AQUATIC WEEDS MANAGEMENT FUND
FINAL REPORT

Yellow Flag Iris Control and Education

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TABLE OF CONTENTS


Iris rhizome


Stem counts, King Co. site

Project Summary

- Background

Yellow flag iris (*Iris pseudacorus*) is a Class C noxious weed with a widespread distribution throughout Washington State. This freshwater noxious weed is known to occur in at least 30 of 39 counties. (Distribution is unknown in 7 counties, and it is not present in 2 counties). In many cases yellow flag iris has been deliberately planted along shorelines as an ornamental plant in both eastern and western Washington. It is offered for sale as a garden ornamental.

Yellow flag iris grows in many soil types. It thrives on sites with full sun and in partial shade, and it can survive winter temperatures to well below zero degrees Fahrenheit. Once established, yellow flag iris can spread in wetland habitats by seed or by slowly colonizing the shoreline via rhizomes. It can form monocultures along the shorelines of lakes and ponds, in wetlands and along rocky streams, in water to 25 centimeters deep. Yellow flag iris tolerates high soil acidity and it can grow in salt marshes. This robust perennial herb spreads aggressively and it can get started in fully developed stands of other emergent vegetation.

While it is not possible to eradicate yellow flag iris from Washington, it may be possible to eradicate it from specific sites such as high quality wetlands or lake shores.

Plant description: Yellow flag iris is a perennial herb, with large, showy flowers resembling the common garden iris. Yellow flag iris is the only yellow iris in North America. A mature plant ranges from 3 to 5 feet tall. Long flowering stalks can produce one, or several, flowers per stem. The flowers color ranges from pale to deep yellow and the sepals are often streaked with brown to purple lines. Flowers occur in late spring or early summer. The seed pods are a glossy green capsule, resembling short green bananas when mature. The 7mm seeds are brown and flattened and corky. Yellow flag iris has cattail-like emergent leaves that 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 30 cm deep. These rhizomes grow together in a tight cluster, forming a massive root base that can be three to four feet in diameter. Reproduction can occur from seeds or rhizomes.

The sap can cause severe blistering or irritation, and if ingested it can cause vomiting and diarrhea. Although generally avoided by herbivores, its roots are toxic to cattle, pigs and humans.

For more specific information on yellow flag iris, and pictures, please refer to the following websites:

http://www.nwcb.wa.gov/weed_info/Iris_pseudacorus.html (WA State Weed Board)
http://tncweeds.ucdavis.edu/esadocs/irispseu.html (The Nature Conservancy)

- Project Objective(s)

Unfortunately there is little information available in the literature on effective control techniques. Additionally, little if any educational material is currently available for educating the public and the nursery industry about the threat yellow flag iris presents to the natural resources of Washington State.

To assist in statewide planning for the control of yellow flag iris, the purpose of this project is to research and evaluate control methods on a site-specific basis and to develop educational materials for yellow flag iris.

- Project Overview

Non-chemical control methods were explored and evaluated using various county weed board staff and/or staff from the Washington State Departments of Ecology and Agriculture. The non-herbicide test plots were established near Buena in Central Washington and at a site near Carnation in King County. Jenifer Parsons, Department of Ecology, is the chair of the Yellow Flag Iris Working Group. She designed and summarized the non-herbicide trials.

Dr. Tim Miller of Washington State University conducted herbicide trials.
Herbicide test plots were established near Buena in Central Washington. The proper permits were obtained for the work by WSDA.

Plant Surveys

County distribution information was gathered on yellow flag iris in 2005. At that time, yellow flag was known to occur in at least 30 of 39 counties. The distribution was unknown in 7 counties, and yellow flag iris was reported as not present in 2 counties.

Thurston and Pend Oreille Counties report having over 1,000 acres of this invasive species. Many counties reported that they had very few acres of yellow flag iris at that time. It is imperative that these small populations be controlled before they can spread to uninfested areas.

Specific yellow flag iris locations thru 2004 include the named waterbodies of 142 sites in 25 counties.
(Attached – Iris Locations Thru 2004; County Distribution Map).

Control - Materials, Methods and Summaries

Herbicide Screen – Conducted by Dr. Tim Miller, WSU Cooperative Extension.
Materials and Methods: Yellow flag iris (*Iris pseudacorus*) infesting Buena Creek (Yakima County near milepost 50 of I-90) was treated with various herbicides on May 4 or September 27, 2005. 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. Products tested were glyphosate (Aquamaster at 2.5 and 5%) and imazapyr (Habitat at 1 and 1.5%), and two combination treatments with both products (3% + 0.75% and 2.5% + 1% for Aquamaster and Habitat, respectively). Treatments were applied using a 5-nozzle boom on a CO_2-pressurized backpack sprayer delivering about 35 gallons/acre. All treatments were mixed with 1% (v/v) surfactant (DynAmic). Plots measured 10 by 20 feet and were located on the south bank of the creek.

Yellow flag iris in each plot were visually rated for percent control (100% = dead yellow flag iris plants, 0% = healthy yellow flag iris plants) on June 15, 2005 (6 weeks after spring treatment, WAST), September 27, 2005 (5 months after spring treatment, MAST), May 5, 2006 (12 MAST, 7 months after fall treatment, MAFT), and October 17 (17 MAST, 12 MAFT). The statistical design was a Randomized Complete Block with three replicates. A general linear models procedure was used to analyze the data and Fisher's Protected LSD (P = 0.05) was used to separate the means.

Results.

Spring treatments. Defoliation at 6 WAST was maximized by both rates of Aquamaster alone or by Habitat at the high rate (Table 1). By 5 MAST, control was 98% with Habitat + Aquamaster (2.5% + 1%, respectively), similar to Habitat alone at 1.5%. Habitat at 1 or 1.5% resulted in a similar level of control at that evaluation as Aquamaster at 5% or Aquamaster + Habitat (3 + 0.75%, respectively) (from 88 to 93% control). By 12 MAST, all treatments with Habitat alone or in combination with Aquamaster provided better control (from 90 to 95%) than Aquamaster alone (73 to 78%), a situation that was still evident at the 17 MAST evaluation. Importantly, yellow flag iris plants did not appear to flower following any of these treatments. In summary, yellow flag iris generally responded more quickly to Aquamaster than to Habitat. After about five months, yellow flag iris control with Habitat at 1 or 1.5% was generally superior to that of Aquamaster at 3 or 5%, as was control from combination treatments.

Fall treatments. While there was a statistical difference in yellow flag iris re-growth in the spring, the difference was not of great practical significance (93% control for Aquamaster, 97 and 99% for Habitat at 1 and 1.5%, respectively, and 97 and 99% for the combination treatments) (Table 1). Control by 12 MAFT was still excellent for all treatments except the low rate of Aquamaster, which had fallen to 72%. In summary, yellow flag iris was controlled by all these tested treatments up to seven months following application. Aquamaster at 3%, however, does not appear to provide a full year of control of yellow flag iris.

Comparisons between spring and fall treatments. At comparable times after treatment, it appears that fall herbicide applications were slightly more effective than spring treatments (Table 2). This was particularly true at the 5 to 7 month evaluation, where the average yellow flag iris control provided by fall treatments was 8 percentage points greater than from spring applications (97 and 89%, respectively). By 12 months after treatment, fall treatments were still providing an average of 93% yellow flag iris control, compared to 87% from the average spring treatments.

Table 1. Yellow flag iris (*Iris pseudacorus*) control after treatment with several herbicides.

		Spring treatment (5/4/05)				Fall treatment (9/27/05)	
Treatment[a]	Rate	6/15/05 (6 WAST[b])	9/27/05 (5 MAST[b])	5/5/06 (12 MAST[b])	10/17/06 (17 MAST[b])	5/5/06 (7 MAFT[b])	10/17/06 (12 MAFT[b])
	% product	%	%	%	%	%	%
Aquamaster	2.5	80 ab	82 d	73 b	62 b	93 b	72 b
Aquamaster	5.0	87 a	83 cd	78 b	60 b	93 b	93 a
Habitat	1.0	65 c	88 bcd	90 a	80 ab	99 a	100 a
Habitat	1.5	78 ab	93 ab	90 a	83 ab	99 a	100 a
Aquamaster + Habitat	3.0 + 0.75	72 bc	90 bc	95 a	88 a	97 ab	98 a
Aquamaster + Habitat	2.5 + 1.0	73 bc	98 a	93 a	91 a	99 a	95 a
$LSD_{0.05}$	---	10	8	6	25	6	14

Means within a column followed by the same letter are not statistically different.
[a]All treatments mixed with 1.0% nonionic surfactant, v/v (DynAmic).
[b]WAST = weeks after spring treatment; MAST = months after spring treatment; MAFT = months after fall treatment.

Table 2. Average yellow flag iris (*Iris pseudacorus*) control.

Treatment timing	5 to 7 months after treatment	12 months after treatment
	%	%
Spring	89	87
Fall	97	93

Non-Herbicide Control - Covering – by Jenifer Parsons, Department of Ecology
Yellow flag iris (*Iris pseudacorus*) at Buena Creek near Yakima, Washington was treated by cutting and covering near the area where the herbicide trial took place (discussed above). The covers were put in place in spring 2005 and remained for either one or two growing seasons.

Material and Methods
We tested the effectiveness of covering yellow flag iris with 4 different materials;

- landscape fabric (a spun-bonded polyester fabric),
- tarp (polyethylene plastic),
- black plastic (6 mil thick (152 nm)
- clear plastic.

The plants in the plot areas were cut with a line trimmer then covered in early spring. The covers were anchored along the edges with concrete bricks (figure 1). The dates of treatment, size and number of plots are provided in Table 3.

Figure 1: April 19, 2005 tarp and black plastic in foreground, landscape fabric in background

Table 3: materials used in cover plot treatments

Treatment Date	Material	# plots	Plot size
4-19-2005	Landscape fabric	2	4 x 10 ft
4-19-2005	tarp	1	7.58 x 9.58 ft
4-19-2005	Black plastic	1	10 x 7 ft
5-4-2005	Clear plastic	1	10 x 8 ft

We made periodic observations throughout the summer and fall of 2005. At this site water levels are highest during the summer irrigation season. During this period water flowed over most of the plot areas. In mid-summer the yellow flag iris was growing beneath the landscape fabric and clear plastic, but was not as robust as the surrounding untreated iris (figure 2). The black plastic and tarp allowed for less initial growth beneath them (figure 3).

Figure 2: landscape fabric with iris growing beneath; July 29, 2005.

Figure 3: black plastic rolled back to reveal water, sediment and little iris growth; July 29, 2005.

The covers of all plots except the tarp were removed in January 2006, after 9 months of treatment. It should be noted that all plots except part of the black plastic had been covered by a layer of silt when the water level was high during the summer irrigation months. Thus, the effect of the cover was likely enhanced by the added opacity and weight of the silt. Table 4 summarizes the results. Percent control was estimated by comparing yellow flag iris growth in the plot to the growth immediately surrounding the plots.

Table 4: percent control of different cover materials over time (months after treatment (MAT)).

	% control		
treatment	1-10-06 (9 MAT)	5-5-06 (12 MAT)	3-2-07 (23 MAT)
Landscape fabric	> 90	90	
tarp	>95		100
Black plastic	60	50	
Clear plastic	75	75	

The plot with black plastic was about half covered with silt, the other half being slightly elevated and not below the summer high water. This was where the greatest regrowth occurred, and why the treatment effect was reduced.

The tarp was left in place almost two years, and when it was removed it was covered with a thick layer of sediment. No iris was growing beneath when it was removed (figure 4). Subsequent visits were not made to the site, so this plot was not monitored for regrowth.

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.

In all treatments where regrowth was monitored after the covers were removed, seedlings began to sprout, and there was encroachment of plants from the edges. Therefore, this method is recommended for small patches of Iris that can be completely covered.

Figure 4: roll of sediment removed with the tarp. March 2, 2007.

Non-Herbicide Control - Underwater Cutting, by Jenifer Parsons, Department of Ecology

In April 2006 we initiated a yellow flag iris (*Iris pseudacorus*) control trial testing the effectiveness of underwater cutting. The site selected was a wetland in King County, Washington, northeast of the city of Seattle (Figure 5).

We created 12 plots, each 1 square meter. Three randomly chosen plots were clipped in spring before flowering, three in mid summer before seed drop, three in fall at the start of senescence and three were untreated as the control (Figure 6). For each plot, the number of yellow flag iris stems were counted at project initiation (April 2006), at the time of treatment (April, July or September 2006), and one year after initial treatment (YAIT) (May 2007).

Figure 5: underwater cutting trial site

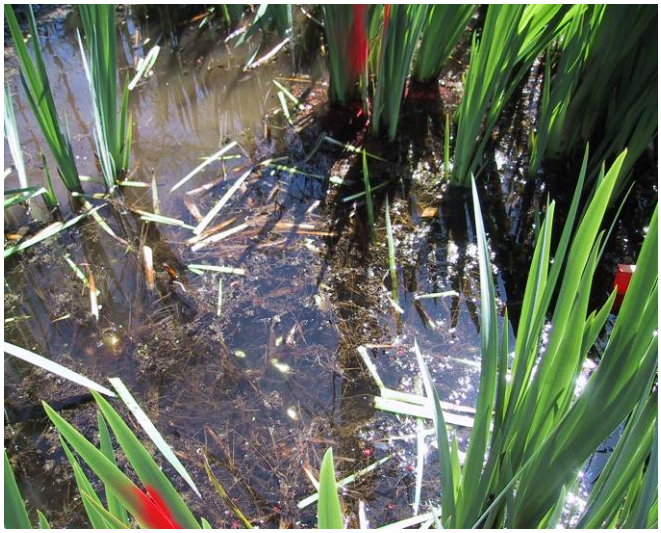

Figure 6: cut plot with surrounding iris.

The data for the 12 plots are presented in Table 5.

Table 5: Yellow flag iris stem count and treatment date data.

		stem count				
Plot #	Date clipped	4/28/2006	7/31/2006	9/29/2006	10/17/2006	5/4/2007
1	4/28/2006	105	12		94	32
2	4/28/2006	61	16		33	29
3	7/31/2006	59	127		47	38
4	control	77			220	94
5	9/29/2006	88		197	0	64
6	7/31/2006	97	130		177	96
7	4/28/2006	89	33		81	48
8	9/29/2006	77		144	0	63
9	control	55			146	86
10	control	75			150	72
11	9/29/2006	49		183	0	45
12	7/31/2006	57	101		39	24

The data were log transformed and analyzed using analysis of variance comparing pretreatment stem counts to one year after initial treatment. The plots that were cut in spring before flower (April) were the only treatment that showed a significant reduction in stem number one year after initial treatment (Table 6). When all of the cut plots were combined (9 total) they were also significantly less one year after treatment compared with before treatment.

Table 6: Yellow flag iris underwater cutting trial results.

	Mean Number of stems		p-value
Treatment	pretreatment	One YAIT	
Cut-spring (4-28-06))	85*	36*	.019
Cut-summer (7-31-06)	71	53	
Cut-fall (9-29-06)	71	57	
Uncut control	69	84	
Mean of all treatment plots combined	76*	49*	.011

*significant reduction in stem count one year after initial treatment (YAIT)

In conclusion, the 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.

It should be noted that all of our plots were surrounded by Iris that was not cut. Since Iris spreads by rhizomes, encroachment into the plots from surrounding untreated plants was evident. In the future, we hope to find small patches where we can cut an entire patch underwater to see if that would kill the plants outright.

Seed Germination Study
Seed capsules (pods) were collected September 29, 2005 by Greg Haubrich, WSDA, to determine how many seeds are produced per capsule and for germination testing. The counts were 67, 30, 57, 29, 36 and 32 seeds per capsule. The capsules varied in size but were representative of the plants at the site. This is somewhat less than the maximum of 120 seeds per capsule that was indicated in some of the literature. These were taken from mature untreated plants. There were a few seeds per capsule that looked as though they had not developed. Several hundred seeds were submitted to the WSDA Seed Lab for germination and viability testing. The initial tetrazolium (TZ) test indicated 65% viability. The germination test following cold storage indicated 82% viability.

Education/Communication Components
30,000 copies of the postcard 'Yellow Flag Iris is a Noxious Weed in Washington State' were produced by Bridget Simon, WSDA. They were printed and distributed to the County Noxious Weed Control Programs, statewide in 2005. There is still a planned mailing to the nursery industry, and WSDA staff is working toward that industry-wide mailing.

The yellow flag iris Profile in the Freshwater Emergent IPM Plan can now be updated to include information from the herbicide and non-herbicide control studies that were accomplished thru this grant. That information will be available via the internet.

Summary
The objectives of this grant were to research and evaluate control methods on a site-specific basis and to develop educational materials for yellow flag iris. A report was required, summarizing those projects. The grant objectives were met. The information gathered will be used to assist land managers in their control of this aggressive and widespread freshwater noxious weed.

Appendix
A. County Distribution Map – yellow flag iris
B. Iris Locations Thru 2004
C. Post Card –Yellow Flag Iris is a Noxious Weed