STATEWIDE KNOTWEED CONTROL PROGRAM

2008 Progress Report

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WSDA
WASHINGTON STATE
DEPARTMENT OF AGRICULTURE

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Cover Photo: Invasive knotweed in the Nisqually River Basin colonizing the understory of a coniferous riparian forest (Pierce County Noxious Weed Control Board)

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Executive Summary

Natives of Asia, the invasive knotweeds targeted by Washington's Statewide Knotweed Control Program include four perennial plant species that are commonly known as Japanese, giant, Bohemian, and Himalayan knotweed. The invasive knotweeds alter riparian vegetation communities, disrupt nutrient cycling, negate riparian restoration efforts, affect the recreational use of watercourses, and decrease property values.

Since 2004, the Washington State Department of Agriculture (WSDA) has provided funding, coordination and other resources to county noxious weed control boards, tribal governments, and other organizations and agencies for the control of invasive knotweed. In 2008, the WSDA Knotweed Control Program budget was $650,000. This allowed WSDA to coordinate control activities, purchase herbicide for control projects, and provide direct funding to both new and continuing projects. In 2008, program cooperators leveraged state funding to bring approximately $640,000 of additional local, non-governmental, and federal funding to these knotweed control projects.

In 2008, project activities occurred in watersheds of 24 counties, including 17 western Washington counties and seven eastern Washington counties. In each project area, surveys were conducted to identify the location of knotweed and the source of the infestation, and treatment methods were selected based on site and infestation characteristics according to integrated pest management (IPM) principles. Application of herbicide was the most common treatment method in 2008.

Approximately 2,607 acres of knotweed were treated in 2008. Project work occurred in 1,073 river miles for 1,988 landowners. At the program's monitoring sites, after four consecutive years of treatment, knotweed populations displayed a 97 percent reduction in stem density and an average visual control estimate of 96 percent. Similar results are being observed at project sites, allowing many native plants to colonize areas where they had previously been displaced by knotweed.

There is evidence that knotweed populations that are not treated in consecutive seasons can return to pretreatment levels. This phenomenon, coupled with the tremendous reproductive capacity of knotweed, reinforces the need to thoroughly re-survey and treat re-growth in project areas on an annual basis for several years. A lack of follow-up treatments will result in the recovery of knotweed populations and the loss of the investments made over past years.

WSDA will continue to support knotweed control as program funding continues to be available. Any reduction in funding would shift the financial burden to local, non-governmental, and tribal governments that are assisting private landowners with their responsibilities under the state's noxious weed control law. A decrease in funding could require the abandonment of projects throughout the state and reduce support for remaining initiatives.

Introduction

This is a progress report for the Statewide Knotweed Control Program carried out by the Washington State Department of Agriculture (WSDA). It describes the program framework, project selection process, budget, survey and treatment methods, and results for calendar year 2008.

The Plants

The invasive knotweed complex is comprised of four herbaceous perennial plant species from the buckwheat family (Polygonaceae) that are native to Asia. They are broadleaf plants that have green stems and swollen, reddish nodes (***Figure 1***). The plants were introduced to the United Kingdom and the United States as garden ornamentals. The four species are commonly referred to as Japanese, giant, Bohemian, and Himalayan knotweed, and are collectively referred to as knotweed in this report.

Figure 1. **The green, bamboo-like stems of invasive knotweed.**

Figure 2. **Leaves of three species of knotweed. From left to right are the leaves of giant, Japanese, and Himalayan knotweed.**

- **Japanese knotweed** (*Polygonum cuspidatum* Sieb. & Zucc.) The leaves of this plant are blunt at the base and sharply tapered at the tip (***Figure 2***). The stems of this plant usually grow to 7 feet tall. Stem diameter ranges from one-half to one inch.

- **Giant knotweed** (*P. sachalinense* Schmidt) This is the largest of the four invasive knotweed species. It has large heart shaped leaves (***Figure 2***) and stems that can grow up to 12 feet tall with stem diameters up to two inches.

- **Bohemian knotweed** (*P. x bohemicum* Chrtek & Chrtkova) This is the hybrid produced by giant and Japanese knotweed. Leaf shape, stem diameter, and stem heights are variable, but are usually within the range of the smaller Japanese knotweed and larger giant knotweed. It is the most common invasive knotweed species in Washington State.

- **Himalayan knotweed** (*P. polystachyum* Wall) has lance-shaped leaves that make it readily identifiable when compared to the other species (***Figure 2***). The stems of this plant usually

reach one half inch in diameter, and four to five feet in height. It is most common in coastal areas of southwest Washington.

All four species are listed as Class B noxious weeds on the Washington State Noxious Weed List (WAC 16-750-011). Class B noxious weeds are designated for control in regions of Washington State where they are not yet widespread. In regions where Class B noxious weeds are abundant, mandatory control is decided at the county level. All four species are also included in the Washington State noxious weed seed and plant quarantine list (WAC 16-752-610). Under this rule, it is illegal to transport, buy, sell, or trade of these knotweed species or any other quarantine species.

Invasive knotweeds have extensive underground rhizome and root systems. They thrive in moist soil or river cobble, in full or partial sunlight, and are most common along rivers, creeks, beaches, and disturbed areas. The aerial stems of knotweed emerge in spring and reach full height by early summer. The plants flower in late summer or early fall (***Figure 3***), and the aerial shoots die after the first frost. The dead aerial shoots persist through the winter, and can remain standing for multiple years (***Figure 4***).

Figure 3. **Flowering knotweed in Skamania County.**

Figure 4. **Dead aerial stems of knotweed on the East Fork Lewis River in Clark County.**

The Problem

The invasive knotweeds are non-native plants that modify the ecosystems they inhabit. The characteristics of a colonizing plant, the absence of natural enemies and diseases, and the reproductive success of knotweed enable these plants to thrive in the Pacific Northwest. These plants alter riparian vegetation communities, disrupt nutrient cycling, negate riparian restoration efforts, affect the recreational use of watercourses, and decrease property values.

In the Pacific Northwest, knotweed spreads when roots and stems are moved by flowing water or human activities (**Figure 5**). Human activities include moving soil that contains knotweed plant

material, mowing or cutting knotweed, or discarding knotweed plant material in vulnerable habitats.

Root and stem fragments as small as one inch can produce a new plant. As a result, one patch can be the source of many downstream populations. In river corridors, knotweed reproduces from fragments and seeds that travel downstream, affecting the gravel bars and riparian forests of entire river systems.

Figure 5. **(Left) Knotweed emerging from fragments in flood deposited soil, and (Right) knotweed stems being transported downstream by flowing water.**

Riparian areas are transitional habitats located between terrestrial and aquatic ecosystems such as lakes or rivers. Riparian areas provide shade, nutrients, and large woody debris to both aquatic and terrestrial ecosystems. These functions take many decades to recover once impacted.

Vegetation communities occupied by knotweed have lower species diversity, richness, and abundance, compared to corresponding stands of uninvaded vegetation. Both deciduous and coniferous trees exhibit decreased juvenile populations in areas with high knotweed stem density, decreasing the number of individuals available to replace mature trees. ***Figure 6*** shows the knotweed infestation of a riparian forest of the Stillaguamish River in Snohomish County, Washington. Knotweed is the only plant species in the understory at this site.

Figure 6. **A knotweed-infested riparian forest of the North Fork Stillaguamish River in Snohomish County.**

The lack of juvenile tree species in knotweed-infested riparian forests could result in a decrease in large woody debris. Large woody debris is important to the rivers and streams of the Pacific Northwest. It creates pool habitats, retains spawning gravels, and provides cover for juvenile salmonids. The loss of large woody debris can disrupt natural processes, leading to channel incision, loss of side channel fish habitat, loss of pool habitat, decreased retention of spawning gravels, and decreased cover for juvenile salmonids and their prey.

Knotweed can affect aquatic invertebrates that compose the basis of the aquatic food chain by disrupting or altering the quality and timing of leaf litter inputs. Invertebrates are the primary food source of juvenile fish species.

Knotweed infestations block river views and limit river access, which can affect recreational opportunities and property values. Substantial resources have been applied to the protection or restoration of riparian areas in Washington State. Knotweed infestations can ruin fish and wildlife habitat projects by outcompeting desirable vegetation.

WSDA Knotweed Control Program

The WSDA Knotweed Control Program provides funding, coordination, and other resources to cooperators that conduct knotweed control projects. WSDA serves as a clearinghouse for knotweed control information and assists any group interested in knotweed control. WSDA also maintains a statewide knotweed distribution database that is updated annually.

WSDA works with groups throughout Washington State to identify knotweed, develop knotweed control projects, and secure grant funding. In 2008, program cooperators leveraged state funding to bring approximately $640,000 of additional local, non-governmental, and federal funding to these knotweed control projects.

In order to minimize duplication of efforts by program cooperators, WSDA fulfills state-level environmental review requirements, provides public notification materials, provides technical training, and publishes required notices.

2008 Project Selection

In March 2008, WSDA facilitated a pre-proposal meeting in Olympia. This meeting gave stakeholders the opportunity to interact with WSDA staff, deliver a presentation to the group outlining their knotweed control project, and provide input regarding the criteria that would be used to evaluate project proposals. In addition, two weed scientists and a biological control specialist shared current knotweed control information with the group.

Representatives from county weed boards, county conservation districts, Tribal governments, Natural Resources Conservation Service, U.S. Fish and Wildlife Service, National Park Service, U.S. Forest Service, WSDA, Washington State Noxious Weed Control Board, Department of Natural Resources, Department of Fish and Wildlife, Department of Ecology, and The Nature Conservancy participated in the meeting.

Stakeholders recommended that WSDA support projects that:

- could cost-effectively control knotweed populations;
- would protect large ecologically important areas; and
- are committed to long-term monitoring.

The stakeholders suggested that the portfolio of projects demonstrate WSDA's commitment to support knotweed control activities throughout Washington State.

An internal review committee used these recommendations to evaluate project proposals. In 2008, twenty-nine proposals requesting a total of $796,541 were submitted. WSDA was able to furnish support to 23 of these projects, awarding a total of $522,242.

Budget

The Washington State Department of Agriculture (WSDA) has administered a knotweed control program since 2004 when the Legislature provided an appropriation of $500,000 per year for a pilot program in southwest Washington. In 2005, the program was expanded to address knotweed control statewide and, in 2007, the budget was increased to $650,000 annually. In 2008, the WSDA knotweed control program budget was $650,000 (***Table 1***). WSDA allocated $522,242 for contracts and agreements, $30,000 for a centralized herbicide purchase, and $97,758 for WSDA coordination.

Table 1. **Estimated budget activity for the 2009 fiscal year.**

Activity			**Budget Expenditure**
Contracts and Agreements			$522,242
	Clark County/Cowlitz County	$82,923	
	The Nature Conservancy (SW)	$62,371	
	Skamania County/Klickitat County	$60,845	
	Clallam County/Jefferson County	$44,592	
	The Nature Conservancy (Skagit)	$42,959	
	King County	$42,740	
	Lewis County	$36,606	
	Pacific County (2)	$35,413	
	10,000 Years Institute	$32,365	
	Stilly Snohomish Task Force	$11,131	
	Pierce County	$10,766	
	Kitsap County	$9,940	
	Snohomish County	$9,000	
	Yakama Nation	$7,431	
	Island County	$6,700	
	Yakima County	$5,125	
	Okanogan County	$5,000	
	Stevens County	$4,758	
	Skagit County	$4,000	
	Whitman County	$4,000	
	Columbia County	$3,177	
	Franklin County	$400	
Herbicide Purchase			$30,000
WSDA Coordination[1]			$97,758
Total			**$650,000**

1. WSDA coordination expenses include agency administration costs, salaries and benefits for the coordinator, legal and clerical support, equipment costs, printing, and other goods and services.

All WSDA expenditures directly supported the control work of cooperators. The centralized herbicide purchase allowed the program to utilize economy of scale to save over $16,000 in 2008. WSDA provided this savings directly to program cooperators' control efforts.

Survey and Treatment Methods

Most cooperators surveyed for knotweed by wading or boating streams and driving the right-of-ways located in each project area. The location of knotweed was documented, and this information was used to identify the ownership of affected parcels. Landowners were contacted and asked if they would allow knotweed control activities on their property. Most landowners were familiar with the negative impacts of knotweed and welcomed the assistance provided by program cooperators. In rare cases where landowners refuse to control knotweed, county noxious weed control boards have the authority to enforce noxious weed law.

Treatment methods were selected based on site and infestation characteristics according to integrated pest management (IPM) principles. An important IPM consideration for the program was treatment of all known knotweed populations in the selected river corridor, starting at the upstream source of the infestation and working in a downstream direction. This strategy ensures that untreated knotweed plant material will not re-infest treatment sites as it moves downstream.

Treatments were conducted May through October or until the first frost of the year. Herbicide applications included foliar applications of imazapyr, glyphosate, or triclopyr alone or in combination, or the injection of glyphosate directly into the stems of knotweed. Foliar delivery of herbicide was the primary treatment method used by project cooperators in 2008.

The herbicide products used by the program cooperators in riparian areas were registered for use in or near water. WSDA required that all herbicide applications be made under the supervision of a licensed applicator.

Results

In 2008, WSDA provided resources to the Yakama Nation, two offices of The Nature Conservancy (TNC), the Stilly-Snohomish Fisheries Task Force, 10,000 Years Institute, the Pacific County Conservation District and the noxious weed control boards of Clallam, Clark, Columbia, Franklin, Island, King, Kitsap, Lewis, Okanogan, Pacific, Pierce, Skagit, Skamania, Snohomish, Stevens, Whitman, and Yakima counties.

These 23 cooperators implemented knotweed control projects in watersheds of 24 counties, including Clallam, Clark, Cowlitz, Grays Harbor, Island, Jefferson, King, Klickitat, Lewis, Mason, Okanogan, Pacific, Skagit, Skamania, Snohomish, Thurston, Whatcom, Whitman, and Yakima counties **(*Figure 7*)**. The resources that are available to groups in Skamania, Yakima, Klickitat, Okanogan, Stevens, Franklin, and Whitman counties allow for the treatment of all known knotweed within each county.

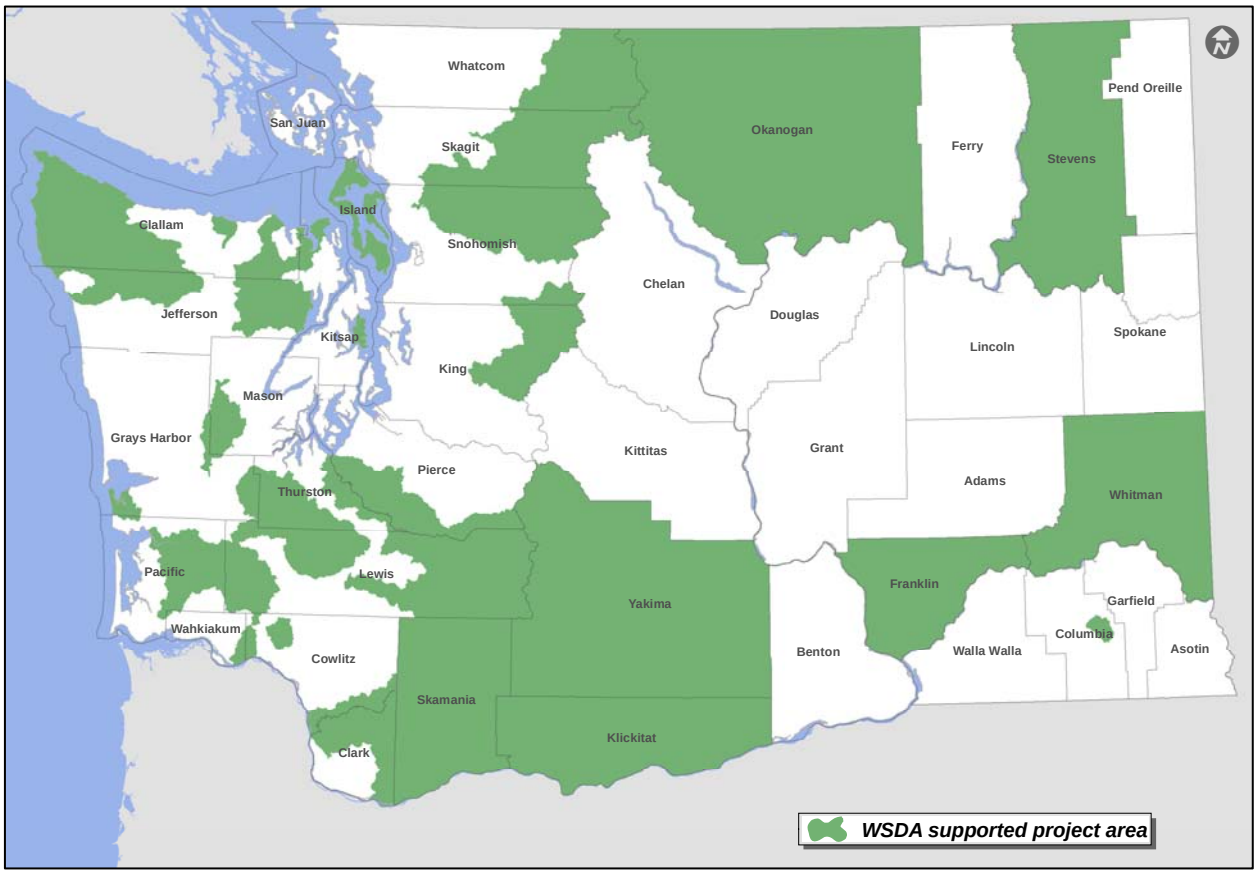

***Figure 7*. Washington State counties and WSDA-supported project areas.**

WSDA continued to support on-going projects and, for the first time, provided resources to the noxious weed control boards of Columbia, Franklin, Kitsap, and Stevens counties. Additionally,

WSDA provided the Pacific County Conservation District with herbicide for its knotweed control project.

Table 2 is a summary of the work the program cooperators performed in 2008. The work that is reported here is the result of a combination of state and other funding. In most cases, program

Table 2. ***Results by region and program cooperator for the 2008 control season.***

Program Cooperator by Region	Acres Treated	River Miles	Landowners Assisted
Lower Columbia			
Clark County	129.0	145.0	114
Cowlitz County	19.3	14.1	103
Lewis County (Cowlitz River)	25.7	51.0	119
Skamania County	132.8	105.8	208
Coastal			
The Nature Conservancy	10.4	223.6	108
Lewis County (Chehalis River)	11.2	36.0	85
Pacific Conservation District	145.0	13.0	92
Pacific County	112.0	27.4	103
Olympic Peninsula and Western Hood Canal			
Clallam County/Jefferson County	1,683.5	140	195
10,000 Years Institute	0.1	23	6
Puget Sound and Eastern Hood Canal			
The Nature Conservancy	1.2	85	40
Snohomish County	104.0	28.6	190
Stilly-Snohomish Fisheries Task Force	0.8	22.7	58
Skagit County	0.2	na	63
Kitsap County	9.9	na	135
King County	57.5	24.5	77
Pierce County	150.2	50.4	98
Middle Columbia			
Yakima County / Yakama Nation	4.2	82	75
Skamania County / Klickitat County	3.1	na	32
Upper Columbia			
Okanogan County	5.1	na	35
Eastern Washington			
Whitman County	0.3	0.1	20
Franklin County	0.6	na	1
Columbia County	0.4	0.3	8
Stevens County	0.5	na	23
Total	2,607.1	1,073	1,988

cooperators leveraged state funds to secure funding from other sources. If the state funding had not been available to program cooperators, the additional funding could not have been awarded, and work funded by state-leveraged resources would not have taken place. In 2008, program cooperators leveraged state funding to bring approximately $640,000 of additional local, non-governmental, and federal funding to these knotweed control projects.

WSDA has used three project metrics to track the progress of the program. The river miles column includes survey, treatment, and monitoring activities. In cases where our projects are focused on the treatment of upland knotweed populations in order to prevent the infestation of the shorelines of rivers, the river miles measure does not apply.

Approximately 2,607 acres of knotweed were treated in 2008 compared to 1,312.6 acres in 2007. This increase in treated acres was a result of the treatments of populations in previously surveyed areas, or the treatment of knotweed in expanded project areas. The work performed by the Quileute Tribe, in partnership with Clallam County and the Olympic Knotweed Working Group, accounted for the majority of the increase.

Project work occurred in 1,073 river miles for 1,988 landowners. In 2008, there was an increase in the river miles where project activities occurred compared to the results of the 2007 season. This increase is a result of a reduction in the amount of time needed to perform treatments at sites that have been treated in previous seasons, and an increase in the number of landowners willing to participate in the program.

The number of landowners that chose to participate in the knotweed control program increased from 1,256 in 2007 to 1,988 in 2008. This was a result of our cooperators' efforts to determine land ownership, and to make contact with those owners. In some cases, landowners that were reluctant to give their written consent in previous seasons chose to participate in 2008.

Monitoring

WSDA uses monitoring plots to gauge the effectiveness of the Knotweed Control Program. In 2008, WSDA staff visited knotweed treatment monitoring plots in Pacific County, Skamania County, and Lewis County in southwest Washington between the months of July and September. In 2008, stem counts, stem heights, stem diameters, and visual control estimates were recorded using the methodology established by Dr. Tim Miller (Washington State University) in 2004. A visual control estimate is a measure of control that is assigned to the monitoring plot based on a visual assessment and is reported as a percent reduction to the nearest 5%.

WSDA compared stem density (number of stems per square foot), stem height, and stem diameter measurements recorded in 2005 to measurements from 2008. All the monitoring plots have been treated each season since 2004. The difference between the measurements are calculated as a percent reduction, and used to evaluate the cumulative effects of treatments over the past four seasons. For all measurements, zero percent control would represent no change compared to the previous season, and 100% control translates to no regrowth of knotweed at the site.

Across all sites, knotweed populations displayed a 97% reduction in stem density and an average visual control estimate of 96% (***Figure 8***). The above ground growth that was present in the monitoring plots displayed a 65% reduction in stem height and a 78% reduction in stem diameter when compared to pretreatment measurements. All knotweed regrowth appeared to come from existing rhizomes or root crowns, and there were no seedlings present in 2008. Sixty percent of the monitoring plots had no knotweed present.

Figure 8. **(Left) Monitoring plot in Lewis County, photo taken prior to herbicide treatment in 2004 (Right) Same monitoring plot, photo taken following four consecutive years of treatment.**

Recolonization of treatment sites by native or non-native plants was noted at all monitoring plots. These results suggest that the need to reestablish native vegetation at treatment sites depends on the vegetation that is present in the surrounding landscape.

Results observed at the monitoring plots are consistent with observations at project sites. Across the state, the knotweed populations that persist in project areas exhibit significantly reduced stem density, stem height, stem diameter, and overall vigor. This has allowed many native plants, including tree and shrub species, to colonize areas where they had previously been displaced by knotweed.

Some program cooperators have observed knotweed growing at treatment sites where there had been no above-ground growth for two seasons, and there is evidence that knotweed populations can return to pretreatment levels if they are not treated for three consecutive seasons. This phenomenon, coupled with the tremendous reproductive capacity of knotweed, reinforces the need for project areas to be thoroughly re-surveyed and re-growth treated on an annual basis for several years.

Although there have been dramatic reductions in knotweed, program cooperators have not yet completely removed knotweed from any landscape-scale project area. Knotweed has a large amount of stored energy in its underground biomass and is very difficult to kill.

Biological Control Program

Fritzi Grevstad, Ph.D., of the University of Washington has been working with an international group of scientists and the U.S. Forest Service to develop a biological control program for the control of Japanese, giant, and Bohemian knotweed. In biological control, natural enemies from the weed's native range are introduced to provide long-term suppression of the plant population.

Dr. Grevstad has surveyed Washington and Oregon for native insects that utilize knotweed as a host. The results of this survey showed that very few insects utilize knotweed as a host and those that did were generalist species, were never very abundant, and did not have any negative impacts on the health of knotweed.

Several natural enemies from knotweed's native range have been identified as promising biological control agents including a sap-sucking psyllid (*Aphalara itadori*), a leaf-chewing chrysomelid beetle (*Gallerucida bifasciata*), a leaf and stem-feeding moth (*Ostrinia ovalipennis*), and a leafspot pathogen (*Mycosphaerella sp.*). In July of 2007, Dr. Grevstad traveled to Japan to collect and import the psyllid and chrysomelid into an insect containment facility located at Oregon State University. These insects are currently being tested for host specificity.

Rigorous testing is required to ensure that the insects will not feed on native or economically important non-target plant species in North America. A test plant list of 68 native and economically important species was submitted for review by the Technical Advisory Group on Biological Control of Weeds (TAG) in March 2007. The TAG is an independent voluntary committee that provides advice to researchers and the U.S. Department of Agriculture's Animal and Plant Health Inspection Service. A majority of these plants have been collected and grown in a greenhouse in preparation for this testing. The availability of biological control agents would be a beneficial addition to current control methodologies.

Summary

Since 2004, the Washington State Department of Agriculture has provided resources to county noxious weed control boards, county conservation districts, tribal governments, the Washington State Parks and Recreation Commission, and three non-governmental organizations for landscape-scale knotweed control projects.

WSDA has served as a clearinghouse for knotweed control information, and disseminated this information to any group interested in knotweed control. In order to minimize duplication of efforts by its program cooperators, WSDA fulfills state-level environmental review requirements, provides public notification materials, delivers technical training, and publishes required notices.

WSDA worked with 23 groups throughout the state, in both western and eastern Washington. These groups used the most effective treatments to control knotweed and experienced excellent results. At the program's monitoring sites, after four years of treatment, knotweed populations displayed a 97 percent reduction in stem density and an average visual control estimate of 96 percent.

Similar results are being observed at project area sites, allowing many native plants to colonize areas where they had previously been displaced by knotweed. However, there is evidence that knotweed populations that are not treated in consecutive seasons can return to pretreatment levels. This phenomenon, coupled with the tremendous reproductive capacity of knotweed, reinforces the need to thoroughly re-survey and treat re-growth in project areas on an annual basis for several years. A lack of follow-up treatments will result in the recovery of knotweed populations and the loss of the investments made over the past five years of the Statewide Knotweed Control Program.

WSDA will continue to support knotweed control if program funding continues to be available. Any reduction in funding would shift the financial burden to local, non-governmental, and tribal governments that are assisting private landowners with their responsibilities under RCW 17.10, the state's noxious weed control law. A decrease in funding could require the abandonment of projects throughout the state and reduce support for remaining initiatives.