Preventing the Spread of

Japanese knotweed

Reynoutria japonica

(AKA: *Fallopia japonica, Polygonum cuspidatum*)



Best Management Practices

New Hampshire Department of Agriculture,
Markets & Food
2018

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Purpose statement:
Japanese knotweed is an aggressive invasive plant species that is becoming more widespread in the state of New Hampshire and the northeast. Because it can be spread vegetatively, the probability of moving Japanese knotweed during routine maintenance and in fill material associated with construction activities is increasing across the state, leaving municipalities and landowners with the costs associated with remediation of this destructive weed. Because of this, it is worthwhile to consider how to address Japanese knotweed movement prior to maintenance activities and during the planning phase of construction projects, rather than mitigating the damage post-construction. These BMPs will help you to understand the risks associated with Japanese knotweed; how Japanese knotweed is moved, both naturally and as a part of maintenance and construction activities; identify some basic critical control points to reduce the movement of Japanese knotweed; and provide some Integrated Pest Management (IPM) based control methods for Japanese knotweed.


Japanese knotweed in flower

Regulatory statement:
Japanese knotweed is a listed prohibited invasive species in the State of New Hampshire, and as such: "no person shall collect, transport, import, export, move, buy, sell, distribute, propagate or transplant any living and viable portion of any plant species, which includes all of their cultivars and varieties" (Agr 3802.01(b)). Transportation of Japanese knotweed in fill is a violation of these rules, and the NH Department of Agriculture, Markets & Food (DAMF) has enforcement authority of these rules. However, a regulatory response is only initiated *after* the knotweed has been moved and a resulting violation confirmed.

A strictly regulatory response to violations is not the most effective way to manage for Japanese knotweed. Effective management involves including best management practices as part of your overall plan – including ensuring that clean fill is used, vehicles are cleaned, and properties are inspected periodically throughout the process. This manual should help you to achieve these goals.

Who should use this manual:
This manual is intended to provide management strategies for developers, site managers, contractors, utility companies, sand & gravel operations, highway/roadway maintenance crews, landscapers, property owners and others working on projects where Japanese knotweed occurs. It is intended to reduce the risk of spreading Japanese knotweed by providing effective on-site management practices.

What is Japanese knotweed:
Japanese knotweed (*Reynoutria japonica* also known as *Fallopia japonica* and *Polygonum cuspidatum*) is an aggressive and highly invasive herbaceous to somewhat woody perennial originating from eastern Asia (Japan, Korea, China and Taiwan). Japanese knotweed is very similar to two other closely related invasive knotweeds found in New Hampshire: giant knotweed (*Reynoutria sachalinensis*) and Bohemia knotweed (*Reynoutria* ×*bohemica* [*R. japonica x R.*

sachalinensis]. All three knotweeds should be managed following the practices described in this manual. Japanese knotweed is one of the 1,200 species found in the buckwheat / knotweed family (Polygonaceae). One of the family characteristics that this plant has are noticeably jointed stems leading many people to believe Japanese knotweed is actually a bamboo. It was first brought to the United States in the late 1800's for ornamental and horticultural purposes. It quickly became popular in the nursery trade and has been planted in landscapes throughout North America. It was also planted for erosion control and as a forage crop; little did they know at the time how damaging these practices would be.

Invasive characteristics of Japanese knotweed:

- Fast growing, ~ 8" per day
- Large woody rhizomes that penetrate the ground up to 10' deep and laterally can exceed 40'
- Allelopathic properties (*chemical compounds that are released by certain plants to eliminate vegetative competition*) allowing it to displace native vegetation
- Forms dense clonal communities
- Regenerates from rhizome fragments as small as ½" in length
- Rhizomes can remain dormant for up to 20-years
- Cut or mowed stem fragments can regenerate from nodes
- Outcompetes native species and reduces or eliminates native plant diversity
- Grows through concrete and pavement causing issues with infrastructure, utilities, drainage, septic systems, walls, and foundations

Movement and dispersal:



Construction/Earth Moving activities are one of the leading causes of Japanese knotweed spreading throughout the state. Small ½" fragments of its rhizomes can survive long periods of time in a dormant state and regenerate when conditions allow, which is why it is imperative to scout for and manage Japanese knotweed prior to moving any earthen materials both on and off site. The most common cause of spread is the result of construction activities in areas where Japanese knotweed occurs such as, routine maintenance of roadway drainage channels, slope work, or site-work involving excavation. Screening earthen material containing knotweed rhizomes often results in the rhizomes being chopped into numerous viable propagules waiting to regenerate.

Mowing/Cutting can result in the spread of Japanese knotweed under certain conditions. Mowed/cut stems/fragments with nodes/joints have the ability to develop adventitious roots and shoots if they come in contact with moist soils or water. This occurs when clods of mowed/cut knotweed stems accumulate on equipment and eventually drop off. Larger stem pieces usually have sufficient moisture reserves to retain their viability whereas mowed/chewed up step fragments are less likely to regenerate on their own.

Mowing/cutting does nothing to manage or reduce knotweed populations. In fact, these types of impacts typically break dormancy of lateral buds along the rhizomes thus expanding the outer limits of the population. Mowing/cutting should only be done if safety is an issue and the equipment is

cleaned before moving off site. If mowing/cutting is required, then foliar herbicide treatments or smothering should be integrated as part of the management effort.

Pathways for introduction of Japanese knotweed:

Vector	Notes	Long Distance
Construction - residential/commercial	Excavation of earthen material	Yes
Roadway – construction/maintenance	Excavation of earthen material	Yes
Machinery/equipment	Tracks, tire treads, soil clods	Yes
Rivers - flowing water/flooding	Scour damage, uprooting	Yes
Collecting - specimens	Hedge/fence row/specimen	Yes
Mowing – viable stem fragments	Stem fragments, mower decks	Yes

Japanese knotweed impacts:

***Structural*:**

When Japanese knotweed occurs adjacent to man-made structures such as bridge abutments, roads, sidewalks, parking lots, and foundations, the rhizome can damage and even weaken their structural integrity as the rhizome system expands in size. As the rhizome increases in diameter, upward pressure is exerted, which can split structures at their weakest points. The rhizomes can also damage subsurface drainage, underground conduits, septic systems, etc.

Environmental:

Japanese knotweed can spread very quickly and forms dense colonies that out-compete native vegetation by blocking sunlight, releasing chemicals (allelopathic) from its rhizome that suppress plant growth and germination, and robbing nutrients and water from the soil. In floodplain and shoreline habitats, knotweed is moved by flowing water during flooding and ice flow events. Whole or partial Japanese knotweed plants are carried downstream and take hold to form new populations. The Baker River is one of New Hampshire's river systems being choked by knotweed. Increases in Japanese knotweed populations within riverine systems can impede water flow and lead to increased risk of flooding.



The Baker River in Rumney, NH, just one of the many areas along this resource choked by Japanese knotweed

Reproduction by seed is not typically an issue that warrants the same precautionary measures as with vegetative propagules. Although seeds can and do germinate, they rarely survive. Seeds and seedlings tend to be fed on by small mammals, injured by frost, or fail to develop due to dry soil conditions and/or lack of sunlight.

The low risk of Japanese knotweed establishing via seed (sexual reproduction) clearly indicates that human actives are a primary cause for its spread and establishment on embankments and floodplains associated with surface waters and wetlands. The source of reproductive material for these areas usually originates from Japanese knotweed growing within the watershed, which was brought there in fill material for commercial / residential development and/or road construction / maintenance. Human activities and/or sheet flow runoff can transport living and viable propagules into surface waters and adjacent habitats where they take root. Because there is a close relationship between human activities and the spread of Japanese knotweed, due diligence can significantly reduce the spread, as well as the economic and environmental costs of Japanese knotweed.

Community:
Japanese knotweed has very few aesthetic qualities that make it a desirable landscape plant, especially as the aboveground portion of the plant dies off leaving dead persistent stalks from late fall to spring. In unmaintained areas and natural habitats, these dead-brown stalks remain standing for up to 5-years. In urban environments, debris and trash tend to accumulate in Japanese knotweed thickets and, in some cases rat/rodent populations increase. Japanese knotweed stands also provide discrete locations for drug use and other illicit activities. All of these factors diminish intrinsic and monetary values of communities, personal property, and natural landscapes.

Economic:
The presence of Japanese knotweed in any location whether in development/construction sites, occurring along roadways, adjacent to homes or buildings or choking rivers and waterways all cause economic impacts. These impacts are difficult to quantify, but are attributed to structural damage/failure, safety concerns for motorists, flooding damage, and loss of important habitats.

According to 2016 cost estimates from the Rockingham County Conservation District (RCCD), the typical cost to manage knotweed using a glyphosate based product is approximately $500/acre for the initial treatment. A follow up second year treatment costs approximately $300/acre and if treatments for a third and subsequent years are necessary, the cost is around $200/acre/per year. These cost figures do not include site remediation, removal of vegetative growth, soil stabilization or revegetation.

Identification of Japanese knotweed:
Japanese knotweed grows to a height of 10’ with a spreading habit of approximately 5’. When mature, the greenish stems with purple splotches grow to 1 inch in diameter and are hollow with segmented joints. The joints, where reproductive nodes form, have a characteristic tannish papery sheath, typical of plants in the buckwheat family. After the first killing frost in the fall, the entire aboveground portion of the plant dies off and turns brown. The stalks remain persistent throughout the winter and into the spring. Emergence from winter dormancy begins in April. The young shoots resemble those of asparagus and are sometimes collected for culinary purposes. Its rapid growth rate allows it to attain 8” in height per day.

Leaves are 4-7” long by 3-4” wide and arranged alternately along the zigzagged stems and branches. The leaf petioles arise from the nodes. The leaves themselves are semi-triangular in shape with smooth margins and a flat truncate base. One of the aspects of Japanese knotweed that allows it to outcompete native species is that the foliage density creates a thick canopy that significantly reduces light levels to the ground below.

Stems are upright, tall-10', greenish with purple splotches, hollow between raised nodes, profusely branched, and grow to 1" in diameter.

Rhizomes are horizontal underground stems that have a high capacity for storing carbohydrates for growth and overwintering. The rhizome accounts for 2/3 of the plant's entire mass and can travel up to 20' horizontally with some accounts of up to 60', and go 6-10' deep. Rhizomes have a dark brown exterior and a bright orange interior. Perennating buds found on the crown and along the rhizomes will also react to shoot damage, i.e., mowing/cutting, by sending up additional shoots along the rhizome. This typically results in radial/clonal spread of the plant and increases its shoot density. These latent buds also allow rhizome fragments, as small as ½" long, to regenerate into new plants when severed. This can occur from ice flows along waterways or by construction activities involving excavation where Japanese knotweed occurs. Evidence also shows that Japanese knotweed releases chemicals into the soil in the form of alleliopaths for the purpose of eliminating competition.

Flowering begins in mid-August and lasts for about 3-weeks. The flowers are small, whitish-green and form dense clusters, called panicles, from the leaf axils. The flowers are pollinated by insects, primarily honeybees and other types of bees. *Because of issues with honeybee and native bee decline, any attempt at using chemical control should be delayed until after flowering and honeybees and other pollinators are no longer present*.

Japanese knotweed is a dioecious type plant, meaning there are both male and female plants. Although it is typically thought that Japanese knotweed seeds are sterile, an anecdotal study conducted by the DAMF found a germination rate of 95% for seeds collected throughout New Hampshire. This anecdotal evidence shows that it can be spread from seed and not just rhizome and stem fragments. Several factors may limit the seeds' ability to become fully mature including competition, dry or wet conditions, shade, predation and frost damage. Examination of where Japanese knotweed occurs clearly demonstrates an association with disturbance events rather than seed dispersal. The seeds that form immediately after flowering are contained in a 3-wing calyx that can be carried in the wind or by water.

What to look for:

- fleshy red tinged shoots when breaking through the ground
- large, heart or spade-shaped green leaves
- leaves arranged in a zig-zag pattern along the stem
- a hollow stem, like bamboo
- dense clumps that can be several meters deep
- clusters of cream flowers towards mid-August that attract bees
- die back between September and November, leaving brown stems



Japanese knotweed flowers

Pre-construction considerations:

1. Survey the site for the presence of Japanese knotweed prior to buying or commencing work.
    a. Learn how to identify Japanese knotweed, and other invasive plants.
    b. If site has been disturbed / cleared, look for emerging shoots poking through the soil.
    c. Look at aerial imagery (Google Earth, Bing Maps or other program) to search for possible presence of Japanese knotweed.
    d. If Japanese knotweed does occur, determine feasibility and prudency for management.
2. Timeframe for treatment and development
    a. Develop management plans that will meet the timeframe of the project.
    b. Initiate herbicide treatments or smothering within the necessary timeframe (3-5 years) to ensure success.
3. Management of treated material
    a. Herbicide treatments are often not successful the first time and require retreatment. Plan accordingly and if the material is needed only use it in locations where further treatments can occur.
4. Keep all material on-site, if possible. If this is not possible, ensure that it will be going to a location where it can be monitored and corrective action taken if needed.

Management guidelines:

1. Provide identification training for employees and contractors involved with scouting or performing vegetation management
2. Prior to initiating any project conduct a site visit to scout for and locate Japanese knotweed. This step is critical. It is worth the time to do a thorough job. Plot infestations on plans to make personnel aware of their locations.
3. Consider which management method is most appropriate for the scale of the knotweed population - herbicide treatments or smothering.
4. Plan activities to eradicate the Japanese knotweed prior to commencement of work. If herbicides are used, then the application needs to be done within the timeframe outlined on the pesticide label.
5. Avoid working in areas where Japanese knotweed occurs.
6. Do not reuse soils containing Japanese knotweed plant parts/propagules. If soil associated with Japanese knotweed needs to be excavated and moved, then stockpile the material on-site.
7. If on-site fill piles already have Japanese knotweed, treat chemically or smother.
8. Do not bring Japanese knotweed infested soils to the site. If soil is required from off-site sources, inspect the source, site, and material prior to purchase. If Japanese knotweed is found on piled material, inform the company of the regulations regarding the movement of Japanese knotweed.
9. Maintain a 20’ buffer beyond the aboveground portion of the Japanese knotweed to prevent excavating rhizome fragments.
10. Prior to moving equipment out of an infested area, inspect and clean by removing all soils, seeds and/or plant parts. This can be done manually or by pressure washing. Avoid washing oils and greases from equipment to reduce risk of contamination.
11. Stabilize and revegetate disturbed soils as soon as possible.
12. Use non-invasive cover crops or native seed for revegetation.
13. Monitor the site to ensure that control methods were effective.
14. Do not move soils containing living and viable propagules off-site unless for proper treatment/disposal.
15. Periodically inspect the project to determine if Japanese knotweed fragments are beginning to establish.

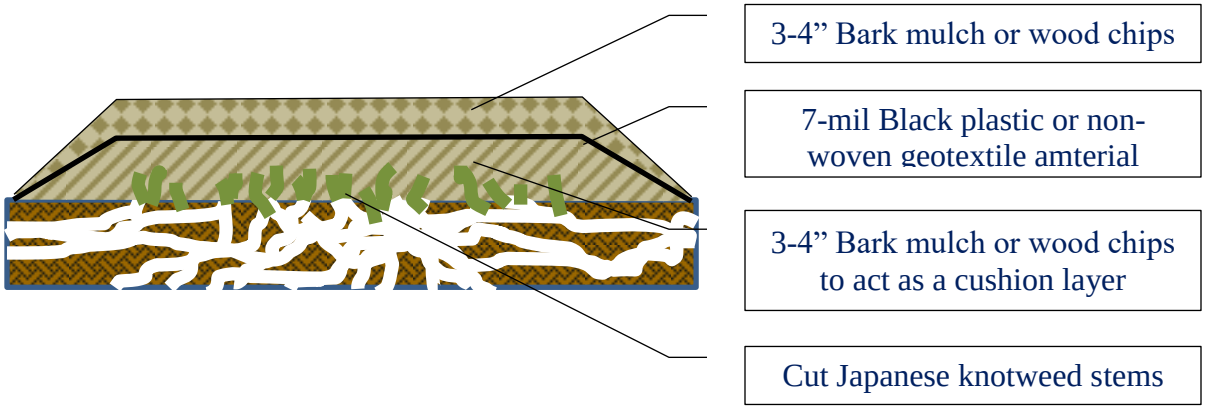
16. Conduct an inspection at the completion of the project to ensure that Japanese knotweed plants have not established. If they have, meet with the project management team to determine a response.
17. Consider including a clause in contracts requiring inspection of the project site one year after completion to address any discovered Japanese knotweed stands resulting from the construction activities.

Methods to control Japanese knotweed:
The following methods detail several options available for the management / eradication of Japanese knotweed plants, and knotweed infested soil both on-site and off-site. The methods are based on Integrated Pest Management (IPM), which is based on mechanical, cultural, biological and chemical controls.

Mechanical:
Mowing/Cutting alone will not eradicate Japanese knotweed and, therefore, should only be used in combination with herbicide applications or smothering. Cutting the aboveground portion of the plant usually stimulates dormant lateral buds along the rhizome system, which then send up new shoots further away from the crown, essentially increasing the total number of stems and extending the limits of the stand. This can have a serious impact to buildings and roadway infrastructure. The cut portion of the Japanese knotweed can be left in place and allowed to dry in the sun. Once the cut stems turn tan to brown in color they are no longer a threat. If freshly cut portions of the plant are moved to another location, ensure they do not come in contact with moist soil, wetlands or surface waters where they can regenerate.

Hand pulling or digging should be limited to new populations that came in with soil containing propagules of Japanese knotweed or small young populations where only a handful of stalks occur. New occurrences in construction sites or work areas can easily be removed by grasping onto the emerging stalks and pulling. If they resist then using a shovel or spade dig adjacent to the stalk to access the rhizome. Ensure that all dug plant material is destroyed before disposing of elsewhere. If herbicide was used as a control method, it's possible that it may take 3-5 years to determine if the management was 100% successful

Smothering is a very effective alternative if you wish to avoid the use of herbicides. Not only does it eliminate the need for chemicals, but there are also no soil disturbance/erosion issues. Here are the general guidelines:



1. Allow the knotweed to grow in the spring without attempting to control it;
2. Cut the knotweed at the base and close to the ground around the first week in June (allowing for early rapid growth causes the plant to exhaust the stored carbohydrates thus weakening the rhizome system);

3. Pile all of the stems on an impervious surface such as a tarp, plastic, pavement, etc. so they can dry (after turning brown the stems are no longer viable or a threat);
4. Spread an adequate layer of mulch, grass clipping or other material over the cut stems to prevent them from puncturing the tarp or plastic, which will be applied in the next step;
5. Cover the entire area with the biggest heavy-duty dark colored tarp you can find, or use large sheets of thick (7-mill or thicker) black plastic. If more than one tarp or sheet of plastic is used make sure to have a wide overlap of 2' between sheets to prevent sunlight from penetrating. Also, make sure the cover material extends a few feet beyond the limit of knotweed in all directions;
6. Weight the top of the tarp/plastic and seal the edges with rocks, sticks, soil, sand, mulch, etc. Do not puncture the tarp/plastic as this can allow knotweed stems to survive. If any tears or holes develop, patch them.
7. If aesthetics is an issue, the tarp/plastic can be covered with attractive bark mulch or other material. If it's on a steep slope some method of anchoring will be required to ensure the mulch doesn't slide off into the surface water. Mulch also protects the plastic from UV photo-degradation.
8. After 5 years the covering material can be removed and the area replanted. If the area falls under the Comprehensive Shoreland Protection Act (CSPA) then approved plants must be used.

   Although this method is time consuming it has been very successful for use in sensitive areas here in NH.

Cultural:
Cultural control involves the alteration to the environment to make it inhospitable for the invasive plant to grow. Unfortunately, Japanese knotweed is highly adaptable to most environments and conditions and cultural controls are not an option. Japanese knotweed grows in soil pH levels ranging from 3.0 to 8.5, it tolerates wet soils, dry soils, and dappled shade. Controlled burning and grazing are also not effective as only the upper portion of the plant is affected and the rhizome system remains intact.

Biological:
Biological control of Japanese knotweed is currently unavailable (as of 2016). However, research is underway to evaluate a leaf-eating insect imported from Japan called a *psyllid*. The *psyllid* was found on knotweed growing wild in Japan and is undergoing host specifity tests with the USDA. The New Hampshire Department of Agriculture, Markets & Food (DAMF) will continue to monitor the status of its availability in hopes that it will soon be viable option for control.

Chemical:
Chemical control can be very effective for managing Japanese knotweed, but can only be done by a NH licensed herbicide applicator or by property owners on their land. Special permits issued by the DAMF Pesticide Control Division may be required so plan accordingly and allow sufficient time for application processing.

Understanding Japanese knotweed physiology will greatly improve the success of chemical control measures. Japanese knotweed is unlike most plants in that the flow of nutrients/carbohydrates is in one direction. Nutrients/carbohydrates move upward during the growing season until flowering and then the process reverses to deliver the nutrients/carbs back down to the rhizome system for overwintering. Therefore, time the application so it occurs just after flowering up until the first killing frost (September – November). This greatly improves the efficacy of the treatment (*early season applications will have little effect on the plant other*

than foliage burn). **Another reason for waiting until after flowering is to avoid impacts to foraging honeybees and other pollinators**. Understanding the timing for chemical control is the key to success.

Herbicides containing the active ingredient (a.i.) glyphosate have been very effectively applied as a 2.5% solution foliar spray. Glyphosate bonds with the carbohydrates and is translocated throughout the rhizome system to kill the plant. In addition, a non-ionic surfactant / spreader / sticker should be used.

A strategy to increase efficacy of chemical control is to cut and remove the aboveground portion of the Japanese knotweed in early June, allowing the stalks to regenerate before treating. Cutting the aboveground portion of the plant automatically stimulates regrowth. This process requires energy stored in the rhizome to be used for new shoot development and thus weakens the rhizome system. Apply the chemical treatment as described above. An added benefit to doing a pretreatment cutting is that the shoots will be shorter at the time of treatment. Typically knotweed grows to 10' tall whereas the regrowth from cutting is usually about half the height, making it easier to access and confirm treatment coverage.

The use of herbicides does not guarantee complete success, and follow-up applications will likely be required for up to 3-5 years. Although 100% control has also been achieved, the average success rate is around 85% after the first treatment. If any viable Japanese knotweed plants survive they will continue to grow, spread and repopulate the site in a matter of years. Japanese knotweed has the ability to remain dormant for many years so even when the site looks to be free of it, it may just be waiting. Long-term monitoring and management is recommended.



Tech Tip

Thorough surveys and early planning efforts will increase the likelihood of success.

Disposal of Japanese knotweed:

- Japanese knotweed crowns and rhizomes can be disposed of by burning/incinerating, burying (>5' below ground), chipping, or sending to a landfill that will accept it. They cannot be stockpiled near wetland or surface waters unless they have been killed by herbicide or heat treatments. Composting crowns and rhizomes is **not** recommended.
- Brown dead stalks of Japanese knotweed can be composted. If the stems are freshly cut then they pose a risk of spreading and need to be dry before composting.
- Never dispose of Japanese knotweed into wetlands, surface waters or in areas with moist soil as the stems may take root.

Utilization of soil containing treated Japanese knotweed rhizomes:

Often the soil from an area with Japanese knotweed populations is needed elsewhere on a project or needs to be taken offsite. By the State's administrative invasive species rules, this can only be done if the Japanese knotweed propagules are non-living or non-viable, in other words, if the risk has been limited by treatment.

Although moving this soil it is not recommended as this could potentially spread surviving rhizome fragments, there are BMP's that can be used to reduce movement, including:

On-site:
Ensure that all of the Japanese knotweed plants have been treated using appropriate herbicides. Allow the herbicide to work and translocate throughout the plant to the point where the leaves become symptomatic / turn yellow. Soil material can then be excavated and moved wherever it is needed. Keep in mind that any remaining viable rhizome fragments can and probably will regenerate. It is your responsibility to ensure this does not happen, and if it does, it is your responsibility to remediate the issue to avoid a possible violation.

Off-site:
The DAMF recognizes that retention of soil materials on site is not always an option, e.g., in roadway maintenance projects or sand & gravel operations. If soil needs to be moved elsewhere, then actions need to be taken to ensure that any remaining viable Japanese knotweed propagules do not become established at their final destination. Any Japanese knotweed that survives needs to be controlled to prevent any possible violations. Deposition sites should not be adjacent to or in close proximity to wetlands, surface waters or sensitive habitats.

Other resources:

Japanese knotweed / invasive species reporting system:
Populations of Japanese knotweed and other invasive species can be reported, by you, directly into the free mapping database program EDDMapS (www.eddmaps.org). This program maps the locations of known invasive species populations nationwide that can be used to determine potential problem areas or help track newly detected invasive species outbreaks for Early Detection & Rapid Response measures. EDDMapS can be accessed via their website, or by using the *Outsmart Invasives* smartphone app. This app automatically records the coordinates for the plant(s). The user must include a clear photo for verification purposes. Although the app includes numerous other data entry fields, they are not required since invasive populations are dynamic changing from year to year. Once the report is submitted it then goes to the approved verifier for the state and released if approved. The photo(s) and information are then available to anyone to view. The information EDDMapS provides can be a valuable resource for anyone involved with early planning and development stages for all types of development / construction.

New Hampshire Department of Agriculture, Markets & Food:
Available on the DAMF website (http://agriculture.nh.gov/divisions/plant-industry/invasive-plants.htm) are numerous invasive species fact sheets, control/management guidelines, and possible funding sources for non-commercial invasive plant control initiatives.

For additional information and guidance regarding Japanese knotweed and/or other invasive species, contact:

Douglas Cygan, Invasive Species Coordinator
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29 Hazen Drive
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Japanese knotweed Identifying Photos



Mature flowering Japanese knotweed cluster



Alternately arranged leaves on zig-zag stem



Jointed/segmented stem



Crown/rhizome



Underground rhizome structure

Japanese knotweed Identifying Photos



Stems are hollow and segmented with partitions



New shoots emerging in the spring-April/May



Many small whitish flowers along the stems



Flowers attract honeybees and other pollinators



Flowering is arranged in panicles



Seeds, 3-wing calyx, develop in the fall

What to look for during and post construction



Rhizome segments/fragments that have regenerated



Large segment of rhizome regenerating



Accidental spread from rhizome fragments



Construction site with regenerated rhizome segments



Wood chips containing Japanese knotweed



Erosion/scour damage moving rhizomes

Problems resulting from movement of Japanese knotweed propagules in soil material



Roadway sight distance and safety issues



Obstruction of fire hydrant



Structural damage to residential home/basement



Power grid sub-station impacts



River embankment/floodplain/farm field impacts



Dense canopy closure outcompetes native plants

Effects from herbicide and smothering



Herbicide effects on right vs untreated on left



Smothering using 7-mil black plastic and 4” mulch



Herbicide treatment after June cutting (Before)



Success of post flowering herbicide treatment (After)



Mutation resulting from insufficient herbicide



On-going project using herbicide to restore site