Controlling Knotweed

(*Polygonum cuspidatum*, *P. sachalinense*, *P. polystachyum* and hybrids)

in the Pacific Northwest

Although produced by and the responsibility of The Nature Conservancy, this document grew from a workshop co-sponsored by Metro, The City of Portland Parks, Natural Resources Division, The Society for Ecological Restoration, Northwest Chapter and The Nature Conservancy held in February 2002. As well as extensive literature review, the data and field experience of many individuals went into the development of this document. Funding for the production of this guide and the research that supported it was provided by: the Bureau of Land Management, For the Sake of the Salmon, the Northwest Service Academy, the Oregon Department of Agriculture, the Oregon Watershed Enhancement Board and the United States Fish and Wildlife Service. The Oregon Department of Agriculture provided friendly review. Thank you all.

Knotweed Description

Japanese, giant and Himalayan knotweed are members of the buckwheat family (Polygonaceae) from Asia with hollow (not true for the Himalayan species), upright, bamboo like stems growing to 1 to 5 meters (3 to 16 feet) (photographs 1 and 2).

Photo 1. Knotweed infested stream bank

Photo 2. Knotweed canes

The large, smooth-edged leaves range from an elongate triangle (Himalayan knotweed), through heart shaped (Japanese knotweed) to huge, “elephant ear” type leaves (photograph 3). Hybrids blur these distinctions.

Photo 3. Knotweed leaves, 3 types

The stems are often reddish or red-speckled (photograph 2). Young shoots look similar to red asparagus (see photograph 12). The small white or greenish flowers form in July and August and grow in dense clusters from the leaf joints (photograph 4). Although it dies back to the ground after hard frosts, the stems may persist through the winter as bare, reddish brown stalks (photograph 5).

Photo 4. Flowering knotweed branch

Photo 5. Dead and persistant knotweed canes

Prostrate knotweed, a common weed in the Polygonaceae family, is not addressed in this document. References to "knotweed" pertain exclusively to Japanese, giant or Himalayan knotweed or their hybrids, unless otherwise noted.

Common names include:

elephant ear bamboo,
Mexican bamboo,
and fleeceflower.

Scientific names include:

Japanese knotweed (*Polygonum cuspidatum, Fallopia japonica, Reynoutria japonica*)

giant knotweed (*P. sachalinense*)

Himalayan knotweed (*P. polystachyum*)

Japanese and giant knotweed hybrid (*P. X Bohemicum*)

Control Summary

So you have knotweed and want to be rid of it? Good. It is possible, but not usually easy, especially at a landscape scale. Because of knotweed's incredibly extensive root system and sprouting ability, landscape level control must be thought of within the context of a program. Even on a patch by patch basis, successful eradication is likely to take more than one year, let alone one treatment in most cases. Finally, although there are potentially successful mechanical or manual control options for small patches, landscape level projects and large sites will almost certainly require integrating herbicide use into a control strategy.

Although this document does not address it, a successful landscape level program will almost certainly involve outreach to private landowners and the broader community, as well as volunteer recruitment and coordination. You may need an outreach program to reach landowners that may have knotweed on their property. You almost certainly will need to educate those property owners and others so that they fully realize the threat knotweed poses. Fully understanding the devastating effects that knotweed can have on waterways and riparian ecological systems can only help motivate people to act.

You may also want to work with volunteers and other organizations in your community to expand your ability to physically get the work done. Helping to create and protect free flowing waterways and noxious weed-free embankments provides the rewards that can inspire citizens to participate more fully in natural resource restoration projects.

Note: *The Nature Conservancy has produced some outreach materials that are available to other projects at little or no cost. These include an informational brochure, an outreach poster and "I found knotweed" postcards. The Conservancy can also provide more detailed control and project structure advice.*

Basic Knotweed Ecology

In the Pacific Northwest (PNW), at low elevation, knotweed typically starts growth in April, earlier in warm areas, and as late as June at higher elevations. Even at low elevation, stems from deeply buried roots may emerge as late as July or August. Knotweed grows extremely fast during the spring. Giant knotweed can reach 15 feet (4.5 meters) by June (photograph 6). The slightly shorter Japanese knotweed reaches "only" 10 feet (3 meters) or so. The "dwarf' Himalayan variety is shorter still, typically reaching 4-6 feet (1.5 - 2 meters).

Photo 6. Giant knotweed patch

Photo 7. Tangled mass of kntoweed rhizomes growing within an eroding river bank. Despite knotweed's large rhizome mass, it provides poor erosion control.

Photo 8. Close-up view of rhizomes with machete in background for comparison. Note small shoot growing "in the air."

Knotweed is a creeping perennial. It dies back to the ground with the first hard frost, and returns each spring from the same root system. The term "creeping" refers to the extensive network of rhizomes (roots that can sprout) spreading at least 23 feet (7 meters), and possibly as far as 65 feet (20 meters) from the parent plant and penetrating at least 7 feet (2 meters) into the soil (photographs 7 and 8).

Knotweed can spread rapidly due to its ability to reproduce vegetatively. Root and stem fragments, as small as 1/2" (1 cm) can form new plant colonies (photograph 9). Seasonal high water events and floods sweep plants into rivers and creeks, then fragment and disperse knotweed plant parts throughout the floodplains and cobble bars. The fast growing knotweed then takes advantage of the freshly disturbed soil to become established. Because it grows faster than most other plant species (including native species and most other weeds) it quickly outgrows and suppresses or kills them.

Photo 9. Root fragment sprout.

Photo 10. Stem cut by beaver, rooted in cobble at nodes.

Roadside ditches, irrigation canals, and other water drainage systems can be colonized the same way. Cut or broken stems and roots will sprout if left on moist soil or put directly into water, or if moved by beavers (or earth moving equipment) (photograph 10). Stem or root fragments can also be spread in contaminated fill material.

Although pure strains of Japanese, giant or Himalayan knotweed are not thought to produce fertile seed in the United States, the hybrid varieties (including the recently described hybrid of giant and Japanese knotweed — *Polygonum X bohemicum*) are able to produce fertile seeds. According to knowledgeable observers, unfortunately, many of the patches in the Pacific Northwest appear to be hybrids of Japanese and giant knotweed. The Nature Conservancy (TNC) has successfully germinated knotweed seeds in a laboratory setting and seedlings have been confirmed in at least one setting on the Sandy River during spring 2002. Should extensive sexual reproduction be confirmed in the field it would certainly alter the strategy for landscape level control projects.

Knotweed resprouts vigorously following cutting, mowing, digging and some herbicide treatments, especially early in the growing season, until at least August. Such treatments apparently stimulate the production of shoots from latent buds dispersed on the root crown or rhizomes (photograph 12).

Based on these ecological features, TNC's more than three years of field experience and extensive literature and "regional expert" review, the following suggestions are provided to help eradicate this fearsome noxious weed threat to our watersheds. Although the advice is designed for the Pacific Northwest, it should be generally useful everywhere.

Mechanical or Manual Control

Variations: Cutting, mowing, pulling, digging, covering

The goal of mechanical control is to remove or starve the root system. In experiments conducted by The Nature Conservancy between June 2000 and June 2003 and as reported in the literature, in the vast majority of cases, monthly cutting fails to eradicate even isolated and relatively small knotweed patches unless conducted for several years. However, The Japanese Knotweed Manual (Child and Wade 2000) reports successful control of an isolated and small patch after **three** consecutive years of uprooting the plants in August. TNC was able to control one small patch (25 stems) with 17 monthly cuttings over three field seasons. Child and Wade recommend against trying this technique for larger, more established patches.

So, unless you are prepared to cut knotweed patches TWICE A MONTH OR MORE - could we say it any stronger? - especially between April and August, and then once a month or more until the first frost, a program based on cutting alone is likely to be a recipe for frustration and failure. In some cases however, using manual / mechanical control may be the only viable option for legal or ethical reasons. For instance, if the knotweed is in a very environmentally sensitive area, if a particular landowner is opposed to pesticide use, on some federal lands and if labor costs are not an issue.

To be successful, one should plan for an aggressive mechanical control program (as described above and below) to be continued for at least two or three years if the patches are well established.

In the end, timely, thorough and persistent cutting over several years can eliminate knotweed, especially small, isolated patches. Because of the level of effort required, this approach is really best suited for individual landowners with easy access to their knotweed patches and a strong commitment to avoiding herbicides. Using a mower/weed-eater is an option if you can set it close to the ground. It is best to remove, rake or carefully dry all knotweed vegetation you cut or mow, because

stems or stem fragments can sprout, and the area (or adjacent areas) may become reinfested. Do not allow cut, mowed or pulled vegetation to enter waterways.

Digging or pulling (uprooting) is a good option if your soil is soft. This will eliminate some portion of, but not all of the root system each time you do it. Be sure to carefully dry or dispose of the roots. Do not put them in a compost pile. In England, soil contaminated with knotweed roots is considered an environmental contaminant and needs to be buried 3 meters (10 feet) deep. You will need to follow up frequently as for cutting/mowing to catch resprouted stems. Be sure to search at least 20 feet (7 meters) away from the original patch center.

There are multiple anecdotal reports of control attempts using extended covering, but no reliable reports of successful knotweed control with covering. This includes those of the Lummi Nation in Washington, who combined digging, tilling and covering with several layers of cardboard on 2, 1/4 acre patches. The results were poor however; they achieved only 80% reduction in stem number, at a cost of $32,000/acre. An effort to control knotweed by covering conducted by the USFS Mt Hood National Forest in Zig-Zag, Oregon, also failed, despite extensive pre-covering digging. TNC also failed to achieve good control covering a single large patch for about 6 weeks in the spring. Others have also reported that knotweed grows out from under the covering material. If you must try it, this method is likely to work better with isolated and smaller patches on open terrain. Plan to leave the covering material in place throughout the growing season and well into the next. As always, check the site through at least September the following year and again the year after.

Mechanical Control - How To:

Hand Cutting
Using a machete, loppers or pruning shears, cut the stems down to the ground surface as often as possible, but at least every 2-3 weeks from April (or as soon as the plant appears) through August. Sprouting slows after August, so you can reduce cutting frequency, but try and prevent the plants from ever exceeding six inches (15cm) in height. Pile the cut stems where they will quickly dry out.

Mowing
Using a weed-eater or mower, cut as low as possible and as often as possible, but at least every 2-3 weeks through August. Be sure you are not scattering stem or root fragments onto moist soil or into the water.

Goats are reported to eat knotweed and in some circumstances controlled goat grazing may be an option similar to intensive mowing. Be aware they will eat desirable vegetation as well.

Digging/Pulling
If the knotweed has established in soft soil, or better yet sand, try pulling the plant and major rhizomes up by the root crown to remove as much of the root system as you can. Although you will almost certainly not kill the plant in one treatment, you will reduce the root mass. Each time you see new sprouts (start looking a week after you pull and search at least 20 feet away from the original plant), uproot them as well, trying to pull out as much of the root as you can each time. This is probably only feasible with small patches. Be sure to carefully dispose of any root material.

Tilling
Used alone, tilling or otherwise physically disturbing the root system will not provide control and will create many resprouts. This approach may however offer some benefit in an integrated strategy, since it will increase the shoot to root ratio.

Covering
First cut stems down to ground surface (and possibly follow with tilling). Cover the area with thick black plastic or multiple layers of cardboard expanding beyond the plant base and stems at least 2 meters (and preferably 7 meters) beyond the outside stems. Weight down the covering material and watch the perimeters to be sure new stems are not popping up outside your cover material. Try this right at the beginning of the year or after you've cut the plant down a couple of times in the spring and reduced some of the rapid plant growth. It may be necessary to leave the plant covered through at least one entire growing season.
**Note - there are no reports of successful long-term control using covering alone (see above).*

Comments on Manual Control and Combining Treatments

No matter which control method(s) is used, manual or mechanical control is going to be a lot of work. But, combining digging/pulling with cutting or even herbicides use, helps break up the root system and encourages the plant to send up new shoots. The more shoots there are per linear foot of root, the more likely you will be to be able to physically pull them out, exhaust them by depriving them of energy (i.e. by cutting the shoot off) or kill them with herbicides.

If you do try and control knotweed manually, be sure you practice the four T's: be timely, tenacious, tough and thorough. And as always, carefully dispose of any stem or root material.

Herbicides

Application method variations include spraying, wicking, injecting, pouring or combinations thereof.

General
Many herbicides, herbicide combinations and application methods have been tried on knotweed, and work to a greater or lesser degree depending on many factors. But like any weed control method, herbicides will fail if used incorrectly. Because knotweed thrives in riparian areas, herbicide exposure to water, the susceptibility of surrounding desirable plants to the herbicide, and the potential impact of herbicides on aquatic organisms must be considered in choosing the most appropriate product for your particular weed control program. Furthermore, using any herbicide correctly means using:
• **An herbicide which has a label allowing applications on the particular use site**;
• The correct concentration (rate);
• An adjuvant if recommended (adjuvants are spray solution additives that may make the herbicide more effective);
• The right application method;
• The correct timing to coincide with plant susceptibility.

As always with herbicide use, carefully read and follow all use directions and any restrictions or precautions listed on the product label. If in doubt, contact your local extension agent, pesticide dealer, Department of Agriculture, or the herbicide manufacturer for advice or clarification.

Herbicide - Foliar Spray

Whether using a small hand held, backpack, or large volume sprayer, spraying herbicide on the leaves is one way to apply herbicides. Spraying poses a relatively high risk of creating drift (allowing pesticide onto the soil, into water or on surrounding desirable plants) if precautions are not taken and care is not used. A basic rule to consider is that the faster the application method, the more likely it is to hit non-target areas. In Washington State it is not legal to apply any herbicides that contact open or moving water without special permit. In Oregon, permits for aquatic applications are not currently required. However, contact your local Department of Environmental Quality for further information. In any state, it is a requirement of federal and state law that the herbicide user follow the product label.

Herbicides with an active ingredient of glyphosate (Rodeo, Aquamaster, Gly Star, Round-up among others), triclopyr (Garlon 3a and many "shrub-killers"), 2,4-D, picloram (Tordon) and Imazapyr (Arsenal) have shown to be variably effective in controlling knotweed either separately or in combinations. Each offers benefits and potential risks. Please consult with your local university extension agent or herbicide company representative for advice on which product is most appropriate to use in your situation.

A note about adjuvants - Adjuvants (also referred to as surfactants, penetrants, activators or sticker-spreaders) are agents added to the herbicide mix that help it stick to or penetrate into the leaf. They can make a significant difference on how well the herbicide treatment works. The surfactant LI-700 has been considered the most salmon safe and has been approved by the National Oceanic and Atmospheric Administration - Fisheries (formerly the National Marine Fisheries Service - see paragraph below). Where direct risks to aquatic organisms aren't involved other non-ionic surfactants such as R-11, Activator or various seed oil derivatives may work safely and most likely will be better than LI-700 for glyphosate based herbicides. Away from water, surfactants with silicone (Syltac by Wilbur-Ellis for instance) may be helpful. Please seek the advice of your pesticide dealer, consultant or university extension agent to determine which adjuvant is best for the herbicide you choose and in consideration if there is any potential exposure to waterways.

To successfully control knotweed with herbicide treatments, the active ingredient in a herbicide product must have a mode of action designed to move the chemical from the leaves into the root system (i.e. be translocated) at sufficient concentration to kill the root tissue. To achieve successful translocation at your site, it may be necessary to conduct some field trials to test the efficacy of different concentrations of spray solution. Some herbicides may need to be used at low concentrations in order to avoid damaging the above ground tissues of the plant before the herbicide is well dispersed in the root system. ***Remember, with herbicides more is not necessarily better***. For instance, using triclopyr (e.g. Garlon 3A) at 5% concentration appears to give good top-kill to leaves but does not adequately destroy the plant root system and results in mediocre long-term control on large patches.

TNC has heard reports of successful control using Garlon at rates as low as 3/4% (about 1 oz per gallon) in high volume application. In TNC's field experiments, both 3-5% Garlon 3a and 3-5% Rodeo with LI-700 eradicate about 50% of small patches after two to four treatments over two years. In controlled experiments comparing treatments on small patches (30-200 stems), Garlon 3a provided 90+ percent control in one year and 100% control within 2 years. Rodeo was slightly but consistently less effective, typically taking 3 years of treatment to achieve full control.

Although some glyphosate products demonstrate acceptable control with one or two treatments in some cases, they frequently allow survival of several badly mutated stems (so called epinastic growth) from a given clump. These stems appear likely to survive and recover if left untreated. Clark County (Washington) Weed Management reports getting good control from applications of 7-8% glyphosate (e.g. Aquamaster) on first year plants or sprouts from nodes, with some patches requiring additional treatments. However, inadequate control was observed with a different glyphosate product (e.g. Rodeo) applied at 7-8% concentration on established knotweed patches. Because both products used in this trial have the same concentration of active ingredient (53.8%) it was not clear as to why the difference in product performance was observed (total root mass is probably an issue).

Besides glyphosate (Aquamaster, Rodeo, Roundup, etc) and triclopyr (Garlon 3A), other herbicides that may be considered for knotweed control are those with active ingredients of 2,4-D, Imazapyr (Arsenal) or Picloram (Tordon). Please remember to check with the pesticide regulatory authority in your state before making your chemical decisions to ensure compliance and applicability for your intended site.

A important note to herbicide users receiving or applying for federal funding: A pesticide label approved by the U.S. Environmental Protection Agency and registered by the appropriate state agency does not guarantee that the product will be allowed to be used in certain federally funded weed eradication projects. If you receive federal funding for your knotweed eradication project, the United States Fish and Wildlife Service (USFWS) and / or the National Oceanic and Atmospheric Administration (NOAA) has the right to consult on herbicide use, and may not approve the use of certain herbicides or additives. For example, NOAA approved only Rodeo or Aquamaster with LI-700 as surfactant for use on the Sandy River in 2002 and 2003. You are advised to check with your grant coordinator to ensure compliance with agency/grant specifications.

Foliar Treatment Timing

The right time to apply herbicides is greatly affected by herbicide choice. According to Oregon Department of Agriculture materials, the ideal time to spray most deep-rooted perennials is when they are in flower bud stage. However, because knotweed may be 15 feet tall when it begins to flower (July or August in the PNW) this is not always practical. The best time, from a practical standpoint, is when the patches are 1-2 meters tall. Shorter plants may not have adequate leaf surface to absorb, and translocate, enough chemical to be effective. However, young, rapidly growing plants do have a more efficient biological process to translocate chemicals. Spraying taller plants means creating more risk of pesticide drift and older plants may not be as efficient in chemical translocation. A spring spray or cutting will set back the plant so that it can be sprayed at an effective height and growth stage later in the year. Plants first encountered late in the year can be cut to 1.5 meters in height immediately before spraying, although control effectiveness is somewhat reduced. TNC field data analysis suggest treatment done in April or May is not as effective as those done in June or July.

Regardless of herbicide choice, rate or spray timing; large, established patches (hundreds or thousands of stems) will almost certainly require foliar treatments over two or more years. Just as when treating patches mechanically, be sure to search for new shoots at least as far as 20 feet away from the central patch after herbicide treatment begins

Foliar Treatment - How To

When mixing herbicides always follow safety precautions and mixing instructions listed on the product label. At a minimum, always wear the required personal protective equipment specified on the label, which may include safety glasses, chemical proof gloves, and long sleeves, especially when handling the concentrated herbicide. A standard mixing sequence for most herbicides that would be used in knotweed control would be to add half the total amount of water to your spray tank, add the measured amount of herbicide, any surfactant (and dye), then the rest of the water. Mix carefully, but thoroughly between steps. After mixing the herbicide solution, follow the directions for foliar applications on the label, which is usually to spray just enough solution to wet the leaves and stems while avoiding dripping. Try and spray the top surface of every leaf on the plant and the stems. The plant may take several weeks to show significant adverse effects. Do not worry or retreat, the best control happens slowly. Return later in the season and again the next season to determine if additional treatments will be necessary.

Herbicide - Stem Injection

Injecting concentrated herbicide directly into the hollow of the lower nodes of knotweed stems is an experimental method showing great promise in trials conducted under experimental use permits from the states of Oregon and Washington (photographs 11 and 12). Although time consuming, not only does this approach essentially eliminate drift, but Clark County (WA) Weed Management reports obtaining 100% control in one treatment by injecting 5ml of 100% Aquamaster or Round Up Pro into each stem of a given clump. More than 20 patches were so treated (please visit www.co.clark.wa.us/ environ/ knotweed.pdf for more information).

Photo 11. Stem injection with plastic syringe

Photo 12. Close-up of lower stem/ root/rhizome structure with section cut-out to expose hollow cavity. Note numerous buds at root crown.

Except under an experimental use permit, stem injection of glyphosate is currently allowed with most glyphosate products at 1ml of undiluted product per 2 inches of stem diameter. Based on preliminary research, this rate is inadequate to control knotweed. TNC, Metro and Clark County Weed Management are currently testing rates between 1.5 and 7 ml of undiluted glyphosate containing herbicide per stem (typically 0.5 - 2 inches in diameter) in order to refine this method. Conclusive results from tests on hundreds of sites in three watersheds will be available during 2004.

We anticipate that a refined stem-by-stem injection method will provide much better knotweed control than is available through other application methods. The manufacturers of Aquamaster (Monsanto) and Rodeo (Dow Agrosciences) have submitted revised labels for review to the EPA. The EPA has already approved Monsanto's request and is likely to also approve Dow's during the winter of 2003-4. Both companies are hoping to provide sufficient data to state regulatory agencies (Department of Agriculture in Oregon) to support the addition of this type of application method to glyphosate product labels in Oregon for the 2004 field season.

**Note: Please review Addendum on the last page of this guide for label revisions in Oregon.*

A high quality injection tool has been created, and if it works as well as reported, it promises to greatly speed the injection process (please visit www.jkinjectiontools.com for more information).

Please contact your state pesticide regulatory agency to stay informed as to the availability of this treatment method. Any use of the injection method that is not clearly allowed for on the product label is a violation of federal and state regulations.

Herbicide: Cut Stem -Wick (wipe) Applications
This methods relies on direct application of herbicide to plant tissue, typically using a sponge or brush of some sort. Although very slow, this approach greatly reduces or eliminates drift. This method may be useful in areas where plants are established in particularly sensitive areas or for landowners who are concerned about spraying. Unfortunately, control is generally mediocre without multiple repeat applications.

After cutting the stem about 2 inches above the ground (between the lowest nodes), apply glyphosate or other herbicide into the stem cavity and onto the cut stem surface. Different herbicides allow various concentrations of solution to be applied by this method. TNC has experienced only partial control of weed growth even after multiple treatments on small patches using a wiper or sponge application method and 33-50% concentrations of Garlon 3a and Rodeo herbicides. Using a handheld mister type sprayer to direct a small amount of concentrated herbicide into the stem cavity as well as the cut surface appears to give better results than wick applications since more herbicide is absorbed by the plant. A follow-up foliar or wicking treatment may be needed to control new seedlings and resprouts.

Herbicide: Cut Stem - Pour Applications
This still somewhat experimental method also relies on direct application of herbicide to plant tissue. Although very slow, this approach also greatly reduces or eliminates drift. This method may be useful in areas where plants are established in particularly sensitive areas or for landowners that are concerned about spraying. Clark County Washington Weed Management reports control results somewhere between injecting and wicking as described above.

After cutting the stem about 2 inches above the ground (between the lowest nodes), carefully pour ~5ml of undiluted herbicide into the stem cavity. Different herbicides allow various concentrations of solution to be applied by this method (EPA has just approved this method for Aquamaster). Please read and follow the label. A follow-up foliar or wicking treatment may be needed to control new seedlings and resprouts.

NOTE: Currently, neither cut and pour nor stem injection methods are covered by the glyphosate or Garlon 3a label. The new supplemental label for Aquamaster and possibly Rodeo will include these methods. If a specific treatment method or concentration is not in the use directions of the herbicide label or it is not possible to accomplish the desired application within the label limitations stipulated for rate and/or concentration, please check with your Department of Agriculture for label clarification before you initiate treatment. The label is the law. In some cases it may be possible to work with your local regulatory agency to obtain an experimental use permit.

Integrated approaches

Combining different control methods offers additional choices and provides flexibility in your weed control program. TNC has found little difference in control effectiveness of cutting the plant in the spring and spraying in the summer / early fall versus spraying both times. The spring cutting may reduce total herbicide load into your watershed and may be more labor efficient than spraying twice. Maximizing available labor and reducing program expenses allows more patches to be treated in a given season. Furthermore, cutting allows the use of volunteers, which is difficult or impossible with herbicide applications.

Digging, pulling or tilling (if conditions warrant) before August and at least one month prior to spraying may also help by increasing the shoot to root ratio and reducing plant vigor and root mass, thereby increasing plant susceptibility to the herbicide.

Many knotweed patches have a significant percentage of stems too small to inject. Research is currently underway comparing the effect of spot spraying the small stems at the time of stem injection, with leaving the small stems untreated until the following year (when they presumably, but not certainly could be injected).

Commentary on herbicide based techniques

If stem injection proves to provide consistent control, a new label is approved by the appropriate state and federal agencies, and an injection tool is available on the market, this will be an important method for knotweed eradication projects. This is especially true for sites along sensitive waterways and very hard to access sites. Until the injection method is approved as needed for knotweed control, foliar applications appear to be a reasonably efficient approach (1 to 4 treatments over two seasons) to obtain control over small and medium size knotweed patches. Larger patches will often require treatment over several years and combinations of manual and chemical control methods. Each project manager will need to weigh the advantages and disadvantages of the control methods presented here to design a comprehensive, integrated approach to manage available resources to attain the goal of eradicating knotweed in your project area.

IMPORTANT NOTICE: *Mention of specific pesticide products in this document does not constitute endorsement of any material.*

Management Recommendations (Best Management Practices)

As for all weeds, there is no single "best" control strategy for knotweed. The choices you make will hopefully be guided by understanding the ecology of the plant, your native system and the costs and effectiveness of the various treatment options discussed here, your project goals and your (or your organizations) capacity to execute them. That said, the following recommendations are made in an attempt to provide guidance based on combining financial, ecological, practical and legal considerations. Good luck.

About stem injection
Although stem injection shows great promise for controlling established knotweed patches in a single treatment (or two), it is currently illegal to use without an experimental use permit at application rates that will work. If (when) such use does become legal, it should definitely be incorporated into your control program, especially for hard to reach patches with a high percentage of injectable (i.e. greater than 0.5 inch diameter) stems. Because injection is slow compared to spraying, some large and easy to reach sites, especially those found well away from water, may still be treated more effectively with foliar spray or an integrated foliar spray - injection program.

When to use manual methods
If you have easy access to your site, the patches are reasonably small (perhaps 50 stems or less) and you can commit to following the intensive control regimen described above, consider employing manual / mechanical methods. Be aware that repeated cutting tends to produce numerous small stems, which may make future treatment with stem injection (should it become legal) more difficult.

Patches outside the 100-year floodplain
Cut the patches in May-early June, then spray in late summer with either glyphosate, triclopyr (Garlon 3a) or an herbicide mixture containing glyphosate and triclopyr at a 2:1 ratio or more of glyphosate to triclopyr. For example use a spray solution of 2% Rodeo, Aquamaster, Gly Star or Round-up and 3/4 - 1% Garlon 3a. Use R-11 or an equivalent surfactant at 1% volume (about 1 oz per gallon). Carefully follow the manufacturer's instructions for combining these two (or any) herbicides.

Alternatively, carefully spray the plants as soon as they reach 1-2 meters tall as above. Return late in the summer to check for resprouts. In some circumstances (i.e. isolated patches on cobble bars etc...) you may be able to spray plants that are in bud without an early season cutting. Spray tall plants very carefully, desirable plants hit with herbicide will be injured or killed.

Patches within the 100-year floodplain
Cut the patches in May-June, then, when they reach at least 1 -2 meters in height, and if doing spot treatment, spray with a 5-8% solution of herbicide containing glyphosate that is labeled for riparian, or better yet aquatic use (i.e. Rodeo, Aquamaster). For wider, broadcast use, the label specifies a 2% application rate. Use a surfactant that is appropriate and legal. As mentioned above NOAA-Fisheries has only approved LI-700, but many other surfactants are labeled for use in riparian areas.

If a new label that includes stem injection is approved in your state, consider using stem injection on a all stems large enough to inject (~0.5-0.75" diameter minimum) and spot spraying small stems as above.

Patches overhanging water
In Washington State you need a permit to apply herbicides where they will contact water. NOAA-Fisheries has also expressed concern about herbicide use where it will contact open water. Regardless of legal concerns it is probably a good idea to minimize herbicide water contact. Too little is known about sub-lethal effects of many herbicides on aquatic fauna to justify disregard. Until stem injection becomes legal, an integrated approach in which stems are cut, then sprayed when they are short enough to prevent drift into water is probably the best compromise. A less attractive option is to use a wicking approach on the stems closest to the water.

Once a supplemental label is approved, this is the ideal situation to use stem injection.

**Addendum: Recent changes regarding the stem injection of herbicides for the control of Japanese and giant knotweed in Oregon*

The stem injection method treatments described in this guide were conducted by The Nature Conservancy and Metro Parks and Greenspaces as part of an experiment through an Experimental Use Permit granted by the Oregon Department of Agriculture. As such, we cautioned that the use of stem injection without a special permit was illegal.

However, as of January 30, 2004, the Oregon Department of Agriculture received the supplemental label for use of the Monsanto product Aquamaster (53.8% glyphosate; 46.2% water) to control Japanese and giant knotweed by **stem injection method**. The label reflected the changes requested by the US Environmental Protection Agency. The use of Aquamaster as per the supplemental label directions **is approved for use in Oregon**.

For practitioners in the Pacific Northwest: the Monsanto representative in Vancouver, Washington, Ron Crockett, can be contacted at telephone (360) 892-9884. He, his company or distributors should have the supplemental labels available with all the use directions.

We expect a similar approval by EPA for Rodeo (Dow Agrosciences version of the same product) in the near future. Contact the Oregon Department of Agriculture with any questions.

Please note that this decision does not affect the legality of this method in any other state. However, because the EPA decision is a federal one, it is likely that the supplemental label will be approved in most states if a manufacturer requests it.

Additional Resources

Because knotweed is such a widespread problem there are many web and print pages devoted to its control. The following are a few examples of resources available for more information:

Child, Lois and Max Wade. 2000. *The Japanese knotweed manual - the management and control of an invasive alien weed.* Packard Publishing Limited, Chichester. 123p

This is a comprehensive guide to designing and executing a Japanese knotweed control program from folks in Great Britain.

The Nature Conservancy Wildlands Invasive Species Website (tncweeds.ucdavis.edu)

This website has a wealth of information on exotic species control, and tools, and includes a review of knotweed control literature. The knotweed page is found at tncweeds.usdavis.edu/esadocs/Polycusp.html.

Washington Department of Agriculture (http://www.wa.gov/agr/)

Information about becoming a licensed pesticide applicator, which may be required prior to conducting herbicide applications. Information is also available for permits for aquatic applications, product label interpretation and product registration status.
360-902-1922

Oregon Department of Agriculture (http://oda.state.or.us/pesticide/index.html)

Information about becoming a licensed pesticide applicator, which may be required prior to conducting herbicide applications. Information is also available for product label interpreta tion and product registration status.
503-986-4621

Jonathan Soll, The Nature Conservancy of Oregon

For details of control experiments and outreach materials, and information about the Knotweed Working Group.
jsoll@tnc.org; 503-230-1221
821 SE 14th Ave
Portland, OR 97214

Cascade Pacific RC & D

For information about knotweed programs around the state, availability of grant funding to start a program or local contacts for information about weed control.
541-757-4807

Phil Burgess, Clark County Weed Management

For details of their work on stem injection and the availability of a injecting tool
phil.burgess@co.clark.wa.us; 360- 397-6140 x7731
11104 NE 149th St - Suite 300
Brush Prairie WA 98606

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