifically focused in this area, however they are only a few decades old.
- Implemented or successful overnight.
- Necessarily a formula to eliminate or reduce pesticide use. However, well-developed, science-based IPM programs have consistently resulted in reduced pesticide use, as they employ a wider array of pest management techniques. IPM programs, by design, result in safer, more judicious use of pesticides.

- A rigid program of management techniques. IPM is a balance of all suitable techniques, providing the landowner or manager with options to manage noxious weeds within a given set of circumstances.
- All the same. Depending on the species and its habitat, programs may differ dramatically for managing a given species.

**For more information on Section III, IPM:**

1. Chapter 17.15 RCW defines IPM  
<http://apps.leg.wa.gov/RCW/default.aspx?cite=17.15>
2. Compendium of IPM Definitions – a Collection of IPM Definitions and their Citations in Worldwide IPM Literature  
<http://ipmnet.org/IPMdefinitions/home.html>



Hairy willow-herb test plots, Island Co. 2008.

Photo: WSDA

## Section IV

### Implementing IPM Strategies, the IPM Process

IPM is a decision making process using the most appropriate control method, or a combination of those methods, to control a targeted weed species with the least impact to the environment and with the greatest impact to the weed. The IPM decision-making process is done on a site by site basis, and is monitored and altered as necessary as the site and conditions change. A successful weed management plan takes into consideration the weed species, the location or habitat, and the size of the infestation.

A prioritized control plan determines the management goals for the site along with the requirements that determine those goals. A range of control options include:

- **Prevention and Early Detection**
- **Mechanical**
- **Cultural**
- **Chemical, and**
- **Biological**

When developing a weed control plan that incorporates the strategies of Integrated Pest Management, it is necessary to evaluate control options based on the biology of the plant, to consider the extent of the infestation, to know the control options available for that species, to be aware of the plants legal status and to know your management goals for the site.

- **Learn as much as you can about the biology of the species.**
  - Is it an annual? Does it spread by seed, by rhizomes?
- **Determine the legal status of the species.**
  - Is it a Class A noxious weed?
- **Survey the extent of the infestation.**
  - Is this a pioneer site? An established 5 acres?
- **Research control options for the plant.**
  - When is the best time to control?
- **Evaluate your site.**
  - What type of access to control? What permits are required?
- **Determine your management goals for the site.**
  - Eradication? A long-term control plan?
- **Coordinate with others.**
  - What are the neighboring sites?
- **Implement the selected control options.**
  - Follow control plan guidelines and continue to evaluate the site.
- **Monitor the effectiveness of the control methods on controlling the plant.**
  - Adjust your control plan as site conditions change.

**1. Learn as much as possible about the biology of the species.**

Is this a grass, or a broadleaf species? If using herbicides, some are selective for broadleaf weeds and some are broad spectrum and will affect grasses as well. Is this a perennial, biennial or annual plant? Annuals and biennials lend themselves to manual control methods more easily than perennial species. How does this species reproduce and spread? Is it rhizomatous? Is this a facultative wetland plant, or is it a terrestrial plant growing in a wetland site? How long has it been present at the site? Is there a seed bank?

**2. What is the legal status of this weed species?**

This species may require containment, control or eradication by state law.

**Class A Weeds** – limited distribution statewide. Eradication is required.

**Class B Designate Weeds** – somewhat limited distribution statewide. Localized control of all propagating plant parts is required. Contact the local county weed control board.

**Class B Non-Designate Weeds** – any control requirements are determined locally by county noxious weed control boards. Contact the local county weed board.

**Class C Weeds** – control requirements are determined locally by the county noxious weed control boards. Contact the local county weed board.

**Quarantine Species** – it is prohibited, except under certain conditions, to transport, buy, sell, offer for sale or distribute plants or plant parts of the listed regulated species. It is also prohibited to intentionally transplant wild plants and/or plant parts of these species within the state of Washington. Many, but not all, of the regulated plant species listed in the quarantines are also listed on the Washington State Noxious Weed List.

With legal control requirements, the following terms are defined:

**Containment** – means to confine a noxious weed and its propagules to an identified area of infestation.

**Control** – means to prevent all seed production and to prevent the dispersal of propagules of aquatic noxious weeds.

**Eradicate** – means to eliminate a noxious weed within an area of infestation.

**3. What is the extent and age of the infestation?**

For new infestations, implementing manual or mechanical control methods and monitoring may be effective control. However, if the infestation is extensive and established, other methods of control should be considered and the seed bank must be taken into account.

**4. What control options are available for this plant?**

Review the literature. Contact the local county noxious weed control program to talk with weed specialists to determine available and effective control measures.

**5. Evaluate and assess the health of the site.**

Determine the necessary steps to make the site less susceptible to invasion, or determine how to inhibit the expansion of the current infestation. Options may include reducing grazing or, eliminating or reducing ground disturbing activities.

**6. Evaluate management goals for the site.**

Determine how to prevent re-infestation. Is site re-vegetation a possibility?

In many cases with noxious weeds the threshold is zero plants, either due to regulatory concerns or because the potential for domination of the site is too great.

**7. Coordinate with others.**

An important aspect of emergent weed management involves other people and adjacent landowners. Even the best management plan cannot be entirely successful if applied on only one site or ownership in an area with wider weed infestations that are not being addressed. The probability of re-infestation from adjacent lands will be very high. Weed management should include communication and planning with neighbors with some agreement on goals, control priorities and annual activities. Coordination at the local level will benefit all landowners, even if they do not currently have a weed problem. It will also protect individual weed management successes over the long run.

**8. Implement your program.**

Follow the weed management plan and strategies based on IPM principles.

**9. Monitor to determine efficacy of efforts.**

Monitor the status of control efforts to determine whether they are effective in achieving the goals. Monitoring can be tailored to suit resources and can be as simple as taking before and after photographs, or can be as rigorous as setting out trials and evaluating biomass pre- and post-control methods.

## **Summary**

Develop a weed management goal and strategy based on IPM principles. Once control options are started, it is important to monitor all sites, and to re-vegetate disturbed areas with desirable or native vegetation for long-term site control. Plan to continually monitor all potential weed growth areas, including the successful control sites, at least annually, for any signs of new plants. These management techniques will help minimize future problems.

## **Section V**

### **PERMITS – NPDES**

#### **Herbicide Application Permits**

Aquatic herbicides are considered to be state restricted use pesticides in Washington State. These herbicides can only be used or applied by certified applicators or persons under the direct supervision of a certified applicator, and only for those uses covered by the certified applicator's license category (WAC 16-228-1231).

The Washington Department of Ecology (Ecology) has oversight of water quality in Washington State, and it regulates any substances that can alter the chemical or biological characteristics of water, including aquatic herbicides. Ecology issues permits for aquatic pesticide use, including the National Pollutant Discharge Elimination System (NPDES) permits, under authority of the federal Clean Water Act, for treating noxious weeds and quarantine-listed weeds.

The Washington State Department of Agriculture (WSDA) registers all herbicides in the state, and has restricted the use of aquatic herbicides to state-licensed applicators. WSDA licenses these aquatic applicators and conducts inspections to ensure compliance with the label. WSDA issues state experimental use permits and maintains toxicology data for adjuvants. Ecology issued the Aquatic Noxious Weed Management NPDES Permit to WSDA, who holds sole coverage.

#### **National Pollution Discharge Elimination System (NPDES) Permits**

These federal permits are overseen by the Environmental Protection Agency (EPA) under the Clean Water Act. In 2001 after a court decision in the 9<sup>th</sup> circuit district court, California and Washington developed comprehensive aquatic pesticide NPDES permits. In 2009 a federal court decision mandated ALL states MUST have NPDES aquatic pesticide permits in place by October 2011. The EPA issued a general NPDES permit for aquatic pesticides on October 31, 2011 for those states that do not have delegated authority to issue their own NPDES permits. In Washington State, Ecology is the delegated authority to develop and administer these permits.

The EPA-NPDES-Pesticides website: <http://cfpub.epa.gov/npdes/index.cfm>

In Washington State, federal agencies and employees of federal agencies must get coverage under EPA's Pesticides General Permit. Aquatic pesticide work taking place on Tribal Lands must be covered under EPA's permit. There are some exceptions for work conducted on federal lands if performed by non-federal employees such as irrigation districts. In those cases, the state-issued NPDES permit may be allowed to substitute for the federal EPA permit. Check with Ecology aquatic pesticides staff to discuss individual circumstances.

## **Aquatic Pesticide General Permits:**

- Aquatic Invasive Species Management (animals and marine algae)
- Aquatic Mosquito Control
- Irrigation System Aquatic Weed Control
- *Zostera japonica*, (commercial clam beds in Willapa Bay, proposed for issuance in 2013.)
- **The Aquatic Plant and Algae Management Permit**, and
- **The Aquatic Noxious Weed Management Permit**.

## **The Aquatic Plant and Algae Management Permit (APAM)**

This permit was reissued in 2011 and modified in 2012 to add new herbicides. It applies to pesticide applications **directly to waters** of the state, to include: lakes, ponds, streams or rivers, to manage submerged and floating freshwater noxious and quarantine-listed weeds and treatment of native nuisance plants.

**Ecology manages this permit**, and may also authorize treatment for non-native and potentially invasive plants not on these two weed lists, as determined by the Washington State Noxious Weed Control Board (WSNWCB), WSDA, Ecology or the Washington Invasive Species Council (WISC).

It takes a minimum of 60 days to acquire coverage under the APAM. Coverage is issued by Ecology for each body of water. However, governments may apply for coverage for every water body within their jurisdiction if they so choose. Applicants must satisfy SEPA requirements, and place a legal notice in a local paper. The annual permit fee is currently over \$400, and the fee generally goes up each year by the fiscal growth factor (through a rule).

There have been several changes to the APAM since it was first issued, including:

- Additional notification steps to affected water body residents when applying for coverage.
- Lake treatment sponsors (generally lake groups) must certify that they have the legal authority to administer common lake areas.

## **The Aquatic Noxious Weed Management Permit**

This permit regulates freshwater and marine emergent noxious and quarantine listed weed management activities that result in a discharge of herbicides, adjuvants and marker dyes **indirectly** into streams, rivers, estuaries, marine areas, wetlands, along lake shorelines and other wet areas to control state noxious and quarantine listed weeds. **Indirectly** means the purposeful application of a chemical to a weed where there may be inadvertent and incidental overspray or dripping of chemical from the plant into waters of the State. The applicator does not intentionally

add the chemical to the water to treat the plant (as occurs during in-water treatments for submersed plants such as Eurasian watermilfoil). **Indirect application** to water may occur into adjacent water bodies or wetlands, particularly when treating plants where the roots may be submerged and the foliage is above water.

For a list of currently accepted herbicides or adjuvants please refer to Ecology's website:

<http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html>

This permit also covers the treatment of noxious and quarantine listed weeds for roadside/ditch bank management activities where chemicals may **indirectly** enter the water.

This permit DOES NOT apply to Federal or Tribal lands, except that there may be exceptions for treatment to federal lands. Check with Ecology pesticide staff to determine individual circumstances.

This permit DOES NOT apply to in-water application of chemicals directly into lakes, ponds, streams or rivers, to manage freshwater weeds. The APAM is the correct permit for these activities.

The changes to the Noxious Weed Management NPDES Permit reissued in 2012 include:

- Permit enables a quicker response to new invaders. Treatment can be authorized for non-native and potentially invasive plants not listed on the noxious weed and quarantine lists, as determined by the WSNWCB, WSDA, Ecology or WISC.
- Fish timing windows were removed from the reissued permit since only incidental overspray should occur and fish should not be impacted.
- The list of approved herbicides and adjuvants was updated. Some new herbicides (active ingredients) were allowed. Other herbicides that are only suitable for in-water application were removed from this permit, but are still allowed for use under the APAM.
- Posting/Notification requirements were simplified.
- WSDA will update the IPM Plan for Freshwater Emergent Noxious and Quarantine Listed Noxious Weeds by February 1, 2013.

Ecology issued the Aquatic Noxious Weed Management NPDES Permit to WSDA, who holds sole coverage. The noxious weed permit is unique because WSDA may contract with other entities as limited agents to treat noxious weeds in those circumstances that benefit the agency's programmatic goals, such as the management of noxious weeds. WSDA may choose to contract with government entities, non-government organizations (NGOs) and private applicators or individuals for noxious weed control on an annual basis. There is on-line application and

reporting, although a printed copy of the application must be signed before submission. The turn-around time is typically less than three weeks and in an emergency WSDA staff can execute a contract within days.

Limited agents must agree to comply with the terms, conditions and requirements of the NPDES permit. They must also submit a year-end summary of pesticide use under this agreement. ***Only if requested***, they must submit copies of the associated spray records to WSDA. They must maintain records of all treatments and retain them for at least 5 years from the date of treatment. They must enter treatment data in the SAW web-based reporting data base by December 31 of the contract year.

The advantages for limited agents are that WSDA pays the annual permit fee, develops the IPM Plan for this permit, and does not require a 60-day waiting period for permit coverage. WSDA also conducts any required monitoring for the permit and submits an annual plan that consolidates all the treatment information from the limited agents. Under the Clean Water Act, there are provisions for third party lawsuits. Obtaining coverage under an NPDES permit helps protect parties from such lawsuits.

#### **How to apply for this permit:**

- [http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)
- <http://agr.wa.gov/PlantsInsects/Weeds/NPDESPermits/>
- Google: Aquatic Noxious Weed Control NPDES General Permit
- Secure Access Washington (SAW) Account

#### **Hydraulic Project Approval (HPA) Permits**

HPA permits are issued by the WDFW for a variety of aquatic plant management activities where that activity takes place in water or disturbs a water body. The agency issues a permit by pamphlet called “Aquatic Plants and Fish” that is available free of charge. It allows noxious weed removal without an individual HPA as long as the project proponent follows the provisions in the pamphlet. It allows some de minimus native weed removal without an individual HPA. Some projects that require HPA permits include: hand pulling, raking, cutting, use of bottom barriers, diver dredging, weed rolling, mechanical cutting, mechanical harvesting and rotoavation. For more information about HPA Permits and related control methods:

<http://www.ecy.wa.gov/programs/wq/plants/management/index.html>

#### **Grass Carp Stocking Permits**

Grass carp are sometimes used to manage aquatic plants, particularly in private small ponds and occasionally in larger lakes. Their use is only allowed under a permit issued by WDFW. There is

a \$25 application charge. WDFW only allows stocking sterile (triploid) grass carp from authorized fish farms. Grass carp may not be suitable for some noxious weed species.

Please see the following links for more information about grass carp:

[http://wdfw.wa.gov/licensing/fish\\_transport/](http://wdfw.wa.gov/licensing/fish_transport/) and

<http://www.ecy.wa.gov/programs/wq/plants/management/aqua024.html>

### **Quarantine Listed Plants Transport Permit**

Plant quarantines are a preventative measure to keep noxious weed species from spreading to natural areas and to keep some species not found in the state, out of the state by prohibiting their sale or distribution. WSDA maintains a plant quarantine list, called '*Plants and Seeds Whose Sales are Prohibited in Washington State*'.

To download a copy of the Quarantine List from the WSNWCB:

<http://www.nwcb.wa.gov/siteFiles/ProhibitedPlants.pdf>

It is prohibited to transport, buy, sell, offer for sale, or to distribute plant parts of these regulated plants into or within the state of Washington. It is further prohibited to intentionally transplant wild plants and/or plant parts of these species within the state of Washington. It is also illegal to distribute seed packets, flower seed blends or 'wildflower mixes' that include these plants.

Anyone who violates the quarantine restrictions is subject to a civil penalty of up to \$5,000 per violation.

Quarantine Rules in regards to Noxious Weed Control (WAC 16-752-100-715), WSDA site:

<http://apps.leg.wa.gov/WAC/default.aspx?cite=16-752>

A permit is required when transporting quarantine listed plants, or plant parts. However, there are exemptions to this permit requirement, contained in WAC 16-752-515, at the following link:

<http://apps.leg.wa.gov/WAC/default.aspx?cite=16-752-515>

No permit is required if plants or plant parts are collected for research, education or scientific activity. No permit is required when weed control activities require transporting plants or plant parts for disposal under supervision by a weed control agency or public agency with management responsibilities. All propagative plant parts and seeds must be prevented from spreading to uninfested areas.

### **Section 404 Permit**

The Army Corps of Engineers may require a Section 404 permit for diver dredging depending on the extent of the project and the site. For example, diver dredging on the Columbia River would probably trigger this permit. Diver dredging in lakes is dependent on the Corps permit writer. However, the activity often referred to as diver "dredging" where the diver hand pulls the plant

and then uses a suction dredge to convey the plant to the water surface is not considered to be dredging and would not trigger the need for this permit. True dredging is where the sediment is removed.

### **Shoreline Management Permit**

Sometimes aquatic weed control activities require a local Shoreline Management Permit. This is dependent on the local jurisdiction (city or county). Sometimes these permits can be quite expensive. Please check with the local jurisdiction before starting an aquatic plant removal project.

### **Websites and Links, Section V, PERMITS**

1. Environmental Protection Agency, NPDES Homepage:  
<http://cfpub.epa.gov/npdes/index.cfm>
2. Ecology: Aquatic Plant Management – Aquatic Herbicides  
<http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html>
3. Ecology: Pesticides (and Adjuvants) currently allowed for use under Permit  
<http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html>
4. How to apply for this permit:  
[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)  
<http://agr.wa.gov/PlantsInsects/Weeds/NPDESPermits/>
5. For more information about HPA Permits and related control methods:  
<http://www.ecy.wa.gov/programs/wq/plants/management/index.html>
6. For information about grass carp:  
[http://wdfw.wa.gov/licensing/fish\\_transport/](http://wdfw.wa.gov/licensing/fish_transport/)  
<http://www.ecy.wa.gov/programs/wq/plants/management/aqua024.html>
7. For a copy of the Quarantine List, visit the following site from the WSNWCB:  
<http://www.nwcb.wa.gov/siteFiles/ProhibitedPlants.pdf>
8. Quarantine Rules in regards to Noxious Weed Control (WAC 16-752-100-715):  
<http://apps.leg.wa.gov/WAC/default.aspx?cite=16-752>
9. Exemptions to transport quarantined species (permit), WAC 16-752-515:  
<http://apps.leg.wa.gov/WAC/default.aspx?cite=16-752-515>

## Section VI

### Freshwater Emergent Noxious Weeds

Freshwater emergent noxious weeds are defined in the Aquatic Noxious Weed Management Permit as species listed on the Washington State Noxious Weed List or on the WSDA Quarantine List/*Plants and Seeds Whose Sales are Prohibited in Washington State*. In addition, the 2012 permit will allow treatment of non-native and potentially invasive species not currently on these lists. These non-listed species can be determined by the WSNWCB, WSDA, Ecology or the Washington Invasive Species Council (WISC) on a case by case basis.

Emergent noxious weeds, in general, grow out into shallow water from 1 inch to 24 inches deep, and upland as long as their roots can easily reach the water table. The extremes vary by species.

Freshwater emergent noxious weeds can survive in many soil types that are normally associated with wetlands. This varies geographically and can be site specific. For instance, along river banks, the soils are often gravelly or sandy, while around lake edges and in emergent wetlands the soils are much finer.

Noxious weed management programs operate under the umbrella of a 1993 Final Noxious Emergent Plant Management Environmental Impact Statement (EIS) and other documents associated with and updating the original EIS.

See the following site: <http://agr.wa.gov/PlantsInsects/weeds/npdespermits>

In addition, WSDA completed a State Environmental Policy Act (SEPA) checklist when it first applied for coverage under the Aquatic Noxious Weed Management Permit. The original SEPA checklist is still applicable since WSDA has continued its coverage when the permit was reissued.

Many freshwater emergent noxious weeds have been intentionally introduced to Washington as ornamental plants (purple loosestrife, garden loosestrife, saltcedar, knotweed), or for stream bank stabilization and pasture grass (reed canarygrass) or by accidental introduction (*Phragmites*).

These introduced species “escaped” into our waterbodies naturally, through floods or by wildlife, by people discarding plants and plant parts, and by being deliberately planted. Once introduced to their new habitat, these invasive plants rapidly out-compete native plants, forming single species stands, and reducing habitat for fish, waterfowl and aquatic mammals and invertebrates. Some noxious weeds can even harm humans and animals. The sap of giant hogweed, a plant that

grows in wet areas, can cause severe burns. Poison hemlock, which can also grow in wet areas, can be lethal if ingested.

One of the primary reasons non-native noxious weeds are so competitive in North America is that they left behind natural predators – such as insects, disease and the native animals that use them as a food source - that evolved with them in their native range. Without these natural checks and balances, plants that may pose few problems in the native countries can become aggressive invaders and noxious weeds in North America. When invasive plants are able to establish dense populations and impact areas on a large scale, biological control agents are sometimes introduced to bring these plants back in check.

In addition to having few natural predators, many noxious weeds have characteristics that permit them to rapidly invade new areas and out-compete native plants for resources such as water, light and nutrients. Once noxious weeds become established, they can crowd out native vegetation, and in severe cases, form monocultures and become the only plants growing in the area. This affects food webs and life cycles of our native flora and fauna.

Some invasive characteristics of noxious weeds can include:

- Early germination and maturation.
- Profuse reproduction by seeds and/or vegetative structures.
- Long seed life in the soil.
- Seed dormancy that ensures periodic germination and prevents seedlings from sprouting during unfavorable conditions.
- Adaptations for spread with crop seeds, by natural agents and by humans.
- Production of biological toxins that suppress the growth of other plants.
- Prickles, spines or thorns that can cause physical injury and repel animals.
- The ability to parasitize other plants.
- Seeds that are the same size and shape as crop seeds, making cleaning difficult.
- Roots or rhizomes with large reserves.
- Survival and seed production under adverse environmental conditions.
- High photosynthetic rates.

## Websites and Links, Section VI

12. Washington State Noxious Weed List

<http://www.nwcb.wa.gov/printable.htm>

13. Quarantine List by species, with pictures:

<http://www.nwcb.wa.gov/searchResultsQuarantine.asp>

Quarantine List, download the Quarantine List:

<http://www.nwcb.wa.gov/siteFiles/ProhibitedPlants.pdf>

14. SEPA Checklist for Freshwater Emergent Noxious

[http://www.ecy.wa.gov/programs/sea/sepa/43\\_21C.htm](http://www.ecy.wa.gov/programs/sea/sepa/43_21C.htm)

15. WSDA Noxious Emergent Plant Management Environmental Impact Statement (EIS)



Non native *Phragmites*

Photo: WSDA

## Section VII

### NEGATIVE IMPACTS OF FRESHWATER EMERGENT NOXIOUS WEEDS

Freshwater wetlands support a variety of fish and wildlife species and contribute to the aesthetic and environmental quality in every state. Millions of Americans use freshwater wetlands for hunting, fishing, bird watching and other outdoor activities. An estimated 100.2 million acres of freshwater wetlands of various types remain in the contiguous United States.

**Riparian is a word used to describe anything connected with or next to the banks of a stream, pond or lake. A ‘riparian area’ is a body of water and the land adjacent to it. Riparian areas typically have a unique combination of flora, fauna and soil characteristics compared to nearby deserts, grasslands or forests. Although riparian areas occupy less than one percent of the landscape, they support some of the greatest diversity of plant and animal species and are essential habitat for much of the native flora and fauna.**

**-- United States Department of Agriculture**

Washington State has wetlands, waterways and riparian areas that are already impacted by freshwater emergent noxious weeds and it has areas that are still weed-free but potentially susceptible to these impacts. The type of weed management program required will depend on each site. Waters that are still weed-free require preventative measures, including early plant identification and diligence in removing any pioneer plants before they establish in an area. Areas already impacted by invasive weeds will require long term and costly control programs utilizing many weed control strategies and techniques. These strategies will change as site conditions change.

**The long-term trends in freshwater wetlands since the 1950’s show that freshwater emergent wetlands have declined by the greatest percentage of all wetland types with nearly 24 percent lost (8 million acres). -- US Fish and Wildlife Service**

Plants like flowering rush, hairy willow-herb, purple loosestrife, reed canarygrass, saltcedar, non-native *Phragmites*, knotweeds, yellow flag iris and other freshwater noxious weeds invade wetlands, shallow waters and aquatic margins. They destroy the commercial or aesthetic standards, fish and wildlife habitat and the recreational value of these areas. Dense, established stands of weeds displace native vegetation and harm wildlife habitat (WAC 16-750). Freshwater emergent noxious weeds can also impact agriculture when costly control measures are required to keep irrigation systems clear and open.

**Purple loosestrife invades wetlands in 48 states at an estimated cost of \$45 million a year for control, and with a loss of forage crops and crowding out 44 native plants and endangering the wildlife that depends on the native plants. --ATTRA 1997 (Applied Technology Transfer for Rural Areas)**

Impacts are often dependent on each other. For example, as *Phragmites* invades a site, it shades out and occupies space normally used by native plants. It then becomes a monoculture growing from shallow water toward the shore. This can limit invertebrate and some fish production which in turn can affect shorebirds and larger fish. The site now accumulates silt, which narrows the channel, reduces water flow and increases weed growth potential. Shorebirds and furbearers cannot use the site now because of the dense growth, and the tall vegetation eliminates dabbling duck and goose use...and so on, into a connected web of interactions.

Reversing these impacts through a committed weed management strategy takes time, effort and considerable expense with no certainty of a successful outcome. Implementing an IPM management program that includes inventory, prevention, early detection, immediate control action and monitoring is generally the most effective strategy.

## **NEGATIVE IMPACTS OF FRESHWATER EMERGENT NOXIOUS WEEDS**

The following negative impacts of emergent noxious weeds are discussed individually in this document, but in reality these impacts almost never occur singly. The severity and order of occurrence depend on the species, site conditions, existing plant communities and current land management practices. Usually all or some combination of impacts will occur as a freshwater emergent noxious weed invades.

### **1. Economic Impacts**

According to a 2008 survey by Cal-IPC and Sustainable Conservation of agencies working to control invasive species, it was estimated that \$82 million per year is spent in California on invasive plants, with costs related to control, monitoring and outreach, and that “many projects are severely underfunded.”

<http://www.cal-ipc.org/ip/research/cost.php>

The impacts to an ecosystem are more difficult to quantify, but are estimated in the billions nationally. Management programs consider the money well-spent, that the funding will “repay itself many times over.” <http://www.cal-ipc.org/ip/research/cost.php>.

Cal-IPC goes on to say that research on costs caused by the damage of invasive plants includes the following:

Cornell University - Research estimates of \$120 billion, annually, in damage in the U.S. (Pimentel, et al., Ecological Economics, 2005).

In Nevada - Invasive plant impact research estimates range between \$6 million and \$12 million due to reduced wildlife-related recreation (Eiswerth et al., Weed Science, 2005).

It is difficult to estimate the **economic impact of aquatic weeds** or the benefits of controlling them, since neither impact nor benefit pass through economic markets. One analysis gives a conservative estimate “that the values-at-risk from aquatic invasive plants in the US is in the range of billions of dollars per year”, (Rockwell, 2003) and that the estimate of either harm or benefit does not receive as much attention as the cost of control. Rockwell goes on to say that if the magnitude of aquatic weed issues in the past were better recognized, aquatic weed control would be in a better position to deal with “what has emerged as a major – if not the major – environmental issue of our day.” He states that “a more comprehensive national approach to problems would take into account the fact that early detection and treatment would have the benefit of preventing harm that would not otherwise develop, following the age-old maxim that “an ounce of prevention is worth a pound of cure”. The US Center for (human) Disease Control is based on these exact principles, but with billions of dollars of potential harm at stake, it would seem that there is no equivalent “Center for Aquatic Health Control”.

## 2. Displacement and Suppression of Native Plant Species

While invasive species cause damage in many ways, one of the most devastating effects is habitat modification. Once a habitat is physically altered, even if the invader is removed, it becomes difficult or impossible to reverse the effects. In *Life Out of Bounds*, author Chris Bright describes the cycle of degradation (1998). As local organisms disappear, the loss weakens the strength of their ecosystem. Invasive species alter habitats in a number of ways. Changes in the physical structure of the land are the most visually obvious, as an example, the narrowing of stream channels.

**Extinction by habitat destruction is like death in an automobile accident: easy to see and assess. Extinction by the invasion of exotic species is like death by disease: gradual, insidious, requiring scientific methods to diagnose.**  
--E. O. Wilson, Harvard University.

Weeds often become established when some site disturbance occurs, which opens desirable plant communities for invasion. Once established, many weed species have some competitive advantage over native plants. For example, purple loosestrife has tall dense growth, produces deep organic litter, shades out shorter plants and has

exceptionally large seed production. These advantages help this species maintain itself and spread into undisturbed sites.

When planning a control strategy, these factors must be taken into consideration for inventory, initial control work, and particularly in follow-up and continued monitoring. However, successful weed management that results in establishment of a desirable plant community will not lessen the need to look for new weed invasion in that area.

Examples of sites in Washington State with negative habitat modification:

- Tall, dense growth of reed canarygrass (*Phalaris arundinacea*) has occupied all adapted shallow water and high water table habitat on the Washington Department of Fish and Wildlife (WDFW) Snoqualmie Wildlife Area, Cherry Valley unit, in the Snoqualmie River Valley near Duval.
- There are extensive, dense purple loosestrife (*Lythrum salicaria*) stands on the WDFW, Desert Wildlife Area, southwest of Moses Lake in Central Grant County.
- Saltcedar (*Tamarix ramosissima*) is growing in areas adjacent to the Columbia River, north of the Tri-Cities, in Franklin County.

Each of these emergent noxious weeds occupies shoreline or shallow water habitat, thus preventing desirable or native plant communities from growing there. Once established, and particularly after developing extensive stands, these weeds are very difficult to manage. They have accumulated seed banks with soil seed reserves, and sites are often modified through silt collection. Saltcedar species change the salinity of sites they occupy. Native or other beneficial plant species are then unable to return and occupy these areas. In addition, many large weed sites produce many outlying infestations that often go un-noticed because most attention is focused on the larger stands.

### **3. Increased Silt Accumulations**

In situations where silt moves through a surface water system, such as streams, ditches or sites with tidal influence and others, emergent noxious weeds can accumulate silt at a much higher rate than native vegetation sites. This often happens as weed density increases and fills the shallow water with stems and plant litter. Silt accumulation can change bank, channel, and shallow water habitat character; in some cases even changing site potential to support native or desirable plants. As silt builds up, particularly during high water events, what were low sloping banks or shallow water may become uplands with steep banks with less water transport capacity. Even though plant roots may easily reach the water table, desirable vegetation may not be able to re-establish with the wet/dry soil conditions that prevail after the weed invasion.

In Washington, rapid silt accumulation caused by dense weed growth occurs in stands of purple loosestrife along waterways in central Grant County and in the Yakima River back waters south of Yakima City. Reed canarygrass growing in central Grant County and in the Snoqualmie Valley near Duval in King County tends to creep out into the water, resulting in accelerated silt accumulation in these channels. *Spartina*, in Willapa Bay in Pacific County, collects much silt transported by rivers flowing into the bay and carried by tidal action. In each case, as silt accumulated, it provided increased substrate for weed expansion. With purple loosestrife and reed canarygrass this process also narrowed channels, reducing water carrying capacity, interfering with anadromous fish passage, and displacing native species. *Spartina* silt accumulation actually raises the tide flat elevation, changing its potential to accommodate more upland plants. Silt accumulation by plants along natural streams can be a very positive process. However, when it contributes to increased weed production and site changes that reduce native plant competitive ability, the process stops being positive.

Yellow-flag iris changed the flow levels and the course of this small creek in Yakima County.

The creek once flowed next to the Russian olive trees on the left.

Photo: WSDA



#### 4. Degradation of Recreational Opportunities

Emergent noxious weeds typically occupy the shallow water shorelines of streams, rivers, ponds, lakes, estuaries, etc. This same area supports much water-associated recreation. Large, tall emergent weed stands can interfere with or prevent activities that depend on open shorelines by making physical access very difficult or unpleasant. Increased insect populations associated with some noxious weed species can spoil the recreational use of popular water areas. Noxious weeds like purple loosestrife occur in similar habitats as cattail and hardstem bulrush. Native cattail and bulrush grow in open stands, allowing

fishermen to launch their boat or to fish with little interference. Purple loosestrife infestations can reduce access to these recreational areas.

Purple loosestrife and yellow flag iris often grow on private shore lands. Home owners may be unaware of the growth and impact of these plants. Noxious emergent weeds can interfere with use of waterfront property. Well established weed infestations are both difficult and expensive to manage. Extensive, dense growth of purple loosestrife, yellow flag iris and saltcedar caused major problems with boat launch facilities on public lands. Purple loosestrife was so dense along parts of the Winchester Wasteway in central Grant County that boat launching was reduced to a single, narrow site on a previously open shoreline. Saltcedar caused the same problems in northern Franklin County on the Columbia River launch site.

Strong weed management programs have minimized some of these problems. Intense control efforts were needed to open these areas enough to allow full public use.

## 5. Degradation of Wildlife Habitat

Dense weed growth can essentially eliminate beneficial habitat provided by normally open shallow water and shorelines. Stem density and litter accumulations may preclude animal passage and change current vegetative structure, both in and above the water. Wildlife affected by these conditions include fish, waterfowl, shorebirds, and some furbearers.

The **impacts on fish**, including yellow perch, bluegill, crappie, bass, salmonids, and others include:

- Interference in salmonid use of habitat and passage in the Snoqualmie Wildlife Area managed by WDFW.
- Reed canarygrass clogged small ditches to the extent that they no longer provided rearing habitat for young fish (Perry 2003).
- Reduced space for movement.
- Reduced access to normal bottom cover features.
- Reduced production of and/or reduced access to insect and invertebrate food sources.
- Litter decomposition may serve to reduce dissolved oxygen in the water.

Extremely dense purple loosestrife growth into a lake, wetland or stream, to a depth of about 16 inches, interferes with fish use of these shallow water sites. During an informal WDFW sampling of sites in central Grant County, with and without dense purple loosestrife growth, more fish occurred along the non-infested areas, while few to none were evident in water just outside the weed growth depth limits. Several factors may be involved, e.g. weed stems take up most water space and additional plant litter

accumulation from past year's growth and its decomposition may reduce dissolved oxygen, thus limiting invertebrate organism food source production. Also, shallow water fish, pushed out to deeper water may be more vulnerable to predators (Perry 2003).

The **impacts on shorebirds**, including avocet, blacknecked stilt, greater yellowlegs, Wilson's phalarope, dowitcher and others include:

- Shallow water and shorelines are not open for their use.
- Reduced production and access to insect and invertebrate food sources.
- Open nesting and rearing areas densely vegetated and covered with plant litter.

Many shorebird species seem to prefer shallow water and nearly bare shore areas or those covered with low growing vegetation. This allows them to readily see predators, look for invertebrate food in water and on the shore, and may provide needed habitat for nesting and rearing young. When purple loosestrife, reed canarygrass, *Phragmites*, or other emergent noxious weeds get established, open shorelines become covered with tall dense vegetation, eliminating open habitat for this class of birds.

In Willapa Bay, conversion of intertidal mudflats and native saltmarsh habitats to stands of *Spartina* had threatened to devastate imperiled shorebird populations that rely on the increasingly rare coastal mudflats as their last remaining habitat. A very successful *Spartina* eradication program has largely eliminated these threats in Washington.

The **impact on furbearers**, including muskrat, mink, beaver and others include:

- Shallow water and shorelines colonized with dense plant growth.
- Difficult passage from water to upland areas.
- Shallow water fish and other food now at much lower densities.
- Reduced cattail, hardstem bulrush and other plants limit food or house/den building material.

Furbearers prefer areas where they have good access to the water and material to use for den construction. For example muskrats build houses from cattail and hardstem bulrush and use roots and lower stems of bulrush for food. When *Phragmites*, purple loosestrife and other emergent weeds become established, they produce dense stands that displace most other shallow water plants species. This removes an important muskrat food source, prevents easy access from upper shore areas to open water, and limits house building material.

The **impacts on waterfowl**, including dabbling ducks such as mallards, widgeons, shovelers, teal and other waterfowl including geese include:

- Shallow water and shorelines not open for their use.
- Water surface and aerial food plants not available.
- Tall dense weeds prevent them from seeing danger and easily escaping.

Dabbling ducks feed by floating in shallow water and tipping over to reach submerged plants and invertebrates. They do not dive. They also use open shorelines or areas with low growing vegetation for resting. Being able to see at distance provides some security from predators. If emergent weeds have filled up the shallow water space and shore areas, these ducks will not use the area. Diving ducks, e.g. redheads, buffelheads, ringneck ducks, and others use much deeper water and dive to considerable depths to feed. This class of waterfowl does not seem to be bothered by dense emergent weed growth in shallow water.

Canada geese also tend to prefer shore areas with low growing vegetation and easy access to the water. Tall dense emergent weed growth largely eliminates goose use of many close-by desirable feeding areas.

## **6. Degradation of Water Quality**

If emergent noxious weed infestations become established, dense plant litter can accumulate and decompose. Litter decomposition decreases dissolved oxygen and can release plant nutrients such as nitrogen and phosphorus into the water. Increased nutrients can increase algal growth that can cause further decreases in dissolved oxygen levels as the algae decompose. Dense weed growth may also reduce water exchange within the stand. Under these conditions water can become stagnant and produce unpleasant odors.

Low oxygen conditions can reduce or eliminate most wildlife uses and many fish species cannot survive under these conditions. It may also reduce some aquatic insect and invertebrate production. Aquatic invertebrates, insects and small fish species are major food sources for larger fish and shore birds.

Water degradation may be one reason that when WDFW conducted informal fish abundance sampling in the central Grant County area, few fish were noted near dense emergent weed infestations (Perry 2003).

## **7. Interference with Water Transport**

Waterways developed for water transport, such as irrigation ditches, have a high potential for emergent noxious weed infestation. Seeding desirable species, compatible with waterway objectives, on banks and along the waters edge will help resist weed invasion

and erosion. If emergent weeds do appear, they may invade into shallow water and collect silt. Their dense stem growth slows water flow and increases the potential for flooding. Silt accumulates changing channel shape and reducing water flow volume. As silt builds up, it allows weeds to move farther out into the channel thus compounding both effects. If a new infestation remains unmanaged, it will result in additional costs to maintain water carrying capacity. In some cases, dredging could be necessary to restore channel shape and volume, which then may require re-vegetation to maintain site control and prevent weed re-establishment.

Weeds established along dirt lined water transport channels produce seed and broken off plant parts that are easily carried by water to new locations along the channel or into water use areas. This readily expands weed problems and greatly increases control costs both along waterways and for land owners and managers where water may be delivered. Prevention coordinated with close survey and monitoring and immediate control action if weeds are detected are necessary to prevent problems caused by emergent weeds. Even if weeds are not present or are successfully managed, monitoring must continue for early detection and to maintain weed free conditions.

WDFW's Snoqualmie Wildlife Area, Cherry Valley Unit has many ditches used for water transport in a large, very high water table area. Reed canarygrass dominates most sites, right up to the water and below the surface in ditches. Each year this plant grows out from banks and into the channel. This dense vegetation and its litter collect silt transported in water. The silt builds up narrowing the channel, reducing water volume and flow velocity. The captured silt provides more rooting zone for reed canarygrass and it moves farther out into the channel. After a year or two, water flow can become very restricted. In this case, dredging these ditches every three to five years has been necessary. A management plan directed at replacing this very dominant weed has been instituted, but it will take many years to make substantial plant community changes.

## **8. Promotion of Mosquito Production**

With the current status of West Nile Virus and other mosquito borne diseases on the rise in the U.S., reducing mosquito populations has become even more important.

Mosquitoes generally require still or slowly moving water for some parts of their life cycle, particularly from egg deposition through final larval development. Water that is rapidly flowing or open to wind and wave action does not provide suitable habitat for these insects. Once emergent weeds move into open shallow water areas, they offer protection from both wind and wave action and slow water movement. Their presence may now allow or increase mosquito production in these sites.

Previous years weed growth often accumulates on the bottom of shallow water areas. As it decomposes additional nutrients are released into the water. These nutrients may serve to stimulate the growth of algae, bacteria and other organisms that mosquito larvae feed upon. Emergent weed growth may also discourage fish predation on mosquito larvae as high stem densities can limit access to shallow water.

## 9. Reduced Property Values

A 1995 Washington Attorney General's opinion stated that noxious weed infestations adversely affect property values and should be disclosed by owners at time of sale (Washington Association of Realtors).

Unfortunately the presence of noxious weeds is rarely considered in real estate transactions. Vegetative features or costs associated with their management are usually not considered, unless they add property value. Many prospective buyers may be unaware of ownership costs and responsibility for noxious weed management. The state noxious weed law requires that property owners manage or control noxious weed problems on all but federal and tribal owned and managed lands, at their expense.

**In 1988, a 1,300 acre ranch in Klamath County, Oregon, was abandoned due to the invasion of leafy spurge. The ranch was then purchased at an auction for about 10 percent of what it would have sold for otherwise (Humphrey 1988). In 1991, a 3,200 acre ranch in Ward County, North Dakota, sold for about 40 percent of the market value due to the same weed. (Weiser 1995).**

The expense of controlling established noxious weed infestations is a negative that should be considered when purchasing property.

## 10. Loss of Biodiversity

High bio-diversity may require the existence of many native and/or desirable adapted life forms. Areas such as open shallow water and/or a high water table will support emergent noxious weeds. The native plants and animals adapted to such wet areas include: song birds, shore birds, waterfowl, fur bearers, fish, aquatic and semi-aquatic insects and invertebrates, grasses, sedges, rushes, broad leaved forbs, and woody plants. With enough area and site diversity, representatives of all these species might be present. These groups interact, forming a dynamic ecosystem with varying species abundance and succession that might support them all or some diverse combination. Noxious weeds can change these ecosystems greatly by reducing plant diversity, bank shape and water features, and this in turn may affect every aspect of that sight, including the food webs.

**“On a global basis...the two great destroyers of biodiversity are, first habitat destruction and, second, invasion by exotic species”.**

**--E.O. Wilson, Harvard University**

In Washington State, *Spartina* grows in estuarine areas on saltwater mud flats, usually not covered with other vegetation. The best example occurs on Willapa Bay, in Pacific County. *Spartina*'s dense growth led to collect silt accumulation from rivers flowing into these areas and from tidal movement of sediment. As the silt accumulates around *Spartina* patches, the sediment elevation increased. This caused some areas that were formerly tidal mud flats to become non-tidal uplands or high salt march. Plant diversity may actually increase in these sites. However, the high production of invertebrates, shellfish, micro-flora, and the fish and shorebirds that eat them are eliminated, so overall bio-diversity decreases. At the very least, the entire site affected has been changed into a different ecosystem with a different potential for even native species. Non-native *Phragmites* is beginning to spread in Grays Harbor and will have similarly detrimental effects if allowed to expand unchecked.

## **11. Expensive Control Costs**

The best way to keep control costs in check is by the early identification of weeds, when the infestation site is still limited to one or very few plants over a very small area. Inventory, prevention, early detection, immediate action and monitoring remain the most effective, lowest cost strategies for weed management.

Once weeds establish over more than a few hundred square feet, control costs rise dramatically. Each site visit to implement a control method adds more cost to the management strategy. Even using bio-controls requires a combination of techniques to insure full control coverage of outlying infestations.

Combining complimentary techniques will not necessarily reduce the cost of each, but may make the overall weed management program more effective, thus reducing long term re-treatment expenses.

Emergent noxious weeds grow in saturated soils of wetlands, tide lands. They will establish on stream banks, ponds, lakes or any other site where water is a major site element. These sites typically are difficult to access for any control methods – whether by foot or with machines. Difficult field conditions slow all weed management actions from initial inventory to re-establishing desirable vegetation. This may dramatically increase costs of implementing any management strategy. Even if a site does provide reasonable

access, often conditions will limit control technique alternatives and/or their effectiveness. Each factor can add its own level of difficulty, often compounding management effort and costs.

**Mechanical Control costs.** In Washington, emergent weed management costs can be very high, although they vary greatly. This cost is usually based on infestation size, age, density, distribution, associated plant communities, and difficulty of site access or on-site movement. Mechanical control of large or dense stands can cost several hundred dollars per acre or much more depending on the need for specialized equipment or techniques. Hand removal of scattered plants in a small area may be less costly, but time and wages can push the price up sharply for infestations more than a few hundred square feet.

**Chemical Control costs.** Herbicides application costs are extremely variable based on the site, the weed species being controlled, infestation size, density, distribution, material used, application method, site access, and permit costs. Chemical control may vary from a minimum of \$50 - \$60 per acre, per year using aerial application to \$200 - \$300 or more per acre, annually, for ground based hand application.

**Grazing Control Costs** - Grazing can be used in very specific circumstances, depending on the weed species and its palatability to the animal being grazed. Grazing as a control technique, and the costs associated with it, will vary greatly relative to the convenience or availability of animals that will eat the target weeds, fencing costs and animal management. For most emergent weeds, one grazing treatment will not often be enough to significantly affect weed occurrence or seed production. A combination of multiple grazing events and/or complementary control methods will have to be developed into an IPM plan. An herbicide application on weakened weed growth following a grazing treatment may improve the herbicide's effectiveness. Re-seeding the treatment sites with desirable or native plants following grazing and herbicide treatments will promote the establishment of a diverse, desirable plant community that would also provide strong competition against weed re-establishment.

**Biological Control costs.** Biological control, when effective and available, can be the lowest cost weed treatment, although introduced organisms are initially very expensive because of the necessary research required prior to their approval for release.

Biological control is a strategy using an organism (often an insect, mite or pathogen) to control or suppress a specific weed species.

Biological controls are most appropriate for large well established weed infestations, or on sites where immediate weed control is not possible, or on sites where other control options are not feasible. Since it can take 4 to 5 years before there are any visible signs of weed control, this is a tool used for long term control plans. This was the case with the *Galerucella* beetles used on purple loosestrife in the Winchester Wasteway.

Biological controls are less appropriate for small weed infestations. Biocontrol agents will not eradicate a weed species, and they are not an option for Class A weed control.

Washington State University (WSU) has an Integrated Weed Control Project (IWCP) that promotes the use of integrated weed management methods, with a focus on biological control. The Director of IWCP manages the biological control program, statewide.

The following website has information on biological controls, and on the safety of introducing biological control agents for weed control:

<http://invasives.wsu.edu/biological/index.htm>

### WEBSITES and LINKS, Section VII

16. Cal-IPC Invasive Plant Research

<http://www.cal-ipc.org/ip/research/>

17. Rockwell, H.W., Jr., Ph.D. 2003. *Summary of a Survey of the Literature on the Economic Impact of Aquatic Weeds*. The Economic Impact of Aquatic Weeds. August 2003.

[http://www.aquatics.org/pubs/economic\\_impact.pdf](http://www.aquatics.org/pubs/economic_impact.pdf)



Surveying native Phragmites in Yakima. Photo: WSDA

## Section VIII

### WEED MANAGEMENT TECHNIQUES

As mentioned in Section IV, Integrated Pest Management is a decision making process using the most appropriate control method, or a combination of those methods, to control a targeted weed species with the least impact to the environment and with the greatest impact to the weed. The IPM decision-making process is done on a site by site basis, and is monitored and altered as necessary as the site and conditions change. A successful weed management plan takes into consideration the weed species, the location or habitat, and the size of the infestation.

A prioritized control plan determines the management goals for the site along with the requirements that determine those goals. A range of control options include:

- Prevention and Early Detection
- Mechanical
- Cultural
- Chemical, and
- Biological Control

Any management strategy or IPM control plan is most effective when all landowners or managers are informed and involved. Weeds do not stop at boundary lines. A coordinated effort that includes education, inventory, planning, control implementation and monitoring both infested and non-infested sites, has a higher chance of success. Since permits are often needed for weed control in aquatic sites, communication should include any local, state and federal agencies, as necessary.

**1. Prevention and Early Detection** - must be considered a part of a successful weed management plan, as it is the most cost effective in time and money. Site surveys and early plant identification lead to rapid response of weed control for newly invading species. If weed problems are ignored until they are plainly evident, the management difficulties and control costs compound. As weeds increase in area and density, the effectiveness of any control strategy will decrease, costs will steeply increase, and success will be much harder to attain and maintain. Options for prevention and early detection include:

- Survey and monitor emergent plant habitat annually for noxious weeds.
- Prevent boats and land vehicles from transporting seeds or propagative plant parts. If boats and vehicles enter weed infested areas, they should be thoroughly cleaned.

- Hand-pulling, digging or mechanically removing emergent weeds (including any plant parts, seeds or soil) from a wet site requires proper disposal. Any plant parts left on site should be well above the water line.
- Do not graze livestock in weedy areas, unless part of a weed management plan. When animals are used as a weed control strategy, ensure that they don't spread the noxious weed to another site.
- Enforce plant quarantines and plant transport laws.

**2. Mechanical** control uses physical control methods such as hand pulling, mowing, mulching and so on. These methods are not usually appropriate for natural areas or rangeland.

**a. Hand pulling, grubbing** - can be effective with most annual species and for perennials with minimal root structure and no rhizomes. Remove the entire above ground plant material, with a goal of removing as much of the root as possible. Pulling has little effect on strong-rooted perennials with well-developed rhizomes or on plants with weak top growth that separates from the plant during hand removal. Many emergent weed species will re-sprout from roots left in the ground. Pulling may force new shoot growth from the root. Digging out roots of perennials is practical on only very small infestations.

**b. Mowing, cutting** – is a practical control for emergent weeds only when the ground is solid enough to support mowing equipment. Emergent plants often grow in saturated soils that are not easily accessible. Mowing emergent weeds may be an effective way to minimize flower and seed production. For many species, the most vulnerable period for mowing is right before to just after flower bud formation. Some sites will have to be mowed several times during a growing season to minimize seed production. Repeated mowing may reduce weed density.

Mowing is non-selective and will affect desirable species as well as the targeted weeds. Mowing is most effective for dense or monoculture stands. Plant fragments cut during mowing operations spread to new sites. Cutting weeds can be more effective on small or scattered infestations, when using hand-operated equipment such as weed eaters.

**c. Covering** - can be effective for small infestations of emergent noxious. An opaque material (heavy black plastic sheeting), blocking all sunlight, should be installed before or when plants first germinate in the spring. Cover the plants completely, sealing the edges with rocks, soil or heavy objects. Leave the covering in place for at least one year. Some species may require more time for control. Covering is non-

selective, and will kill non-target species. Covering is also used in combination with other treatments, such as hand removal/digging, or with herbicide applications.

- d. Water Management** - involves raising or lowering water levels long enough to either drown the plants or dry them out. If water levels can be manipulated when the plant is actively growing it may serve to limit growth or kill the plant. Water level control is most appropriate for large monoculture weed populations or for plant populations growing along a shoreline. Perennial weed species may need water levels to be maintained for several years. Water level fluctuation will affect non-target species, shoreline residents and public access.

A water draw down may only be effective when the low water level can be maintained long enough for the soil to dry out. Monitoring is required following this treatment as seed banks will germinate as the water levels rise. Lowering water levels has significant impact on animal communities and can strand fish. Only consider this option after talking to your local jurisdiction, WDFW, and others.

Raising water levels may be a control option for some emergent species under specific conditions. Emergent weeds grow in limited water depths and their top growth must be above the water's surface. Raising the water level in the spring when plants start growing, may stop or minimize growth for that season.

- e. Manipulating Site Environmental Conditions** – might be a consideration for new pond installation, or for similar water features. Some emergent plants, like purple loosestrife, grow in shallow water to a depth of about 16 inches and upland to about 18 inches above the water table. They do best along shorelines that slope gradually out into the water. Reshaping banks with a steep gradient to the water, and below its surface, minimizes suitable site conditions. Any emergent weeds will grow within a narrow band along the shoreline, resulting in less control work and with a focus on target weeds. This is not a suitable control technique in naturally occurring wetlands or lake shores. This method eliminates habitat for desirable native emergent species and the animals that depend on them.
- f. Dredging, cookie cutter removal** – are control options for monocultures, for weed infestations growing in extensive areas of shallow water. These control methods increase water depth, reshape banks and they can remove plants, root mass and soils from sites. These control techniques result in more open and deeper water, and they often change the site, resulting in less potential emergent weed habitat. Monitoring and control requirements for potential new invaders are reduced. These techniques

use expensive equipment, the control is non-selective and it causes major site changes and disturbance. Re-vegetation is often necessary.

**3. Cultural Control** decreases the suitability of the environment to weeds establishing and spreading. Cultural control often includes re-vegetation and fertilization.

- a. Re-vegetation** – is a technique used as part of an overall weed management plan or it can be used as a primary control. Re-vegetation is often needed after other management methods reduced or eliminated a weed population, and when bare areas remain. In some cases, native or beneficial plants from associated or adjacent plant communities will re-establish. Establishing desirable vegetation, preferably native species, helps prevent weed re-establishment and it may keep other weed species from moving in. Re-vegetation can be done with mechanical equipment if site conditions allow or by hand on small scattered sites.
- b. Fertilizers** – are used to improve the growth and vigor of plants. They are used to increase the productivity of desirable vegetation on site, making it more effective in occupying space both above and below the ground. This reduces the chance a weed species gaining a foothold on that site. However, it is generally not a good idea to use fertilizers around natural lakes, rivers, and streams since this can lead to problems with algae and nuisance aquatic weeds.
- c. Burning** – by itself usually does not result in emergent weed control, but it can be an effective tool to remove dead or dried vegetation, allowing better site access for other control measures. In eastern Washington, emergent vegetative growth often dries enough in late winter to burn, and the fire can be easily controlled. However, emergent plants are often growing in cool moist soil, so the roots never get hot enough to completely eliminate spring re-growth. As a result, fire has little effect on weed plants or other vegetation the following spring.

**4. Chemical Control.** In Washington State, aquatic herbicides are all restricted use. Any person purchasing or applying aquatic herbicides in Washington State is required to have a valid Washington State Applicators License with all applicable endorsements. In addition, if herbicides are applied in areas where they may indirectly enter the water, coverage under an applicable National Pollutant Discharge Elimination System (NPDES) permit is required. Herbicide use and the regulations that apply to herbicide control in this state are covered in Sec V, Permits, of this IPM Plan.

The Washington State Department of Ecology website has information on permits and legal requirements necessary to apply aquatic herbicides in Washington State.

[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)

For specific information on herbicides and recommendations for control, please see the [Pacific Northwest Weed Management Handbook](#).

- a. **Aquatic Herbicides** – are chemicals specifically formulated for use in water to kill or control plants. Herbicides approved for aquatic use by the U.S. EPA have been reviewed and are considered compatible with the aquatic environment when used according to label directions. Washington State imposed additional constraints on their use.

For more detailed information on aquatic herbicide use in our state, please visit Ecology's website:

<http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html>

Aquatic herbicides are often an effective control method for many emergent weed sites. They are a valuable management tool and often work well within an integrated weed control program. To be effective, and to comply with the law, label rates must be followed. When using herbicides, other factors to consider include: timing, application method, rate or concentration, weather conditions, plant growth stage, plant coverage at the site and environmental conditions. There also may be irrigation, livestock watering, or potable water restrictions after application to water. The selection of the herbicide or herbicide formulation may depend on variables such as water exchange, presence of endangered species, area coverage and density of the targeted plant, susceptibility of the targeted plant to that particular herbicide, water chemistry, etc. The herbicide with the least toxic impacts to non-target organisms, but is still highly effective in controlling the targeted species should be used.

When used improperly, herbicides have the potential to contaminate water, degrade water quality and impact human health.

- b. **Adjuvants** – in general, are anything added to or applied with an herbicide to increase its efficacy. In the U.S., there are several hundred name brand adjuvants with various effects on aquatic herbicides.

For a list of currently approved adjuvants, please check Ecology's website:

<http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html>

In general, adjuvants can be classified into three categories:

**1) Activator adjuvants** increase the effectiveness of the herbicide by altering the spray droplet size, distribution of the spray on the plant, viscosity of the spray, evaporation rate, rate of uptake (absorption) by the plant, and solubility of the herbicide in the spray solution. These include:

- a) Surfactants (surface-active agent) - promote the penetration of the chemical into the leaves of the plant.
- b) Wetting agents - increase the ability of water to displace air or liquid from the plant's surface so the herbicide will spread more evenly over the plant, and
- c) Oils - increase the retention time of the sprayed material on the plant and enhance uptake through the leaf surface.

**2) Spray-modifier adjuvants** affect the delivery and placement of the spray solution. They make the herbicide spray easier to aim, reduce herbicide drift and cause the spray to more readily adhere to the plant. These include:

- a) Stickers and spreaders - made of gels, oils, and waxes that help spread and adhere herbicide spray droplets to foliage.
- b) Foams - help in controlling drift, so the herbicide is less likely to be misapplied.
- c) Polymers - used for drift control and to help break surface tension on the water, thus enabling the herbicide to sink onto submersed aquatic weeds, and
- d) Inverting oils - form a viscous blend that reduces drift during application, increases contact time on the plant, and sinks the herbicide onto submersed plants.

**3) Utility-modifier adjuvants** make the herbicide more useful in certain environmental conditions. These include:

- a) Buffering agents - help disperse the herbicide in alkaline or acidic water, and
- b) Anti-foam agents - enabling herbicides to mix with soft water.

**5. Biological Weed Control** – is a strategy using an organism (often an insect, mite or pathogen) to control or suppress a specific weed species. Biological controls are most appropriate for large, well established weed infestations, or on sites where other control options are not feasible. Biocontrols are less appropriate for small weed infestations. Biocontrol agents will not eradicate a weed species, and they are not an option for Class A weed control.

Using biological controls is a long term process, as it can take anywhere from four years to ten years or more to make an impact on a large infestation. When used for weed control, as population levels of a biocontrol agent increase, the target weeds are weakened, seed production is reduced, and ultimately plants may be killed or out competed by other plant species. Eventually the remaining weed population will not be large enough to support a large biocontrol population. The biocontrols then die back until their numbers balance with the available weeds. With the pressure from biocontrols reduced, the weed population again expands. As the biocontrols food source increases, their numbers again increases. Assuming no other influences this mutual cycling of predator and host will continue, keeping the weed population in check, but not completely eliminating its occurrence. Ideally, the cycling, or population fluctuations, of both the biocontrol agent and weed will become less dramatic and both will become a minor component of the ecosystem.

Many of our noxious weeds are native to Europe and Asia, as are the insects and pathogens that keep these plant species under control in their native habitat. This relationship is the basis for classical biocontrol, where organisms from the plant's native range are introduced in the new range in order to achieve this balance. Any potential biocontrol agent undergoes rigorous host-specificity testing to ensure that the potential biological control will only attack a specific weed species, and not native species or commercial crops. The insects, mites or pathogens eventually approved and released to the US for weed control are host-specific, safe and effective.

The following website has information on biological controls, and on the safety of introducing biological control agents for weed control:

<http://invasives.wsu.edu/biological/index.htm>

Washington State University has an Integrated Weed Control Project (IWCP) that promotes the use of integrated weed management methods, with a focus on biological control. The Director of IWCP manages the biological control program, statewide.

Since biological controls are specific to each targeted weed species, the Plant Profiles, found in Appendix A of this IPM Plan, contain information on biological controls if they are available for that particular weed species.

**Grazing** – is also considered a biological control. Grazing by sheep, goats, cattle, or other livestock can be effective in reducing weed top growth and plant vigor. Grazing alone may not kill plants and not all emergent species are palatable to grazing animals. Cattle leave about one-inch stubble on herbaceous species, while sheep and goats may graze the same species more closely to the ground. Goats will also eat woody plants. For some sites, grazing is most effective if repeated within each year and for several years in a row. Moderate grazing for weed control will generally not change associated plant communities.

Temporary fences confine grazing animals to the targeted weed areas, minimizing impacts to desirable plant communities, sensitive habitat and local streams or waterways. Animal grazing is not completely selective to target weeds but because emergent noxious weeds often develop monoculture stands this may not be a problem.

Grazing results in ground disturbance, particularly in emergent plant habitat. This disturbance can be used as a tool to prepare a site for planting and/or re-vegetation. Seeding an area when animals are present promotes re-vegetation, as the animals trample seeds into the ground. This technique is effective when desirable plant communities occupy the site but scattered bare patches or weed infestations need re-vegetation.

Grazing in wetland or shoreline areas may contribute to water quality and habitat degradation from site disturbance and manure production. Be selective in choosing suitable sites.



**IPM Freshwater Emergent Noxious Weeds**  
**PLANT PROFILE**  
**Common Reed/*Phragmites* (nonnative genotype)**  
**(*Phragmites australis* ssp. *australis*)**  
**Updated January, 2013**

**Distribution in Washington State, by county**

<http://agr.wa.gov/PlantsInsects/Weeds/WeedMapLists/docs/CommonReedNonNativeGeno.pdf>

The non-native *Phragmites*, also known as common reed, is physically similar to the native variety. The non-native *Phragmites* (*Phragmites australis* ssp. *australis*) has some distinctive features, including an aggressive, dominant, growth habit. This aggressive genotype is recognized as a non-native weed and currently appears on Washington's noxious weed list as a Class B Noxious Weed.

*Phragmites* has many genotypes adapted to the environmental conditions where they are native. The Pacific Northwest native genotype (*Phragmites australis* ssp. *americanus*) grows in wetlands, on stream and ditch banks. It is also found on shores of lakes and ponds and on some estuary shores. The native species occurs as part of the natural plant community and does not spread aggressively. Some remnant populations of the native genotype are found in the Yakima River Basin.

*Phragmites* is found in both eastern and western Washington. The nonnative genotype is aggressively invading eastern Washington locations along the Snake River and in the Winchester Wasteway. In western Washington the non-native type is found in the Grays Harbor National Wildlife Refuge, and spreading. It is probably not possible to eradicate the nonnative genotype from Washington, but outlier populations should be eradicated and wide-spread infestations should be contained and prevented from further spread.



**Impacts of the non-native type**

*Phragmites* prefers sites near stagnant water or where wave action is minimal. New plants often get started on disturbed sites, in areas with considerable water fluctuation or with new sediment accumulations. Dense, monotypic stands are formed in wetlands. Wildlife is displaced when wetland hydrology, structure and function are altered. Water quality deteriorates when water flow or circulation is adversely affected by this species

Mature stands can reach densities of 200 culms per meter square in wet areas, and up to 300 culms per meter square in dry areas. These dense *phragmites* stands are poorly utilized by mammals or birds and species diversity is low. In western Washington, *phragmites* is threatening the Grays Harbor National Wildlife Refuge with the loss of crucial habitat for migrating shorebirds.

### **Plant Characteristics**

The nonnative type of *Phragmites* is a very large, perennial grass with creeping rhizomes that grows to 15 feet tall under favorable conditions. This tall grass has distinctive dense, feathery flower heads that are tawny or purplish and they can range from 1 to 16 inches long. These flower heads are visible from July through October.

The nonnative type has large hollow stems which produce lance-shaped leaves 8 to 16 inches long and ½ -1½ inches wide along most of their length. Leaf blades are smooth, and the loose blades will twist to the wind to one side. Ligules (short papery bracts growing from the leaf where it bends out from the stem) look yellow or green, and the stems on the weedy genotype are ribbed, rougher, and larger than native plants.

The native *Phragmites* tends to grow in less dense stands, the stems are thin and shiny, and flowers are less dense.

#### **Native *Phragmites* characteristics**

Red colored basal stems in the spring and summer  
Stems smooth, appear polished  
Leaf sheaths fall off in fall, or are easily removed

#### **Nonnative Characteristics**

Generally have tan stems  
Stems ribbed, visible ‘ridges’  
Leaf sheaths remain on plant

Other distinguishing characteristics such as stem density and inflorescence density are somewhat subjective, and experience with both the native and nonnative varieties is needed for these traits to be apparent.

The Cornell University Ecology and Management of Invasive Plants Program website, with work by Dr. Bernd Blossey, offers information and pictures. This information is updated as more samples are collected nationwide. <http://invasiveplants.net/Phragmites/nativeandintroduced.asp>

### **Reproduction**

Common reed is a clonal grass species that reproduces both vegetatively and by seed dispersal. The seeds are generally dispersed from November to January, and they are distributed by wind, water or birds, and by attaching to animals. However, the plant generally spreads by rhizomes. Many seeds are sterile

Seedlings may be produced on nearly any site that has some surface water (even somewhat brackish or alkaline water). *Phragmites* seedlings may germinate and develop some top growth and remain as relatively small plants for several years. They blend in with existing grasses and are very difficult to spot during a weed inventory. Once well established, they produce massive top growth in a very dense stand, which eliminates most other competing plants

Mature plants produce stout rhizomes five to fifteen feet or longer. The rhizomes may live three to six years, and new rhizomes are also produced every year. New plants develop at each node, allowing spread into adjacent plant communities. In some cases, plants also produce stolons capable of producing additional plants.

## **WEED MANAGEMENT PROJECTS**

The Washington State Department of Agriculture (WSDA) received a grant from Ecology in 2003 for a statewide *Phragmites* project. WSDA conducted a survey and inventory of *Phragmites* populations in Washington in 2003 and 2004. Sites were mapped, and a GIS layer was produced. Plant samples were collected, statewide, and sent to Dr. Bernd Blossey at Cornell University for genotyping for native and non-native types, and input into their national database. WSDA continues to survey and identify the native and nonnative populations and to map *Phragmites* sites in Washington State.

Before starting a control program, distinguish between the native and introduced genotypes of *Phragmites*. Only the aggressive introduced genotype should be controlled. Controlling native strains of this species may have a detrimental effect on this limited species.

## **MANAGEMENT PLANS**

As mentioned in Section IV, Integrated Pest Management is a coordinated decision making process using the most appropriate control method, or a combination of those methods and strategies, to control a targeted weed species with the least impact to the environment and with the greatest impact to the weed.

A successful weed management plan takes into consideration the weed species, the location or habitat, and the size of the infestation. Site-appropriate control methods must be used and they need to be monitored or altered as necessary as the site and conditions change.

Listed below are the control methods, or a combination of methods, that may be suitable for site specific control of the non-native *Phragmites*.

## **MANAGEMENT AND CONTROL OPTIONS for *Phragmites*/Common reed**

### **Prevention, Early Detection, Follow-Up**

*Phragmites* is not very widespread in the state of Washington, and very few wetlands have large infestations. Early detection and prevention is still an effective control option for most areas.

- Familiarize yourself with plant characteristics and impacts.
- Notify local county weed boards of any suspected plants.
- Get a positive identification for the non-native type.

Post-cards were produced and distributed in 2012 to help with identification and education concerning the negative impacts of *Phragmites*.

## MECHANICAL CONTROL

**Hand Pulling** - is only suitable for seedlings and young plants that have not established much top growth or have not developed rhizomes or an extensive root system. Larger, older plants generally cannot be hand pulled or even dug out because any rhizomes left will propagate new plants.

**Mowing** - is possible on sites that can accommodate a tractor and mower. In smaller stands, weed whackers can be used. In many areas, *Phragmites* grows with its feet in the water and the plants may be difficult to access. A heavy duty tractor mounted mower may be required to cut the large coarse stems of mature *Phragmites*. Younger plants are easier to mow. To be effective, start mowing plants at the end of July before seed heads form, cutting the plants as low as possible. A single mowing may stimulate more production from root crowns and rhizomes. Repeated mowing of at least several times each year, for a minimum of two growing seasons is needed to reduce growth.

Up to eight cuttings per year may be required to kill perennial grasses. However, mowing does reduce plant energy reserves since plants must re-grow. Over time the plant depletes its carbohydrate reserves. Mowing will reduce stand density and minimize seed production. Herbicide application to these smaller weakened plants will result in better coverage, increasing potential effectiveness and lower chemical volumes may be necessary.

**Cutting** - has been successful for control. However, multiple cuttings of common reed at the wrong times of the year may increase stand density. For successful control, cut the plants just before the end of July. This regime may eliminate a colony if carried out annually for several years. Care must be taken to remove any cut shoots from the site to prevent re-growth. Cutting seed heads is not a control option, as many seeds are considered to be sterile.

**Disking** – may be an effective control. However rhizome fragments can sprout new plants.

**Burning** - does not reduce the growing ability of common reed unless the roots are burned, which is difficult to achieve. While burning alone is not an effective control technique, it can be useful in reducing the very dense biomass and overstory of monoculture stands. Sites may be dry enough in late winter or early spring to burn. At this time the soil will be cool and moist, allowing the top plant material to burn without killing any desirable plant seed still remaining in the soil. Once this dense plant cover has been removed, access will be improved for herbicide application on new plant growth.

## CHEMICAL CONTROL

For specific information on herbicides and recommendations for control, please see the [Pacific Northwest Weed Management Handbook](#).

Note: In Washington State, aquatic herbicides are all restricted use. Any person purchasing or applying aquatic herbicides in Washington State is required to have a valid Washington State Applicators License with all applicable endorsements. In addition, if herbicides are applied in areas where they may indirectly enter the water, coverage under an applicable National Pollutant Discharge Elimination System (NPDES) permit is required.

Permits are covered in SEC V of this IPM Plan. Please refer to the Washington State Department of Ecology website for more information on permits and for other legal requirements necessary to apply aquatic herbicides in Washington State.

[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)

Because of its size, both horizontal and vertical density, extensive rhizomes and stolons, it may be very difficult to get adequate herbicide coverage. Follow-up treatment will be necessary.

**Glyphosate and imazapyr** labeled for aquatic use is effective for *Phragmites* control in aquatic situations. Glyphosate and imazapyr are non-selective systemic herbicides.

- Ideally these herbicides should be applied after the tasseling stage when the plants are translocating nutrients to their roots.
- Glyphosate is most effective if applied in late summer through late fall.
- A successful control option used on wildlife refuges is the application of glyphosate late in the growing season, followed by burning or mechanical removal of the dead vegetation the following spring. Retreatment is often necessary every two to three years.

On seedlings and small patches of mature plants a backpack sprayer or wicking may work best. In large monotypic stands, aerial application may be the most economical method to apply herbicides.

The Nature Conservancy in Indiana reports success using 1.5% Rodeo® applied from backpack sprayers with five foot wand extensions (to reach the tall plants). They treat just before the plant senesces in monotypic stands of up to twenty acres. They have gotten 97 percent mortality after one year of treatment. The treated vegetation is burned the following spring to make follow-up treatment easier and to promote the germination of native seeds.

In areas without monotypic stands where overspray may kill desirable species, plants can be cut and an appropriate solution of glyphosate can be dripped (or injected with a large hypodermic needle) into the hollow stem. This technique has been reported by The Nature Conservancy to result in 50-75 percent mortality. Although this application method is very labor intensive, it preserves remaining desirable plants and can protect rare plant species. (2004 IPM Plan).

## BIOLOGICAL CONTROL

Biological control is a strategy using an organism (often an insect, mite or pathogen) to control or suppress a specific weed species.

Biological controls are most appropriate for large well established weed infestations, or on sites where immediate weed control is not possible, or on sites where other control options are not feasible. Since it can take 4 to 5 years before there are any visible signs of weed control, this is a tool used for long term control plans. Biological controls are less appropriate for small weed infestations. Biocontrol agents will not eradicate a weed species, and they are not an option for Class A weed control.

Washington State University has an Integrated Weed Control Project (IWCP) that promotes the use of integrated weed management methods, with a focus on biological control. The Director of IWCP manages the biological control program, statewide. The following website has information on biological controls, and on the safety of introducing biological control agents for weed control: <http://invasives.wsu.edu/biological/index.htm>

The following Cornell University website offers an overview of insects feeding on *Phragmites*: [http://invasiveplants.net/Phragmites/new\\_insects.aspx](http://invasiveplants.net/Phragmites/new_insects.aspx)

This website reports that research into biological control agents for *Phragmites* is still in the early stages and no approved bio-control insect releases have been made in the U.S for *Phragmites* management. Some experts feel it may be possible to isolate insects that will only attack the weedy *Phragmites* genotype. Researchers have identified at least 140 European insects which feed on or in other ways affect the invasive *Phragmites* genotype. Of these insects, 50 percent use this plant for a major part of their life cycle and 40 percent use *Phragmites* almost exclusively. Twenty-one species from this European group have been identified in some states in the eastern U.S. The source of their introduction is unknown, although some insects were probably introduced in shipping materials in ports.

The study and screening of insect impact on desirable and native plants continues for species that show promise of having a major impact on *Phragmites*. Several European insects are being evaluated as potential control agents for *Phragmites*. These insects were selected based on their life history and impact of *Phragmites* populations in Europe. These potential bio-control agents include:

- *Archanaria geminpuncta*, a shoot-boring moth;
- *Phragmataecia castaneae*, a large shoot and root mining moth;
- *Chilo phragmitella*, another shoot and root mining moth;
- *Schoenobius gigantella*, a moth that mines underwater shoots; and
- *Platycephala planifrons*, attacks shoots early in the year and stunts growth.

## REFERENCES, WEB LINKS for *Phragmites*/Common reed

1. Washington State Noxious Weed Control Board, Noxious Weed List  
[http://www.nwcb.wa.gov/nwcb\\_nox.htm](http://www.nwcb.wa.gov/nwcb_nox.htm)
2. Written Findings, *Phragmites*, WSNWCB  
[http://www.nwcb.wa.gov/siteFiles/Phragmites\\_australis.pdf](http://www.nwcb.wa.gov/siteFiles/Phragmites_australis.pdf)
3. Pacific Northwest Weed Management Handbook  
<http://pnwhandbooks.org/weed/>
4. Ecology – Aquatic Noxious Weed Control, NPDES General Permit  
[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)
5. Ecology: Pesticides (and Adjuvants) currently allowed for use under Permit  
<http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html>
6. WSDA, April 2012. Yakima River Basin Integrated Aquatic Vegetative Management Plan. Plant Profile – *Phragmites*.
7. Cornell University Ecology and Management of Invasive Plants Program, for additional information and photos. <http://www.invasiveplants.net/Phragmites/Default.htm>
8. Morphological characteristics to distinguish native from nonnative genotypes:  
<http://www.invasiveplants.net/Phragmites/phrag/morph.htm>
9. Overview of insects that feed on *Phragmites*  
[http://invasiveplants.net/Phragmites/new\\_insects.aspx](http://invasiveplants.net/Phragmites/new_insects.aspx)
10. WSDA, Ecology, 2004. IPM Plan for Freshwater Emergent Noxious Weeds and Quarantine Listed Weeds, *Phragmites* Plant Profile.  
<http://search.usa.gov/search?utf8=%E2%9C%93&affiliate=www.ecy.wa.gov&query=weeds+ipm&x=0&y=0>
11. Saltonstall, K. 2002. Cryptic invasion by a nonnative genotype of *Phragmites australis* into North America. Proceedings of the National Academy of Sciences, USA. 99(4): 2445-2449. Follow the link below for the Saltonstall paper.  
<http://invasiveplants.net/Phragmites/nativeandintroduced.asp>
12. Simon, B and G. Haubrich, 2004. Interim Report, *Phragmites australis* (common reed), WSDA, December 27, 2004.
13. Haubrich, G and B. Simon, 2004. Native and Nonnative *Phragmites australis* in Washington State, *Douglasia* Article (WNPS), Vol. 28, No. 2, Spring 2004.

**IPM Freshwater Emergent Noxious Weeds**  
**PLANT PROFILE**  
**Flowering rush (*Butomus umbellatus*)**  
**January, 2013**

**Distribution in Washington State by county**

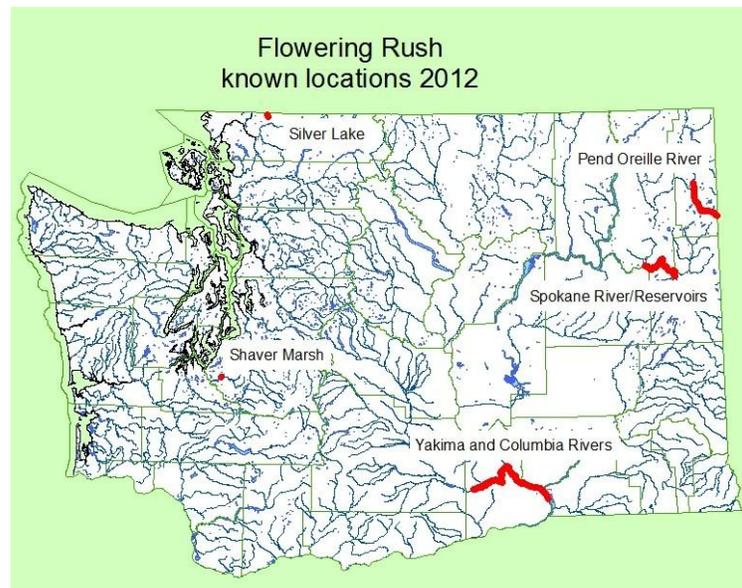
<http://www.nwcb.wa.gov/siteFiles/Flowering%20Rush%202011.pdf>

As of 2012: Locations are also known from Pierce, Spokane and Lincoln Counties.

Flowering rush is currently a Class A noxious weed, with a limited distribution in Washington State. As of 2012, in western Washington, this species is established throughout the shoreline in Silver Lake in Whatcom County, and from a small wetland on Joint Base Lewis McCord in Pierce County.

In eastern Washington plant populations are found in the lower Yakima River and in the Columbia River in Benton, Franklin and Walla Walla Counties; in the Pend Oreille River in Pend Oreille County; and in the Spokane River in Stevens, Spokane and Lincoln Counties.

Flowering rush has been known from Silver Lake since 1997. It came to the attention of the weed community when a large population was causing problems in Flathead Lake, MT. In 2008 it was found during a weed and plant survey along the Yakima River in Benton County. Current populations in the Yakima River Basin are found along the Yakima River, from just above the Prosser Dam, continuing down to the Columbia River. No flowering rush is found above the Prosser Dam pools. In the Columbia River there are scattered sites from the Yakima/Columbia confluence down to Wallula Gap. The Pend Oreille River flowering rush is the result of downstream spread from the Flathead Lake, MT population. The other populations likely resulted from escaped ornamental plantings.



## Impacts

Research suggests that in areas with flowering rush populations there will be a negative impact to the restoration and maintenance of native salmonid habitat in Montana and in the Pacific Northwest. Flowering rush stands create the habitat necessary for introduced fish species (small and large mouth bass, yellow perch, northern pike) that are considered predators to cutthroat trout, bull trout and juvenile salmon (2009, Rice and Dupuis).

Flowering rush can rapidly disperse and colonize new areas through rhizome fragments and rhizome buds, allowing it to form dense stands in previously un-vegetated areas. Flowering rush can impact irrigation systems, and wetlands. It will colonize the littoral zone of freshwater lakes and slow moving river edges. Flowering rush may hinder recreational uses such as swimming, fishing and boating.\* It can impact the industrial uses of shallow water. Because this species has monotypic tendencies, it may affect native shoreline species, or other shallow water emergent plants, possibly altering aquatic food webs.

The Yakima River is a Heritage River, a Federal Waters River, and an important salmon stream. Its fluctuating water levels may provide an ideal habitat for the spread of this invasive plant. Fluctuating water levels facilitate flowering rush colonization and increase in stand abundance. Draw-downs to un-vegetated sediments provide ideal sites for new establishment from rhizome bulblets and lateral rhizome fragments. In addition, the warmer water temperatures of exposed sediment or the water/sediment interface at shallow depths promotes sprouting and growth of bulblets, rhizome fragments and any seeds. Warmer sediment and shallow water column temperatures also promote new sprouting from established rhizomes and lead to stand thickening.

(\*Anecdotal accounts suggest there is a specialized relationship between pond snails and *Butomus*, making flowering rush a potential intermediate host for the *cercaria* that cause swimmer's itch (cercarial dermatitis). Whatcom County reports a significant drop in swimmer's itch cases in 2012, after treating the flowering rush in Silver Lake with diquat.)



flowering rush flower



Inflorescence

Photos: T. Miller

## Plant Characteristics

Flowering rush is not a true rush. This aquatic perennial is considered a wetland obligate and grows only in freshwater habitats. It roots in the mud, sand or cobble from along shore where it grows emergent, out to deep water where it is fully submersed. It is generally found in shallow waters to a depth of about 10 feet, although it grows to 20 feet deep in Flathead Lake, MT. and about 15 feet deep in Silver Lake in Whatcom County, WA. Flowering rush is found most often in wetlands and along shorelines of lakes and slow-moving rivers. Flowering rush also does well in areas of moderate flow on the Yakima and Pend Oreille Rivers.

The emerged form supports flower stalks that can grow up to 3 tall and bears a single cluster of 20 to 25 white to pink flowers, each with 3 petals and 3 sepals. Not all plants flower, so it is important to also recognize the leaves.

The emergent leaves are rigid, and can be 6 feet long. They are 3-sided at the base and then flatten out towards the tip. They have a distinctive, slow spiral, or twist. Leaves can grow above the water's surface or can be completely submersed.

The submersed form has lax leaves, up to 10 feet long and they can float on the surface or grow with the top several inches emerging.

Plants are strongly rhizomatous, with buds or bulbils present along the rhizome. These break off when the plant is disturbed and form new plants.



roots and rhizome buds, flowering rush

Photos: Parsons

## Reproduction

Whether or not seeds are produced depends on whether flowering rush is the sexually fertile diploid ( $2n = 2x = 26$ ), or the sterile triploid ( $2n = 3x = 36$ ). Flowering rush in the PNW, and in the western US, is thought to be the triploid type. They rarely flower and rarely produce viable seed. Dispersal is mainly by buoyant rhizomes and rhizome buds.

Sexually fertile diploid plants produce hundreds of clonal bulbils which readily detach from rhizomes, quickly develop on moist substrate and exhibit very high survivorship. These plants

can also produce viable bulbils that form at the base of the inflorescence (Brown and Eckert 2005).

Sterile triploid plants produce no bulbils at all and propagate only through occasional rhizome fragmentation and rhizome buds. (Thompson and Eckert 2004; Lui et al. 2005 as referenced in Klüber and Eckert 2005). This big difference in clonal reproduction seems peculiar to North America. Experimental comparison of diploids from North America versus Europe indicated that introduced plants invest far more in bulbil production than the native. (Brown and Eckert 2005).

Data supports an association between sexual sterility and polyploidy in regards to pollen size and shape. Sterile (triploid) plant populations had pollen grains that were significantly larger and frequently misshapen as compared to fertile (diploid) plant populations. Pollen size and shape was also diagnostic of sexual fertility for individual plants (Lui et al. 2005).

(This reproductive information above is found in the Written Findings, 2008, Flowering Rush, WSNWCB. A web link to this paper is at the end of this Plant Profile.)

Flowering rush has an extensive monopodial rhizome. “The rhizomes are extremely friable. Lateral rhizome buds develop a constriction between the bud and main rhizome itself. This constriction allows spontaneous release of lateral rhizome structures by flowing water, waves, ice scour, passing boats, waterfowl, animals and any other disturbance of the littoral zone and the rhizome mat. The same disturbances, including waterfowl feeding on the rhizomes, break the rhizomes into pieces. These rhizome propagules are buoyant and this facilitates their dispersal.” (Marie-Victorin 1938 as cited in 2009, Rice and Dupuis).

## WEED MANAGEMENT PROJECTS

**Whatcom County:** The Whatcom County Noxious Weed Board received funding from WSDA in 2010 and from Ecology in 2011-12 for a flowering rush control project in Silver Lake located near Maple Falls, WA. Silver Lake is 180 acres in size and flowering rush is established throughout the shoreline of the lake. Work on the projects has been a multi-agency effort on-going since 2008. Surveys and biomass sampling started in 2010 and continued into 2011 and 2012. Small trial plots were completed by WSU in 2008 and 2009, and the first large scale treatment (27.5 acres total) was made in 2011. In 2012, ten acres were treated in Silver Lake, and it impacted the flowering rush through most of the lake.

**Stevens/Spokane County:** In the Spokane River at Lake Spokane, AVISTA (the utility managing the reservoir) has contracted with a diver to hand pull and put bottom barrier over selected patches of flowering rush in 2011 and 2012. AVISTA has been monitoring the results.

**Pend Oreille County:** In the Pend Oreille River, hand pulling and a bottom barrier were done in 2011 and 2012. Plant location data were collected on patches found and they are monitored yearly.

## **Yakima River Basin:**

**2009 – 2012.** The Benton County Weed Board received an Aquatic Weeds Management Fund Grant from DOE for a flowering rush control project. In 2009, surveys began and flowering rush was found scattered for about 96 miles of river and canal shorelines. A total of about 6 miles (3 river miles on each side) were treated. GPS points and data were taken for flowering rush and other weed species were noted. In 2010 all plants were treated. The Yakima River Cooperative Weed Management Area (CWMA) member agencies conducted surveys and provided GPS units and air boats with crews.

WSDA staff was in contact with all of the land managing agencies to coordinate survey and data collection efforts. This information was entered into the State Weed and Pest (SWAP) database, and is available to all Yakima River CWMA members.

The Yakima River CWMA continues to meet to discuss data gaps and prioritize survey needs for flowering rush. WSDA continues to provide oversight and staff for the project. The surveys continue from the Yakima/Benton County line to the Columbia River. The CWMA members met several times and held several phone conferences in 2011. For 2012, control was planned to start in July above the Prosser Dam pools and behind all diversion dams for irrigation districts, but there was no control in the Yakima River. The Corps of Engineers did limited control work in the Columbia River.

## **Research**

**2008-2012.** Emergent growth herbicide trials at Silver Lake, Whatcom Co. Data and results are in the Chemical Control section of this Plant Profile.

- 2008-2009. Dr. Tim Miller, WSU, conducted emergent growth herbicide trials at Silver Lake. 2 feet of leaf growth was treated with a backpack sprayer. All treatments reduced leaf growth, but not density.
- 2010 – 2011. Dr. Miller also conducted emergent growth herbicide trials on 1 foot of leaf growth, trying to compound the effects of submersed herbicides. Products, rates and % control are found below, in the CHEMICAL CONTROL Section.
- 2011. Jenifer Parsons, Ecology. Submersed growth herbicide trails at Silver Lake, Whatcom Co. Products, rates and results are found below, in the CHEMICAL CONTROL Section.
- 2012. Miller and Parsons. Field trials were conducted using diquat. The data needs to be analyzed.

**2010.** Emergent growth, greenhouse shading trials, Yakima River, Benton Co. (Dr. S. Link)

**2012.** Phone conference (source: J. Parsons, Ecology) with various states, and Army Corps of Engineers to discuss and better understand flowering rush control strategies around the country.

- **For submersed plant growth,** current recommendations for some sites are to try repeated treatments with contact herbicides diquat or endothall (or combinations) to try to wear out the plant. Several additional product combinations were tried in Flathead Lake, MT last summer. Results from those plots (expected summer, 2012) could yield insight into other methods that may hold promise.

- **Summer 2012:** using repeated treatments of the contact herbicide diquat on submersed plants in Silver Lake (Whatcom Co).
- **Bottom barrier:** Plan to use on the flowering rush patches upstream of Prosser Dam. Benton Co plans to spray other large patches.
- **Columbia River survey:** Plans to survey and control from the downstream end of the populations in the Columbia River.

## **MANAGEMENT PLANS**

As mentioned in Section IV, Integrated Pest Management is a coordinated decision making process using the most appropriate control method, or a combination of those methods and strategies, to control a targeted weed species with the least impact to the environment and with the greatest impact to the weed.

A successful weed management plan takes into consideration the weed species, the location or habitat, and the size of the infestation. Site-appropriate control methods must be used and they need to be monitored or altered as necessary as the site and conditions change.

Listed below are the control methods, or a combination of methods, that may be suitable for site specific control of flowering rush.

### **MANAGEMENT AND CONTROL OPTIONS for Flowering Rush**

#### **The Quarantine List – Prohibited for Sale**

Plant quarantines are a preventative measure to keep noxious weed species from spreading to natural areas and to keep some species not found in the state, out of the state by prohibiting their sale or distribution. WSDA maintains a plant quarantine list, called '*Plants and Seeds Whose Sales are Prohibited in Washington State*'. Flowering rush is a Class A noxious weed. All Class A noxious weeds are on this list.

Historically flowering rush was known and sold as a garden ornamental. As a wetland and aquatic quarantine species, it is illegal to transport, buy, sell, offer for sale, or to distribute plant parts of these regulated plants into or within the state of Washington. It is also illegal to distribute seed packets, flower seed blends or 'wildflower mixes' that include these plants. Anyone who violates the quarantine restrictions is subject to a civil penalty of up to \$5,000 per violation. It is further prohibited to intentionally transplant wild plants and/or plant parts of these species within the state of Washington (WAC 16-752-505).

#### **Prevention, Early Detection, Follow-Up**

At this time, flowering rush has a somewhat limited distribution in Washington state. Early detection and prevention is still a control option in many areas.

- Familiarize yourself with plant characteristics and impacts.
- Follow quarantine laws. Do not buy flowering rush and do not plant this species.
- Notify WSDA Plant Services if plants are offered for sale (web link below).
- For larger sites, develop a long term Integrated Pest Management Plan.

Educational post-cards were produced and distributed by the State Weed Board in 2011 to help with identification and education concerning the negative impacts of flowering rush.

## MECHANICAL CONTROL

**Digging or suction dredging** by hand as a control option for isolated or individual plants in areas of low density populations. This method is not used in the Yakima River. To be successful, the entire rhizome must be removed without dislodging the rhizome bulbs. Even a slight bottom disturbance can cause the rhizome bulbils to release. Land disposal of plant material is necessary. No plants or sediments can be returned to the water.

**Hand pulling** has largely been ineffective.

**Covering** with bottom barrier will work so long as the barriers are properly installed.

**Shading trials:** on emergent growth suggest this may control flowering rush, but it will not kill the plant. Field experiments are needed to determine if shading can be duplicated outside of a controlled greenhouse environment. (Link, 2012).

## CHEMICAL CONTROL

For specific information on herbicides and recommendations for control, please see the [Pacific Northwest Weed Management Handbook](#).

Note: In Washington State, aquatic herbicides are all restricted use. Any person purchasing or applying aquatic herbicides in Washington State is required to have a valid Washington State Applicators License with all applicable endorsements. In addition, if herbicides are applied in areas where they may directly or indirectly enter the water, coverage under an applicable National Pollutant Discharge Elimination System (NPDES) permit is required.

Permits are covered in SEC V of this IPM Plan. Please refer to the Washington State Department of Ecology website for more information on permits and for other legal requirements necessary to apply aquatic herbicides in Washington State.

[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)

**2008-2009: Dr. Tim Miller, WSU,** Emergent growth trials, herbicide on emergent growth at Silver Lake. 2 feet of leaf growth was treated with a backpack sprayer. All treatments reduced leaf growth, but did not reduce density.

Product	Concentration	% Control 12 MAT
Glyphosate	3%	44%
Glyphosate	5%	61%
Imazapyr	1%	74%
Triclopyr amin	6.7%	56%

**2010-2011, Dr. Tim Miller, WSU,** Emergent growth herbicide trials on 1 foot of leaf growth, treated Aug 2010. Trying to compound the effects of submersed herbicides. Treatment in 2011.

Product	Concentration	% Control 12 MAT
Rodeo + Habitat	4% + 0.5%	50%
Rodeo + Habitat	3% + 0.75%	45%
Habitat	1%	40%
Rodeo	5%	29%

### Results:

Chemical control of flowering rush in the Yakima River watershed is very limited, especially for plants that are mostly submerged. Imazapyr and glyphosate are for use on emergent plants in aquatic situations, but neither is 100% effective. While imazapyr offers somewhat better control than glyphosate, it cannot be used near irrigation water outtakes.

**Imazapyr** – works best on emergent growth. At least 2 feet of leaf are required to be above water, the more the better.

**Glyphosate** – a 5% solution of glyphosate with a suitable surfactant provides fairly good control in some areas and is the only chemical option available for use near irrigation water outtakes.

### 2011, Benton County Herbicide Treatments.

- 2010 – 100% of the plants were treated in the Yakima River by staff from the Benton County Noxious Weed Control Board (BCNWCB). BCNWCB started with a 2% solution of glyphosate and a suitable surfactant and later switched to a 5% solution of glyphosate with a suitable surfactant. Treatments were conducted from mid-July to mid-August.
- 2011 – The BCNWCB treated plants from Benton City to the Columbia River with a 5% solution of glyphosate. This resulted in very little control, estimated at less than 50%. Fewer plants produced flowers than in 2010 however it should be noted that plants do not tend to flower annually anyway.
- 2012 – The BCNWCB plans to implement control measures behind all irrigation district diversion dams using a 5% solution of glyphosate starting in July when the water level in the river decreases.

**2011, Whatcom County, Silver Lake Herbicide Treatments. WCNWCB.**

Submersed growth herbicide trials. Jenifer Parsons, Ecology,  
Applied late May, 2011, assessed mid- August 2011.

Product	Plot size (acres)	Rate (ppb)	Sig reduction 11WAT
Triclopyr (granular)	10	2500	no
Triclopyr+2,4-d(gran)	10	1000 + 4000	no
Imazamox (liquid)	7.5	500	no

WCNWCB Report 2011: Update flowering rush eradication project, Silver Lake.

- Representatives from Washington State University, University of Montana, WA State Department of Ecology, and Sepro Inc were included in strategy discussions for controlling flowering rush.
- All lake residents were invited to hear about the project.
- Three herbicides were used in three separate areas of the lake. Plants were treated early in the season (mid to late May) before growth became emerged above the water line. All treatments were at a mean depth of 5 feet.
- The northernmost plot was treated with Renovate® OTF (triclopyr), application rate of 2500 ppb; the middle plot was treated with Renovate® Max G (triclopyr/2,4-D), application rate of 4687 ppb; a southern plot was treated with Clearcast® (imazamox), application rate 500 ppb. The control area (untreated) was the far south end of the lake.
- Site visits and monitoring were monthly throughout the growing season.



**Submersed flowering rush. Silver Lake.**

**Photo: Parsons**

## BIOLOGICAL CONTROL

Biological control is a strategy using an organism (often an insect, mite or pathogen) to control or suppress a specific weed species. Biological controls are most appropriate for large well established weed infestations, or on sites where immediate weed control is not possible, or on sites where other control options are not feasible. Since it can take 4 to 5 years before there are any visible signs of weed control, this is a tool used for long term control plans. Biological controls are less appropriate for small weed infestations. Biocontrol agents will not eradicate a weed species, and they are not an option for Class A weed control.

Washington State University (WSU) has an Integrated Weed Control Project (IWCP) that promotes the use of integrated weed management methods, with a focus on biological control. The Director of IWCP manages the biological control program, statewide. The following website has information on biological controls, and on the safety of introducing biological control agents for weed control: <http://invasives.wsu.edu/biological/index.htm>

While flowering rush is limited in Washington State at this time, it is widespread in the northern tier of the U.S. and is expected to become increasingly prevalent here and in Idaho and Montana. Although appropriate chemical and mechanical control methods continue to be explored, they have thus far been relatively ineffective, creating concerns that the flowering rush populations will continue to expand and spread without restriction. In looking for possible control methods, a proactive approach is being taken to assess the interest and potential for a biological weed control research.

Flowering rush may be an excellent candidate for biocontrol because it is the only genus and species within the family Butomaceae. This increases the likelihood of finding a host-specific biocontrol agent, and could mean that the number of test plant species required for host-specificity testing could be limited. In addition, a brief preliminary search indicates that there are two monophagous (host-specific) insects that attack flowering rush in its native range – a beetle *Bagous nodulosus* (Curculionidae), and a fly *Metopomyza ornate* (Agromyzidea).

Jennifer Andreas, Director of IWCP at Washington State University, will lead the Flowering Rush Biocontrol Consortium and will work with partners from several states, Canada and scientists from CABI – Switzerland. CABI estimates it will take \$40,000 to \$60,000 to initiate a research program and funding is currently being pursued. As this tends to be a very long term process, the consensus from the Yakima River CWMA and others in the Pacific Northwest working on flowering rush is that this option is worth exploring further.

## LITERATURE, REFERENCES CITED

14. Washington State Noxious Weed Control Board  
<http://www.nwcb.wa.gov/detail.asp?>
15. Written Findings, Flowering Rush. 2008 . WSNWCB  
[http://www.nwcb.wa.gov/siteFiles/Butomus\\_umbellatus.pdf](http://www.nwcb.wa.gov/siteFiles/Butomus_umbellatus.pdf)
16. Washington State Quarantine List:  
<http://www.nwcb.wa.gov/siteFiles/ProhibitedPlants.pdf>
17. WSDA Plant Services Program – contact info for quarantine enforcement  
<http://agr.wa.gov/PlantsInsects/PlantServicesProgram/default.aspx>
18. Pacific Northwest Weed Management Handbook  
<http://pnwhandbooks.org/weed/>
19. Ecology – Aquatic Noxious Weed Control, NPDES General Permit  
[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)
20. Ecology: Pesticides (and Adjuvants) currently allowed for use under Permit  
<http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html>
21. Rice, P. M. and V. Dupuis, 2009. Flowering Rush: An Invasive Aquatic Macrophyte Infesting the Headwaters of the Columbia River System.
22. Link, S.O. March, 2012. Effect of shading on *Butomus umbellatus*
23. Silver Lake Flowering Rush Eradication Project Report. 2011. Whatcom County Noxious Weed Control Board.

**IPM Freshwater Emergent Noxious Weeds**  
**PLANT PROFILE**  
**Garden loosestrife (*Lysimachia vulgaris*)**  
**Updated January 2013**

**Distribution in Washington State by county**

<http://www.nwcb.wa.gov/siteFiles/Loosestrife%20Garden%202011.pdf>

Garden loosestrife is currently a Class B noxious weed in Washington State.

At this time, garden loosestrife is established in some sites in western Washington. Overall, this species has a limited distribution in Washington State. The first known record of garden loosestrife is from 1978 in King County, and most garden loosestrife sites are currently reported in that county. For more information, contact the King County Noxious Weed Control Board.



Photo: King Co Noxious Weed Board

**Plant Characteristics**

Garden loosestrife is an emergent perennial plant growing from a root mass that includes long stolon-like rhizomes, extending 15-20 feet or more. Plants can be three to four feet tall, or more, depending on the site. The leaves are three to five inches long, lance shaped, growing opposite or in whorls along the stem. The leaves are dotted with orange or black glands.

Each stem produces clusters of bright yellow primrose-like flowers with 5 petals, and stamens that are red-orange. The sepals have distinct orange margins. The largest flower clusters are at the top of the stem, smaller clusters are lower on the stems. The round stems are covered with soft hairs. Blooms from July to September in our area, but the plant may not flower in the first few years. Seed pods are egg shaped capsules.

Mature plants produce flowers and rhizomes. Plants spread mainly by rhizomes, but viable seeds are produced and spread through waters. Garden loosestrife shares habitat with purple loosestrife, but these two species are not related.



Garden loosestrife infestation at Marymoor Park

### **Impacts**

Garden loosestrife grows in the moist soils of wetlands, on lakeshores, fens, wet woods, riverbanks and stream banks. It grows in areas that are permanently moist or saturated. This non-native, invasive emergent noxious weed clogs shallow waterways, displaces native vegetation and reduces habitat necessary to waterfowl and fish, including salmon species. Garden loosestrife seems to dominate where it grows in natural wet areas. Once established, it spreads and digs in, by long rhizomes that extend to form dense mats. Garden loosestrife can out-compete purple loosestrife in areas where they share habitat. Once established, it is extremely difficult to remove those rhizome mats.

## **MANAGEMENT PLANS**

As mentioned in Section IV, Integrated Pest Management is a coordinated decision making process using the most appropriate control method, or a combination of those methods and strategies, to control a targeted weed species with the least impact to the environment and with the greatest impact to the weed.

A successful weed management plan takes into consideration the weed species, the location or habitat, and the size of the infestation. Site-appropriate control methods must be used and they need to be monitored or altered as necessary as the site and conditions change.

Listed below are the control methods, or a combination of methods, that may be suitable for site specific control of garden loosestrife.

## **MANAGEMENT AND CONTROL OPTIONS for Garden loosestrife**

### **The Quarantine List – Prohibited for Sale**

Plant quarantines are a preventative measure to keep noxious weed species from spreading to natural areas and to keep some species not found in the state, out of the state by prohibiting their sale or distribution. WSDA maintains a plant quarantine list, called '*Plants and Seeds Whose Sales are Prohibited in Washington State*'.

Garden loosestrife is a Class B noxious weed, and it is a wetland and aquatic quarantine species. Historically this species has been sold as a garden ornamental. However, it is illegal to transport, buy, sell, offer for sale, or to distribute plant parts of these regulated plants into or within the state of Washington. It is also illegal to distribute seed packets, flower seed blends or 'wildflower mixes' that include these plants. Anyone who violates the quarantine restrictions is subject to a civil penalty of up to \$5,000 per violation. It is further prohibited to intentionally transplant wild plants and/or plant parts of these species within the state of Washington (WAC 16-752-505).

Links to the Quarantine List, and to WAC 16-752, are at the end of this Plant Profile.

### **Prevention, Early Detection, Follow-Up**

Garden loosestrife has been sold as a garden ornamental, and it has the biggest negative impacts when it escapes and established in natural wetland areas. At this time, garden loosestrife has a limited distribution in Washington State, and it has a very limited distribution in eastern Washington. Early detection and prevention is still the preferred control option in most areas.

- Follow quarantine laws. Do not buy garden loosestrife and do not plant this species.
- Familiarize yourself with plant characteristics and impacts.
- Survey, or be aware of this species in its preferred habitat of wet lands and shorelines.
- Flowers are visible from July – September. Seedlings are visible in June.
- Hand- remove individual plants and any small patches. Remove plants from the site.
- For larger sites, develop a long term Integrated Pest Management Plan.

Currently the King County Noxious Weed Control Program has current information on controlling garden loosestrife in Washington State. Many of the control recommendation listed below are found on their website. That website is listed at the end of this Plant Profile.

## MECHANICAL CONTROL

**Hand pull** or dig up individual plants or small isolated patches of plants. Smaller or immature plants can be dug and removed if they do not have the large rhizome mats. Do not pull the plants. Any rhizomes or stolons or root fragments left will generate new growth.

When flowers are present, cut and bag all flowers and seed heads. Remove and bag all plant parts from the site – including any flowers, seeds, roots. Do not compost any parts. Plants should be thrown in the trash, or taken to a transfer station.

**Covering** is a control option for seedlings. Covering will slow down the growth of plants, and it will prevent flowers and seed production. Sites can be covered with sheet mulch, black plastic, landscape fabric or cardboard with 6” of mulch. Extend the cover several feet beyond the plants and secure the cover with weights. Rhizomes will extend under the mats past all covering.

This method is not effective on mature plants because it does not kill the rhizomes and roots.

**Mowing, or cutting are not control options.** Cut plants will grow from roots and rhizomes. Mowing will spread plant parts, which can root and establish new plants.

## CHEMICAL CONTROL

For specific information on herbicides and recommendations for control, please see the [Pacific Northwest Weed Management Handbook](#).

Note: In Washington State, aquatic herbicides are all restricted use. Any person purchasing or applying aquatic herbicides in Washington State is required to have a valid Washington State Applicators License with all applicable endorsements. In addition, if herbicides are applied in areas where they may indirectly enter the water, coverage under an applicable National Pollutant Discharge Elimination System (NPDES) permit is required.

Permits are covered in Section V of this IPM Plan. Please refer to the Washington State Department of Ecology website for more information on permits and for other legal requirements necessary to apply aquatic herbicides in Washington State.

[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)

The herbicides listed below require an approved surfactant. Follow all label instructions. Surfactants must be approved for aquatic use in Washington State. A link for surfactants (adjuvants) is listed in Section V (Permits) of the IPM Plan, and at the end of this Plant Profile.

- **Glyphosate** - Apply to actively growing plants in full to late flowering stage. Application to pre-flowering plants or seedlings may be effective if these immature, non-flowering plants can be correctly identified. Apply to foliage, avoid runoff. (Non-selective herbicide, will effect monocots and dicots).
- **Imazapyr** - Apply to actively growing foliage. (Non-selective herbicide, will effect monocots and dicots).
- **Triclopyr** - Apply when plants are in mid to full-bloom. Application to pre-flowering plants or seedlings may be effective if these immature, non-flowering plants can be correctly identified. (Selective herbicide, will only effect dicots).

## **BIOLOGICAL CONTROL**

Biological control is a strategy using an organism (often an insect, mite or pathogen) to control or suppress a specific weed species.

Biological controls are most appropriate for large well established weed infestations, or on sites where immediate weed control is not possible, or on sites where other control options are not feasible. Since it can take 4 to 5 years before there are any visible signs of weed control, this is a tool used for long term control plans. Biological controls are less appropriate for small weed infestations. Biocontrol agents will not eradicate a weed species, and they are not an option for Class A weed control.

Washington State University has an Integrated Weed Control Project (IWCP) that promotes the use of integrated weed management methods, with a focus on biological control. The Director of IWCP manages the biological control program, statewide.

The following website has information on biological controls, and on the safety of introducing biological control agents for weed control: <http://invasives.wsu.edu/biological/index.htm>

**No biological control agents** are known at this time. No research is underway.

## REFERENCES, WEB LINKS for Garden loosestrife

1. Washington State Noxious Weed Control Board, Noxious Weed List  
[http://www.nwcb.wa.gov/nwcb\\_nox.htm](http://www.nwcb.wa.gov/nwcb_nox.htm)
2. Written Findings, Garden loosestrife, WSNWCB  
[http://www.nwcb.wa.gov/siteFiles/Lysimachia\\_vulgaris.pdf](http://www.nwcb.wa.gov/siteFiles/Lysimachia_vulgaris.pdf)
3. Washington State Quarantine List:  
<http://www.nwcb.wa.gov/searchResultsQuarantine.asp>  
To download a copy of the quarantine list  
<http://www.nwcb.wa.gov/siteFiles/ProhibitedPlants.pdf>
4. Quarantine Rules, Noxious Weed Control (WAC 16-752-100-715):  
<http://apps.leg.wa.gov/WAC/default.aspx?cite=16-752>
5. WSDA Plant Services Program – contact info for quarantine enforcement  
<http://agr.wa.gov/PlantsInsects/PlantServicesProgram/default.aspx>
6. Pacific Northwest Weed Management Handbook  
<http://pnwhandbooks.org/weed/>
7. Ecology – Aquatic Noxious Weed Control, NPDES General Permit  
[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)
8. Ecology: Pesticides (and Adjuvants) currently allowed for use under Permit  
<http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html>
9. WSDA, Ecology, 2004. IPM Plan for Freshwater Emergent Noxious Weeds and Quarantine Listed Weeds, garden loosestrife Plant Profile.  
<http://search.usa.gov/search?utf8=%E2%9C%93&affiliate=www.ecy.wa.gov&query=weeds+ipm&x=0&y=0>
10. King County Noxious Weed Control Board – garden loosestrife Best Management Practices  
<http://your.kingcounty.gov/dnrp/library/water-and-land/weeds/BMPs/Garden-Loosestrife-Control.pdf>
11. King County Noxious Weed Control Board – garden loosestrife (pictures)  
<http://www.kingcounty.gov/environment/animalsAndPlants/noxious-weeds/weed-identification/garden-loosestrife.aspx>

**IPM Freshwater Emergent Noxious Weeds**  
**PLANT PROFILE**  
**Hairy willow-herb (*Epilobium hirsutum*)**  
**(Updated January, 2013)**

**Distribution in Washington State by county**

<http://www.nwcb.wa.gov/siteFiles/Hairy%20Willow-Herb%202011.pdf>

Hairy willow-herb is currently a Class B noxious weed in Washington State.

**Distribution History:** The earliest herbarium specimens for Washington State are from 1930 in Klickitat County, and from 1965 from the Bellingham area of Whatcom County. In 1999 a large Whidbey Island (Island County) site was identified, and a survey that same year in southern Whatcom County reported 115 sites, covering an estimated 9.25 acres. Currently, hairy willow-herb is known in 11 counties. Four counties (Franklin, Island, Klickitat and Whatcom) have large hairy willow-herb sites (up to 40 hectares). The remaining counties (Clallam, King, San Juan, Skagit and Thurston) report hairy willow-herb sites of less than 40 hectares. (Looney et.al, 2012).

**Impacts**

*Epilobium hirsutum*, known commonly as hairy willow-herb, is a tall perennial herb capable of escaping cultivation to form monotypic stands in natural wetland areas, where aggressive and dense growth can crowd out native or beneficial species. While often found along ditch-banks and roadsides this plant is capable of spreading to undisturbed meadows. Records indicate hairy willow-herb is considered established throughout most of the northeastern United States, and the distribution continues to spread westward. Initially the majority of Washington populations were thought to be limited to Whatcom County, where this plant was regularly found as a garden ornamental, and also as an escapee to natural wetland areas. This non-native, emergent noxious weed is capable of disrupting the ecology of our wetlands by altering food chains, hydrologic cycles and floral composition. Hairy willow-herb is aggressive and capable of spreading by wind dispersed seeds, and by a large root system that produces rhizomes, helping to facilitate vegetative spread. These factors all determine the succession or long term management plans of these wetland areas.

**Plant Characteristics**

Hairy willow-herb is a semi-aquatic, emergent perennial herb ranging in height from 3 feet to 6 feet tall, depending on the site. It spreads by seeds and rhizomes.

Flowers occur in July and August. The showy rose-purple colored flowers extend from leaf axils near the top of the plant. Flowers are approximately  $\frac{3}{4}$  inch across. Each flower has four sepals, four notched petals and eight stamens. The overall plant is covered with fine soft hairs. The leaf arrangement is mostly opposite, and the toothed leaves are much longer than wide and widest below the middle.

Taxonomically, hairy willow-herb is closely related to the native fireweed (*Chamerion angustifolium*, syn. *Epilobium angustifolium*), and with a casual look, they share characteristics. Both species are about the same height, they both have purple flowers at the top of the plants and they can share habitat along roadsides. However, **it is easy to tell them apart**. The individual hairy willow-herb flowers are much larger than fireweed, the white stamens are prominent even from a distance, and each plant prefers different habitat. The native fireweed prefers dry roadsides and the non-native, invasive hairy willow-herb likes its feet wet.



Hairy willow-herb flower  
Photos: Simon, WSDA



L- native fireweed      R-hairy willow-herb

This semi aquatic, perennial herb is found in a wide range of moist soils, including wetlands, ditch and stream bank, low fields, pastures and meadows. In its native range hairy willow-herb is found in damp lands and waste places to an elevation of 8100 feet, and it is intolerant of shade, though it becomes somewhat more shade tolerant once established. Hairy willow-herb often shares habitat with purple loosestrife. Hairy willow-herb outcompetes and grows faster than purple loosestrife in the shorter days and colder temperatures of autumn. In the spring, this relationship is reversed, with purple loosestrife having a faster growth rate. Hairy willow-herb requires habitat with a pH of 5.5 or higher for seed germination.

## Reproduction

This perennial spreads by seed and by rhizomes. Flowers buds develop after 10 to 12 weeks of growth. Side shoots also produce flowering stems and the whole plant is flowering by mid-summer (July – August). Self-pollination is possible, but this reduces seed production. Seeds ripen and begin to disperse 4 to 6 weeks after flowering. Each seed is oblong and flattened with tufts of long white hairs.



Hairy willow-herb seeds. Photo: WSNWCB



Flowers, immature seed pods. Photo: WSDA



Hairy willow-herb: Stolons, adventitious roots, rhizomes.



Photos: Simon, WSDA

Axillary buds, found at the base of the stem, produce stolons. These stolons develop adventitious roots, which pull the stolons into the ground, where they develop into fleshy, soft rhizomes. These rhizomes branch repeatedly, and spread to new areas. When the axillary buds produce stolons that spread along the soil surface, the stolons root and produce a pseudo-rosette of leaves. If this rosette gets separated from the parent plant, it produces an aerial shoot and develops much the same way as an autumn seedling. The aerial shoots die back each autumn, but the rhizome system remains. These rhizomes can reach almost 2 feet in length from the time of initial development to aerial shoot production.

Hairy willow-herb adapts to its growing conditions. The rhizomes growing in submerged water, or water-saturated mud, develop aerenchyma tissue. Rhizomes not submerged are mostly cork.

## Research

In June of 2006, the Washington State Department of Agriculture (WSDA) received a grant from the Washington State Department of Ecology (Ecology). WSDA developed a knowledge base for hairy willow-herb in Washington State by providing research into control methodology, developing educational materials, looking at the species distribution and range in Washington, updating documentation and suggesting a statewide management strategy.

There was little information available on control of hairy willow-herb when this species was first listed on the state noxious weed list. Several field trials were initiated in 2006 and 2007 to assess various control methods. This included herbicide trials in Whatcom County, and manual control plots in Klickitat and Island Counties. The Klickitat County plots had water up to knee deep. The Island County plots were in a low, damp pasture, but no visible standing water when plots were set up or monitored.

**Manual control plots** - Island and Klickitat Counties: All measured and staked plots had 100% cover with hairy willow-herb. In each plot the plants were either: trampled down then tarped; plants were cut and tarped; or plants were cut and removed and tarped. All plots were monitored over the course of 2 years.

At both trail sites, all plants were down, dead and decomposed under the tarps. No plants appeared to be growing up from under the tarps. All tarped areas had white roots, or stolons, encroaching in from all sides from the larger hairy willow-herb infestations surrounding the plots. It was not clear, at either site, if there were any live roots from the tarped plants.

**Herbicide Control Plots** – Whatcom County: Herbicide plots and trials were started in 2006, by Timothy W. Miller, PhD, WSU, Mount Vernon. Data reported in Chemical Control.

## MANAGEMENT PLANS

As mentioned in Section IV, Integrated Pest Management is a coordinated decision making process using the most appropriate control method, or a combination of those methods, to control a targeted weed species with the least impact to the environment and with the greatest impact to the weed.

A successful weed management plan takes into consideration the weed species, the location or habitat, and the size of the infestation. Site-appropriate control methods must be used and they need to be monitored or altered as necessary as the site and conditions change.

Listed below are the control methods, or a combination of methods, that may be suitable for site specific control of hairy willow-herb.

## **MANAGEMENT AND CONTROL OPTIONS for Hairy willow-herb**

### **The Quarantine List – Prohibited for Sale**

Plant quarantines are a preventative measure to keep noxious weed species from spreading to natural areas and to keep some species not found in the state, out of the state by prohibiting their sale or distribution. WSDA maintains a plant quarantine list, called '*Plants and Seeds Whose Sales are Prohibited in Washington State*'.

Hairy willow-herb is sometimes sold and planted as a garden ornamental, and in the past it was reported from a number of gardens in the Bellingham area. This plant was used as a replacement for purple loosestrife - but both plants are state listed noxious weeds. Hairy willow-herb and purple loosestrife are on the WSDA Quarantine List.

As a wetland and aquatic quarantine species, it is illegal to transport, buy, sell, offer for sale, or to distribute plant parts of these regulated plants into or within the state of Washington. It is also illegal to distribute seed packets, flower seed blends or 'wildflower mixes' that include these plants. Anyone who violates the quarantine restrictions is subject to a civil penalty of up to \$5,000 per violation. It is further prohibited to intentionally transplant wild plants and/or plant parts of these species within the state of Washington (WAC 16-752-505).

Links to the Quarantine List, and to WAC 16-752, are at the end of the Plant Profile.

### **Prevention, Early Detection, Follow-Up**

At this time, hairy willow-herb has a somewhat limited distribution in Washington State. In natural areas where hairy willow-herb is not well established, early detection and prevention is still a control option.

- Familiarize yourself with plant characteristics and impacts.
- Survey, or be aware of this species in its preferred habitat of wet lands, wet ditches.
- Follow quarantine laws. Do not buy hairy willow-herb and do not plant this species.
- Notify WSDA Plant Services if plants are offered for sale (website at end of this Profile).
- Flowers are visible mid- summer (July – August), a good time to look or survey.
- For larger sites, develop a long term Integrated Pest Management Plan.

In 2009, post-cards were produced and distributed by WSDA and the State Weed Board and WSU's Integrated Weed Control Project (IWCP) to help with identification and education concerning the negative impacts of hairy willow-herb.

## MECHANICAL CONTROL

Small infestations can be dug up or hand pulled, starting in the least infested areas first. Sites will need to be monitored for several years. Off-site composting is not recommended. Plants should be destroyed on site, or disposed of in bagged garbage. If seeds are visible, cover the seed heads with a bag, then cut the stems. The roots should be removed last.

**Hand pulling:** Small sites or young plants can be dug up, or hand-pulled. Any plant parts, including roots and rhizomes, flowers need to be appropriately destroyed on site. Seed heads need to be bagged and removed.

**Covering:** Manual control plots were established in Klickitat County in June 2007 and in Island County in August, 2007. The sites were monitored for 2 years. Results indicate that this could be an effective control for smaller sites. The plants under the tarp died back. There was no seed production. (Detailed information in 2004 IPM Plan).

**Mowing:** No research was conducted for this method. The Island County control site had portions mowed by the landowner. This prevented hairy willow-herb from spreading further, and it apparently reduced seed production. Due to the extensive root system of this plant, mowing would not eliminate the plants from a site and would not be recommended in wet sites. Mowing equipment could potentially spread the seeds to uninfested areas.

## CHEMICAL CONTROL

For specific information on herbicides and recommendations for control, please see the [Pacific Northwest Weed Management Handbook](#).

Note: In Washington State, aquatic herbicides are all restricted use. Any person purchasing or applying aquatic herbicides in Washington State is required to have a valid Washington State Applicators License with all applicable endorsements. In addition, if herbicides are applied in areas where they may indirectly enter the water, coverage under an applicable National Pollutant Discharge Elimination System (NPDES) permit is required.

Permits are covered in SEC V of this IPM Plan. Please refer to the Washington State Department of Ecology website for more information on permits and for other legal requirements necessary to apply aquatic herbicides in Washington State.

[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)

Hairy willow-herb herbicide plots and trials were started in Whatcom County in 2006. Plants, about 5 foot tall, were treated in mid-July, on dry foliage. The solution was applied with a back pack sprayer. All treatments were mixed with 0.25% DyneAmic surfactant, resulting in an application rate of 76 gallons per acre.

The following results were reported after one year of field tests. The results showed 100% control with all herbicides. (Timothy Miller, PhD, WSU, Mount Vernon).

Glyphosate (Aquamaster) at 5%

Imazapyr (Habitat) at 0.5 and 1%

Imazamox (Clearcast) at 0.5 and 1%

Triclopyr (Garlon 3A) at 1% and 1.5%

Aminopyralid (Milestone) at 0.5% (Milestone not registered for aquatic use in WA)

Several combinations were also tested. All products had DyneAmic included at 0.5%.

Glyphosate + Imazapyr at (3% + 0.5%)

Glyphosate + Imazamox at (3% + 0.5%)

Glyphosate + Triclopyr at (3% + 1%)

Imazapyr + Triclopyr at (0.5% + 1%)

Imazamox + Triclopyr at (0.5% + 1%)

## BIOLOGICAL CONTROL

Biological control is a strategy using an organism (often an insect, mite or pathogen) to control or suppress a specific weed species.

Biological controls are most appropriate for large well established weed infestations, or on sites where immediate weed control is not possible, or on sites where other control options are not feasible. Since it can take 4 to 5 years before there are any visible signs of weed control, this is a tool used for long term control plans. Biological controls are less appropriate for small weed infestations. Biocontrol agents will not eradicate a weed species, and they are not an option for Class A weed control.

Washington State University has an Integrated Weed Control Project (IWCP) that promotes the use of integrated weed management methods, with a focus on biological control. The Director of IWCP manages the biological control program, statewide.

The following website has information on biological controls, and on the safety of introducing biological control agents for *weed control*:

<http://invasives.wsu.edu/biological/index.htm>

There are no known biological controls for hairy willow-herb, and the information below is not provided to suggest that the **moth** (*Mompha epilobiella*) be used as a biocontrol agent. All biocontrol agents undergo thorough testing to be sure they do not attack other species. The accidentally introduced moth has not been through this testing and should not be redistributed for use as a biocontrol agent.

In June, 2005, the moth was collected in a hairy willow-herb population in Island County by Jennifer Andreas, Director of IWCP. *Mompha epilobiella* was collected relatively recently in New York and Quebec (Sinev, 1996), but the 2005 Island County collection is the first record of *M. epilobiella* from the western United States. Since 2005, the moth has been found in four counties in Washington State, all associated with its host plant hairy willow-herb, and the distribution is likely more widespread than originally thought.

Although the adult moths are small and easily overlooked, the damage is readily visible in July and August. If plants are examined, larvae and pupae are noticeable. The majority of the plant damage, caused by the larval stage, was concentrated in auxiliary shoots. Although the damage was noticeable, there were no obvious impacts on individual plant vigor. It is unclear whether *M. epilobiella* affects hairy willow-herb at either the individual plant or population level. It is also unknown whether it attacks native species (Looney et al. 2012).

Photographs of the moth (*Mompha epilobiella*): <http://ukmoths.org.uk/show.php?id=3226>  
Photographs also in Looney et al. 2012 paper.

**In addition to the moth, a blister rust fungus (*Pucciniastrum* sp.)** was observed attacking hairy willow-herb in Klickitat County in 2010. It appeared to reduce plant vigor in spring and early summer, but the plants had recovered fairly well by late summer. The preliminary identification of the fungus was provided by Dr. William Bruckart with USDA ARS.



## REFERENCES, WEB LINKS for Hairy willow-herb

1. Washington State Noxious Weed Control Board, Noxious Weed List  
[http://www.nwcb.wa.gov/nwcb\\_nox.htm](http://www.nwcb.wa.gov/nwcb_nox.htm)
2. Written Findings, Hairy willow-herb, WSNWCB  
[http://www.nwcb.wa.gov/siteFiles/Epilobium\\_hirsutum.pdf](http://www.nwcb.wa.gov/siteFiles/Epilobium_hirsutum.pdf)
3. Washington State Quarantine List:  
<http://www.nwcb.wa.gov/searchResultsQuarantine.asp>  
To download a copy of the quarantine list  
<http://www.nwcb.wa.gov/siteFiles/ProhibitedPlants.pdf>
4. Quarantine Rules, Noxious Weed Control (WAC 16-752-100-715):  
<http://apps.leg.wa.gov/WAC/default.aspx?cite=16-752>
5. WSDA Plant Services Program – contact info for quarantine enforcement  
<http://agr.wa.gov/PlantsInsects/PlantServicesProgram/default.aspx>
6. Pacific Northwest Weed Management Handbook  
<http://pnwhandbooks.org/weed/>
7. Ecology – Aquatic Noxious Weed Control, NPDES General Permit  
[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)
8. Ecology: Pesticides (and Adjuvants) currently allowed for use under Permit  
<http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html>
9. WSDA, Ecology, 2004. IPM Plan for Freshwater Emergent Noxious Weeds and Quarantine Listed Weeds, hairy willow-herb Plant Profile.  
<http://search.usa.gov/search?utf8=%E2%9C%93&affiliate=www.ecy.wa.gov&query=weeds+ipm&x=0&y=0>
10. 2012, King County Noxious Weed Board, Weed of the Month, Hairy willow-herb  
<http://www.kingcounty.gov/environment/animalsAndPlants/noxious-weeds/weed-identification/hairy-willowherb.aspx>
11. King County Noxious Weed Board – Weed Alert flyer.  
<http://your.kingcounty.gov/dnrp/library/water-and-land/weeds/Brochures/Hairy-Willowherb-Fact-Sheet.pdf>
12. Whatcom County, Hairy Willow-herb fact sheet  
[http://www.co.whatcom.wa.us/publicworks/pdf/weeds/aquatic/hairy\\_willow\\_herb.pdf](http://www.co.whatcom.wa.us/publicworks/pdf/weeds/aquatic/hairy_willow_herb.pdf)
13. Looney, Chris, J. Andreas and E. LaGasa. 2012. *Mompha epilobiella* (Momphidae), a European Moth in the Pacific Northwest, with Notes on Associated Parasitoids. *Journal of the Lepidopterists' Society*. 66(4), 2012-233-237.

**IPM Freshwater Emergent Noxious Weeds  
PLANT PROFILE  
KNOTWEEDS (*Polygonum spp*)**

**Japanese knotweed (*Polygonum cuspidatum*)  
Giant knotweed (*P. sachalinense*)  
Himalayan knotweed (*P. polystachyum*)  
Bohemian knotweed (*P. x bohemicum*)**

**Updated January 2013**

**Distribution in Washington State by county**

Bohemian <http://www.nwcb.wa.gov/siteFiles/Knotweed%20Bohemian%202011.pdf>  
Giant <http://www.nwcb.wa.gov/siteFiles/Knotweed%20Giant%202011.pdf>  
Himalayan <http://www.nwcb.wa.gov/siteFiles/Knotweed%20Himalayan%202011.pdf>  
Japanese <http://www.nwcb.wa.gov/siteFiles/Knotweed%20Japanese%202011.pdf>

All four species are listed as Class B noxious weeds in Washington State. There is some dispute about the botanical nomenclature of these four species, but the detrimental effect on native habitat by all of these species remains unchanged. In Europe and the United Kingdom, *P. sachalinense* is synonymous with *Reynoutria sachalinensis* (Seiger 1995). Some taxonomists believe that the correct generic name is *Fallopia*, based on recent morphological and biosystematic evidence (Bailey 1990). Garden ornamentals of these knotweed species are found under all three generic names.

For this Plant Profile, all 4 species will be referred to as knotweeds, unless making a specific point about a specific species.

**Impacts**

Knotweed can invade and thrive in a variety of habitats, and these species pose a significant threat to large swaths of riparian areas in Washington State. Certain riparian areas naturally exhibit poor soil characteristics that inhibit native plant growth. Most native plant species are not well adapted to colonize these landscapes. Knotweed has characteristics that aid in exploiting the poor soils of riparian areas to rapidly colonize a stream or river systems once a population gains a foothold.

Riparian areas are essential to maintaining the water quality of streams and rivers by acting as filters that remove sedimentation and toxins from surface waters before they reach flowing water. These riparian areas include woodlands, vegetation, and floodplains. The high water table in riparian areas creates unique soil conditions that generate plant communities that are distinct from upland habitats. The diversity of water systems in Washington State forms a variety of habitats that support a wide assortment of species.

Riparian areas act as natural migration and dispersion corridors for wildlife. Between 80 to 90% of Washington wildlife utilize riparian areas during some life stage. These areas are important to the migration and fresh water life cycles of anadromous fish native to the northwest. Anadromous fish have evolved to best survive in the conditions created by healthy riparian areas. Today, many riparian areas in Washington State, if not already infested with knotweed species, face wide scale invasion by this species.

Knotweed is an aggressive colonizer that displaces plants and animals historically associated with Washington State riparian areas. Many species of mature shrubs are shaded out by the taller knotweed. Some tree species, such as alder, exhibit smaller populations in areas heavily infested with knotweed. Knotweed colonization poses the threat of decreasing biodiversity and disrupting the food chain by reducing habitat available for species that depend on riparian areas. Several research projects are investigating detrimental effects of knotweed on salmonid species.

Property values may diminish as river views are blocked and river access is limited. Recreational opportunities are threatened with a loss of access to stream banks. Knotweed patches knocked down and trampled during passage contribute to further spread when plants parts break off and sprout from new pieces. Maintenance costs to land-owners may increase when plants are cut and fragments are allowed to float downstream, increasing the spread of knotweed.

### **Plant Characteristics**

In their native lands, knotweed adapted to inhabit the harsh environment on the slopes of volcanoes with very poor soil characteristics. These site characteristics are found in the sand and gravel environments of Pacific Northwest streams. Many native or desirable plant species cannot grow in such harsh conditions, enabling knotweed to grow without competition. In less harsh area of the riparian zone, knotweed's success as a colonizer gives these plants a competitive edge over native plants.

Knotweeds are tall, shrub-like perennials that can grow from seeds, rhizomes or stem pieces. In Washington State, knotweeds colonize both upland and riparian areas. These herbaceous plants have a basal crown root that can produce 30-50 stout bamboo-like shoots that can be 15 feet tall or more, depending on the site, and the species. The hollow shoots may be an inch or more in diameter with swollen nodes three to five inches apart, reddish-brown in color. Leaves are produced on upper stems and on the limited side branching.

Individual plants may be 8 – 15 feet or more in diameter and often occur in large clumps of several hundred square feet to several acres, or they can occupy an entire shoreline. The plants die back after a hard frost, and bare stalks often remain through the winter. Plants start to grow in April or earlier in warm regions, or as late as June in higher elevations. Young knotweed shoots resemble red asparagus.

The leaf size and shape vary by species.



**Japanese knotweed (middle):**

Leaves are a distinctive triangular shape, typically less than 7 inches long, with a blunt or truncated base. There are scattered swollen knobs on the midvein.

**Giant knotweed (left):** This plant is big. The huge, elephant ear shaped leaves are typically 12 inches to 20 inches long. The leaf base is deeply indented and rounded. Multicellular hairs are found on the leaf midvein.

**Bohemian knotweed (not shown):** This hybrid cross between Japanese and giant knotweed has characteristics somewhere between both parent plants. The leaves are an intermediate length, ranging from 7 inches to 12 inches long. Leaves are more oval or egg-shaped rather than triangular. The base of the leaf is slightly indented, or heart shaped – it is neither truncated nor deeply lobed. Short stout hairs are found on the leaf midvein.

**Himalayan knotweed (right):** This species has long, slender, dark green leaves ranging from 4 inches to 8 inches long.

### **Reproduction**

Knotweeds have a range of reproductive mechanisms to invade and establish in riparian areas in this region. New plants can establish from seeds, from broken off stem parts or from any node along the rhizomes. A small, half inch fragment can start a new plant. Tiny white or greenish flowers appear in open sprays near stem ends during July and August. They produce small winged fruit. The tiny seeds are transported by water, short distances by wind, and in attached mud. The seeds of hybrids are considered fertile, unlike Japanese or giant knotweed. Fibrous roots produce a spreading rhizome system, possibly from each major shoot, that can extend 25 to 40 feet or much more. The rhizomes can penetrate more than seven feet into the soil.

## **WEED MANAGEMENT PROJECTS**

1. WSDA serves as a clearinghouse for knotweed control information and assists any group interested in control. WSDA also maintains a database of all known knotweed locations in the state. WSDA works with groups throughout Washington to identify knotweed, develop control projects, and secure grant funding. In order to minimize duplication of efforts by program cooperators, WSDA fulfills state-level environmental review requirements, coordinates Federal Clean Water Act permit compliance, provides public notification and education materials, and publishes required notices.

WSDA has received over \$3 million for knotweed control since 2004. This funding has been critical for our program cooperators to secure additional resources by providing them with state origin matching funds.

With the combination of funds available in 2010, approximately 2,088 acres of knotweed were treated with integrated pest management techniques, and project work occurred in 833 river miles for 1,698 landowners. In 2010, eighteen were submitted. WSDA furnished support to 15 of these projects and to one biological control development project, providing a total of \$428,315 for agreements and contracts.

WSDA will continue to support knotweed control as program funding allows. (Source: 2010 Knotweed Report).

2. **The Olympic Knotweed Working Group (OKWG)** is a loose-knit consortium of governments, tribes, non-profits and private landowners, all working to eliminate invasive knotweed from riparian areas in Clallam and Jefferson Counties and the rest of the Olympic Peninsula. The group has met twice a year since 2005 to share information and to create a strategic plan for knotweed control. Meeting minutes, maps, annual reports are available at the following web site: <http://www.clallam.net/weed/okwg.html>

Clallam County Noxious Weed Control Board (CCNWCB), as the *de facto* group leader, coordinates the meetings and supports the work of other group members. Most partners have sought and received independent grant funding. Knotweed control is taking place in all four Peninsula Counties (Clallam, Jefferson, Mason and Grays Harbor).

2011 Annual Report Summary: Years of treatment have greatly reduced most infestations, many of which are no longer in water and are therefore easier for landowners to control. One focus in 2011 (and 2010), involved getting landowners to monitor and control their sites, as this is the only long-term solution that will work. Public workshops were offered, equipment and supplies were made available to landowners who attended. The State's knotweed program provided funding, leadership and guidance and helped with permitting and technical advice

**Clallam County** - tackled previously untreated streams of concern, focused treatments on the four major west- end rivers (Big, Hoko, Sekiu and Clallam Rivers) where knotweed control is now mandatory. Data was collected for a better baseline, to assess the efficacy of past treatments and assist with future planning.

**Jefferson County** - treated a number of small sites, re-treated the entire Big Quilcene River and surveyed and re-treated the Dosewallips. Jefferson County Noxious Weed Control Board (JCNWCB) worked with (and was funded by) the Quinault Indian Nation, to acquire landowner permissions for knotweed survey and control in the Queets-Clearwater watershed.

**Mason County**—surveyed and treated on the Skokomish River (MCD), and the Union, Tahuya and Dewatto Rivers (HCSEG). The Mason County NWCB specifically worked to develop a landowner control program and on-line resources.

**Grays Harbor County**—a separate CWMA formed in Grays Harbor, to battle knotweed in the Lake Quinault, Queets-Clearwater area. The Quinault Indian Nation (QIN) was active in surveying and treating.

**Data Management/Documentation:**

A contractor was hired to modify, populate, and install a Knotweed Projects Database for Clallam and Jefferson Counties' Noxious Weed Control Boards, and to train staff in its use.

**Summary 2004 - 2011:**

**2004:** Large stands of knotweed in both Clallam Bay and Sekiu and along Highway 112. Many of the infestations were in or close to water (Straits of Juan de Fuca).

**2006:** CCNWCB hired local residents to educate landowners about knotweed and collect permission forms. The Makah Tribe and CCNWCB treated in Sekiu and Clallam Bay.

**2011:** One knotweed site was treated on a bluff overlooking the Start of Juan de Fuca. This was the only obvious knotweed site in the Sekiu—Clallam Bay area, a marked contrast to the huge stands of knotweed previously seen in both towns. The treatments have been very effective. Just as impressive is the fact that many residents are aware of knotweed and are actively looking for it and treating it on their own property. This is the long-term goal.

3. **The 2006 Chehalis River Basin Knotweed Control Project**, managed by The Nature Conservancy, is part of a coordinated control effort for invasive aquatic weeds species in the Chehalis River Watershed. Beginning in 2004, knotweed control was managed on five watersheds within the Chehalis River Basin. A project goal is to survey all sub-basins in the Chehalis Basin, expand an education and outreach program to landowners about the threats of knotweeds to property and habitat, and to control knotweeds in all priority habitats, leading to action on the main stem of the Chehalis River. (Source: Integrated Aquatic Plant Management Plan for the Chehalis River Basin. 2006. Knotweed Weed Management Profile. <http://www.co.thurston.wa.us/tcweeds/documents/ChehalisRiverplan2006.pdf>)

## MANAGEMENT PLANS

As mentioned in Section IV, Integrated Pest Management is a coordinated decision making process using the most appropriate control method, or a combination of those methods and strategies, to control a targeted weed species with the least impact to the environment and with the greatest impact to the weed.

A successful weed management plan takes into consideration the weed species, the location or habitat, and the size of the infestation. Site-appropriate control methods must be used and they need to be monitored or altered as necessary as the site and conditions change.

Listed below are the control methods, or a combination of methods, that may be suitable for site specific control of knotweeds.

## MANAGEMENT AND CONTROL OPTIONS for Knotweeds

### The Quarantine List – Prohibited for Sale

Plant quarantines are a preventative measure to keep noxious weed species from spreading to natural areas and to keep some species not found in the state, out of the state by prohibiting their sale or distribution. WSDA maintains a plant quarantine list, called '*Plants and Seeds Whose Sales are Prohibited in Washington State*'.

The 4 knotweed species are all listed as Class B noxious weeds, and they are all WSDA Quarantined species. It is illegal to transport, buy, sell, offer for sale, or to distribute plant parts of these regulated plants into or within the state of Washington. It is also illegal to distribute seed packets, flower seed blends or 'wildflower mixes' that include these plants. Anyone who violates the quarantine restrictions is subject to a civil penalty of up to \$5,000 per violation. It is further prohibited to intentionally transplant wild plants and/or plant parts of these species within the state of Washington (WAC 16-752-610).

### Prevention, Early Detection, Follow-Up

At this time, the knotweeds are widespread, especially in western Washington. Distribution in eastern Washington is limited, and county weed boards continue to survey. In natural areas where knotweeds are not well established, early detection and prevention is still a control option in many areas.

- Familiarize yourself with plant characteristics and impacts.
- Follow quarantine laws. Do not buy knotweeds, and do not plant these species.
- Notify WSDA Plant Services if plants are offered for sale (web link below).
- Small sites or individual plants can be hand removed in wet soil.
- Remove all plant parts from a wet site. The rhizomes and roots should be thrown in the trash. Do not compost. Stems can be composted if dried out completely first.
- For larger sites, develop a long term Integrated Pest Management Plan.

## MECHANICAL, CULTURAL CONTROL

**Hand Pulling/Hand Digging/Tilling:** Hand pulling knotweed is an option only if the soil is soft, the plants are young, there are only a few plants, and the effort is persistent and ongoing for an extended time period. Once the plants have developed extensive roots and rhizomes they will be impossible to completely remove. Any rhizomes remaining in the soil will produce new plants at each node. All knotweed vegetation must be disposed of so it cannot take root. Even small plant fragments can root if they are in moist soil.

In soft soil or sand, pull the plant up by the root crown, trying to remove as much of the rhizomes as possible. Check for any leftover plants parts, or resprouts at least 25 feet around the original plant location. Three years of consistent effort can be required to eradicate a small patch of plants using this method.

**Cutting:** It is possible to eradicate small patches of knotweed with repeated and persistent cutting of the plants. The patches must be mowed or cut twice a month between April and August and then at monthly intervals until frost. Like pulling/digging this effort will need to be maintained for at least two to three years. Using a hand pruner, lopper, or brushcutter, the stalks should be cut as close to the ground as possible. The regrowth should not be allowed to exceed six inches in height before the stalks are again cut to the ground. The cut stalks need to be stacked where they will dry out and not root (away from moist ground).

**Mowing** is not effective for control, as it can spread plant fragments that can resprout and establish new sites. Mowing can be used in combination with other control methods, and it can be used initially to prep a site for other control methods.

**Burning:** Knotweed is not killed or much impacted by burning. However, burning does remove dense herbaceous litter and opens access to dense stands for other treatments, such as herbicide application or grazing. Burning should be considered only for stands of one half acre or larger and planned carefully relative to surrounding features and improvements.

**Grazing** - Goats will eat most plants down to stems that are too woody for ingestion. Grazing will not eradicate knotweed and the plant will continue to grow once grazing ceases. The animals should be allowed to graze it a second time after sufficient regrowth. This cycle should continue through two consecutive growing seasons at a minimum. This may kill some plants and greatly weaken others, as well as, breakup the dense mat of rhizomes extending out from each plant. Grazing could be followed by herbicide application to kill existing regrowth, before revegetating with suitable native plants.

## CHEMICAL CONTROL

For specific information on herbicides and recommendations for control, please see the [Pacific Northwest Weed Management Handbook](#).

Note: In Washington State, aquatic herbicides are all restricted use. Any person purchasing or applying aquatic herbicides in Washington State is required to have a valid Washington State Applicators License with all applicable endorsements. In addition, if herbicides are applied in areas where they may indirectly enter the water, coverage under an applicable National Pollutant Discharge Elimination System (NPDES) permit is required.

Permits are covered in SEC V of this IPM Plan. Please refer to the Washington State Department of Ecology website for more information on permits and for other legal requirements necessary to apply aquatic herbicides in Washington State.

[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)

Timing for chemical control depends on the plant and the site, and field results indicate June or July is more effective than April or May. Knotweed sites too tall to spray, without risk of drift, can be treated or cut in early spring, making herbicide control more effective later in the growing season.

**Glyphosate:** 2% to 5% solution

Apply as coarse spray with uniform coverage.

Apply when knotweed is actively growing and in bud/early flower stage until frost.

**Imazapyr:** 1% solution with 0.25% surfactant

Apply after seed set until first killing frost.

**Combining control methods** can increase their effectiveness.

- **Cut and Spray** – cut stems followed by foliar spray 3-4 weeks later. Reduces overall herbicides used in the watershed, and is labor efficient.
- **Bend and Spray** – Bend stems, foliar spray the site 3-4 weeks later.
- **Cut and Cover** – Time consuming and moderately effective.
- **Spray and spray** – spring or summer spray, followed by fall foliar spray. This sets the plants back so they can be sprayed at the appropriate growth stage and the easiest height.

(Source: King County Invasive Knotweed BMP)

<http://your.kingcounty.gov/dnrp/library/water-and-land/weeds/BMPs/Knotweed-Control.pdf>

**Skip treatments** - a strategy where treatments are alternated between years. Use at some sites where 3 or more years of treatment had taken place. This option is being examined for use on sites where epinastic re-growth may not provide sufficient surface area or connectivity to underground mass to effectively kill roots, our primary target. If effective, *skip treatments* may also provide a means of stretching funding.

Three methods of herbicide application were considered—*injection*, *foliar* and *wipe*:

1. **Injection**—injecting undiluted herbicide directly into the stem  
Equipment consisted of JK Injection Systems hand injection guns.  
Rate applied was 3-5 mls of 100% solution per cane (no surfactants or dyes added).  
Various aquatic glyphosate formulations, labeled for this method, were used.
  - Crews could chose to inject canes greater than ½ inch in diameter, except on sites where doing **so would exceed the maximum legal herbicide use per acre**.
  - Injected into the lower internode.
  - Used short needles and if we encountered pressure while trying to inject we punched a relief hole in the stem and injected herbicide below the relief hole.
  - Marked injected canes with a spot of paint to prevent treating the same cane twice.
2. **Foliar**—spraying plants that were too small to inject; or where plant density was great enough to exceed allowable rates per acre with injection  
Equipment consisted of low pressure, Solo Backpack Sprayers, 4 gallon capacity  
Rate applied varied, but was generally either a 6% solution of an aquatic glyphosate product, or a 4% solution of an aquatic glyphosate product with 1% of an imazapyr product, either Habitat or Polaris AQ. We also added 1-2% of a surfactant and 0.5% of a marker dye.

3. **Wipe**—applying herbicide to the surface of the leaves and stems with a foam paint brush. Effective when treating small sprouts or when there is a need to be highly selective.  
*Rate a 33% solution with 10% surfactant, by volume, (as allowed by label)*
  - This method was not used in 2011 because it is so labor-intensive.  
(Source: Olympic Knotweed Working Group, 2011 season).

## **BIOLOGICAL CONTROL**

Biological control is a strategy using an organism (often an insect, mite or pathogen) to control or suppress a specific weed species.

Biological controls are most appropriate for large well established weed infestations, or on sites where immediate weed control is not possible, or on sites where other control options are not feasible. Since it can take 4 to 5 years before there are any visible signs of weed control, this is a tool used for long term control plans. Biological controls are less appropriate for small weed infestations. Biocontrol agents will not eradicate a weed species, and they are not an option for Class A weed control.

Washington State University has an Integrated Weed Control Project (IWCP) that promotes the use of integrated weed management methods, with a focus on biological control. The Director of IWCP manages the biological control program, statewide.

The following website has information on biological controls, and on the safety of introducing biological control agents for weed control: <http://invasives.wsu.edu/biological/index.htm>

### **Knotweed Biocontrol Update – October 2012**

The sap-sucking psyllid, *Aphalara itadori*, has been tested and proposed for release for the knotweed complex (Japanese, giant and the hybrid, Bohemian). The petition has been submitted to the Technical Advisory Group (TAG), a scientific group that reviews petitions and makes recommendations to USDA APHIS about whether potential biocontrol agents are safe to release in the U.S. If the TAG recommends the release of *A. itadori*, the petition will proceed to USDA APHIS and go through an extensive review by federal and state agencies and is open to public comment. This entire process can take well over a year.

*Aphalara itadori* is a small insect that feeds on the sap of knotweed, causing the leaves to twist and bind and killing meristem tissue. Under quarantine conditions, the psyllid populations build quickly and can kill knotweed.

Two strains have been proposed for release:

- 1) northern strain
  - a. primarily attacks giant knotweed
  - b. can quickly kill meristem tissue
  - c. because they kill their host plant rapidly, their population density remains low which could negatively impact their long-term success

- 2) southern strain
  - a. attacks both Japanese and Bohemian
  - b. kills meristem tissue more slowly
  - c. insect populations can build to larger numbers which may ultimately lead to better success
- 3) hybridizing the two strains
  - a. preliminary lab work indicates that when the two strains are crossed they can develop on all three knotweeds
  - b. it is unknown whether the crossed strain can impact knotweed as strongly as the individual strains
  - c. more lab work is planned to assess the hybrid's potential effectiveness

Host-specificity tests indicate that *A. itadori* is very host-specific. It can marginally develop on three non-target species, 1) buckwheat (*Fagopyrum* sp.), a minor crop species, 2) *Fallopia cilinodis*, a native eastern U.S. species, and 3) *Muehlenbeckia axillaris*, a minor ornamental species. Although the psyllid can develop on the latter two, it cannot sustain multiple generations. Buckwheat sustained up to three generations of psyllids but at extremely low levels and the insects developed slowly and failed to thrive.

#### **Pre-release knotweed site requirements**

We are currently surveying for potential biocontrol release sites. Long-term monitoring (both pre- and post-release) will be conducted at these sites. In the first year, we will likely focus on four sites (two each in WA and OR). Currently, we likely have a site selected on the Skykomish River but continue to pursue another site, perhaps on the Skagit River or a river with predominantly giant knotweed presence. Site requirements include:

- 1) no treatments in any way for several years (5+ years)
- 2) knotweed infestation should not be too large or too small; the psyllids disperse readily so if the patch is too small they may leave the site entirely, if too large they will be difficult for us to recover in the first few years; sites can be less than an acre in size.
- 3) diversity of knotweed species
- 4) site should be sunny with trees present (possibly with a preference for conifers)
- 5) easy access – so we can visit multiple times/year
- 6) site is preferably fairly flat for ease in monitoring and can be linear

(Information obtained from Dr. Fritzi Grevstad, the knotweed biocontrol researcher from Oregon State University; email: [fritzi.grevstad@science.oregonstate.edu](mailto:fritzi.grevstad@science.oregonstate.edu))

For additional questions, comments or if you believe you might have a site, please contact:

Jennifer Andreas, WSU Extension

[jandreas@wsu.edu](mailto:jandreas@wsu.edu)

253.651.2197

## REFERENCES, WEB LINKS for knotweeds

1. Washington State Noxious Weed Control Board, Noxious Weed List  
[http://www.nwcb.wa.gov/nwcb\\_nox.htm](http://www.nwcb.wa.gov/nwcb_nox.htm)
2. WSNWCB, Class B Noxious weeds. Follow links to all 4 knotweed species  
<http://www.nwcb.wa.gov/searchResults.asp?class=B>
3. Washington State Quarantine List.  
<http://www.nwcb.wa.gov/siteFiles/ProhibitedPlants.pdf>
4. Quarantine Rules, Noxious Weed Control (WAC 16-752-100-715):  
<http://apps.leg.wa.gov/WAC/default.aspx?cite=16-752>
5. WSDA Plant Services Program – contact info for quarantine enforcement  
<http://agr.wa.gov/PlantsInsects/PlantServicesProgram/default.aspx>
6. Pacific Northwest Weed Management Handbook: <http://pnwhandbooks.org/weed/>
7. Ecology – Aquatic Noxious Weed Control, NPDES General Permit  
[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)
8. Ecology: Pesticides (and Adjuvants) currently allowed for use under Permit  
<http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html>
9. WSDA, Ecology, 2004. IPM Plan for Freshwater Emergent Noxious Weeds and Quarantine Listed Weeds, Knotweed Plant Profile.  
<http://search.usa.gov/search?utf8=%E2%9C%93&affiliate=www.ecy.wa.gov&query=weeds+ipm&x=0&y=0>
10. WSDA, Knotweed Eradication – Reports, IPM Plan  
<http://agr.wa.gov/PlantsInsects/Weeds/Knotweed/Knotweed.aspx>
11. WDFW, WSDA. 2006. Integrated Aquatic Plant Management Plan for the Chehalis River Basin. Knotweed Weed Management Profile.  
<http://www.co.thurston.wa.us/tcweeds/documents/ChehalisRiverplan2006.pdf>
12. Olympic Knotweed Working Group: <http://www.clallam.net/weed/okwg.html>
13. OKWG, Annual Report 2011.  
[http://www.clallam.net/weed/documents/2011\\_Knotweed\\_Report.pdf](http://www.clallam.net/weed/documents/2011_Knotweed_Report.pdf)
14. King County – Invasive Knotweed BMP  
<http://your.kingcounty.gov/dnrp/library/water-and-land/weeds/BMPs/Knotweed-Control.pdf>

**IPM Freshwater Emergent Noxious Weeds**  
**PLANT PROFILE**  
**Purple and Wand Loosestrife**  
**(*Lythrum salicaria* and *L. virgatum*)**  
**Updated January 2013**



**Purple loosestrife (*Lythrum salicaria*)**

**Distribution by county in Washington State**

**Purple loosestrife:**

<http://agr.wa.gov/PlantsInsects/Weeds/WeedMapLists/docs/LoosestrifePurple.pdf>

Purple loosestrife is widespread and well-established in Washington. While it is not possible to eradicate this plant from the state, it is possible to control it in some areas and to contain it from spreading any further. Eradication is possible from specific sites such as high quality wetlands or lake shores with very few plants or with newly discovered plants. Purple loosestrife is currently listed as a Class B noxious weed in Washington State. It is also a Quarantined species.

**Impacts**

Purple loosestrife is considered one of the worst noxious weed invaders of wetland habitat, and its impact on various regions of Washington State has been significant. Purple loosestrife is invasive and competitive and unavailing to native wildlife. Seed banks build for years. Mono-specific stands are long-lived in North America as compared to European stands, illustrating the competitive edge loosestrife has over other plant species.

Wetland ecosystems are altered. Purple loosestrife can quickly adapt to environmental changes and expand its range to replace native plants used for ground cover, food or nesting material. Loosestrife stands are dense at the top, and open at the base. The root mass structures create a 3 foot opening in the water, between plants. This provides no cover for nesting ducks. Large

loosestrife infestations are hard to mow and manage. Recreational hunting or trapping grounds are lost, decreasing the land value to those that own or manage operational wetlands. Threatened and endangered species are impacted by monotypic stands of purple loosestrife that replace native vegetation.

Economic impacts are high in agricultural communities when irrigation systems are clogged or when wet pastures are unavailable for grazing. Agriculture is also impacted by a loss of wild meadows, hay meadows and wetland pastures.

### **Plant Characteristics**

Purple loosestrife is a non-native perennial, emergent aquatic weed that grows in shallow, fresh or brackish water in wetlands and along streams, lakes or ditch banks. This species grows in water from about 14” deep to habitat approximately 12” above the water table.

This perennial plant grows from a persistent tap root and spreading root stock. Plant stems can reach 10 feet tall and the crown can be 5 feet wide. Mature plants may have 30 to 50 stems.

Purple loosestrife blooms from June to October, depending on the local climate. Hundreds of showy, magenta flowers are densely clustered on a 4 – 16 inch long, narrow terminal flowering spike. Each individual flower usually has 6 petals (but can have 5 to 7 petals). The flowers mature from the bottom of the flowering spike, to the top. Flowers on the bottom of the cluster mature first, before the flowers on the top. The mature lower flowers may produce seed while the upper flowers are still in bloom on the same flowering spike.

The leaves are alternate, opposite or in whorls of 3. They are 1.5 to 4 inches long, lance shaped to narrowly oblong and covered in fine hairs. Stems are somewhat square, with 4 to 6 sides. The stems are herbaceous and upright, either branched or unbranched. The taproot develops early in the seedling state. When mature, the taproot and major root branches become thick and woody.

The seeds are in capsules. A mature plant can produce 2.7 million thin-walled, flat seeds about the size of ground pepper. The seeds are viable for about three years. Water dispersal is by floating seedlings and by floating un-germinated seeds. Purple loosestrife also spreads vegetatively. Buried stems harbor adventitious buds with the ability to produce shoots or roots. Disturbance to the plant initiates bud growth. Other distribution methods include transport through wetland mud by animals, humans, boats or vehicles. Spread also occurs when seeds are eaten by birds.

Purple loosestrife may be confused with the native spirea (*Spirea douglasii*), or fireweed (*Chamerion angustifolium*, syn. *Epilobium angustifolium*).

## Wand loosestrife (*L. virgatum*)

### Distribution by county in Washington State:

Wand loosestrife: <http://www.nwcb.wa.gov/siteFiles/Loosestrife%20Wand%202011.pdf>

Wand loosestrife is difficult to distinguish from purple loosestrife, however:

- wand loosestrife is not as tall as purple loosestrife.
- stems on mature plants are generally three feet tall.
- leaves are hairless and smooth, opposite (sometimes alternate) and narrower.
- flowers are mostly paired or clustered in leafy, open flower clusters.

All eradication and control methods and management for the smaller wand loosestrife are the same as for purple loosestrife. Wand loosestrife is a Class B noxious weed, and it is a WSDA Quarantined species.

## WEED MANAGEMENT PROJECTS

The Purple Loosestrife Task Force started in 1990. The initial task force research focus was the large infestation of purple loosestrife at the Winchester Wasteway site in Grant County. The Task Force was successful. Over time this task force evolved into a statewide program to control purple loosestrife. Many federal, state and county agencies and research institutions worked together to control or stop the spread of purple loosestrife on a large scale in a natural landscape area. The Task Force invested in biological control research. These biological controls, specifically the *Galerucella* beetles, proved to be very effective for large scale purple loosestrife control. Once established, these beetles were collected from the Winchester Wasteway and widely distributed throughout the state of Washington through the county noxious weed control boards. They were also distributed to other states. Distribution continues on a much smaller scale.

Purple loosestrife is still surveyed, controlled and monitored on a large scale in Washington State, as reported in 2012, The Yakima River Basin Integrated Aquatic Vegetation Management Plan (IAVMP).

## MANAGEMENT PLANS

As mentioned in Section IV, Integrated Pest Management is a coordinated decision making process using the most appropriate control method, or a combination of those methods and strategies, to control a targeted weed species with the least impact to the environment and with the greatest impact to the weed.

A successful weed management plan takes into consideration the weed species, the location or habitat, and the size of the infestation. Site-appropriate control methods must be used and they need to be monitored or altered as necessary as the site and conditions change. Listed below are the control methods, or a combination of methods, that may be suitable for site specific control of purple loosestrife.

## MANAGEMENT AND CONTROL OPTIONS for Purple and Wand Loosestrife

### The Quarantine List – Prohibited for Sale

Plant quarantines are a preventative measure to keep noxious weed species from spreading to natural areas and to keep some species not found in the state, out of the state by prohibiting their sale or distribution. WSDA maintains a plant quarantine list, called ‘*Plants and Seeds Whose Sales are Prohibited in Washington State*’.

Purple loosestrife, and wand loosestrife, are dramatic, showy plants that were often introduced as garden ornamentals. Both species are Class B noxious weeds, control is required by all landowners, and both are WSDA Quarantined weeds.

As a *Lythrum* quarantine species, it is illegal to transport, buy, sell, offer for sale, or to distribute plant parts of *Lythrum salicaria* or *L. virgatum* into or within the state of Washington. It is also illegal to distribute seed packets, flower seed blends or ‘wildflower mixes’ that include these plants. This includes hybrid crosses and named cultivars of *L. salicaria* and *L. virgatum* (WAC 16-752-400). Anyone who violates the quarantine restrictions is subject to a civil penalty of up to \$5,000 per violation. It is further prohibited to intentionally transplant wild plants and/or plant parts of these species within the state of Washington

Links to the Quarantine List, and to WAC 16-752, are at the end of this Plant Profile.

### Prevention, Early Detection, Follow-Up

Purple loosestrife is widespread and well-established in Washington. While it is not possible to eradicate this plant from the state, it is possible to control it in some areas and to contain it from spreading any further. Eradication or control is possible from specific sites such as high quality wetlands or lake shores with very few plants or with newly discovered plants.

- Follow quarantine laws. Do not buy purple or wand loosestrife and do not plant them.
- Notify WSDA Plant Services if plants are offered for sale (website at end of this Profile).
- Familiarize yourself with plant characteristics and impacts.
- Survey, or be aware of this species in its preferred habitat of wet lands and shorelines.
- Flowers are visible from June – October, this is the best time to look or survey.
- For larger sites, develop a long term Integrated Pest Management Plan.

Education and outreach over the years has reached many gardeners, but sometimes purple loosestrife still shows up in gardens (private and public), and sometimes it is found for sale.

## MECHANICAL CONTROL

**Hand pulling** is appropriate for isolated young plants or for the removal of seedlings that may have germinated after other control measures. Purple loosestrife can generally be successfully hand pulled only during the first or second year after establishment. At this stage the plants typically have not developed their full woody root mass. Careful hand pulling can remove most of the roots so that any remaining material should not generate a new plant. Hand pulling is easiest when the water is at or just above the soil surface.

**Covering** plants with a material such as heavy black plastic sheeting or 100 percent shade cloth can help eliminate small patches of purple loosestrife by preventing photosynthesis and producing high undercover temperatures. Covering will also affect any non-target plants that are covered. This technique may be used on small, dense infestations of about ten to twenty feet in size which contain mostly target weeds.

**Cutting:** A single mature purple loosestrife plant can produce over two million seeds per year. Removing the flower spikes can prevent seed production and seed set. Along with the flower spike, previous year's dry seed heads should also be removed because they may still contain seeds. Cutting the stems to the ground also inhibits growth. At sites where plants have already gone to seed, remove all of the flowering spikes first by bending them over a plastic bag and cutting them off into the bag.

Proper disposal is important. Composting is not advised, because purple loosestrife seeds may not be destroyed and the thick, woody stems and roots take a long time to decompose. Clothes and equipment may transport the small seeds to new areas. Thoroughly brush off clothes and equipment before leaving the site.

## CHEMICAL CONTROL

For specific information on herbicides and recommendations for control, please see the [Pacific Northwest Weed Management Handbook](#).

Note: In Washington State, aquatic herbicides are all restricted use. Any person purchasing or applying aquatic herbicides in Washington State is required to have a valid Washington State Applicators License with all applicable endorsements. In addition, if herbicides are applied in areas where they may indirectly enter the water, coverage under an applicable National Pollutant Discharge Elimination System (NPDES) permit is required.

Permits are covered in SEC V of this IPM Plan. Please refer to the Washington State Department of Ecology website for more information on permits and for other legal requirements necessary to apply aquatic herbicides in Washington State.

[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)

**Glyphosate** - labeled for aquatic use is effective for purple loosestrife control in aquatic situations. Best results are obtained when the herbicide is applied when the plants are actively growing at or beyond the bloom stage of growth. Fall treatments must be applied before a killing frost. Application after flowering starts and some seed cases have formed will not prevent development of at least some viable seed. Treating even later in the season will not prevent most current year's seed production. If possible, remove the seed heads from these plants. Glyphosate is not selective and will damage most other plant species. However, there are few non-target plants in a monoculture of purple loosestrife.

**Triclopyr or 2,4-D amine** - As the stands open up and native species return, a selective herbicide such as can be used to target purple loosestrife while having little impact on native broad leaved species. However, if carefully wicked or wiped onto individual plants, glyphosate can be made selective through application techniques.

**Imazapyr** - like glyphosate, is non-selective and systemic. It appears to move rapidly into the rhizomes making it potentially very effective in controlling rhizomatous species

**Triclopyr TEA** - is a selective herbicide that can damage broad leaf herbaceous plants, trees, and shrubs, but should not affect grasses, sedges, rushes, or similar monocotyledon plants. According to label information it can be effective if applied to seedling purple loosestrife plants through full bloom growth stage. For best effect apply from bud to mid-flowering stage of growth. Thorough wetting of the leaves and stems is necessary to achieve good control. As with glyphosate, triclopyr should be applied selectively to target plants to prevent damage to existing desirable competing broad leaf vegetation.

**2,4-D herbicides** are selective chemicals that will damage broad leaf herbaceous plants, trees, and shrubs, but should not affect grasses, sedges, rushes or similar monocotyledon plants. According to The Nature Conservancy, 2,4-D is most effective in controlling first-year seedlings and preventing seed production in mature plants. It does not kill mature plants and it should be applied before flowering in May. However, there are use restrictions on 2,4-D in eastern Washington. Currently only the amine formulation of 2,4-D is approved for use in emergent control of noxious weeds in Washington State.

## BIOLOGICAL CONTROL

Biological control is a strategy using an organism (often an insect, mite or pathogen) to control or suppress a specific weed species.

Biological controls are most appropriate for large well established weed infestations, or on sites where immediate weed control is not possible, or on sites where other control options are not feasible. Since it can take 4 to 5 years before there are any visible signs of weed control, this is a tool used for long term control plans. Biological controls are less appropriate for small weed infestations. Biocontrol agents will not eradicate a weed species, and they are not an option for Class A weed control.

Washington State University has an Integrated Weed Control Project (IWCP) that promotes the use of integrated weed management methods, with a focus on biological control. The Director of IWCP manages the biological control program, statewide.

The following website has information and pictures on biological controls, and on the safety of introducing biological control agents for control. <http://invasives.wsu.edu/biological/index.htm>

**In 1992 three beetles were released in Washington.** Their damaging impact on purple loosestrife populations was evident in the Winchester Wasteway area of Grant County in 1997.

*Galerucella californiensis* and *G. pusilla* - both leaf-feeding chrysomelids. These beetles defoliate, and attack the terminal bud area, drastically reducing seed production. The mortality rate to purple loosestrife seedlings is high. Evidence of *Galerucella* ssp. damage is round holes in the leaves. 4-6 eggs are laid on the stems, axils or leaf underside. The larvae feed constantly on the leaf underside, leaving only the thin cuticle layer on the top of the leaf. By 1996 populations of *Galerucella* ssp. visibly impacted purple loosestrife stands in the Winchester Wasteway.

*Hylobius transversovittatus* - root-mining weevil that also eats leaves. This beetle eats from the leaf margins, working inward. The female crawls to the lower 2-3 inches of the stem then bores a hole to the pithy area of the stem, where 1 -3 eggs are laid daily from July to September. Or, the female will dig through the soil to the root, and lay eggs in the soil near the root. The larvae then work their way to the root. *H. transversovittatus* damage is done when xylem and phloem tissue are severed, and the carbohydrate reserves in the root are depleted. Plant size is greatly reduced because of these depleted energy reserves in the root. The larvae evidence is the zig-zag patterns in the root.

Several other biological control agents have been studied for release:

*Nanophyes marmoratus* - a seed eating beetle. Young adults feed on new leaves on shoot tips, later feeding on the flowers and closed flower buds. 60 - 100 eggs are laid in the immature flower bud. Seed production is reduced by 60%. There were two test sites releases in 1996.

*N. brevis* - is another seed beetle that attacks the seed capsules.

## REFERENCES, WEB LINKS for purple loosestrife

1. Washington State Noxious Weed Control Board, Noxious Weed List  
[http://www.nwcb.wa.gov/nwcb\\_nox.htm](http://www.nwcb.wa.gov/nwcb_nox.htm)
2. Written Findings, purple loosestrife, WSNWCB  
[http://www.nwcb.wa.gov/siteFiles/Lythrum\\_salicaria.pdf](http://www.nwcb.wa.gov/siteFiles/Lythrum_salicaria.pdf)
3. Washington State Quarantine List:  
<http://www.nwcb.wa.gov/searchResultsQuarantine.asp>  
To download a copy of the quarantine list  
<http://www.nwcb.wa.gov/siteFiles/ProhibitedPlants.pdf>
4. Quarantine Rules, Noxious Weed Control (WAC 16-752-100-715):  
<http://apps.leg.wa.gov/WAC/default.aspx?cite=16-752>
5. WSDA Plant Services Program – contact info for quarantine enforcement  
<http://agr.wa.gov/PlantsInsects/PlantServicesProgram/default.aspx>
6. Pacific Northwest Weed Management Handbook  
<http://pnwhandbooks.org/weed/>
7. Ecology – Aquatic Noxious Weed Control, NPDES General Permit  
[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)
8. Ecology: Pesticides (and Adjuvants) currently allowed for use under Permit  
<http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html>
9. WSDA, Ecology, 2004. IPM Plan for Freshwater Emergent Noxious Weeds and Quarantine Listed Weeds, *Lythrum* Plant Profile.  
<http://search.usa.gov/search?utf8=%E2%9C%93&affiliate=www.ecy.wa.gov&query=weeds+ipm&x=0&y=0>
10. For further information and additional photographs, please refer to the following websites: USGS, Northern Prairie Wildlife Research Center:  
<http://www.npwrc.usgs.gov/resource/1999/loosstrf/loosstrf.htm>

**IPM Freshwater Emergent Noxious Weeds**  
**PLANT PROFILE**  
**Reed canarygrass (*Phalaris arundinacea*)**  
**Updated January 2013**

**Distribution in Washington State by county**

<http://www.nwcb.wa.gov/siteFiles/Reed%20Canarygrass%202011.pdf>

**Distribution and Impacts**

Reed canarygrass occurs around the world in temperate climates. It grows as a pasture grass in areas with at least 24 inches annual rainfall or irrigation. Farmers often plant it for hay or pasture and it has been used to protect stream or ditch banks from soil erosion. Reed canarygrass readily escapes from cultivation and its very aggressive nature allows invasion into any suitable site with saturated soil or a high water table, not shaded by trees or shrubs.

Reed canarygrass in the Pacific Northwest is a mix of European and mid-west strains although there is some disagreement about whether this species is native to the area (Society for Ecological Restoration 2001)

Reed canarygrass is widely distributed throughout Washington and in some areas is considered a desirable pasture grass. In other areas, it is considered a nuisance, but is not a serious problem. Reed canarygrass interferes with fish passage, causes localized flooding, or outcompetes desirable native wetland species. Reed canarygrass generally causes these problems in western Washington streams, although it can also invade and degrade high quality wetlands and lake shores.

**Plant Characteristics**

Reed canarygrass, a class C noxious weed, is a large, densely-growing, perennial grass reaching three to six feet tall and rising from a sturdy base with extensive fibrous roots and stout rhizomes. The leaves are flat and one to three quarter inches wide and occur to half or more of culm height. The flower heads are compact panicles three to six inches long that gradually open as flowering progresses through June and July. Reed canarygrass produces high number of seeds which often build up as a seed bank. Reproduction occurs by seed and from spreading rhizomes.

Reed canarygrass often produces monoculture stands. When established in most herbaceous plant communities, this tall plant overtops and crowds out other vegetation. It grows in fully saturated or partially/temporarily saturated soils, associated with a high water table, stream or ditch banks, lake or pond shores, and shallow water wetlands. Reed canarygrass can tolerate temporary and extended flooding, but does not usually start growing in standing water. It may often be found along ditches, roadsides, dikes, wetlands, and other places where saturated soil commonly occurs. Once established, reed canarygrass can creep out into open water, partly floating. This tangle of roots, stems, and

leaves can interfere with water flow in a ditch or stream and through silt collection, actually reduce waterway volume. This grass is palatable to livestock in spring and early summer.

## MANAGEMENT PLANS

As mentioned in Section IV, Integrated Pest Management is a coordinated decision making process using the most appropriate control method, or a combination of those methods and strategies, to control a targeted weed species with the least impact to the environment and with the greatest impact to the weed.

A successful weed management plan takes into consideration the weed species, the location or habitat, and the size of the infestation. Site-appropriate control methods must be used and they need to be monitored or altered as necessary as the site and conditions change.

Listed below are the control methods, or a combination of methods, that may be suitable for site specific control of reed canarygrass. It is important to select control methods that are appropriate to the site because some control methods may do more damage to the site than the weed itself.

## MANAGEMENT AND CONTROL OPTIONS for reed canarygrass

### Prevention, Early Detection, Follow-Up

Landowners, especially in western Washington, should avoid deliberately planting reed canarygrass. However this species is a very wide-spread and aggressive weed that has invaded many suitable sites without human intervention. Inventory and survey critical habitat areas at least once a year to detect initial infestations in weed free areas. Immediate control actions are the most effective and the least costly.

- Familiarize yourself with plant characteristics and impacts.
- For larger sites, develop a long term Integrated Pest Management Plan.

## MECHANICAL CONTROL

**Hand pulling** - is suitable only if the plants are immature. Mature plants cannot be effectively hand pulled because they have developed extensive rhizomes that are difficult to completely remove. When these underground stems are broken or damaged they can produce a new plant at each node. In an area without reed canarygrass or at the edges of an expanding stand, seedlings can be pulled before rhizomes form if care is taken to get most of the root. The best time to hand pull reed canarygrass is in mid-spring when the plants develop secondary leaves and become tough enough to stay connected to their roots during pulling. Once rhizome formation begins, hand pulling will not reduce weed numbers.

**Covering (solarization):** Small infestations of reed canarygrass (10 to 20 feet across) can be covered with opaque material to prevent photosynthesis and to produce high under-cover

temperatures. Covering can be done with any opaque fabric that eliminates all light (heavy-duty black plastic sheeting or 100 percent shade cloth works well). This material should be installed in early spring before the plants have produced much top growth. Cut the plants before laying the material over the weeds and secure the edges with rocks or wood. Use at least two layers because wind, sun, or other disturbances can cause tearing of the top sheet. If the fabric is torn or dislodged, the plants may recover.

Once installed, with the edges sealed, the cover must be left in place for at least one full growing season. Periodically check to see if the plants have died. Covering is best used for monoculture infestations because all plants, including desirable natives will also be killed or damaged.

**Shading:** Reed canarygrass needs full sun to flourish so increasing shade from woody plants will help prevent its establishment or will retard its vigorous growth. Plant the appropriate native riparian trees and shrubs along stream and river corridors, lake shores, and in suitable wetland sites. However, it can be difficult to establish new plantings in areas where beavers are found. It may be necessary to protect new plantings from animal damage until they become fully established.

**Mowing:** According to literature produced by The Nature Conservancy, mowing or cutting by itself does not kill perennial grasses unless it is repeated 5-8 times per year for several years in a row. Occasional mowing (once or twice a year) will generally increase shoot density in perennial grasses. Close mowing or clipping can be used to prevent seed production for that year and can also be used as pre-treatment prior to herbicide application. Because reed canarygrass is a tough, densely-growing plant, mowing must be done with a tractor and heavy mower. Mowing should be done just as the seed heads are forming. At this growth stage the plant has allocated maximum resources into vegetative growth and the beginnings of seed production. Mow the plants as short as practical. This will cause the plants to start leaf and culm growth again, greatly weakening their vigor. To be most effective, mow each time the plant growth reaches early seed head development stage. This control method can be an effective part of a well-planned IPM program, when followed by herbicide application, water level control, burning, or other complementary control techniques.

## CULTURAL CONTROL

**Water Level Management** - is only effective if the water levels can be raised several feet for an entire growing season or longer. Reed canarygrass has a high level of tolerance for flooding and also temporary drought caused by decreased water levels. However, mature plants which are tall enough to emerge above the water level will be unaffected. Flooding works better to control seedlings. Lowering the water level may be even less effective unless the site can be entirely dried up for an equal length of time. The ground water height must be lowered below the rooting depth of at least 24 inches to have much effect on this grass. Either water level regime will have a negative effect on desirable competing vegetation that may exist on the site. Therefore, this technique has potential only in areas completely dominated by dense reed canarygrass monocultures where water level controls are available.

**Site Modification:** Site modification is suitable for constructed wetlands or already highly modified sites where permits can be obtained. Heavy machinery is used to change the site by deepening the water and leaving steep banks or shoreline. The changed site contours eliminates reed canarygrass habitat (and other native wetland species habitat too) except for narrow areas along the shoreline. Site modification is not a suitable method for high quality wetland habitats. Site modification will cost at least several hundred dollars per acre, but should result in long term control. It will be necessary to revegetate the site after excavation is completed and the establishment of desirable native plants will provide competition for new weed invasions. However, monitoring must continue and be combined with rapid control action, when new weeds are identified. These activities will help protect the site from potential rapid reed canarygrass reestablishment.

**Burning** - is most effectively used to reduce the large amounts of vegetation produced by reed canarygrass each year. Spring burning generally does not kill reed canarygrass, but removing the dried vegetation does allow more access to the site for follow-up management and monitoring. Eliminating litter and opening the site to new weed growth may also improve the effectiveness of herbicides or make the new growth more available for grazing. Burning is best used for large monoculture stands that have existed for at least several years. If burning can be done in early flower formation stage or in the fall this technique will kill some plants and open dense infestations. However, burning may also increase the size, vigor, and density of reed canarygrass. Although not highly effective in either killing weed plants or reducing their density, burning can prepare the site for other weed control measures as part of an IPM plan.

**Grazing** - Cattle, sheep, and goats can graze on reed canarygrass from first growth in early spring until the culms start to form in late spring. After this, the leaves and stems of some strains of reed canarygrass can become very coarse and unpalatable. Grazing can be used on open stands of scattered plants to solid, monoculture stands. However, livestock will graze all palatable plants and this may impact desirable species in open reed canarygrass stands. This treatment will be most effective on monoculture stands because these contain almost no other desirable plants. Most removal of new growth will occur if the animals can be fenced into the weed stand, so grazing can be concentrated on the target plant. Grazing animals can reduce the grass to very short stubble. Grazing has similar impacts to mowing and will weaken the plants as they try to produce top growth. Grazing differs from mowing in that it can be used earlier in the season. Animals will continue to graze as long as they are left on the site, although there must be enough forage to support their nutritional needs. Grazing will greatly weaken the weeds ability to re-grow and produce seeds. If grazing can be continued or repeated two or more times through a growing season, from spring to fall, for three to five years, it will greatly reduce stand density. In monoculture stands intensive grazing will eliminate many plants and leave an open stand of scattered plants with many less palatable, but more desirable sedges, rushes, and other plants remaining. If re-vegetation is necessary, seed can be distributed before the last grazing treatment, so the animals can trample the seed in.

Grazing will not remove all existing reed canarygrass plants. However, it can fit well into an IPM plan by weakening weeds for further treatment with herbicides, water level changes, or other treatments. Burning the heavy residual plant litter in the early spring will promote new grass growth and maximize the animals' ability to graze the grass down to nearly soil level.

Complementary control techniques used under an IPM plan can improve overall management effectiveness. Animals grazing in wetlands also contribute nutrients and fecal bacteria to waterways.

**Competitive Planting:** Native grasses and forbs are the best plants to use as competitors to reed canarygrass. Seeds can be collected and raked into the soil after reed canarygrass control efforts. Planting appropriate native trees or shrubs can help shade the area, reducing habitat for this sun loving species.

## CHEMICAL CONTROL

For specific information on herbicides and recommendations for control, please see the [Pacific Northwest Weed Management Handbook](#).

Note: In Washington State, aquatic herbicides are all restricted use. Any person purchasing or applying aquatic herbicides in Washington State is required to have a valid Washington State Applicators License with all applicable endorsements. In addition, if herbicides are applied in areas where they may indirectly enter the water, coverage under an applicable National Pollutant Discharge Elimination System (NPDES) permit is required.

Permits are covered in SEC V of this IPM Plan. Please refer to the Washington State Department of Ecology website for more information on permits and for other legal requirements necessary to apply aquatic herbicides in Washington State.

[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)

**Glyphosate** - can be applied any time growth occurs, from spring to early fall. However, treatment is most effective when glyphosate is applied just at flower formation or in the fall from mid-September to the first frost. Using a hand held sprayer or wick applicator will make this non-selective herbicide more selective to the target plants by careful application to individuals in scattered stands. If a monoculture has formed, boom spraying may provide more uniform coverage.

Apply 3-4.5 pints per acre in a broadcast spray or as a  $\frac{3}{4}$  percent solution when using hand held equipment, but always check the label for the most up-to-date information. If desirable vegetation is growing as an under story in a reed canarygrass stand, the herbicide may be applied with a wick applicator set at an elevation that applies the chemical to the target weeds but not on the shorter desirable plants. Because of its dense growth form and extensive rhizomes, more than one herbicide application may be necessary to get a satisfactory kill. The Nature Conservancy reports that small, isolated patches can be killed with only one application of glyphosate, but that large infestations will require two to three applications to be fully effective.

**Imazapyr** – also a non-selective herbicide. The label recommends using 3-4 pints per acre on actively growing reed canarygrass plants.

## BIOLOGICAL CONTROL

Biological control is a strategy using an organism (often an insect, mite or pathogen) to control or suppress a specific weed species. Biological controls are most appropriate for large well established weed infestations, or on sites where immediate weed control is not possible, or on sites where other control options are not feasible. Since it can take 4 to 5 years before there are any visible signs of weed control, this is a tool used for long term control plans. Biological controls are less appropriate for small weed infestations. Biocontrol agents will not eradicate a weed species, and they are not an option for Class A weed control.

Washington State University has an Integrated Weed Control Project (IWCP) that promotes the use of integrated weed management methods, with a focus on biological control. The Director of IWCP manages the biological control program, statewide. The following website has information on biological controls, and on the safety of introducing biological control agents for weed control: <http://invasives.wsu.edu/biological/index.htm>

There are **no biological controls** because reed canarygrass has economic value for pastures, hay, and erosion control under some conditions. Biological control has not been studied and no insects are approved for Washington release.

## REFERENCES, WEB LINKS for reed canarygrass

24. Washington State Noxious Weed Control Board, Noxious Weed List  
[http://www.nwcb.wa.gov/nwcb\\_nox.htm](http://www.nwcb.wa.gov/nwcb_nox.htm)
25. WSNWCB, fact sheet, Written Findings, reed canarygrass,  
<http://www.nwcb.wa.gov/detail.asp?weed=100>
26. Pacific Northwest Weed Management Handbook  
<http://pnwhandbooks.org/weed/>
27. Ecology – Aquatic Noxious Weed Control, NPDES General Permit  
[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)
28. Ecology: Pesticides (and Adjuvants) currently allowed for use under Permit  
<http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html>
29. WSDA, Ecology, 2004. IPM Plan for Freshwater Emergent Noxious Weeds and Quarantine Listed Weeds, reed canarygrass Plant Profile.  
<http://search.usa.gov/search?utf8=%E2%9C%93&affiliate=www.ecy.wa.gov&query=weeds+ipm&x=0&y=0>

**IPM Freshwater Emergent Noxious Weeds**  
**PLANT PROFILE**  
**Saltcedar (*Tamarix ramosissima*)**  
**Updated January 2013**

**Distribution in Washington State by county**

<http://www.nwcb.wa.gov/siteFiles/Saltcedar%202011.pdf>

**Impacts**

Saltcedar is native to southern Europe, northern Africa, and Asia. It was first brought to the U.S. in 1823 as an ornamental plant, but by 1920 it was becoming a problem along riparian areas in the southwestern states. It now occurs in most western states where it dominates suitable sites.

Saltcedar has an ability to exude salt solution from its leaves that raises the soil salt content around each plant. Saltcedar requires high water consumption that can lower the water table in arid lands. Saltcedar produces an extreme amount of tiny seeds that disperse by wind or water. Saltcedar seeds may sprout within 24 hours of wetting. The ability to alter sites (with salt exudates) and high seed production allow this plant to eliminate most competing desirable herbaceous and woody species.

Compared to native riparian vegetation, saltcedar has very little wildlife value. Its tiny seeds have low nutrient content and are not an attractive food source for birds. Its open growth form provides little cover or structure for birds or other wildlife. The monoculture stands eliminate most understory vegetation, further eliminating habitat diversity within infestations.

<p>Saltcedar uses an excessive amount of water. A mature saltcedar plant consumes as much as 800 liters of water per day. 10 to 20 times the amount used by the native species it tends to replace. --Cooperrider 1995.</p>
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**Plant Characteristics**

Saltcedar grows as a perennial, deciduous, tall shrub or small tree with many ascending branches from its base. Mature plants vary in height from five to twenty feet or more. These trees can produce a taproot that can be more than 20 feet long, depending on site conditions.

Saltcedar leaves are small scale-like bracts, and the flowers appear in cylindrical clusters of small pink or white blooms that appear to hang from the branches. Saltcedar has a gray-green coloration and with its narrow branches and minimal leaf surface area, it is often difficult to see when mixed with other vegetation, particularly as seedlings or young plants.

Saltcedar is a phreatophyte – a deep-rooted plant that occurs along rivers or other wet sites and obtains its water from the water table. Saltcedar is often found in seasonally saturated soils. Plants typically occur on banks of streams or ditches; lake, pond and wetland shores or in areas with high water tables.

The genus *Tamarix* has many species, and they are difficult to identify. Distinguishing characteristics are extremely variable, with some hybridization occurring in the field.

Some scientists recognize many species, and others will group them all under two or three species names. In Washington, experts have identified aggressively spreading plants as *Tamarix ramosissima*. Another species, *T. parviflora*, was identified as being capable of spreading to natural areas in Washington. *T. parviflora* has proven to be a significant problem in other states.

### **Reproduction**

Saltcedar reproduces from seeds, root sprouting, and broken off branches or stems that land on moist sites. An extremely high production of tiny seeds are able to disperse by wind or water. Saltcedar seeds may sprout within 24 hours of wetting.

## **WEED MANAGEMENT PROJECTS**

A Saltcedar Task Force formed in 1994, with a focus on the Central Basin area of Washington, including White Bluffs and wildland areas. Saltcedar distribution is somewhat limited in Washington, with about 800 acres in arid natural lands in eastern Washington as of 2008. At that time it was estimated that a potential 75,000 acres were at risk of saltcedar spread. USFWL identified 10 areas, each with its own control strategy. One site was destroyed by a fire in 2007, impacting or destroying biological control release areas and insectories. The biological release program planned to continue as one control option. Long range control plans included continuing to survey and eradicating outliers to contain the spread.

## **MANAGEMENT PLANS**

As mentioned in Section IV, Integrated Pest Management is a coordinated decision making process using the most appropriate control method, or a combination of those methods and strategies, to control a targeted weed species with the least impact to the environment and with the greatest impact to the weed.

A successful weed management plan takes into consideration the weed species, the location or habitat, and the size of the infestation. Site-appropriate control methods must be used and they need to be monitored or altered as necessary as the site and conditions change.

Listed below are the control methods, or a combination of methods, that may be suitable for site specific control of saltcedar.

## MANAGEMENT AND CONTROL OPTIONS for Saltcedar

### **The Quarantine List – Prohibited for Sale**

Plant quarantines are a preventative measure to keep noxious weed species from spreading to natural areas and to keep some species not found in the state, out of the state by prohibiting their sale or distribution. WSDA maintains a plant quarantine list, called '*Plants and Seeds Whose Sales are Prohibited in Washington State*'.

Saltcedar can still be found for sale as a garden ornamental. However, it is a Class B noxious weed and a WSDA Quarantine species.

It is illegal to transport, buy, sell, offer for sale, or to distribute plant parts of these regulated plants into or within the state of Washington. It is also illegal to distribute seed packets, flower seed blends or 'wildflower mixes' that include these plants. Anyone who violates the quarantine restrictions is subject to a civil penalty of up to \$5,000 per violation. It is further prohibited to intentionally transplant wild plants and/or plant parts of these species within the state of Washington (WAC 16-752-505).

Links to the Quarantine List, and to WAC 16-752, are at the end of the Plant Profile.

### **Prevention, Early Detection, Follow-Up**

Saltcedar was introduced as a wind block for homesteads in arid lands throughout the western states, where it escaped cultivation and is widely established in riparian areas throughout western states. At this time, saltcedar has a somewhat limited distribution in Washington State. In natural areas where it is not well established, early detection and prevention is still a control option.

- Familiarize yourself with plant characteristics and impacts.
- Follow quarantine laws. Do not buy saltcedar and do not plant this species.
- Notify WSDA Plant Services if plants are offered for sale (web link below).
- For larger sites, develop a long term Integrated Pest Management Plan.

## MECHANICAL CONTROL

**Plowing** - Using a heavy tractor and special plows that hook the roots and drag the entire plant out of the ground can be effective in stands with mature plants. All vegetation, including roots and broken off stems, must be removed and placed in a dry environment. This prevents new plants starting from stems or roots landing on moist ground. The use of heavy equipment can be very expensive and result in much site disturbance. Also, this equipment will not remove all seedlings and scattered young plants. Re-vegetation is required after pulling out large numbers of saltcedar trees.

**Root Plowing** - has been successful in managing saltcedar infestations. If properly performed, root plowing can achieve 90 percent control of saltcedar stands. The root plow must be set 12 to

18 inches below the soil surface to ensure cutting below the root crown of saltcedar. If the root crown is removed the plant will not be able to sprout again and form new plants. For root plowing to be effective, the aboveground vegetation should be piled and burned to prevent resprouting of shoots. Root plowing during hot and dry weather can also increase the effectiveness of this control method. Modified root plows which inject herbicides below the soil surface can increase saltcedar control by as much as 45 percent without injuring many of the cover grasses and other shallow rooting plants.

**Hand Pulling** – is effective on saltcedar plants up to two years old. Hand pulling is not effective for older/larger plants because they are extremely hard to pull and if the taproot is not fully removed, the plant may regrow. Hand pulling efforts need to be repeated for at least three or four years to assure complete removal of newly-germinated seedlings. Because of their color and spindly growth form, young plants are hard to see and therefore easy to miss. The site should be revisited often.

**Mowing** - is only feasible for small plants and seedlings because mature plants (shrubs and trees) have large woody stems. Mowing does not kill saltcedar plants as they resprout from the root crown. However, repeated mowing does weaken the plants over time. By removing much of the large aboveground biomass, re-growth is much easier to access for treatment with herbicides.

(The manual control strategies source: WSDA, Ecology, 2004. IPM Plan for Freshwater Emergent Noxious Weeds and Quarantine Listed Weeds, Saltcedar Plant Profile.)

## CULTURAL CONTROL

**Water Level Management** - If water levels can be controlled at the saltcedar site, flooding may be an effective control. Water levels must be raised so the roots are underwater and then maintained in this condition for at least 24 to 36 months. Grub et al. reported that submergence for 28 months provided 99 percent control of saltcedar where plants were inundated for one entire growing season, and over half of the next two growing seasons. They also reported that dropping the water table along the Gila River in Arizona reduced saltcedar stands.

**Burning** - Dense monoculture stands of saltcedar can be effective, although the plants will resprout from root crowns. However, like mowing, it will provide access to new growth, which could then be more effectively treated with herbicides. Burning has the advantage that the aboveground stems do not need to be removed from the site.

**Re-vegetation** – may be necessary when control methods cause site disturbance requiring reestablishment of desirable and native plants. Establishing woody plants that shade the ground will give the best chance to keep saltcedar from reinvading the site.

Re-vegetation may require tilling the surface layer and planting extremely salt tolerant species like saltgrass (*Distichlis stricta*) and tall wheatgrass (*Elytrigia spicata*). Once the soil salinity has diminished, plants such as willow (*Salix* spp.), cottonwood (*Populus trichocarpa*), and other riparian trees and shrubs can be planted.

Native plants like willow (*Salix* spp.), cottonwood (*Populus trichocarpa*), hawthorn (*Crataegus douglasii*), chokecherry (*Prunus virginiana* or *P. emarginata*), and dogwood (*Cornus*

*stolonifera*) may be suitable revegetation species. Willow, cottonwood, and dogwood can be started from live stem cuttings as long as the cuttings contain at least several nodes or growth points. These cuttings are buried in the soil. Hawthorn and chokecherry can be established by planting bare rootstock or container grown plants. These plants take about five years to attain a sufficient size.

If dense, mature stands of saltcedar are removed, the soil may be too salty to support desirable woody species. At least some of the salt accumulation may need to be leached away before trying to revegetate an area. If the salt cannot be removed, planting tall wheatgrass (*Elytrigia elongata*), a large, very salt/alkali tolerant grass, may help modify the site. This may allow a natural invasion of desirable woody species or it may allow planting as outlined above.

(The cultural control strategies source: WSDA, Ecology, 2004. IPM Plan for Freshwater Emergent Noxious Weeds and Quarantine Listed Weeds, Saltcedar Plant Profile.)

## CHEMICAL CONTROL

For specific information on herbicides and recommendations for control, please see the [Pacific Northwest Weed Management Handbook](#).

Note: In Washington State, aquatic herbicides are all restricted use. Any person purchasing or applying aquatic herbicides in Washington State is required to have a valid Washington State Applicators License with all applicable endorsements. In addition, if herbicides are applied in areas where they may indirectly enter the water, coverage under an applicable National Pollutant Discharge Elimination System (NPDES) permit is required.

Permits are covered in SEC V of this IPM Plan. Please refer to the Washington State Department of Ecology website for more information on permits and for other legal requirements necessary to apply aquatic herbicides in Washington State.

[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)

Imazapyr, triclopyr, and glyphosate are effective for saltcedar control.

**Foliar Application:** Imazapyr, or a mixture of imazapyr and glyphosate, used as a foliar application in late summer or fall should result in 90% or more kill on mature plants and seedlings. Once treated, the plants should not be disturbed for two years to give the herbicide a chance to translocate through both the top foliage and the roots. If these treatments fail to show major plant impact after one year, or if skipped spots appear, re-treatment may be required at the end of one year.

Foliar applications may also kill any existing understory species. In mature saltcedar stands, soil salt accumulation probably excludes most herbaceous species, but saltgrass (*Distichlis stricta*) may be able to survive in these saline conditions.

**Cut Stump Application** - the plant is cut as close to the ground as possible using a chainsaw (for large trees) or loppers (for shrubs). The cut stump is then immediately (within 15 minutes) sprayed with diluted triclopyr to prevent vigorous resprouting. (From: Inyo County Saltcedar Control Program (<http://www.inyowater.org/Saltcedar/Default.htm>). This should result in 90% or greater kill. This treatment is most effective if done in summer or fall. However, cut saltcedar should be removed from the site to avoid resprouting.

**Basal Bark Application** - triclopyr is mixed with special oil that can be applied directly to uncut stem bark. This requires treating the entire stem circumference. For greatest effect, apply on stems three inches in diameter or less in late summer or early fall. It may take up to two years for the herbicide to kill both stems and roots. If these treatments fail to show major plant impact after one year, or if skipped spots appear, re-treatment may be required at the end of one year.

(The chemical control strategies source: WSDA, Ecology, 2004. IPM Plan for Freshwater Emergent Noxious Weeds and Quarantine Listed Weeds, Saltcedar Plant Profile.)

## BIOLOGICAL CONTROL

Biological control is a strategy using an organism (often an insect, mite or pathogen) to control or suppress a specific weed species.

Biological controls are most appropriate for large well established weed infestations, or on sites where immediate weed control is not possible, or on sites where other control options are not feasible. Since it can take 4 to 5 years before there are any visible signs of weed control, this is a tool used for long term control plans. Biological controls are less appropriate for small weed infestations. Biocontrol agents will not eradicate a weed species, and they are not an option for Class A weed control.

Washington State University has an Integrated Weed Control Project (IWCP) that promotes the use of integrated weed management methods, with a focus on biological control. The Director of IWCP manages the biological control program, statewide. The following website has information on biological controls, and on the safety of introducing biological control agents for weed control: <http://invasives.wsu.edu/biological/index.htm>

Releases of the saltcedar leaf beetle (*Diorhabda elongata*) should only be made where saltcedar infestations are large and eradication is not the primary goal. Smaller infestations and satellite plants may be sprayed. The saltcedar leaf beetle removes the leaves, at least partially defoliating the plants. As the plants produce replacement leaves, *Diorhabda* continues to feed depriving the plants of needed nutrients.

## REFERENCES, WEB LINKS for Saltcedar

1. Washington State Noxious Weed Control Board, Noxious Weed List  
[http://www.nwcb.wa.gov/nwcb\\_nox.htm](http://www.nwcb.wa.gov/nwcb_nox.htm)
2. Fact sheet, link to Written Findings, Saltcedar, WSNWCB  
<http://www.nwcb.wa.gov/detail.asp?weed=134>
3. Washington State Quarantine List:  
<http://www.nwcb.wa.gov/searchResultsQuarantine.asp>  
To download a copy of the quarantine list  
<http://www.nwcb.wa.gov/siteFiles/ProhibitedPlants.pdf>
4. Quarantine Rules, Noxious Weed Control (WAC 16-752-100-715):  
<http://apps.leg.wa.gov/WAC/default.aspx?cite=16-752>
5. WSDA Plant Services Program – contact info for quarantine enforcement  
<http://agr.wa.gov/PlantsInsects/PlantServicesProgram/default.aspx>
6. Pacific Northwest Weed Management Handbook  
<http://pnwhandbooks.org/weed/>
7. Ecology – Aquatic Noxious Weed Control, NPDES General Permit  
[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)
8. Ecology: Pesticides (and Adjuvants) currently allowed for use under Permit  
<http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html>
9. WSDA, Ecology, 2004. IPM Plan for Freshwater Emergent Noxious Weeds and Quarantine Listed Weeds, Saltcedar Plant Profile.  
<http://search.usa.gov/search?utf8=%E2%9C%93&affiliate=www.ecy.wa.gov&query=weeds+ipm&x=0&y=0>
10. Invasive Species Council - saltcedar  
<http://www.invasivespecies.wa.gov/priorities/tamarix.shtml>

**IPM Freshwater Emergent Noxious Weeds**  
**PLANT PROFILE**  
**Yellow-flag iris (*Iris pseudocorus*)**  
**Updated, January, 2013**



**Distribution in Washington State by county**

<http://www.nwcb.wa.gov/siteFiles/Yellow%20Flag%20Iris%202011.pdf>

Yellow flag iris is a Class C noxious weed with a widespread distribution throughout Washington State. In many cases yellow flag iris has been deliberately planted as an ornamental species in gardens and in lakes and ponds. This iris is sometimes offered for sale as a garden ornamental. Yellow flag iris is found in wetlands and along shorelines in both eastern and western Washington.

In a 2005 county survey by WSDA, yellow flag iris was known to occur in at least 30 of 39 counties. Thurston and Pend Oreille Counties reported over 1,000 acres of this species. Many counties reported having very few acres of yellow flag iris at that time. These small populations must be controlled before they spread to uninfested areas.

While it is not possible to eradicate yellow flag iris from Washington, there are natural areas without this non-native, invasive noxious weed, and control programs are working to keep this species from spreading. Because of this, early detection and prevention still apply as control options in some areas.

In the Yakima River Basin, yellow flag iris is widespread in most areas, but there are areas where it is not currently present. In Kittitas County yellow flag iris was found to be non-existent along the Yakima River above Ellensburg. A control program is planned for the upper part of the Naches River and small creeks and drains, where there are no known plants at this time. In Benton County yellow flag iris is found in pockets along the Yakima River. (2012 Yakima River Basin IAVMP).

## Impacts

Yellow flag iris is a robust perennial herb that spreads aggressively, and it can get started in areas with fully developed stands of other emergent vegetation. Large, dominant stands of yellow flag iris are commonly found along the wetland shorelines of ponds and streams, and it quickly forms a monoculture in this type of habitat. As long as it is planted in backyard ponds and gardens, yellow flag iris will continue to escape and naturalize into new wild land areas. Once established, yellow flag iris can spread through wetland habitat by seeds or by slowly colonizing the shoreline via rhizomes.



## Plant Characteristics

When flowering, yellow flag is unmistakable with its showy yellow flowers colorfully displayed along the edge of water and in wetlands. In Washington, the flowers occur in late spring or early summer. Several flowers can occur on each stem, along with one or two leafy brackets. The plant, including flower stalk, is 4 to 5 feet tall.

Yellow flag iris is perennial, and will remain green during winter where the weather is mild. When no flowers are present the leaves of yellow flag iris can be mistaken for common cattail, and both plants often share habitat. Yellow flag iris has emergent leaves, 20 to 36 inches long, with a prominent mid-rib. They clasp the stem to form a fan-like base. The leaves are mostly basal, with the shorter leaves toward the outside of the plant. At the base of each plant are thick, stout rhizomes with roots that can extend to 12 inches deep. These rhizomes grow together in a tight cluster, forming a massive root base that can be three to four feet in diameter.

This iris prefers to grow in wet conditions, and it is widely sold in nurseries and on the internet as a popular ornamental for wet areas. However, this species will grow in many soil types since the rhizomes can survive dry habitat, and it is often used in dry flower beds and in roadside gardens. This species tolerates high soil acidity and it can grow in salt marshes. It has often been

planted in wastewater and storm water treatment ponds. It thrives on sites with full sun and in partial shade, and it can survive winter temperatures to well below zero degrees Fahrenheit. Yellow flag iris is toxic. The sap can cause severe blistering or irritation, and if ingested it can cause vomiting and diarrhea. It will sicken livestock if ingested, and is generally avoided by herbivores (although muskrats will eat the rhizomes).

### **Reproduction**

Plants can reproduce from seeds or rhizomes. The seed pods are glossy green capsules, resembling short green bananas when matures. The 7mm seeds are brown and flattened and corky. Seeds germinate along shorelines once the water recedes. Seeds disperse in the water. In 2005, seed pods were collected, with a range of 29 to 67 seeds per capsule. Seed viability tests from that collection indicated 65% viability, with an 82% cold storage viability.

## **WEED MANAGEMENT PROJECTS**

### **Yakima River Basin IAVMP, 2012**

Yakima County: Yellow flag iris is very widespread. However a control plan could be implemented on the upper Naches River and include any small creeks and drains that flow into the Yakima River which would serve to prevent spread from these site into the main stem of the Yakima River.

In other areas along the river, the timing for future yellow flag iris control projects could coincide with purple loosestrife control. However Yakima County prefers to use a different herbicide for purple loosestrife (triclopyr) than is used for yellow flag iris (glyphosate or imazapyr). A long term (5 year+) control plan for yellow flag iris could be implemented in conjunction with the Yakima County invasive knotweed control program.

Kittitas County: yellow flag iris is aggressively controlled on the Yakima River upstream (north) of the confluence of Wilson Creek, at the south end of the Yakima River Canyon. Downstream of Wilson Creek yellow flag iris is well established along both shorelines.

Fio Rito and Mattoon Lakes: Yellow flag iris was the dominant species around the entire shoreline of these lakes when a 2007 Management Plan went into effect. Since then, control efforts were implemented and shoreline plant diversity is much greater now. The long term control plan includes applying spot applications as needed of an aquatic formulation of imazapyr. Plants were checked 1 month after herbicide application, and any that have produced flowers were manually controlled before they set seed. These plants were cut at the base and disposed of in a landfill. Since yellow flag iris grows mainly along the shoreline in wetland areas where rapid re-colonization by native plants should occur after treatment, there should be no need to re-vegetate these sites.

## Research

**2005 Herbicide Screen at Buena Creek, Yakima Co.** (T. Miller, PhD, WSU Cooperative Extension). Yellow flag iris plants were in bud stage at the time of the spring treatment. Few open flowers were present in the infestation at that time, and no open flowers were in the plots. Yellow flag iris seedpods were present on iris plants at the time of the fall treatment, although none had yet shattered seed. Results are in the Chemical Control section of this Plant Profile.

## MANAGEMENT PLANS

As mentioned in Section IV, Integrated Pest Management is a coordinated decision making process using the most appropriate control method, or a combination of those methods and strategies, to control a targeted weed species with the least impact to the environment and with the greatest impact to the weed.

A successful weed management plan takes into consideration the weed species, the location or habitat, and the size of the infestation. Site-appropriate control methods must be used and they need to be monitored or altered as necessary as the site and conditions change.

Listed below are the control methods, or a combination of methods, that may be suitable for site specific control of yellow-flag iris.

### MANAGEMENT AND CONTROL OPTIONS for Yellow-flag iris

#### Prevention, Early Detection, Follow-Up

At this time, yellow-flag iris is widespread in Washington State. However, there are natural areas without this non-native, invasive noxious weed, and control programs are working to keep this species from spreading. Because of this, early detection and prevention still applies as a control option in some areas.

- Familiarize yourself with plant characteristics and impacts.
- Do not buy yellow-flag iris and do not plant this species.
- For plants that need to be removed, clip and remove the seed pods. Remove individual plants, including rhizomes when possible. Yellow-flag iris spreads by seeds and by rhizomes. Wear gloves, the sap is toxic.
- Remove all plants parts, including rhizomes from the site. Do not compost any parts.
- For larger sites, develop a long term Integrated Pest Management Plan.

Yellow flag iris is often planted as a garden ornamental, and there was a statewide effort (2008) to educate landowners and the nursery industry with post cards and educational material about the widespread distribution and the negative impacts of this plant in many wetland habitats.

## MECHANICAL CONTROL

**Hand pulling** - may only be effective for seedlings or immature plants. While it is possible to dig out established plants, it is not practical unless there are just a few mature plants in the waterbody or wetland. Once an infestation has developed beyond this point, other methods of eradication or control should be considered.

Care should be taken when pulling or digging yellow flag iris because the resin in the leaves can cause skin irritation. Immature plants can be hand pulled as long as the leaves stay firmly attached to the roots. Young plants will not have formed bulky rhizomes and pulling should completely remove most roots. Once the plant is firmly established (during the second year and later), it will be nearly impossible to hand pull, and digging is required. Dig out a fairly wide area around the plant so all roots and rhizomes can be removed. Nearly any plant material left in the soil can develop into a new plant.

**Covering (solarization)** is recommended for small patches of Iris that can be completely covered. In all treatments where re-growth was monitored after the covers were removed, seedlings began to sprout, and there was encroachment of plants from the edges.

Use several layers of an opaque material such as very strong black plastic sheeting because this tough plant may penetrate weaker material. Of the different fabrics used, the tarp held up the best. The landscape fabric tended to tear; the clear and black plastics were brittle and disintegrating by the time they were removed.

Cover the plants in the early spring before growth starts after removing all the top vegetation. Completely cover each plant or group of plants with the plastic sheeting, sealing the edges with rocks, heavy boards, or other natural materials. The seal must be complete, blocking all light from entering for at least one to three growing seasons. Because yellow flag iris usually grows at the waters edge, it may be necessary to seal the water side with heavy rocks. (Source: Test plots at Buena Creek, Yakima Co., 2005 by J. Parsons, DOE, cited in 2008 IPM Yellow Flag Iris Plant Profile Update, WSDA).

**Cutting:** Cutting off the seed heads after the plant flowers can help minimize its spread to other areas of the waterbody. Lakeside gardeners will also have to manage the spread of this plant from creeping rhizomes to keep it from taking over their shoreline.

Underwater cutting reduced stem density of yellow flag iris for one year after initial treatment. The plots that were cut in spring before flowering showed the best result.

## CHEMICAL CONTROL

For specific information on herbicides and recommendations for control, please see the [Pacific Northwest Weed Management Handbook](#).

Note: In Washington State, aquatic herbicides are all restricted use. Any person purchasing or applying aquatic herbicides in Washington State is required to have a valid Washington State Applicators License with all applicable endorsements. In addition, if herbicides are applied in areas where they may indirectly enter the water, coverage under an applicable National Pollutant Discharge Elimination System (NPDES) permit is required.

Permits are covered in SEC V of this IPM Plan. A link to Ecology's website is listed at the end of this Plant Profile for more information on permits and for other legal requirements necessary to apply aquatic herbicides in Washington State.

### 2005 Herbicide Screen, Yakima County.

#### Spring treatment summary:

- yellow flag iris generally responded more quickly to glyphosate (Aquamaster®) than to imazapyr (Habitat®).
- After five months control with imazapyr at 1 or 1.5% was generally superior to that of glyphosate at 3 or 5%, as was control from combination treatments.

#### Spring and fall treatment Comparison:

- Fall herbicide applications were slightly more effective than spring treatments.
- 5 to 7 month after treatment, average fall control treatment was 8 percentage points greater than from spring applications (97% and 89%, respectively).
- 12 months after treatment, fall treatments were still providing an average of 93% control, compared to 87% from the average spring treatments. (IPM Yellow Flag Iris Plant Profile, 2008).

Glyphosate and imazapyr labeled for aquatic use may be used anytime plants are actively growing. Glyphosate and imazapyr are non-selective and should be applied with hand held equipment to minimize non-target impacts and water contact.

- Cutting followed by wicking with glyphosate may be the best treatment method in sensitive areas and will also minimize the amount of herbicide needed.
- Because yellow flag iris has large rhizomes, one application of herbicide may not kill mature plants.
- Re-apply the herbicide through mid-fall if the plant is still actively growing and recovery from the initial herbicide application appears likely.
- Final results may not be apparent till the following spring. If the plants are still alive, retreatment may be necessary.
- If care is taken to minimize off target impacts, adjacent desirable vegetation may naturally re-vegetate the site.
- Because yellow flag iris sets seed, at least annual monitoring will be required to find any new plants and rapidly remove them from the site. (Yakima River Basin IAVMP, 2012).

## BIOLOGICAL CONTROL

Biological control is a strategy using an organism (often an insect, mite or pathogen) to control or suppress a specific weed species. Biological controls are most appropriate for large well established weed infestations, or on sites where immediate weed control is not possible, or on sites where other control options are not feasible. Since it can take 4 to 5 years before there are any visible signs of weed control, this is a tool used for long term control plans. Biological controls are less appropriate for small weed infestations. Biocontrol agents will not eradicate a weed species, and they are not an option for Class A weed control.

Washington State University has an Integrated Weed Control Project (IWCP) that promotes the use of integrated weed management methods, with a focus on biological control. The Director of IWCP manages the biological control program, statewide.

The following website has information on biological controls, and on the safety of introducing biological control agents for weed control: <http://invasives.wsu.edu/biological/index.htm>

**No biological control** agents have been researched or released for the control of yellow flag iris. Yellow flag iris and other iris species are cultivated and prized for their flowers in many states, so biological control research for this species is not likely.

## REFERENCES, WEB LINKS for yellow flag iris

1. Washington State Noxious Weed Control Board, Noxious Weed List  
[http://www.nwcb.wa.gov/nwcb\\_nox.htm](http://www.nwcb.wa.gov/nwcb_nox.htm)
2. Written Findings, yellow flag iris, WSNWCB  
[http://www.nwcb.wa.gov/siteFiles/Yellow\\_flag\\_iris.pdf](http://www.nwcb.wa.gov/siteFiles/Yellow_flag_iris.pdf)
3. Pacific Northwest Weed Management Handbook  
<http://pnwhandbooks.org/weed/>
4. Ecology – Aquatic Noxious Weed Control, NPDES General Permit  
[http://www.ecy.wa.gov/programs/wq/pesticides/final\\_pesticide\\_permits/noxious/noxious\\_index.html](http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html)
5. Ecology: Pesticides (and Adjuvants) currently allowed for use under Permit  
<http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html>
6. WSDA, Ecology. 2004 Integrated Pest Management Plan for Freshwater Emergent Noxious and Quarantine Listed Weeds. IPM Plant Profile – yellow flag iris.
7. WSDA, April 2012. Yakima River Basin Integrated Aquatic Vegetative Management Plan. Plant Profile – yellow flag iris.