Japanese Knotweed on the Shoreline of the Missisquoi and Trout Rivers: Westfield, Troy, Richford, Berkshire, Enosburgh, and Montgomery, Vermont

Prepared for:

Missisquoi River Basin Association

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1 Summary Findings

Arrowwood Environmental, LLC (AE) conducted an inventory of the occurrence of the plant Japanese knotweed *(Reynoutria japonica)* along the shorelines of the Missisquoi and Trout Rivers located in north-central Vermont. Knotweed was mapped along these rivers within the Towns of Westfield, Troy, Richford, Berkshire, Enosburgh and Montgomery. The Missisquoi and Trout Rivers within these towns are designated as part of federal Wild and Scenic Rivers program administered by the National Park Service. Knotweed distribution was scattered and isolated on the shorelines within the Towns of both Westfield and Troy east of the Green Mountains. However, on the shorelines of both the Missisquoi and Trout Rivers within the Towns of Richford, Berkshire, Enosburgh, and Montgomery (all towns located west of the Green Mountains) knotweed had a greater presence and was often found growing along the majority of shoreline areas.

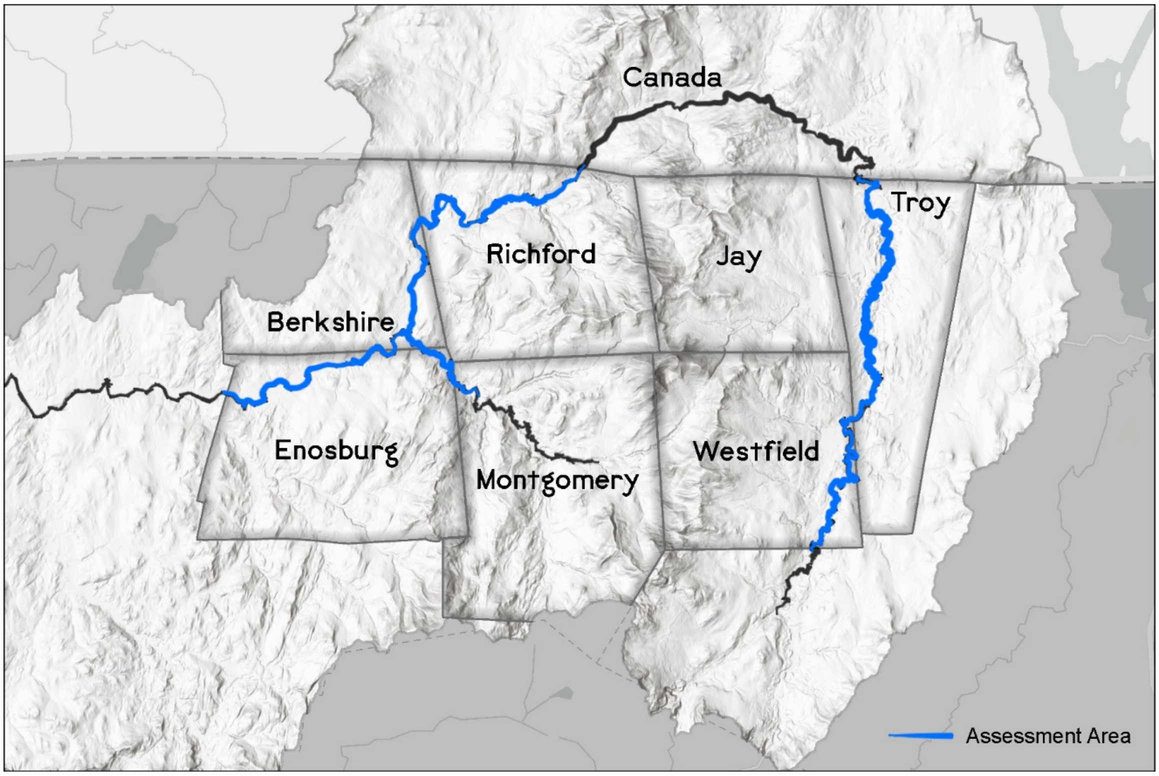
2 Introduction

Japanese Knotweed (*Reynoutria japonica)* is a Non-native Invasive Species (NNIS). An NNIS is a species which is not native to Vermont and whose establishment threatens biological diversity and in the case of knotweed it threatens the native ecology of our waterways. The Vermont Agency of Agriculture maintains a list of "Noxious Weeds" in Vermont and regulates the sale and importation of these Class A and Class B species. Japanese knotweed is a Class B noxious species indicated on the Vermont Agency of Agriculture list. On the iNaturalist website, Japanese knotweed is among the top 30 most observed and reported species (native or non-native) in the State of Vermont (site accessed 01-04-2021) with over 1,500 observations in Vermont.

As the name implies, this species, which looks similar to bamboo, is of Asian origin and was introduced into North America in the late 1800s. Knotweed prefers full sunlight and disturbed soils, conditions that are abundant along the riverbanks and floodplain forests of river systems such as the Missisquoi and Trout Rivers. This species grows vigorously under the right conditions and can form dense colonies that prevent the growth of almost any other plant. Plant fragments, even minute fragments, which are washed downstream can readily re-sprout, forming new populations. This method of reproduction makes this species very difficult to control, especially where it occurs along riverbanks. Japanese knotweed is one of the most wide-spread and well-established invasive species found along both the Missisquoi and Trout Rivers.

3 Methodology

The study area for this inventory consisted of the Missisquoi River from the Lowell-Westfield town line north to the Canadian border in Troy (where the river enters Canada) and in Richford from the US-Canada border south to the Sheldon-Enosburgh. The Trout River study area was from the Longley covered bridge in Montgomery to its junction with the Missisquoi River in Berkshire. The field methodology consisted of canoeing the Rivers and mapping knotweed presence on each side of the river as well as on any islands. All or part of 11 days were spent canoeing the 2 rivers throughout the summer of 2020.



Japanese knotweed has a distinct leaf size and shape as well as a distinct purplish stem color and stems of the plant can readily be distinguished from other plants. Giant knotweed *(Reynoutria sachalinensis*) is a similar plant but with different leaf morphology and was not observed on either of the rivers.

Only knotweed stems that were visible from the canoe were mapped. Effectively only populations on the immediate shoreline and other shoreline features such as banks and point bars were inventoried. No attempt at determining the extent of knotweed populations away from the immediate shoreline was made as the visibility from the canoe was limited.

On the Missisquoi River east of the Green Mountains and for the entire length of the Trout River, shorelines and knotweed stems could be identified and mapped from the canoe without having to physically traverse from side to side in the river. On the lower river sections in Berkshire and downstream, binoculars were utilized to aid in the identification and discrimination of knotweed from other large-leaved shrubs such as dogwood. Occasionally it was necessary to cross the Missisquoi River to ensure the proper identification of shoreline plants and knotweed.

A handheld gps-enabled device running a custom-built data collection tool using ESRI's ArcGIS Quickcapture software was used to record information about the distribution of knotweed on the shoreline. Point features were recorded when knotweed was encountered. Single-stem, populations under 5 feet in length, and populations between 5 to 20 feet in length were recorded in the middle of the stem/population. Start and stop point features were recorded for populations greater than 20 feet in linear length.

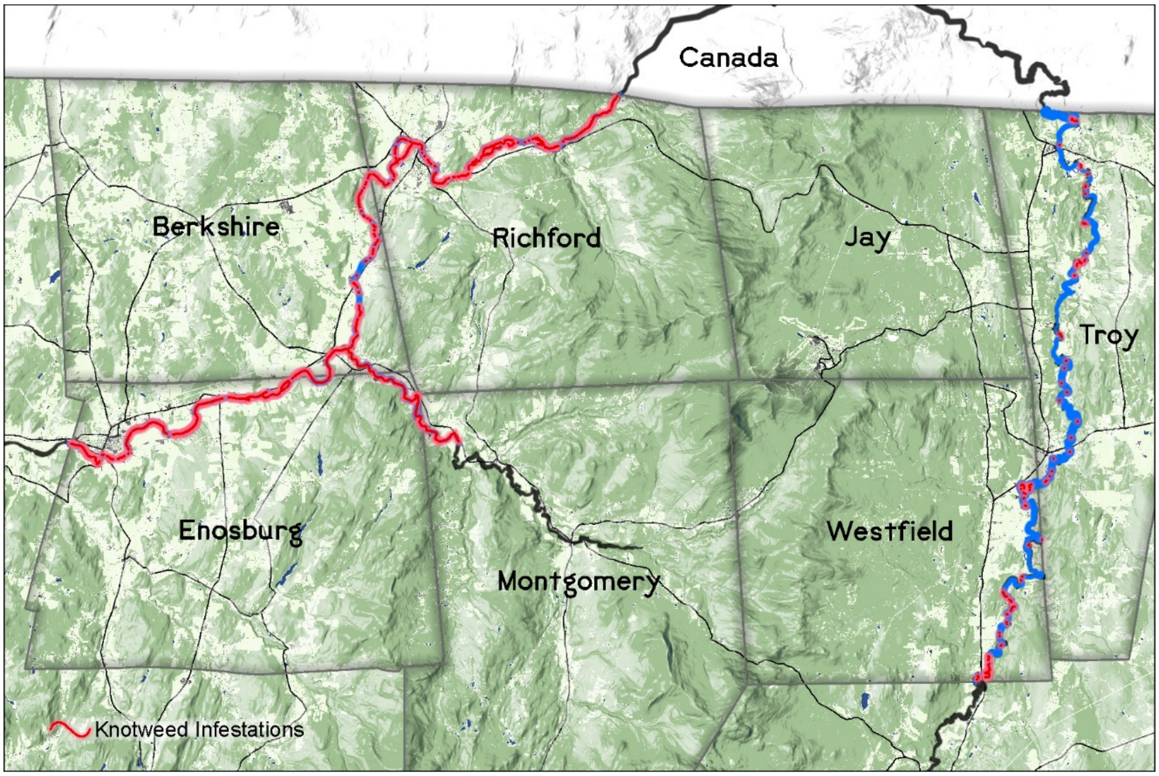
4 Japanese Knotweed Biology and Impacts

Japanese knotweed is a shrub-like, herbaceous perennial (that dies back to the ground each fall) within the Buckwheat family. Knotweed can grow to over 10 feet in height and form dense thickets that prevent sunlight from reaching the ground. Young knotweed seedlings generally are not able to reproduce under the dense canopy of its parent plant and are most likely to become established on open bare soil. Knotweed reproduces sexually as well as vegetatively through an extensive network of rhizomes (roots that can sprout new stems) that may spread up to 65 lateral feet from the parent plant. Plant fragments from both stem and root material can sprout and produce new plants. Knotweed fragments buried in soil as deep as 3 feet have produced viable seedlings. Knotweed has a deep tap-root and an extensive system of rhizomes that can grow to 3 inches in diameter and penetrate as much as 7 feet deep in certain soils. The underground portion of the plant can account for two-thirds of the plant biomass. Knotweed produces creamy white flowers in late summer.

Japanese knotweed is most commonly found in areas with full sunlight and areas where the soil has been disturbed. However, knotweed can grow under a forest canopy in areas that receive ample oblique sunlight such as in riparian habitats. It is often seen along stream banks (often in erosion-prone and depositional areas), roadways and waste places.

Japanese knotweed can cause a myriad of problems when found along shorelines. It poses a significant threat to riparian areas, where it can survive severe floods and is able to rapidly colonize scoured shores and islands. Once established, populations are extremely persistent and difficult to control. Dense stands of knotweed are nearly impenetrable and due to a lack of light penetration can limit the growth of other native shoreline plants. There is some evidence that knotweed also has allelopathic or phytotoxic effects, suppressing the growth of other shoreline plants including trees such as willow and cottonwood (Dommanget et al 2014). Dense knotweed can prevent human access to rivers for fishing, swimming, and other recreational pursuits. Because knotweed dies back each fall leaving shorelines and banks unvegetated– floods occurring in winter and spring can erode shorelines in areas where the knotweed occurs. In Europe, the presence of knotweed may even cause difficulties in securing home mortgages (The Guardian 2012).

5 Knotweed Distribution



Japanese knotweed is widely, but not evenly, distributed along the shoreline of the Missisquoi and Trout Rivers within the Wild and Scenic designated regions. Within eastern reaches of the Missisquoi River, in the Towns of Westfield and Troy, knotweed distribution is characterized by many scattered and isolated small populations with fewer continuous shoreline populations present. Westfield has the greatest aggregations of knotweed in the southern part of the town and again as the Missisquoi River nears Route 100 in the northern reaches of the town. Overall Westfield has approximately 9% coverage of the riverbank by knotweed. The Missisquoi River in Troy has mainly scattered and isolated small populations and overall has approximately 2% shoreline coverage by knotweed. The largest concentration of knotweed in Troy is located just north of the Veilleux/Bergeron Road bridge crossing on River Road.

Japanese knotweed populations are much more extensive on the west side of the Green Mountains on both the Missisquoi and Trout Rivers. The Missisquoi River west of the Green Mountains flows south out of Quebec, Canada. In the Town of Richford immediately south of the border, 38% of the river shoreline has knotweed present. In Enosburgh shoreline coverage is highest at 58% and in Berkshire approximately 40% of the total shoreline area has knotweed present.

The Trout River shoreline is nearly completely infested with knotweed throughout the area inventoried. Approximately 93% of the Trout River has knotweed present. With such a wide distribution, knotweed is found in nearly all land-use settings including agricultural, forest, and more developed areas along the Trout River shoreline.

6 Knotweed Control and Management

Japanese knotweed populations in the study area range from small, isolated single-stem occurrences on the Missisquoi east of the Green Mountains to the nearly continuous knotweed cover located on the Trout River and shoreline areas of the Missisquoi River west of the Green Mountains.

The techniques utilized for the management and control of knotweed populations will differ based on the following considerations: 1) the linear and lateral extent of a particular knotweed infestation at a location; 2) the available labor to work on the control and or elimination of knotweed on a shoreline section or parcel -including possible multi-year commitments; 3) the availability and commitment of funds to control knotweed populations; and, 4) the willingness to use techniques such as herbicide applications that may have a negative effect on other shoreline biota and the riverine environment including plants and animals.

Controlling infestations such as the continuous populations found on the Trout River or over large shoreline areas on the Missisquoi west of the Green Mountains in the Towns of Richford, Berkshire and Enosburgh is a major undertaking. Attempts at knotweed control in these areas will require a sustained commitment of time, effort, and money. This is not to suggest that landowners and conservation groups not begin attempts at control of the plant in these areas – but they should do so realizing that it will be a long-term and labor intensive process.

In order to maximize results in the control of knotweed for the current study area the preferred approach may be to focus on knotweed control within smaller isolated populations like those that occur along most of the Missisquoi River shoreline east of the Green Mountains in the Towns of Westfield and Troy.

In all regions of these 2 rivers, it is highly unlikely that knotweed presence in the overall watershed will be eliminated in the near future. This suggests that re-infestations can and will occur along the shoreline. Long-term knotweed control techniques will be more effective when accompanied by land-use changes that promote the establishment and persistence of natural forested communities along the shoreline. This might include the planting of native trees and shrubs that are intended to minimize shoreline erosion as well as establish native plants and plant communities.

6.1 Knotweed Control Techniques

6.1.1 Chemical Control of Knotweed

The use of herbicides in the control of knotweed is well-established and has been used in Vermont and elsewhere by both landowners and as part of scientific experiments aimed at knotweed control. The most common chemicals used are Glyphosate-based chemicals. Glyphosate-based herbicides are considered relatively non-toxic, and as a non-controlled herbicide are available for public purchase. Rodeo, Roundup, Gallup, Landmaster, Pondmaster, Ranger, and Touchdown formulations have all been used in attempts to control knotweed.

Glyphosate is applied during the fall months either by foliar spray or stem injection methods. Knotweed's extensive rhizomatous root system and a fall application targets the plant when carbohydrates are being shunted to the root system (and thus herbicides too) thereby partially controlling root growth and expansion, but also depleting energy storage, and future plant growth. Fall applications should therefore be timed to occur before the 1st killing frost. A targeted hand cutting of the stem, often in late spring (after the plant has translocated carbohydrates from the rhizomes to the growing stem), is sometimes done in conjunction with the fall application. Glyphosate has been shown to be the most effective herbicide used to control knotweed. The herbicide triclopyr has also been used with some success.

Herbicide application techniques can be used on single stem, as well as more extensive, knotweed infestations. Foliar applications utilizing a spray can, brush-on, or drip application can be utilized to control larger multi-stem infestations. For single-stem and other small infestations using a needle-type insertion technique can be utilized whereby the herbicide is injected directly into individual stems of the plant.

Glyphosate and its surfactants can have negative impacts on living organisms, especially aquatic plants but also aquatic insects, and to a lesser degree fish, amphibians, reptiles and the terrestrial organisms that depend on these organisms (Concalves 2019). Glyphosate should only be used sparingly within floodplains and other areas that flood or have a direct hydrological connection (ex. ditches) to surface waters such as the Missisquoi and Trout Rivers. On floodplains that flood regularly, a targeted needle injection method is the safest choice for chemical control within these shoreline areas. All herbicide application should be avoided in areas subject to frequent flooding and within 1-3 days of large rain events.

The use of herbicides in wetlands and near the Trout and Missisquoi Rivers may also require special permits and/or conditions. The Vermont Wetlands Program and the Vermont Rivers Programs should be consulted prior to any herbicide application near these resources.

Herbicide applications can be costly as both the herbicide and its spraying/painting/injection device generally needs to be purchased. Compared to the manual control and plastic or metal mesh covering techniques (discussed below), herbicide application can be conducted with a relatively low commitment of time resources but like those techniques will require a multi-year commitment involving the re-application of chemicals for 2 or more years.

Considerations					
Extent	**Labor**	**Commitment**	**Cost**	**Effectiveness**	**Potential Impact**
Single stem-Large Infestations	Low	2+ years	High	High	High

Resources: Japanese Knotweed (*Reynoutria japonica*): Best Management Practices. No Date. New York Invasive Species Research Institute, Cornell College of Agriculture and Life Sciences.

6.1.2 Mechanical Cutting to Control Knotweed

Mechanical control of knotweed can take the form of mowing, pulling the stems, and the use of machetes, clippers, scythes, or other hand-held cutting implements. The physical cutting of knotweed stems is not difficult as the plant is non-woody and hollow-stemmed. While mechanical clearing of knotweed can be the least expensive, safest, and low-tech method to control knotweed, over the long-term the mechanical cutting of knotweed is a relatively ineffective and time-consuming method of controlling and eliminating plant populations. Because of the extensive rhizomatous root system, merely cutting the above-ground portions is limited in its ability to control the plant, unless cutting is persistently conducted as part of a multi-year effort.

The mechanical removal of knotweed has the greatest impact on plant growth when knotweed stems are cut in spring after the translocation of carbohydrates from the rhizomes to the main stem of the plant. Additional cuttings throughout the year may also help control the plant.

The mechanical control of knotweed needs to be conducted cautiously. Because knotweed can spread through the movement and propagation of plant parts, even small plant parts, the proper treatment and disposal of removed knotweed plant parts is important. Knotweed plants and plant parts should be removed from areas that may flood to an upland location where the plants are allowed to completely desiccate. It is critical to the success of the control effort that during the cutting of knotweed plant fragments do not enter surface waters where they can be dispersed. It is important to keep in mind that knotweed stems and leaves can remain viable after drying for almost a week, and parts of the roots/rhizomes can remain viable for over 2 weeks.

The mechanical control of knotweed is an in-expensive, but time-consuming method for the control of plant populations. Successful control of knotweed populations through the physical cutting of knotweed plants, can achieve (but only with sustained multiple cuttings) a substantial reduction of plant vigor, plant persistence, and plant spread. Anecdotal evidence suggests that effective control by this means can be obtained only by removing the active growing plant several times during the growing season over as long as a decade or more.

Considerations					
Extent	Labor	Commitment	Cost	Effectiveness	Potential Impact
Single plant-Large Infestations	High	Multi-year	Low	Medium-High*	Low**

**Medium but potentially High if conducted with multiple cuttings per year over long time periods*

***If stems, roots, fruit and flowers are properly destroyed and disposed of - potential impacts are minimal. Soil disturbances associated with knotweed removal must be conducted in such as way that soil erosion into surface waters is not enhanced or soil erosion problems created.*

Resources: (1) Managing Japanese Knotweed and Giant Knotweed on Roadsides. 2005. Roadside Vegetation Management. Penn State Department of Horticulture. Factsheet 5. (2) Controlling Knotweed in the Pacific Northwest. 2004. Jonathon Soll. The Nature Conservancy.

6.1.3 Plastic Covering to Control Knotweed

Placing a thick black plastic tarp over knotweed to prevent photosynthesis and plant growth is a method of control that has been used in Vermont. Before installation of the plastic, knotweed is cut back to the ground after the spring trans-location of carbohydrates from the roots to the growing stems, usually somewhere around the first week of June. The cut plant materials must be dried and disposed of properly. Thick (at least 7mil) black plastic is placed over the knotweed stems extending out at least 2-3 meters laterally from the remnants of the above-ground knotweed plants. Fabric cloth (a rug works well) or mulch may have to be placed between the cut stems and plastic to prevent the growing plants from penetrating the plastic cover and allowing light to reach the plants. Every effort must be made to maintain a light free environment under the tarp. The edges of the tarp should be sealed with soil or sand fill, and then weighted down with larger rocks, mulch, and stones. Covering the tarp with soil also helps increase the longevity of the plastic tarp by providing shading from the degrading effects of sunlight on the plastic.

There is some limited anecdotal (including from Craftsbury Common in Vermont) evidence that the black tarp method can control knotweed spread and kill existing populations. Experience has shown that it may take several years to be completely efficacious and that maintaining the structural integrity of the plastic is critical in its success.

Considerations					
Extent	**Labor**	**Commitment**	**Cost**	**Effectiveness**	**Potential Impact**
Single plant-medium Infestations	Low	5-years	Medium	Medium-High*	Low

** Medium but potentially High if all factors remain favorable (high tarp integrity, no floodwater damage)*

Resources: Preventing the Spread of Japanese Knotweed. 2018 Best Management practices. New Hampshire Department of Agriculture, Markets and Food Publication.

6.1.4 Mesh Covering to Control Knotweed

This method involves the placement of wire fence mesh with openings of ½” inch by ½” inch over the ground on top of the knotweed stems. If more than 1 row of wire mesh is required, substantial overlap between the different rows is required. The wire mesh is laid out after clearing the ground of knotweed stems (cut and remove), with the best time to cut being before in early fall. The wire mesh extends at least 3 feet laterally from the edge of current knotweed growth. The wire mesh is staked into the ground and the edges held down by heavy rocks and stakes to prevent growing knotweed plants from pushing the mesh upwards with plant growth and to prevent the mesh from being washed downstream. The knotweed stems will grow through the openings in the mesh, expand in diameter, and the mesh will girdle the stems cutting off the transfer of water upward from the roots. The plant will continue to push up fresh shoots through the mesh eventually depleting the plant’s energy reserves. The knotweed plants (with its large system of rhizomes) have enough energy to form stems for a couple of years and this methodology may take several years to control the population.

Considerations					
Extent	**Labor**	**Commitment**	**Cost**	**Effectiveness**	**Potential Impact**
Single plant-small Infestations	Low	3-years	Medium	Medium-High*	Low

** Medium but potentially High if all factors remain favorable (mesh remains well-anchored)*

Resources: https://vtinvasives.org/news-events/news/a-new-way-to-treat-knotweed.

Andrea Shortsleeve, A New Way to Treat Knotweed.

The following table provides a summary of the specific considerations for the various control methods discussed in this report.

Chemical Control Considerations					
Extent	**Labor**	**Commitment**	**Cost**	**Effectiveness**	**Potential Impact**
Single stem-Large Infestations	Low	2+ years	High	High	High
Mechanical Control Considerations					
Extent	**Labor**	**Commitment**	**Cost**	**Effectiveness**	**Potential Impact**
Single stem-Large Infestations	Low	2+ years	High	High	High
Plastic Cover Control Considerations					
Extent	**Labor**	**Commitment**	**Cost**	**Effectiveness**	**Potential Impact**
Single plant-medium Infestations	Low	5-years	Medium	Medium-High*	Low
Mesh Cover Control Considerations					
Extent	**Labor**	**Commitment**	**Cost**	**Effectiveness**	**Potential Impact**
Single plant-small Infestations	Low	3-years	Medium	Medium-High*	Low

7 References

Bruno Bastos Gonçalves, Percilia Cardoso Giaquinto, Douglas dos Santos Silva, Carlos de Melo e Silva Neto, Amanda Alves de Lima, Adriano Antonio Brito Darosci, Jorge Laço Portinho, Wanessa Fernandes Carvalho and Thiago Lopes Rocha. 2019. Ecotoxicology of Glyphosate-Based Herbicides on Aquatic Environment. DOI: 10.5772/intechopen.85157

Dommanget, Fanny, A. Evette, T Spiegelberger, C Gallet, M. Pace, M. Imbert and M-L Navas. 2014. Differential allelopathic effects of Japanese knotweed on willow and cottonwood cuttings used in riverbank restoration techniques. *J. of Env. Mgmt*. Vol. 132, pgs. 71-78.

The Guardian, 2012. Lisa Campbell. https://www.theguardian.com/money/2012/sep/08/japanese-knotweed-house-sale

New Hampshire Department of Agriculture, Markets & Food. Undated Manuscript. Control Methods for Japanese knotweed.