SPECIES AT A GLANCE

Knotweed

AngusMacAskill

REPORT THIS SPECIES! **Oregon: 1 866 INVADER or OregonInvasivesHotline.org; Washington: 1 877 9 INFEST or www.invasivespecies.wa.gov/report.shtml; California: 1 866 440 9530 or www.wildlife.ca.gov/Conservation/Invasives/report**

Knotweeds are a group of closely related invasive plants from Asia that includes Japanese knotweed (*Fallopia japonica*), giant knotweed (*Polygonum sachalinense*), Bohemian knotweed (*Fallopia x bohemicum*), and Himalayan knotweed (*Polygonum polystachyum*). Knotweeds are very tall plants (they can grow to over three meters) with bamboo-like hollow stems and heart-shaped or lance-shaped leaves. All knotweeds are highly invasive. They spread quickly and form tall, dense thickets. They dominate stream banks, sides of roads, gardens, and other sunny, moist, and disturbed sites. They shade out native and desirable plants, reduce access to streams, and their strong roots can destroy buildings. In the UK, archaeological sites are threatened by the spread of knotweed!

Species in the news

"Invasion of Japanese knotweed putting house at risk—family fears" by Daniel Mansfield, *Ely Standard*. November 20, 2014. http://www.elystandard.co.uk/news/invasion_of_japanese_knotweed_putting_house_at_risk_family_fears_1_3855220

Learning extensions

"Polygonum Positions," a critical-thinking writing activity about the cost and benefit of knotweed control. Available in the Teacher Guide to Knotweed Activities.

Resources

Comprehensive information and photos about knotweed from King County in Washington state. Available at http://www.kingcounty.gov/environment/animalsAndPlants/noxious-weeds/weed-identification/invasive-knotweeds.aspx

Why you should care

Knotweed forms a tall, dense canopy that shades out native plants and alters wildlife habitat. These attractive perennials have been introduced as ornamental plants to many new regions, where they often become invasive. Along streams, knotweed can prevent establishment of trees that are critical to riparian health. Trees are important along streams and rivers because they stabilize the bank, provide nutrient-rich plant litter to the river, and and are habitat for birds, insects, and salmon (by providing shade and large woody debris). Knotweed also increases erosion along streams, and its strong roots can reduce the value of property by damaging buildings, roads, and levees.

How it got here and spread

Knotweed was first introduced as a popular ornamental plant and escaped into wild lands. It primarily spreads vegetatively and is transported to new sites through soil movement, flooding, or discarded garden clippings. New populations can be established from root or stem fragments as small as 1 cm.

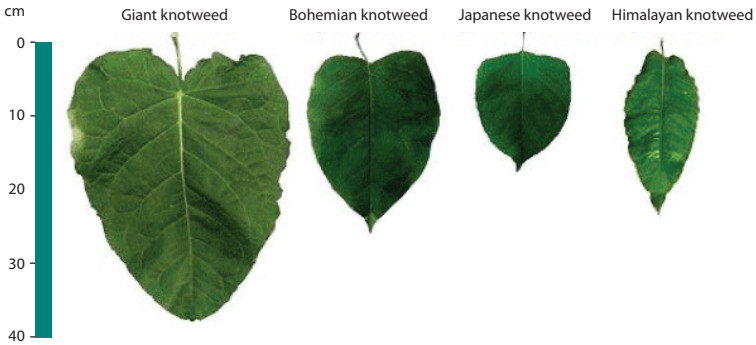
What you can do

Help stop the spread of knotweed by using native or noninvasive alternatives in your garden. Help spread the word by making others aware of this noxious invader. Use proper control techniques, which must be thorough, to prevent further spread. Controlling knotweed is a long-term, multiyear project.

COOL FACT

In Japan, knotweed is known by the name "Itadori," meaning "heals the sick."

USFWS



National Biodiversity Data Centre, County Waterford, Ireland.

Japanese knotweed (*Polygonum cuspidatum*)
Giant knotweed (*Polygonum sachalinense*)
Bohemian knotweed (*Polygonum* x *bohemicum*)
Himalayan knotweed (*Polygonum polystachyum*)

Knotweeds are a group of four closely related invasive plants that belong to the buckwheat family (Polygonaceae). They are often referred to collectively as "knotweeds" because of similar behavioral and morphological characteristics. Japanese knotweed is an herbaceous perennial whose smooth, hollow stems have a bamboo-like appearance and can reach heights of 1–2.5 m. Leaves are 10–15 cm long, 5–12 cm broad, and sit on a 1–3 cm stalk. They are rounded to flat or semi-heart-shaped at the base, tapering to a point toward the end. Greenish-white flowers (2.5–3 mm long) are arranged in drooping clusters.

Giant and Bohemian knotweeds are often confused with Japanese knotweed, but are distinguished by leaf shape and plant height. Giant knotweed is substantially taller than Japanese knotweed (usually over 3 m tall), with strongly heart-shaped leaves that are often 30 cm long and twice the width of Japanese knotweed leaves. Bohemian knotweed, a hybrid of Japanese and giant knotweed, has intermediate leaf, flower, and height characteristics, but is most easily distinguished from its parents by the pubescence on the underside of the leaves. See Zika and Arthur Jacobson (2003) for more information on how to distinguish these three species.

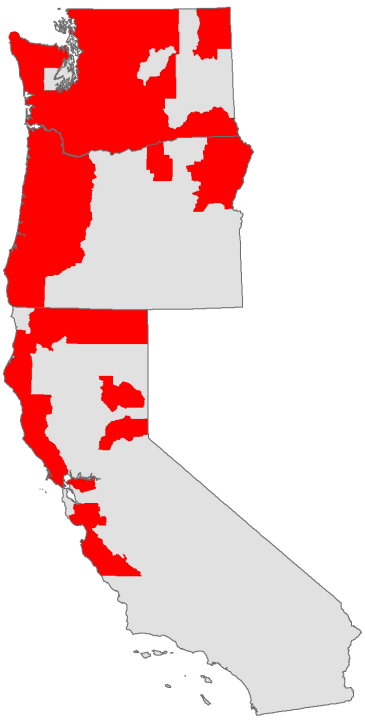
Himalayan knotweed is not typically confused with the others; its leaves are lanceolate (long and pointed) and 10–20 cm long, with bases that are slightly heart-shaped to tapered.

NATIVE AND INVASIVE RANGE

All knotweeds are native to Asia. Japanese knotweed is native to Japan and northern China, giant knotweed is native to Japan and the Sakhalin Islands, and Himalayan knotweed is native to South and Central Asia, including the Himalayas. Riverbanks and roadsides are typical knotweed habitat in its native range. Knotweed is also able to colonize new volcanic soils—for example, after eruptions of Mt. Fuji. Now, Japanese knotweed and its cousins have invaded and are widespread in Europe and North America.

WEST COAST DISTRIBUTION

Knotweed is rapidly gaining a foothold along the coast and western Cascades of Washington and Oregon. They are also washing up on river banks in northern California. They occur primarily in moist, sunny sites such as riverbanks, wetlands, waste places, along roadways, and in other disturbed areas. In riparian areas of the Pacific Northwest, knotweed co-occurs with native plant species such as salmon berry (*Rubus spectabillis*), red alder (*Anlus rubra*), and balsam poplar (*Populus balsamifera*).



Knotweed distribution by county in West Coast states, 2008. Amy Benson, USGS.

Knotweed

Maja Dumat

Japanese Knotweed grows in thick clumps and produces many blooming flowers.

ECOLOGY

Life cycles and migration patterns

Insect pollination, sexual reproduction, and wind dispersal of seed are the dominant methods of reproduction and dissemination in knotweed's native environment. However, once established, knotweed spreads vegetatively by rhizomes (underground stems) and is capable of resprouting from a rhizome fragment as small as 1 cm. Knotweed has low shade tolerance, and growth begins early in the season, typically around March or April. Because knotweed grows very rapidly, at times exceeding 8 cm a day, full height is often attained in early summer, with flowers forming in July and August. Leaves senesce (deteriorate) after reproduction, and the above-ground parts die back completely with the first hard frost, leaving behind a thick layer of leaf and stem litter that can persist throughout the winter.

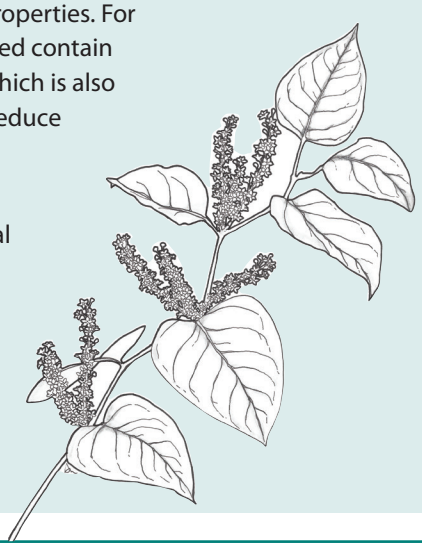
Habitat and food webs

In its native range of Japan and northern China, Japanese knotweed is one of the first to colonize new volcanic soils. After colonization, knotweed facilitates succession in its native range by increasing levels of soil organic nitrogen, which is a nutrient essential for plant growth. Also, central portions of an expanding patch usually die back due to rhizome death, allowing the establishment of secondary successional plants that eventually displace knotweed. Areas of "central dieback" appear to create conditions favorable to plant growth as they harbor other plant species that are not found on bare ground outside the knotweed patch. In its native range, knotweed is also an important link in the food web, since native insects and pathogens consume it. Having native predators also ensures that knotweed remains an innocuous member of the native flora of Asia. For example, giant knotweed populations are kept in check by a stem-mining butterfly, and Japanese knotweed is attacked by a suite of fungal pathogens.

COOL FACTS

In Japan, knotweed is known by the name "Itadori," meaning "heals the sick." Indeed, knotweed does have antibacterial and medicinal properties. For example, the roots of giant knotweed contain the antioxidant trans-resveratrol, which is also found in red wine and thought to reduce the risk of heart disease.

Introduced to Britain in 1825, knotweed was popular as an ornamental plant. Well-intentioned gardeners distributed cuttings all over Europe and North America. Genetic analysis now reveals Britain's population originated from one male-sterile clone, making it the largest known female plant in the world.



How it got here

Knotweed was first introduced to the North America in the late 19th century for ornamental purposes.

How it spreads

Spread in North America is primarily vegetative and is aided by human and beaver activities, for example, movement of containment fill material or beaver dam construction. Flood events transport plant material downstream to new sites, and fragments as small as 1 cm can sprout to form a new knotweed colony.

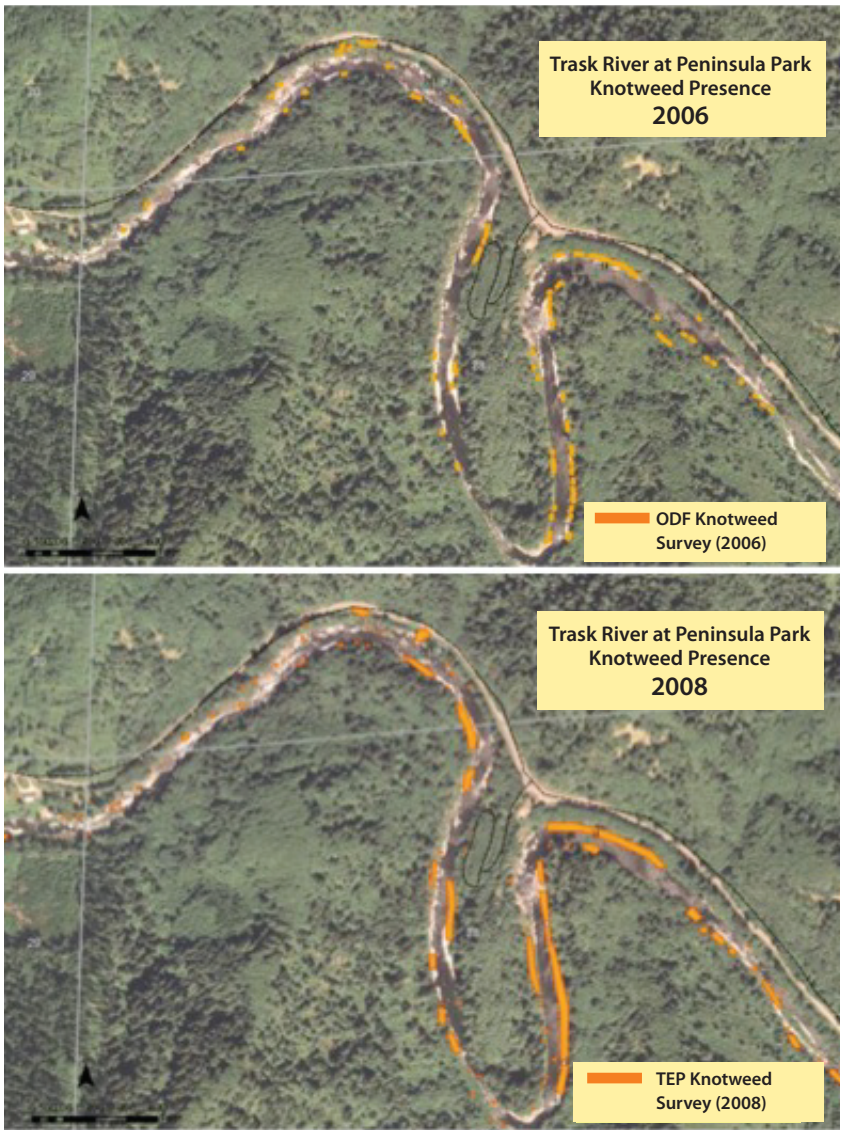
Recent studies show that both Japanese and Bohemian knotweed populations in the Northwest produce viable seed that can germinate and survive in the wild. However, the extent to which sexual reproduction (seed production) contributes to knotweed spread in North America is unknown. Vegetative spread is assumed to be the primary means of dissemination.

Ecological impacts

Unlike in its native range, knotweed in the Northwest does not exhibit central dieback, which allows native plant establishment within a patch. Instead it forms monocultures that exclude native vegetation. This situation is especially problematic along stream banks (riparian habitat), where high knotweed stem density has been shown to reduce native riparian plant species richness. Knotweed suppresses native plants primarily through shading, but also may inhibit native plant growth through allelochemicals produced by knotweed roots. Loss of woody seedling recruitment could result in the eventual loss of overstory riparian trees that normally provide shade, nutrient input, fish habitat, and bank stabilization to streams.

Preliminary work also suggests knotweed leaf litter has reduced nutrient value (as compared to riparian trees), due to its ability to sequester nutrients into its rhizomes at the onset of winter. Leaves and organic material in stems are colonized by microscopic algae and bacteria, known as periphyton, that are an important food source for aquatic macroinvertebrates. Because they are not as nutritious, knotweed leaves may have less periphyton, which would support fewer invertebrates—which, in turn, may negatively impact those invertebrates' fish predators. However, more research is necessary to determine whether knotweed's impact actually penetrates stream food webs.

Terrestrial food webs can also be affected by knotweed: green frogs in upstate New York show reduced foraging success in old-



Chris MacDonald

Japanese knotweed can spread rapidly through stem fragments. Compare knotweed survey maps from 2006 and 2008 of the Trask River at Peninsula Park, Tillamook, Oregon. The first survey, conducted in 2006 by the Oregon Department of Forestry (ODF), shows several small patches of growth along the river. The second survey, conducted in 2008 by the Tillamook Estuaries Partnership (TEP), shows a significant increase in knotweed in just two years. In that short time period, knotweed had occupied twice the stream length and three times the area infested with the invasive plant, including several new patches and large patches that had grown together.

Robert Vidéki, Doronicum Kft., Bugwood.org.

Knotweed stalks look similar to bamboo and quickly grow to become very thick in just one growing season.

field habitat invaded by knotweed, possibly due to a reduced arthropod abundance within the knotweed stand. Knotweeds were associated with low invertebrate diversity and abundance in U.K. riparian ecosystems, due to the lower overall plant diversity compared with native grass- and shrub-dominated areas.

Economic impacts

Beneficial

Giant knotweed is a major source of the chemical trans-resveratrol, which is increasingly being sold as a supplement to reduce the risk of heart disease. However, scientific studies have yet to determine the effect of resveratrol on humans, and, as such, the chemical's appropriate concentration and dosage are unknown.

Detrimental

Knotweed control requires substantial human and monetary resources. Knotweed has the potential to cause damage to buildings; rhizomes have been observed growing through two inches of asphalt. Forming dense thickets along streams, knotweed may impede access to streams by anglers, boaters, and wildlife.

Laws currently in place

Japanese, giant, and Himalayan knotweeds are legally designated as Class B noxious weeds by the Washington, Oregon, and California Departments of Agriculture. Quarantine is established against Class B weeds due to their perceived menace to the public welfare.

In the United Kingdom, people are required to prevent knotweed spread from their land and have to pay a large fine if knotweed from their property causes damage elsewhere.

Cultural significance

The dried rhizomes are an herbal source of laxatives and diuretics. Knotweed is also used as a medicinal herb and is said to promote group consciousness, sensitivity, and telepathy. Knotweed flowers provide a valuable nectar source for honeybees, and young knotweed shoots are edible, with a taste similar to rhubarb.

Management strategies

- Small patches of knotweed that are easily accessible throughout the year can be controlled through frequent stem cutting or mowing. Using a machete, loppers, pruning shears, weedeater, or mower, cut as low to the ground as possible at least every two to three weeks, especially early in the growing season. This process is designed to starve the root system, but it requires at least three to five years of repeated control because knotweed resprouts vigorously following mechanical disturbance.
- Digging or uprooting knotweed can be effective if the infestation is very small and the soil is soft. This approach also requires many years of persistent attention, and much care must be taken to properly dispose of plant material. Do not scatter, compost, or allow plant material to enter waterways. Cut stems should be piled where they quickly dry out. This method should not be attempted at remote sites or near streams, as the possibility of spread is too high.
- Covering knotweed with plastic, cardboard, or geotextile fabric may work well in combination with mechanical or herbicide methods; however, there are no examples of successful control with covering alone. Stems are mowed or cut to the surface before

securely anchoring the covering. It is recommended to leave the covering in place for at least an entire growing season.

- Applying herbicide to foliage or injecting it into the hollow lower node of the stem can be effective in controlling knotweed. Stem injection is often preferred when treating infestations near streams or other sensitive sites, because it eliminates drift onto desirable plants or into nearby water bodies; however, neighboring plants can be affected through movement of herbicides through the soil. Stem injection also requires a much larger amount of herbicide per area treated. See the *Pacific Northwest Weed Management Handbook* for specific information about herbicides (http://pnwhandbooks.org/weed/). Always follow label instructions before applying herbicides.
- Biocontrol insects are being evaluated for knotweed control, but at present it is unknown whether the insects will be approved for release. Promising candidate agents are a leaf-feeding chrysomelid beetle (*Gallerucida bifasciata*), a sap-sucking psyllid (*Aphalara idadori*), a stem-boring moth (*Ostrina* sp.), and a leaf-spot pathogen (*Mycosphaerella* sp.).
- Controlling knotweeds is most successful using a combination of control strategies that integrate plant biology and specific habitat conditions. Outreach, education, and landowner support are key to successful control at a large scale.

WHAT YOU CAN DO!

- Prevent the further spread of knotweed by using native alternatives in your garden.
- Help spread the word by making others aware of this noxious invader.
- Use proper control techniques. Remember, control must be thorough and is a long-term time investment.

INFORMATION GAPS

Food webs

Understanding multitrophic consequences to shifts in riparian plant communities would be useful in watershed management decisions, especially in light of the already imperiled state of the Northwest's salmon populations.

Mode of reproduction

Confirmation of whether or not extensive sexual reproduction (seed production) is occurring would impact strategies for knotweed control at the landscape level.

Control strategies

More work needs to be done to determine the most effective means of control with the least impact on the environment, especially considering that knotweed grows in very sensitive riparian habitats.

Tom Heutte, USDA Forest Service, www.invasive.org

Giant knotweed towers over a woman in Alaska.

REFERENCES

Adachi, N., I. Terashima, and M. Takahashi. 1996. Central die-back of monoclonal stands of *Reynoutria japonica* in an early stage of primary succession on Mt. Fuji. *Annals of Botany* 77:477–486.

Bímová, K., M. Bohumil, and I. Kašparová. 2004. How does *Reynoutria* invasion fit the various theories of invisibility? *Journal of Vegetation Science* 15:495–504.

Gerber, E., C. Krebs, C. Murrcll, M. Moretti, R. Rocklin R, and U. Schaffner. 2008. Exotic invasive knotweeds (*Fallopia* spp.) negatively affect native plant and invertebrate assemblages in European riparian habitats. *Biological Conservation* 141:646–654.

Hirose, T., and M. Tantino. 1984. Soil nitrogen patterns induced by colonization of *Polygonum cuspidatum* on Mt. Fuji. *Oecologia* 61:218–223.

Inoue, M., H. Nishimura, H-H. Li, and J. Mizutani. 1992. Allelochemicals from *Polygonium sachalinense* Fr. Schm. (Polygonaceae). *Journal of Chemical Ecology* 18:1833–1840.

Locandro, R. R. 1973. Reproductive ecology of *Polygonum cuspidatum*. Dissertation. Rutgers University, New Brunswick, New Jersey, USA.

Maerz, J. C., B. Blossey, and V. Nuzzo. 2005. Green frogs show reduced foraging success in habitats invaded by Japanese knotweed. *Biodiversity and Conservation* 14:2901–2911.

Shaw, R. H., and L. A. Sieger. 2002. Japanese knotweed. Pages 159–166 in R. Reardon, editor, *Biological control of invasive plants in the eastern United States.* FHTET-2002-04. USDA Forest Service, Morgantown, West Virginia, USA.

Siemens, T., and B. Blossey. 2007. An evaluation of mechanisms preventing growth and survival of two native species (*Fallopia ×bohemica*). *American Journal of Botany* 94:776–783.

Urgenson, L. S., S. H. Reichard, and C. B. Halpern. 2009. Community and ecosystem consequences of giant knotweed (*Polygonum sachalinense*) invasion into riparian forests of western Washington, USA. *Biological Conservation* 142:1536–1541.

Yoshioka, K. 1974. *The present flora: Its general features and regional divisions*. Elsevier, Amsterdam, The Netherlands.

Zika, P. F., and A. Jacobson. 2003. An overlooked hybrid Japanese knotweed (*Polygonum cuspidatum* × *sachalinense*; Polygonaceae) in North America. *Rhodora* 105(992):143–152.

ADDITIONAL RESOURCES

Comprehensive information and photos about knotweed from King County in Washington state.

Available at: http://www.kingcounty.gov/environment/animalsAndPlants/noxious-weeds/weed-identification/invasive-knotweeds.aspx

Last update: October 2013

Last accessed: November 2014

Students investigate the "crimes" of Aquatic Invasive Species on the "Nab the Aquatic Invader!" website.

Japanese knotweed is one of the criminals students can investigate.

Available at: http://www.iiseagrant.org/nabinvader/

Last update: Unknown

Last accessed: November 2014

Washington State Department of Ecology knotweed factsheet.

Available at: http://www.ecy.wa.gov/programs/wq/plants/weeds/aqua015.html

Last update: Unknown

Last accessed: November 2014