Knotweed Vulnerability Analysis
Kitsap County, Washington State

Introduction

Invasive species are one of the most serious and imminent threats to biodiversity, and in Kitsap County, Washington, the knotweed family jeopardizes protected habitats, endangered species, and fragile ecosystems. Native to Japan, Korea, and China, knotweed was deliberately introduced to Europe and later to North America as ornamental garden plants. Because of its tolerance for a wide range of salinity, pH, soil composition, and temperature, knotweed became a widespread and successful invader in the absence of its native trophic control, outcompeting native American and European vegetation. Because knotweed has only female and hermaphrodite individuals, spread by seed is negligible: however, any small segment of the plant can form a rhizome and grow a new colony. Once knotweed is established it is impossible to control without at least five years of repeated chemical treatment or expensive mechanical removal of the rhizome which can easily be nine feet in depth. Knotweed poses a threat to infrastructure – it can grow through tarmac, concrete and even building foundations – and dry knotweed stalks in winter can be a fire hazard. Most importantly, knotweed weakens many ecosystems in Kitsap County by: crowding out native vegetation with important ecological functions, including rare plants like Pink Sand-Verbana and Yellow Oxtail; degrading rich habitat for wildlife, including spawning ground for federally protected species like Chinook, Chum and Coho Salmon; and disproportioning nutrient cycles by clogging riparian effluent flow with dense colonies and increasing erosion in the winter during its dieback.

Figure 1: Location of Kitsap County in Washington State, USA

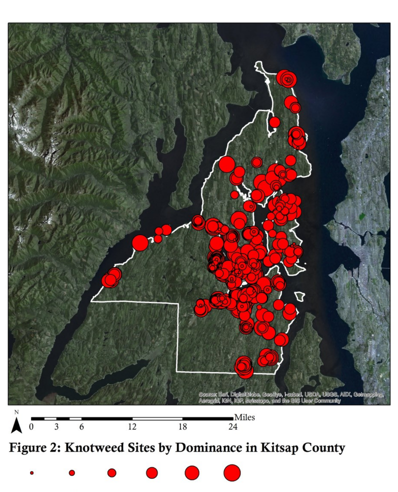


Figure 2: Knotweed Sites by Dominance in Kitsap County

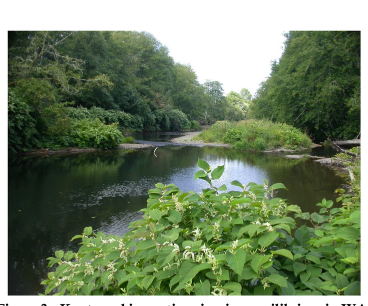


Figure 3: Knotweed impacting riparian equilibrium in WA

Definitions:

Knotweed—giant, Japanese, Himalayan, and Bohemian are biologically similar and are analyzed together in this project.

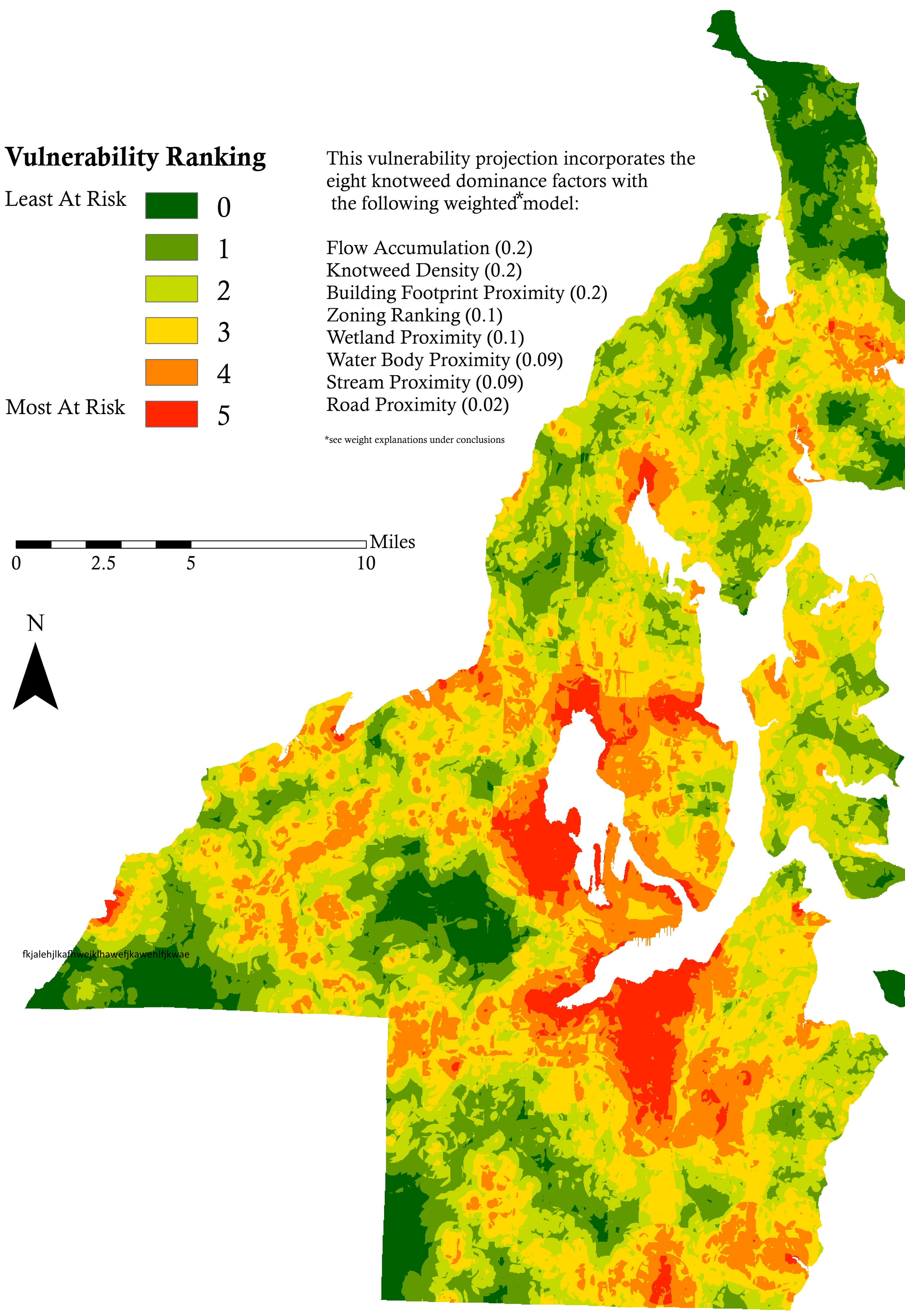
Dominance—Knotweed data is ranked by dominance on a scale from zero (not present) to six (only visible plant species in area). For example, a dominance of three describes a site with relatively equal presence of knotweed and other plants.

Final Weighted Vulnerability

This vulnerability projection incorporates the eight knotweed dominance factors with the following weighted* model:

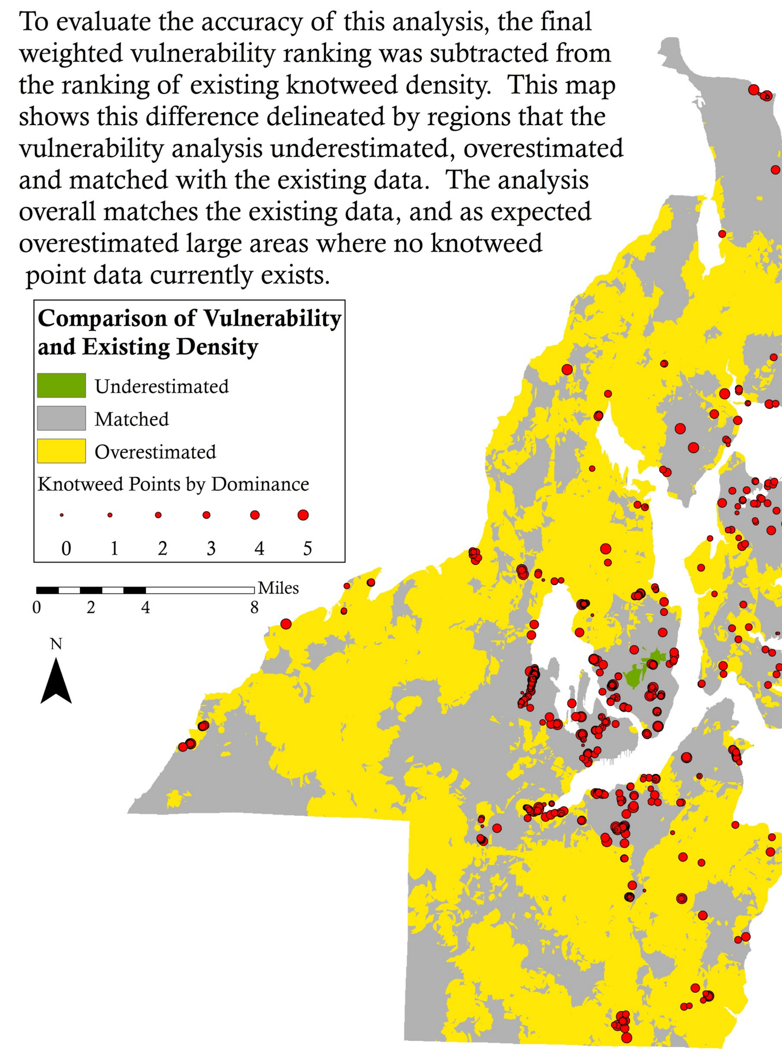
Flow Accumulation (0.2)
Knotweed Density (0.2)
Building Footprint Proximity (0.2)
Zoning Ranking (0.1)
Wetland Proximity (0.1)
Water Body Proximity (0.09)
Stream Proximity (0.09)
Road Proximity (0.02)

*see weight explanations under conclusions



Accuracy & Conclusions

To evaluate the accuracy of this analysis, the final weighted vulnerability ranking was subtracted from the ranking of existing knotweed density. This map shows this difference delineated by regions that the vulnerability analysis underestimated, overestimated and matched with the existing data. The analysis overall matches the existing data, and as expected overestimated large areas where no knotweed point data currently exists.

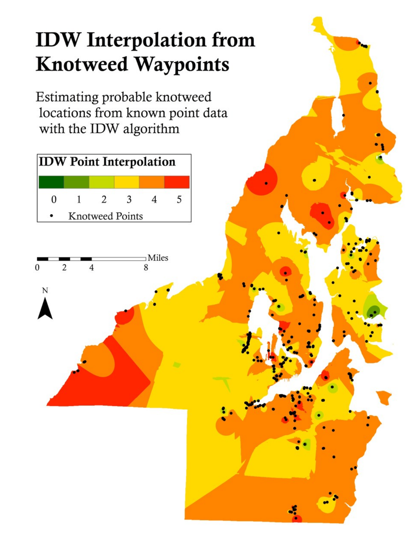


This vulnerability analysis modeled many of the parameters determining knotweed success, using a weighted system to emphasize disturbed wetlands as preferred habitat. *Flow Accumulation* was weighted high because of the unique ability of any part of the plant to travel by water, root, and colonize downstream. *Knotweed Density* was weighted high because of the plant's inability to establish from seed, only biomass. *Building Footprint Proximity* was weighted high because of the plant's preference for cleared areas over competition with established plants. *Road Proximity* was weighted low because Kitsap Noxious Weeds has been recording knotweed data on roadways for years, and while knotweed does tend to grow in disturbed corridors alongside roads, these sites are better documented than other less accessible sites.

For comparison, two interpolations (left) show how a simpler model would project knotweed distribution. Interpolation of existing data is valuable but insufficient to accurately model the dominance of knotweed on a large scale. There are countless other factors that influence colony location, especially in the context of climate change. Given knotweed's ability to survive a wide range of temperatures, the plant's range may extend higher in elevation and further north. This is a serious concern given the value of habitats that knotweed deteriorates—one study found a large negative correlation between knotweed invasion and native biodiversity, a 70% reduction in native leaf inputs into stream load, and upset of nutrient cycles due to knotweed's huge nitrogen absorption (Urgenson 2006). The relatively small area found to be at high risk by this analysis could guide future field work in Kitsap County. Research into control and quarantine needs to be augmented to halt knotweed invasion and restore riparian health.

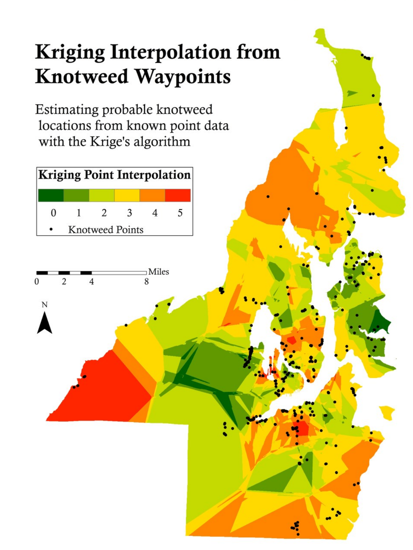
IDW Interpolation from Knotweed Waypoints

Estimating probable knotweed locations from known point data with the IDW algorithm



Kriging Interpolation from Knotweed Waypoints

Estimating probable knotweed locations from known point data with the Krige's algorithm



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Data Sources: Kitsap Noxious Weeds 2013, Kitsap County GIS 2006, U.S. Census Bureau TIGER 2013, Washington University GIS 2001

Projection: NAD_1983_StatePlane_Washington_North_FIPS_4601_Feet

Methods

To determine sites most likely to be invaded by knotweed, eight impacting factors were analyzed:

Flow Accumulation –DEM data for Kitsap County from Washington University were processed with the Fill, Flow Direction, and Flow Accumulation tools to model water volume increase from upstream to downstream. Based on this distribution, high flow was defined as 10,000 raster cells or greater, and Euclidian Distance was used to find relative distance to high flow regions.

Knotweed Density – Point data from Kitsap Noxious Weeds were processed with the ass XY Data and Kernel Density tools based on dominance to rank proximity to existing knotweed.

Building Footprint Proximity – Footprint data from Kitsap County GIS were processed with the Euclidian Distance tool to rank relative distance to development.

Zoning Ranking – Zoning delineation data from Kitsap County GIS were given weighted proportion by comparing the total number of prohibited uses for each classification. Higher prohibited uses, found in classes like Park and Rural Wooded, were ranked as less likely to be developed, while lower prohibited uses were ranked more likely to be developed.

Wetland Proximity – Wetland delineation data from Kitsap County GIS were processed with the Euclidian Distance tool to rank relative distance to wetlands.

Water Body Proximity - Polygon water data from TIGER were processed with the Euclidian Distance tool to rank relative distance to bodies of water.

Stream Proximity – Linear water data from TIGER were processed with the Euclidian Distance tool to rank relative distance to streams.

Road Proximity – Street centerline data from Kitsap County GIS were processed with the Euclidian Distance tool to rank relative distance to right-of-ways.

Interpolations – IDW and Kriging tools were used to interpolate the knotweed point data, for comparison to the final vulnerability analysis.

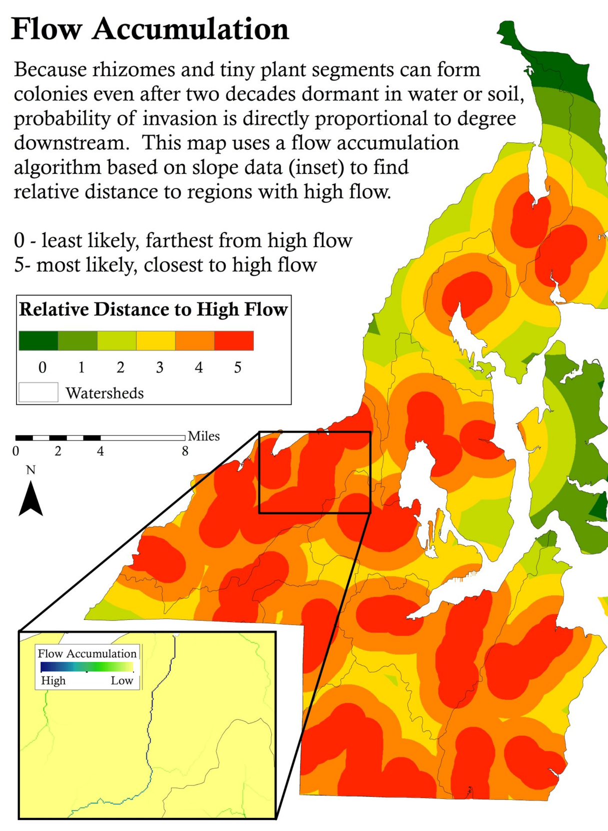
Note – All data was reclassified to match dominance distribution from 0 to 5 and clipped or masked by a Kitsap County border outline.

Intermediate Vulnerability Factors

Flow Accumulation

Because rhizomes and tiny plant segments can form colonies even after two decades dormant in water or soil, probability of invasion is directly proportional to degree downstream. This map uses a flow accumulation algorithm based on slope data (inset) to find relative distance to regions with high flow.

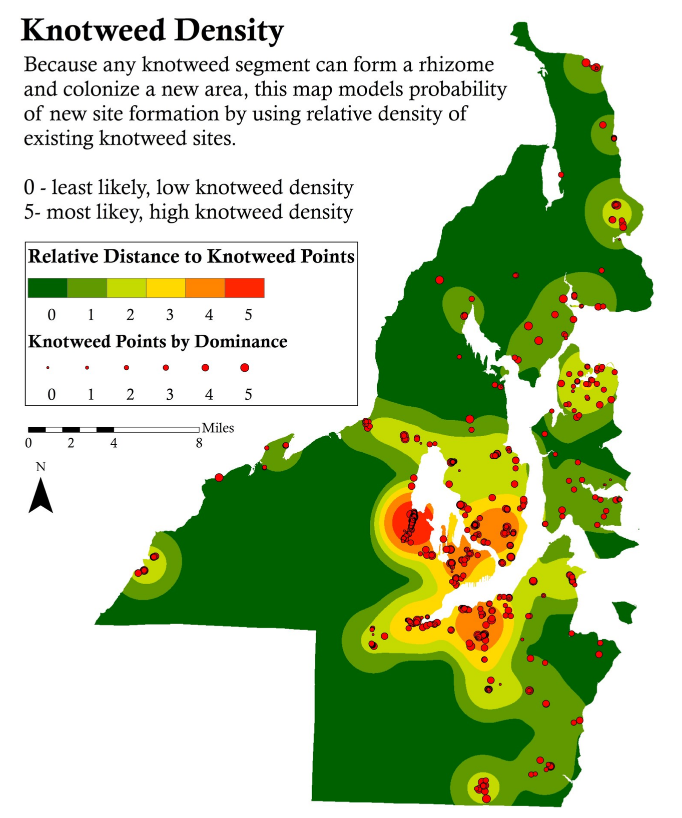
0 - least likely, farthest from high flow
5- most likely, closest to high flow



Knotweed Density

Because any knotweed segment can form a rhizome and colonize a new area, this map models probability of new site formation by using relative density of existing knotweed sites.

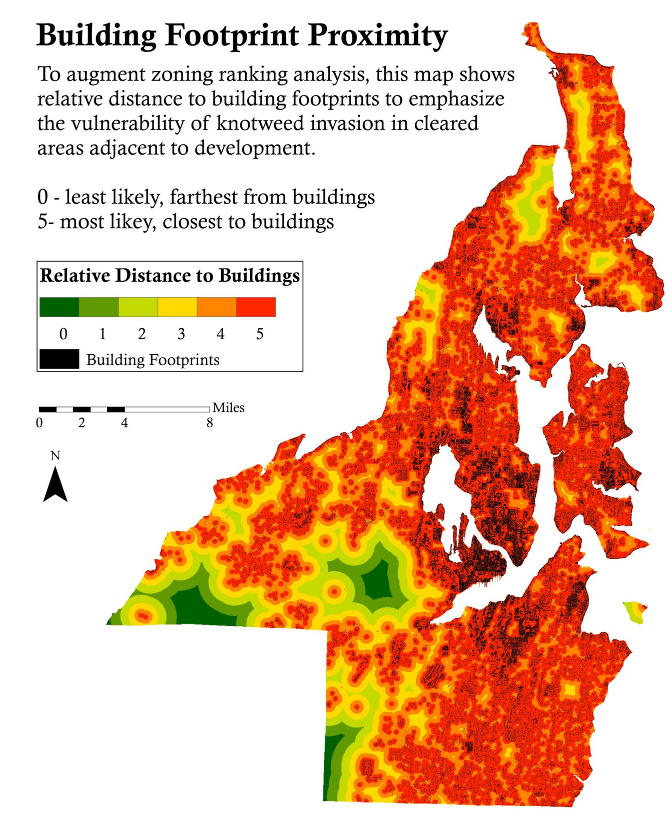
0 - least likely, low knotweed density
5- most likey, high knotweed density



Building Footprint Proximity

To augment zoning ranking analysis, this map shows relative distance to building footprints to emphasize the vulnerability of knotweed invasion in cleared areas adjacent to development.

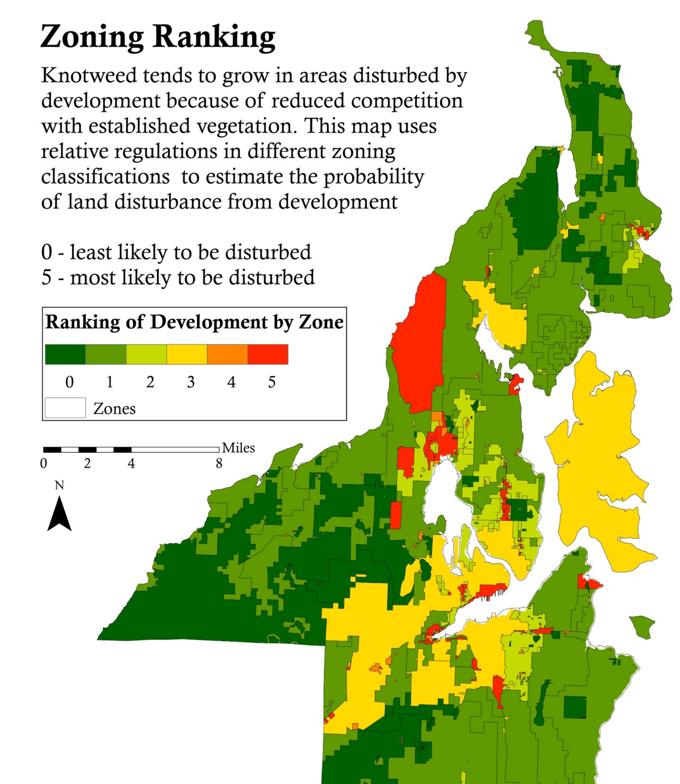
0 - least likely, farthest from buildings
5- most likey, closest to buildings



Zoning Ranking

Knotweed tends to grow in areas disturbed by development because of reduced competition with established vegetation. This map uses relative regulations in different zoning classifications to estimate the probability of land disturbance from development

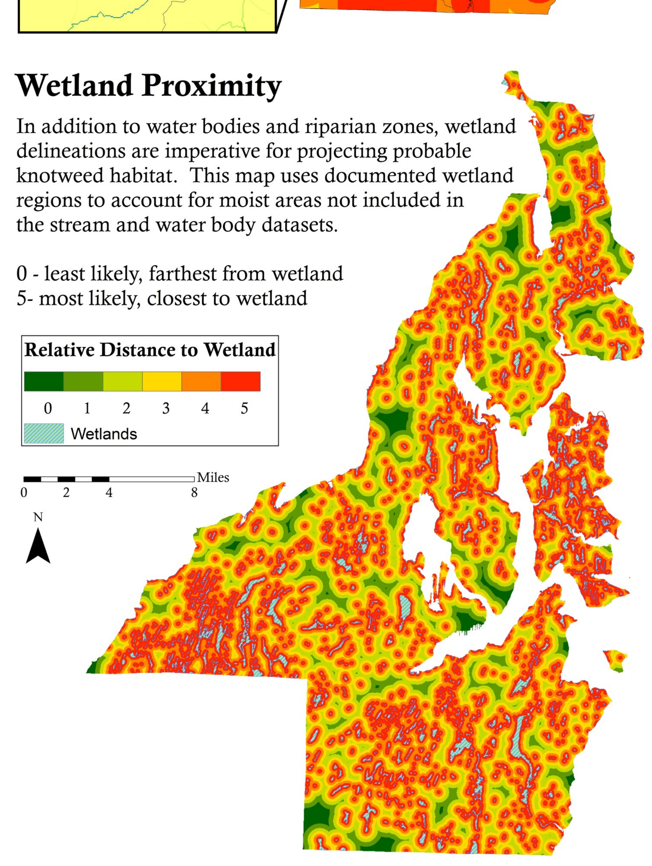
0 - least likely to be disturbed
5 - most likely to be disturbed



Wetland Proximity

In addition to water bodies and riparian zones, wetland delineations are imperative for projecting probable knotweed habitat. This map uses documented wetland regions to account for moist areas not included in the stream and water body datasets.

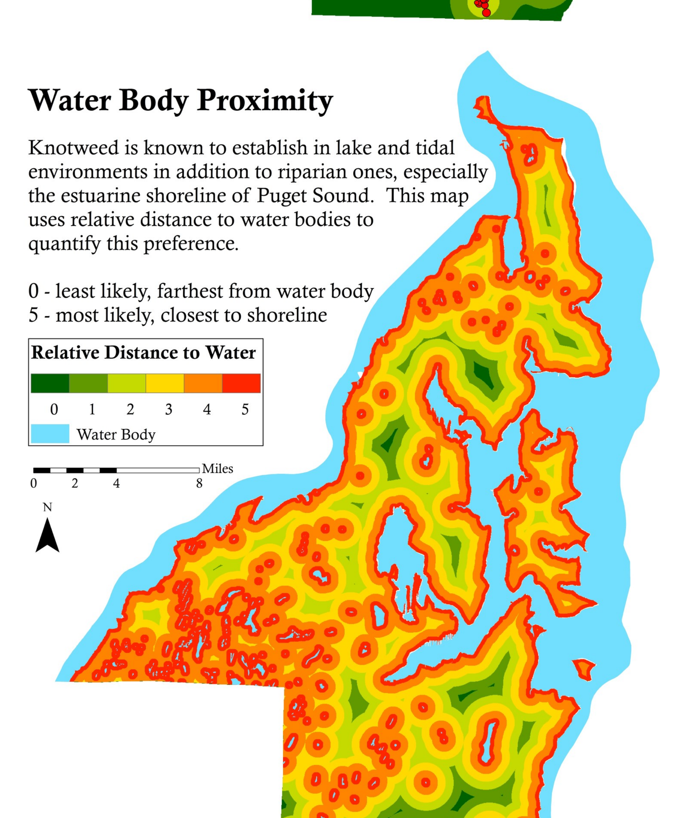
0 - least likely, farthest from wetland
5- most likely, closest to wetland



Water Body Proximity

Knotweed is known to establish in lake and tidal environments in addition to riparian ones, especially the estuarine shoreline of Puget Sound. This map uses relative distance to water bodies to quantify this preference.

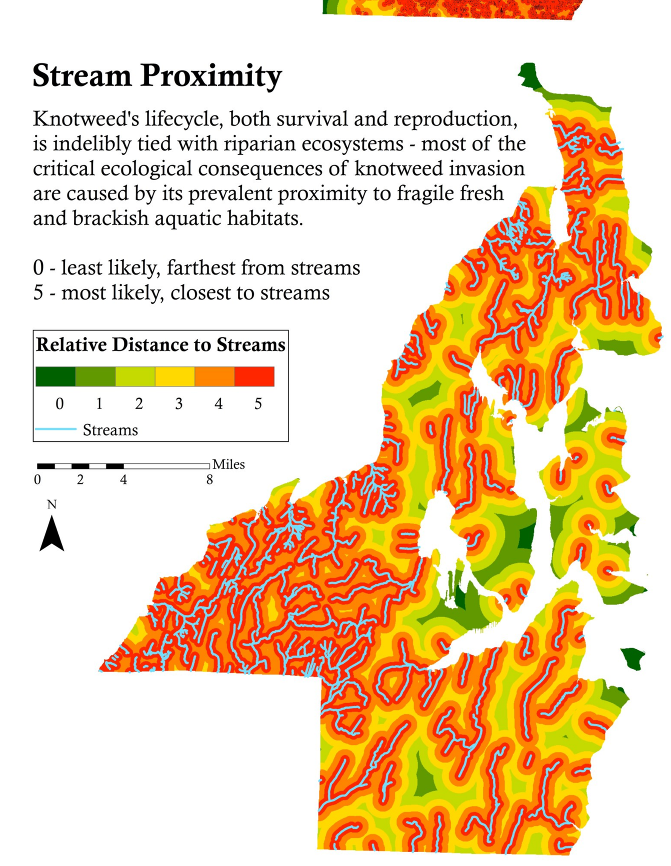
0 - least likely, farthest from water body
5 - most likely, closest to shoreline



Stream Proximity

Knotweed's lifecycle, both survival and reproduction, is indelibly tied with riparian ecosystems - most of the critical ecological consequences of knotweed invasion are caused by its prevalent proximity to fragile fresh and brackish aquatic habitats.

0 - least likely, farthest from streams
5 - most likely, closest to streams



Road Proximity

Because knotweed prefers disturbed areas with reduced competition from established native vegetation, it often colonizes cleared areas bordering transportation arteries This map uses relative distance to streets and highways to account for this preference.

0 - least likely, farthest from road
5- most likely, closest to road