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AP Biology Honors
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GLOBE Research on Phragmites Australis and Japanese Knotweed

Introduction

The Phragmites Australis and Japanese Knotweed are plants that are classified as invasive species. An invasive species is a species that grows exponentially and is very difficult to get rid of. For example, one of the first methods to get rid of phragmites was to set them on fire and burn them. That did not work, however, because it only killed plants above the ground, not below. The rhizomes, the part of the plant that allows it reproduce asexually, remained unaffected which resulted in the phragmites growing back. The same situation occurs with the knotweeds. Scientists do not definitely know where the phragmites are truly native to. There have been assumptions that they are native to the coasts of North America, but it was not until the late twentieth century when the phragmites began growing in a greater abundance. If they are not native to North America, it was not difficult to adjust surviving here because all they need to is live near rivers, not areas with salt water. The phragmites normally inhabit areas near fresh water and the knotweed inhabit areas near rivers, hedges, roadways, and railways. The knotweed is native to South East Asia. They were introduced to North America in the nineteenth century because of the attractive flowers. The most destruction that they both cause is invading natural habitats of the animals and can damage the foundation and hard surfaces of buildings when they grow beneath them. The phragmites are mainly seen on the coasts and the knotweeds are seen all over since they do not rely on water as much as the phragmites. When the seasons change and the climate is colder, the plants die because of the conditions, but when the temperature begins to rise, they grow back once again. The area near the Cove River is where we will be studying both plants throughout the school year.

Hypothesis

If the rhizomes of phragmites remain unharmed, even in harsh temperatures, then the species can grow again in the spring, because this species of plant has evolved to survive such punishment.

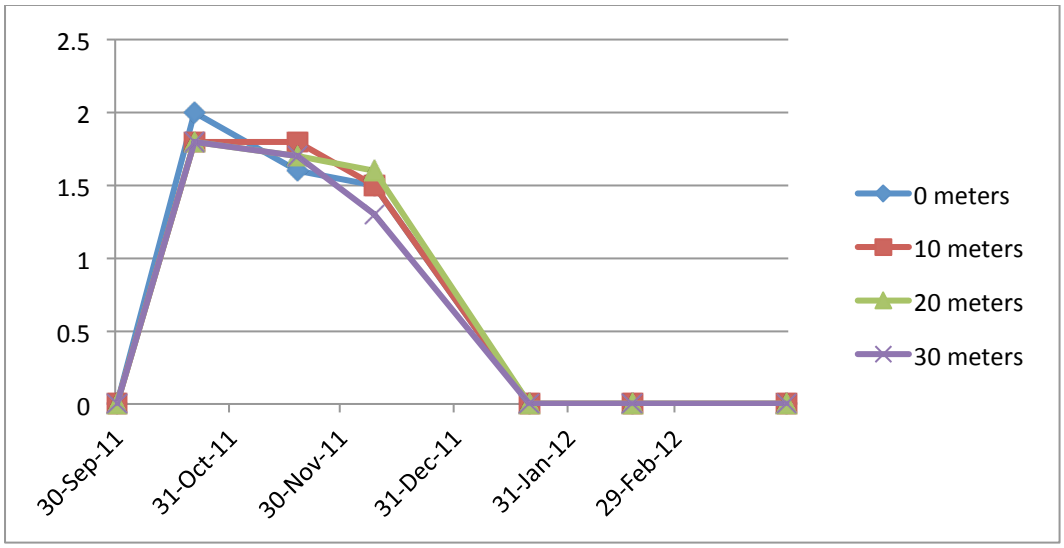
Procedure

1.) Gather all materials including yard stick, meter tape, camera and tape measure.
2.) Walk to the Cove River and approach where the phragmites are growing.
3.) Measure in random 10 M transects, including both land and phragmites. This allows you to measure transition zones.
4.) Repeat doing so until you measured most of the area where the phragmites are gtowing.
5.) Record data as you measure.

Data

Height of the Phragmites Throughout the School Year

	0 meters	10 meters	20 meters	30 meters
September 30, 2011	No data yet	No data yet	No data yet	No data yet
October 21, 2011	2 meters	1.8 meters	1.8 meters	1.8 meters
November 18, 2011	1.6 meters	1.8 meters	1.7 meters	1.7 meters
December 9, 2011	1.5 meters	1.5 meters	1.6 meters	1.3 meters
January 20, 2012	Cut down by DEP	Cut down by DEP	Cut down by DEP	Cut down by DEP
February 17, 2012	0 meters	0 meters	0 meters	0 meters
March 30, 2012	0 meters	0 meters	0 meters	0 meters



September 30: The temperature was 72 ºF and there was an ample amount of rain the day before. The sky was currently blue, but a little hazy.

October 21: There is about 5% to 10% cloud cover. It was windy and slightly chilly, but sunny at 60 ºF. There was lots of rain in the past few days.

November 18: There are no clouds in the sky and it is windy. The temperature is 53 ºF. There is no variation in leaf color.

December 9: The temperature was 43 ºF and there was 50% cloud cover. It was hazy and there were contrail clouds in the sky.

January 20: The temperature was 30 ºF and there is no cloud cover. There has been recent snowfall and little snow on the ground from the past few days.

February 17: The temperature was 32 ºF and it was sunny. It was also windy.

March 30: Abnormally warm the past week with temperatures reaching 70 ºF. It was currently sunny with little rain the past few days. It is windy and the temperature was 52 ºF. There is now green grass once again.

Conclusion

The hypothesis of the experiment is if the rhizomes of phragmites remain unharmed, even in harsh temperatures, then the species can grow again in the spring, because this species of plant has evolved to survive such punishment. My hypothesis was not able to be answered due to the phragmites being cut down by the DEP in January. From the data that was able to be obtained, the phragmites were taller at the beginning of the year because of the warmer temperature. They started to decrease in height during October and continued to decrease as the temperature

continued to drop. When January arrived, the phragmites were cut down, and I decided to alter my experiment slightly. My new experiment was to measure how much the phragmites have grown each month since. Fortunately for the environment, the phragmites have not grown back, but still was not able to collect any data. The knotweeds were also cut down at the same time as the phragmites, and have not yet grown back. One major error in the experiment was the DEP cutting down the phragmites. There is no way I could have corrected this because the purpose to help the environment. A second error may have been that because we used random transects, we most likely did not measure the entire in which the phragmites were growing. This can be corrected by taking more time next to make sure we have the correct measurement in distance. A third error may have been the spontaneous changes in climate. This year, we have had a hurricane in August, a snow storm in October, temperature in the sixties during January, and above average temperatures throughout the rest of the winter. The phragmites may have receded less than usual due to the warmer temperature, and this cannot be corrected. The data would have been valid if the phragmites were killed by natural causes. The experiment is going to be revised because I plan on visiting the Cove River at least once every month to measure the growth rate of the phragmites. My hypothesis for that experiment will be if the rhizomes are left untouched throughout the summer, they will grow back at about one foot a month because they are the cause of constant reproduction.

In the near future, scientists will be able to study other parts of the environment. For example, they will have the ability to see if the native plants grow back since the phragmites are no longer there to take over their habitats. Scientists will be able to observe how the plants evolved since the last time they inhabited the area. Another way of studying to Cove River would be to see how the quality of the watershed has changed. Phragmites almost always inhabit areas near water in order to survive, but now since they were eradicated from the area near Cove River, there may be more water since the roots are not absorbing it. The current pH quality of the water may have also been a result from the phragmites. Last, scientists would not only observe to see if native plants would return, but also see if the animals that used to be native have reclaimed their habitats. The population ecology of the Cove River would be further studied.

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AP Biology

April 13, 2012

Japanese Knotweed Growth at Cove River

I. Background

An environmental problem that is faced throughout the world concerns invasive species. An invasive species is defined as not native to the ecosystem being observed or whose introduction causes or is likely to cause economic or environmental harm or harm to human health (National Agricultural Library). The state of Connecticut is home to many invasive species, including the Japanese Knotweed (*Polygonum cuspidatum).* This plant is present throughout the state and grows in abundance in the Cove River, the observation site for this project.

Japanese Knotweed was introduced to the United States in the late 1800s as an ornamental flower and to aid in erosion control. It can grow up to about 3 meters in height. The plant is characterized by large, oval leaves that are wide at the base but taper to a point. The stems of the plant resemble bamboo. In the summer, the plant blooms with tiny white flowers, making it esthetically pleasing. The Japanese Knotweed has a complex root system with a large tuberous root surrounded by a web of roots and rhizomes. Rhizomes are underground stems that can survive the winter, while the remainder of the plant may either fall dormant or die. In early spring, rhizomes generate rapidly growing shoots that refill the area where the plant had grown earlier.

The motivation for studying the Japanese Knotweed lies in the threat it poses to the ecosystem of West Haven. Japanese Knotweed poses a threat to the natural environment of West Haven because it dominates the land where it grows. The root system prevents native species from regenerating and suppresses the growth of the vegetation that is already present. The height and density of the plants cause them to block sunlight from lower levels and due to this plants are unable to grow beneath them. Furthermore, by killing off and suppressing native vegetation, the Japanese Knotweed destroys wildlife habitats and displaces animals. It is common for Japanese Knotweed to grow along and in streams, such as in Cove River. Not only can it block the flow of water, it can also spread itself through the water which could allow it to cover an entire streambed. Consequently, the ecosystem of the water ways would be altered as native plants and animals are no longer present. Not only does it affect the natural aspects of West Haven, it can also affect infrastructure, such as roads and buildings. The extensive root system can grow beneath the asphalt and break through it, causing damage. The roots can also block drainage ditches, preventing water from exiting the proper way, thus causing more damage. An abundance of herbicides have been used to try to kill the plant. While the plant remained unaffected, other plant species were severely damaged by the chemicals.

II. Proposal

By understanding the growth patterns of the Japanese Knotweed, and what conditions cause it to thrive, one can come to understand how to control it and eventually eliminate it.

The research will focus on the height of the plant and the total area it encompasses in Cove River throughout the duration of one year.

Hypothesis: If the height and amount of the Japanese Knotweed increase, then the conditions of the environment must be beneficial to the plant because the plant is able to proliferate whereas the plant would die or have trouble growing in negative conditions.

Independent Variable: Favorable weather conditions (temperature, sun exposure, cloud cover, humidity, rain. etc.)

Dependent Variable: Height of the Japanese Knotweed and general amount of plants

The hypothesis shall be tested by recording the different aspects of the weather such as temperature, rain, and cloud cover as well as measuring the height of the plant at a set interval (ex. every 10 meters) and the total area of Cove River that is covered by the plant.

III. Materials

The project requires relatively few materials but has the potential to provide valuable data that could inform the people of West Haven and other afflicted areas of plant growth and characteristics.

- Notebook
- Pen or pencil
- Meter stick or measuring tape

IV. Procedure

1. Gather materials
2. Observe general environment (sunlight, clouds, recent weather)
3. Record observations in notebook.
4. Go to one edge of the area where knotweed grows.
5. Measure height of plants in 100 meter transects until the opposite edge is reached. (Random sampling is the best research technique, even though the knotweed may not be present in that area, it shows transition growth areas between bare land and land where the plant grows.)
6. Record Data in notebook.
7. Observe plant characteristics and note the observations.
8. Repeat steps 1-7 regularly (ex. every month)

V. Data and Observations

September 30, 2011

General Environment Observations	Knotweed Observations
• Ample rain previous night • Full canopy • Some leaves beginning to change color • Few clouds • Sunny • Plants affected by hurricane Irene in late August • Premature leaf loss due to high winds • Possible salt spray	• Knotweed is damaged by nature (high winds, hurricane) • Knotweed has been crushed by ATVs • Knotweed does not extend across the trail (stops at trail edge) • Knotweed does not grow where it meets the area of phragmite growth

October 21, 2011

General Environment Observations	Knotweed Observations
• 5% to 10% cloud cover (cumulus and stratus) • Sunny • Chill from wind • Ample amount of rain in recent days	• No change from last time • Knotweed is damaged by nature (high winds, hurricane) • Knotweed has been crushed by ATVs • Knotweed does not extend across the trail (stops at trail edge) • Knotweed does not grow where it meets the area in which phragmites grow

November 18, 2011

General Environment Observations	Knotweed Observations
• No clouds • Sunny • Cold • Few leaves on trees • Leaves of the ground • Windy	• Knotweed broken and wilted • Stem turned brown and brittle • Stem is hollow • Leaves are rigid and brittle • Tear upon contact • Dry

December 9, 2011

General Environment Observations	Knotweed Observations	Knotweed Measurements	
• 1% canopy cover • Almost all leaves have fallen • Leaves on the ground • 50% cloud cover (contrail clouds) • Chilly	• Little change from last visit • Knotweed hibernating and trampled • Knotweed stems appear dead • All leaves gone	**Distance (Meters)**	**Height (Meters)**
		10m	1.5m
			1.56m
			1.34m
		20m	No knotweed present
		30m	1.86m
			1.71m
			1.3m
		40m	2.3m
			1.8m
			2.1m

January 20, 2012

General Environment Observations	Knotweed Observations
• Temperature= -1°C • No cloud cover • Snow on the ground from recent snowfall	• No changes from last trip • No growth • Measurements same as last trip • Knotweed wilted and broken • Brown stem color • No leaves • Remains in same general area • Is not extending beyond the constraints of the phragmites or the path

March 30, 2012

General Environment Observations	Knotweed Observations
• Abnormally warn recent weather • Recent rain • Sunny • No cloud cover • Chill from wind	• Knotweed from last year (parental generation) is dead and dry • No change in growth of P_1 generation • Has begun to sprout

• Trees budding • Some leaves have reappeared • Undergrowth has appeared (green grass)	• Sprouts have extended into the path and beyond it. • Have not extended into the phragmites

Images of Knotweed

1)

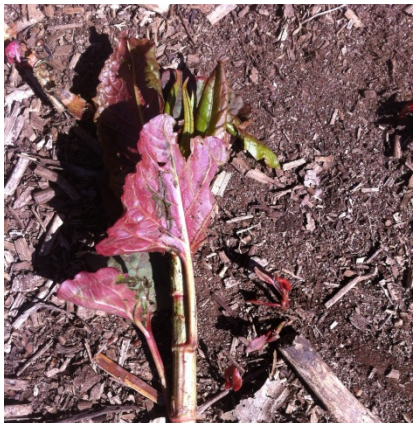
2)

3)

4)

5)

6)



Pictures 1, 2, and 3 all depict the stems of the knotweed. Note the color ranging from light brown to dark brown. Image 2 shows the inside of the stem which is hollow. Stem height ranged from a under a meter to approximately three meters.

Pictures 4, 5, and 6 all depict the sprouts that have recently grown. Image 1 shows the growth of the sprouts into and beyond the path. Image 2 and 3 provide a close up, side-view of the plants. In image 3, the root system of a torn-our sprout is visible toward the bottom of the frame. The shoots are currently between 6cm and 30cm, but continue to grow.

VI. Conclusion

In conclusion, this particular experiment was focused on the observation of the invasive plants species, Japanese Knotweed, rather than its eradication.

The initial hypothesis was, "If the height and amount of the Japanese Knotweed increase, then the conditions of the environment must be beneficial to the plant." This hypothesis was directly supported by the observations and data from this experiment because there was an increase in amount of plants, demonstrated by the large amount of sprouts. This rapid spread of new plants shows that the Cove River site and the environmental conditions there are beneficial to the growth of the knotweed and allow the plant to expand the perimeters of its growth. Even in the winter months in which the plant is dormant, the plants did not shrink, but they stopped growing. This stunted growth resulted from the death of the shoot system. However, the root system was undamaged by the cold and was temporarily dormant beneath the soil. The healthy condition of the root system is evident in the abundance of shoots present in the first wave of warm weather in early spring.

There were several possible experimental errors. It was difficult to measure the plants accurately because many were broken. While some of the breakage was due to natural occurrences,

(hurricane, snow, wind, hail…) many plants were damaged by human interference, specifically ATV usage. Also, although the lab trips were on a relatively consistent basis, they did not span the length of a full growing cycle and occurred mainly during the winter months, in which the plant is dormant. Therefore, many characteristics of the plant may have been missed.

This experiment can be improved and continued by observing a plant for a full growing cycle and creating a more detailed cross section for plant measurement.

One potential research project is to see if the knotweed proliferates even more after the removal of the phragmites, since it no longer has a competing invasive species in the area. Also, this experiment can be altered to transcend observation into eradication. The person doing the experiment can alter different variables, (heat, chemicals, lack of water, humidity,etc…) to see which is the most detrimental to the plant and most likely to permanently get rid of it.

This experiment relates to the curriculum of the AP Biology course. In the course, students encounter a broad study of ecosystems and a more in-depth look at plant physiology. Through this knotweed experiment, students are able to get a hands-on experience with both the root and shoot systems of the knotweed plant and are able to observe the effects of an invasive species on a local ecosystem.

VII. Resources

"Invasive Species: Plants - Japanese Knotweed (Polygonum Cuspidatum)." National Invasive Species Information Center. Web. 07 Oct. 2011. <http://www.invasivespeciesinfo.gov/plants/knotweed.shtml>.

"Invasive Species Sheet - Japanese Knotweed." Connecticut NRCS. Web. 07 Oct. 2011. <http://www.ct.nrcs.usda.gov/japanese-knotweed.html>.

"Japanese Knotweed (Polygonum Cuspidatum)." Connecticut Botanical Society. Web. 07 Oct. 2011. <http://www.ct-botanical-society.org/galleries/polygonumcusp.html>.

"Japanese Knotweed.Web. 07 Oct. 2011. <http://www.hort.uconn.edu/cipwg/art_pubs/TNC/html/nat_japhnot.html>.

"Japanese Knotweed." US Forest Service - Caring for the Land and Serving People. Web. 07 Oct. 2011. <http://www.fs.fed.us/r10/spf/fhp/leaflets/japanese_knotweed.htm>.

"National Environmental Policy Act | New England | US EPA." US Environmental Protection Agency. Web. 03 Oct. 2011. <http://www.epa.gov/region1/nepa/>.

Current Research on the Japanese Knotweed:

In England and Wales, people are facing a similar problem to those in West Haven. The Japanese Knotweed was introduced as an ornamental plant and has spread uncontrollably. The non-profit organization CABI has obtained licenses from the governments of England and Wales and is planning a country-wide release of a Japanese Knotweed eating bug, the psyllid *Aphalara itadori.* In Japan, natural factors prevent the uncontrollable spread of this plant. One of these factors is the psyllid. It has been tested and the data supports that this bug will not cause damage to the native plants of England and Wales, but should control further spreading of the knotweed.

"Continued Testing of Japanese Knotweed Bug in England and Wales." CABI. Web. 07 Oct. 2011. <http://www.cabi.org/?site=170>.

Current Research in West Haven:

The University of Connecticut College of Agriculture and Natural Resources has a group dedicated to the study of invasive plants. They are called the Connecticut Invasive Plant Working Group (CIWPG). They have published an article concerning the Japanese Knotweed and possible methods of control. It is unclear if current research is being conducted on the plant.

"Connecticut Invasive Plant Working Group | UConn." Untitled Document. Web. 07 Oct. 2011. <http://www.hort.uconn.edu/cipwg/>.