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# Evaluating Imazapyr in Aquatic Environments

## Searching for Ways to Stem the Tide of Aquatic Weeds

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Weed control in aquatic environments is a difficult proposition. The environments are sensitive, chemical alternatives are few, and the transport and dilution of chemical herbicides in water complicate efficacy and economy. Special concerns apply to fresh water, salt water, and estuaries (an estuary is the point where a freshwater river joins a body of salt water).

## Willapa Bay, Washington

Willapa Bay is a saltwater bay in Washington State that is separated from the Pacific Ocean by the 25-mile Long Beach Peninsula. The area in and around Willapa Bay is both an agricultural area and a natural recreation area. Commodities farmed here include cranberries and shellfish. Recreational activities include typical beach pastimes such as kite flying, camping, and bird watching. The area is home to the Willapa National Wildlife Refuge, 11,200 protected acres of marsh, forest, estuary, beach, and migratory bird habitat.

## Spartina and Parrotfeather

Weed problems in and around the Willapa Bay area include Spartina (*Spartina alterniflora*) and parrotfeather milfoil (*Myriophyllum aquaticum).* While both of these plants can be useful in

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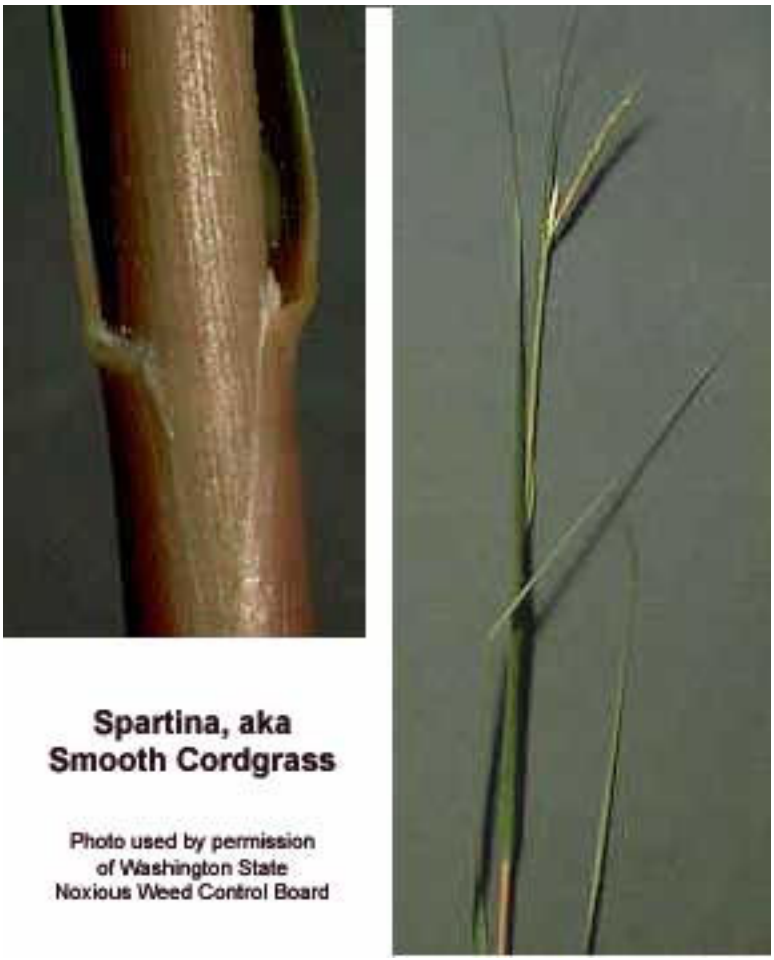
certain environments (Spartina meadows are valuable ecosystems in their native Atlantic and Gulf coasts and parrotfeather milfoil is an attractive aquatic landscaping plant), they are highly invasive and are considered noxious weeds by the Washington State Noxious Weed Control Board (http://www.nwcb.wa.gov/ ).



**Spartina, aka Smooth Cordgrass**

Photo used by permission of Washington State Noxious Weed Control Board

Spartina, also known as smooth cordgrass, is a perennial, deep-rooted saltmarsh grass that has proven to be a problematic invasive species in estuaries throughout the world. Willapa Bay is no exception; we have one of the world's largest infestations here. Spartina is a very difficult plant to control; it re-sprouts each year from a dense, persistent root mass, spreading as a clone through horizontal underground rootstocks known as rhizomes. It also has the ability to disperse longer distances by way of broken root fragments and floating seeds. As rhizomes intermingle, circular patches of the plant grow together to form dense meadows that entrap sediments, physically raising the elevation of the tidelands. Marshes colonized by Spartina have exhibited build-up at rates from less than one inch to over eight inches per year, transforming mudflats into marshes and eliminating much of the upper part of existing tidal flats. Long-term ecological impacts of invasive Spartina marshes include drastic decline in shorebird populations, eelgrass beds, and waterfowl presence.

The other significant weed we are dealing with, parrotfeather milfoil, is also known simply as "parrotfeather." Where Spartina is an emergent (above-the-water) grass and thrives in the salty-freshwater environment of estuaries, parrotfeather is a submersed-emergent freshwater plant. Parrotfeather's emergent (above-the-water) leaves are an inch or two long, bright green, and have the appearance of a feather or a small fir tree. The submersed leaves are shorter, less distinctively green in color, and limp, often appearing to be dying. But appearances are

deceptive, as parrotfeather stems can be very sturdy and healthy. This sturdy stem and the emergent leaves have a tough cuticle that resists penetration by herbicides.

**Parrotfeather Milfoil**
Photo by Bridget Simon, used by permission of the Washington State Department of Ecology

Like Spartina, parrotfeather forms dense mats of vegetation. These can quickly cover the surface of shallow bodies of water, affecting habitat and recreation and even causing flooding. The plant also provides ideal habitat for mosquito, a topical problem given this year's concerns about West Nile Virus.

## Expanding Control Options

Here at Washington State University's Long Beach Research and Extension Unit, we have been working on controls for Spartina for over six years. This research has been supported in part by the Washington State Commission on Pesticide Registration and has been outlined in articles listed at the end of this essay. In 2002, we applied for and received a mini-grant from the U.S. Environmental Protection Agency (EPA) Region 10 enabling us to expand this research to include parrotfeather milfoil. My article in last August's issue of *Agrichemical and Environmental News* discussed our rates of success with various chemical and mechanical strategies against Spartina as well as some of the environmental effects of these strategies. This article will concentrate on our parrotfeather research and the efficacy, fate, and persistence of one particular chemical strategy: imazapyr.

As with Spartina, parrotfeather milfoil control is limited by lack of effective tools. Mechanical control tends to be a poor option for parrotfeather because broken plant fragments spread growth of the plant. Biological control efforts have not been successful because herbivores do not like the tough cuticle or the high-tannin taste of parrotfeather. The only practical chemical control available is glyphosate, which is more of a suppressant than a true control, as it takes several years of repeated application to affect control on parrotfeather. It's hard to employ integrated pest management when you do not have multiple control options to integrate with one another. We turned to imazapyr as a potential control option.

To compare the efficacies of imazapyr and glyphosate, we established 12-foot-by-20-foot test plots in two drainage canal sites in Long Beach, Washington. We applied Arsenal (imazapyr) at 6 pints per acre and Aquamaster (glyphosate, same active ingredient and concentration as Rodeo) at 20 quarts per acre. Each was applied with an adjuvant (Agri-Dex and R-11, respectively). This application rate was employed both at regular volume-to-wet and at high volume-to-wet in two separate areas. We also applied a tank mix of Arsenal at 3 pints per acre

plus Aquamaster at 6 pints per acre plus Agri-Dex. Applications were made on September 20, 2001, and October 1, 2001, and weed control was evaluated the following spring, May 10, 2002.

## Imazapyr: Efficacy

Our initial test results showed that imazapyr provided excellent control of parrotfeather milfoil (Tables 1 and 2). Control was slightly better than glyphosate numerically, though the numbers were not far enough apart to be statistically significant. We plan to conduct additional research in the summer of 2003 to distinguish further between the two chemical treatments.

**TABLE 1**

2001 Applications of Imazapyr (Arsenal) and Glyphosate (Aquamaster) for Control of Parrotfeather Milfoil

| Treatment Name | Rate | % Control May-10-02 |
|---|---|---|
| Control | | 0.0 (b) |
| Arsenal + Agri-Dex | 6 pt/A<br>1% v/v | 86.8 (a) |
| Aquamaster + R-11 | 20 qt/A<br>1% v/v | 81.0 (a) |
| Arsenal + Aquamaster + Agri-Dex | 3 pt/A<br>6 pt/A<br>1% v/v | 74.6 (a) |
| LSD (P=.05) | | 20 |

**Means followed by same letter do not differ significantly (P=.05, Student-Newman-Keuls).**

**TABLE 2**

2001 Applications of Imazapyr (Arsenal) and Glyphosate (Aquamaster) for Control of Parrotfeather Milfoil Using HIGH VOLUME Spray to Wet

| Treatment Name | Rate | % Control May-10-02 |
|---|---|---|
| Control | | 0.0 (b) |
| Arsenal + Agri-Dex | 6 pt/A<br>1% v/v | 90.3 (a) |
| Aquamaster + R-11 | 20 qt/A<br>1% v/v | 80.0 (a) |
| LSD (P=.05) | | 17 |

**Means followed by same letter do not differ significantly (P=.05, Student-Newman-Keuls).**

## Imazapyr: Environmental Effects

Of course, efficacy is only part of the picture when you are dealing with sensitive ecosystems. We have also been conducting experiments on the fate and persistence of imazapyr in aquatic environments.

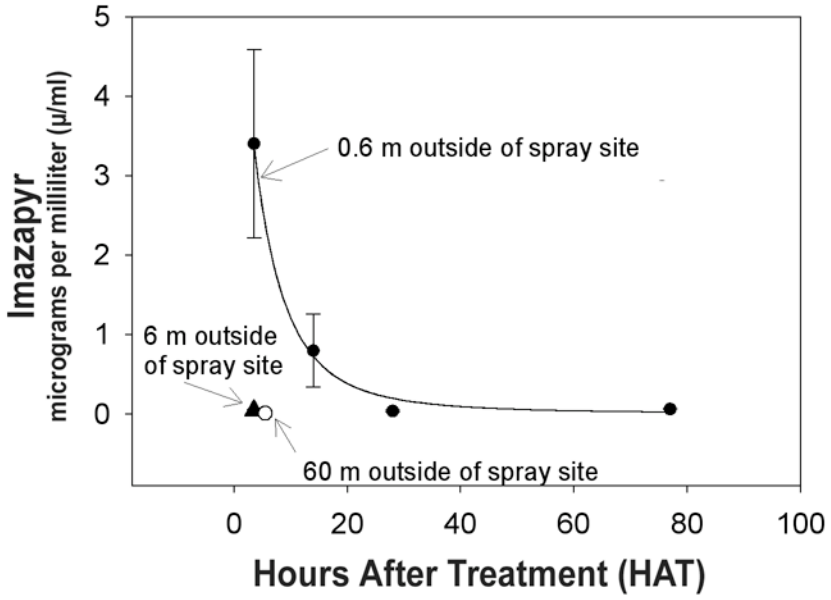
In late August 2001, we applied imazapyr at 1.5 pounds acid equivalent per acre to a plot of bare mudflat approximately 100 feet by 100 feet in the upper intertidal zone of Willapa Bay near the outlet of the Bear River. We made our applications about 1.5 hours after the tide receded from the site. We then collected water samples by burying one-liter jars in the mud so that only a small lip of the sample jar protruded above the surface. Jars were placed 0.3 meters, 6 meters, and 60 meters beyond (above) the upper end of the test plot. When the tide came in, 3.1 hours after treatment (HAT), we waited until the jars filled with incoming tidewater, capped them immediately, and removed the samples. We repeated tidewater collection at the second, third, and seventh tidal sequences at the 0.3-meter location (i.e., 3.5, 14, 28, and 77 HAT). We also collected sediment samples by pressing one-liter sample jars into the mud within the

treatment plot. These we collected one hour after treatment (before the first incoming tide), then after the first, second, sixth, fourteenth, twenty-eighth, and fifty-sixth tidal sequences (i.e., 1, 14, 27, 77, 184, 366, and 703 HAT).

When we analyzed our samples, we found that imazapyr exhibited a rapid rate of decay in both water and sediment after application to estuary mud (Figures 1 and 2). The quantity of imazapyr remaining in the water approached zero by forty hours after application and the quantity remaining in sediment approached zero by four hundred hours following application. Water collected at 6 and 60 meters outside the spray zone at the first incoming tide showed an imazapyr concentration equivalent to water collected at the seventh tide at the immediate edge of the spray zone. When water was removed from the sediment samples taken at the first and twenty-eighth tidal sequences, this interstitial water was found to contain slightly less imazapyr than the sediment itself.

**FIGURE 1**

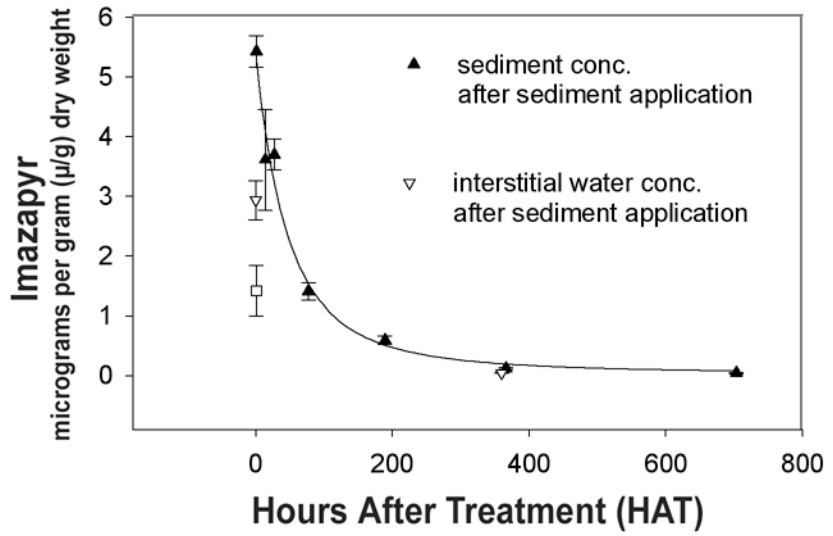
**Persistence of Imazapyr in Willapa Bay Estuary Water**




*continued*

**FIGURE 2**

**Persistence of Imazapyr in Willapa Bay Estuary Sediment**




## Imazapyr: Regulatory Status and Next Steps

Imazapyr shows promise as a control option for the noxious aquatic weeds Spartina and parrotfeather milfoil. Our work with this chemical is timely, as EPA is scheduled to conduct its review of imazapyr for aquatic registration in the third quarter of this year. We are seeking a Special Local Needs (SLN, 24c) registration for Spartina control in estuary use in Washington State in 2004 and a Federal Experiment Use Permit (EUP) to conduct research on 100 acres in Willapa Bay in 2003. Washington State Department of Agriculture has contracted out a supplemental Environmental Impact Statement review for imazapyr, which will be done in June 2003.

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## References

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**Parrotfeather Milfoil in Lake**
Photo by Mark Sytsma, used by permission of the Washington State Department of Ecology

**The work described in this article is just one of many integrated pest management (IPM) efforts underway in Washington State. Several other Washington IPM projects are detailed in the March, April, and May issues of *Agrichemical and Environmental News,* available on the Internet at http://aenews.wsu.edu . For additional information on IPM in Washington State, please consult the following resources:**

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