The Yew-nique Presence of Yew (*Taxus canadensis) on Pells Island*

(Douglas Lake, Pellston, MI)

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EEB 381

17 June 2010

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Abstract

Canada yew (*Taxus Canadensis*) can be found in abundance on Pells Island, but nowhere else on UMBS property around Douglas Lake in Pellston, Michigan. One hypothesis is that the presence of yew on Pells Island is due to the fact that deer, the yew's main consumer, do not cross over to the island. We compared the ecological conditions on Pells Island to two other ecologically similar areas, testing amongst sites for similarity in micro site conditions such as light intensity, moisture content, soil carbon:nitrogen ratio, soil phosphorous content, and pH of soil. Based on the results of our research, presumably Canada yew would be able to grow at both control sites, which leads us to believe that the absence of yew within our control sites can be attributed solely to the pressures of deer browsing.

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Introduction:

Islands are great locations for ecological exploration. The enclosed populations and ecosystems provide a unique environment in which to study ecological patterns. For centuries, ecologists have used islands as natural laboratories; notably, Darwin and his studies of birds and tortoises on the Galapagos Islands (Darwin, 1859), and Alfred Wallace and his studies of species diversity in the Malay Islands (Wallace, 1890). The uniqueness of islands makes them perfect sites for ecological and population studies.

Our study involves Pells Island on Douglas Lake in Pellston, Michigan. We were intrigued by this small lake islet (sometimes a peninsula), because it had such a large population of an evergreen ground-covering shrub commonly known as Canada yew (*Taxus canadensis)* (Figure 1). Resident University of Michigan Biological Station (UMBS) Biologist, and long-time Douglas Lake resident, Bob Vande Kopple, suggests that yew is unique to Pells Island within the Douglas Lake region. Vande Kopple suggests this may be due to the lack of the yew's main predator, the white-tail deer, on the island. Although Canada yew is poisonous to humans and most livestock, deer enjoy browsing on it (Snyder and Janke 1976, Allison 1990), and there is anecdotal evidence that yew existed on the mainland in recent past, but is no longer found due to intense deer browsing. The yew is unique to southeastern Canada and northeastern United States (Martell 1974); however, to our knowledge, the Canada yew is not found in any other area in the Douglas Lake region (Figure 2).

In periods of low water, Pells Island is more like an attached peninsula instead of an island; but even in high water, it is very nearly connected to the southwest shore of Douglas Lake.

In the winter, when the water freezes, access to the island is improved. At the time of our investigation, Pells Island was attached to the mainland by a 40 meter sand spit—in other words—the island was easily accessed on foot. Evidence from a UMBS study in the 1970's suggests that Pells Island was a peninsula at that time as well (Cowan et al. 1970). This suggests, that not just today, but also in decades past, deer could access the area to feed on the Canada yew.

Consequently, it appears that the Douglas Lake deer populations should be able to access the yew on Pells Island. Yet, even so, the yew seems to flourish on the island. We hypothesize that ecological conditions on Pells Island may be unique and favor yew growth. In order to test out hypothesis, we selected two otherwise ecologically similar sites on the banks of Douglas Lake for ecosystem comparison. We compared micro-site environmental data from these sites to those of Pells Island to test for differences in micro-site conditions.

Materials and Methods

Pells Island is located on Douglas Lake in Pellston, Michigan. It is 1/5 km wide and less than 1 km long. To select control sites, we used the Landscape Ecosystems of the University of Michigan Biological Station, Cheboygan and Emmet Counties, MI (Pearsall & Barnes 1995). This map provides descriptions of all the ecosystem types within these two counties (Figure 3). The ecosystems are classified based on climate, physiography, soil, and biota. Areas with these similar characteristics tend to have the same ecosystem classification and are mapped accordingly. The ecosystem on Pells Island was classified as ecosystem 92: a moderately well drained medium sand with low lake terraces where Red maple and White pine are the most common over story and *Taxus canadensis* is the most common ground cover (Pearsall and Barnes 1995, p 133). Although the island represents the single occurrence of ecosystem 92 on

UMBS property, we located two locations near the island described as ecosystem type 91, an ecosystem type with similar conditions but which lacked Canada yew. We chose two locations in ecosystem 91 to test, Maple Point and Sedge point, both were located on University of Michigan Biological Station Property.

We used a random number generator and geographic information system to identify four random points at each location. The points were entered into a Garmin GPS 60, which was then used to locate the points. We located points within a precision of 5 to 20 meters as reported by the GPS. We used the point quarter method of sampling at each point (Brower 1977 p 93). At each point we took four soil and light samples: one meter to the north, south, east, and west of the center point (a total of 16 soil samples at each location). We used a meter stick to measure distance, and a compass to locate points north, south, east, and west of the center point. We took approximately three teaspoons of soil and stored our samples in metal tins which we labeled numerically with tape. We then used a light meter (LI-COR model 189) to measure light intensity (LUX) at three heights (ground, a meter, and two meters).

We weighed each soil sample and then placed the metal tins (without lids) into an oven for approximately 60 hours at 100 degrees Celsius to remove all of the moisture. After 60 hours, we removed the tins and weighed them again. We used these weights to calculate the percent of moisture in the soil using the equation: ((weight1-weight2)/weight1)*100. After drying and weighing the soil, we ground the soil and placed it in glass vials. We then had the lab analyze the soil samples for pH, carbon, nitrogen, and phosphorous. Once we received the results from the lab we ran statistical analysis on our data. We ran an ANOVA to test for significant differences between sites for moisture content, light intensity, carbon: nitrogen ratio, phosphorous content, and pH. We assumed independence of cases, normality of distribution,

and equal variances. If the ANOVA reported p-values of less than 0.05 for any of the tests, a post-hoc Tukey's test was performed to identify which means were significantly different from one another.

Results

The ANOVA showed no significant difference between sites in terms of moisture content, light intensity at two meters, carbon:nitrogen ratio, and phosphorous content. However, a difference was detected between light intensity at ground level and at one meter, and in the pH of the soil sampled ($F = 59.930$; $df = 1$, $p < 0.05$). A post-hoc Tukey test was performed to identify which means were significantly different from one another. The Tukey test revealed that the difference in light intensity and pH was between Pells Island and Sedge Point (Table 1). The pH of the soil at Pells Island was between 5.55 and 6.85, whereas the pH at Sedge Point ranged from 4.81 to 6.02 (Figure 4).

Discussion

Our results revealed that the ecological conditions at our two control sites were similar to those at Pells Island with notable exceptions including soil pH and light intensity. Lower light intensity at Pells Island is not unexpected since *Taxus canadensis* forms a thick groundcover, preventing ample amounts of sunlight from reaching the ground. This difference in light intensity is not what permits the yew to grow at this site, rather it is an environmental change caused by the yew itself. Although a significant difference was detected in the pH levels of soil sampled on Pells Island and Sedge Point, the difference does not account for the absence of yew since Canada yew can grow in the pH conditions found at Sedge Point (Allison 1990).

Of all the comparisons made, perhaps the most interesting comparison is between Pells Island and Maple Point, the two locations with the most similar physiographic features. None of the variables tested were significantly different between these two locations. Both sites were narrow peninsulas, but Maple Point was smaller and less developed. We observed a large amount of deer tracks at Maple Point; therefore we were able to conclude that deer were present at this site. On the other hand, we found no evidence of deer presence (tracks or scat) on Pells Island. Strangely, we did notice one set of deer tracks on the sand bar just south of Pells Island suggesting that they are close-by. While human presence was found at both sites, Pells Island had much more human activity. This is especially true in the summer months, when tourists and seasonal residents live on and near the island.

Based on the results of our research, presumably Canada yew would be able to grow at both control sites, which leads us to believe that the absence of yew within our control sites can be attributed solely to the pressures of deer browsing. There is also evidence to suggest that deer browse in residential areas. Human presence will not discourage deer from grazing on lawns or gardens (DeNicola et al. 2000). This may suggests that at this time deer populations are low enough that they are not being pushed into residential areas. Moreover, although Canada yew is a winter foraging plant, and the island is scarcely inhabited in the winter months, it appears that deer do not cross the ice; previous studies have shown that deer will cross ice and even swim to reach food (Scheffer 1940). It is possible that deer already have sufficient resources on the mainland and have no need to cross the ice simply to consume the Canada yew.

Our experiment leaves open the possibility for future research on this topic. For example, it would be interesting to transplant Canada yew from Pells Island to one of our control sites where deer were clearly present. We would then be able to observe whether or not the deer

consume the yew when it is located off of Pells Island. Additionally, monitoring Pells Island for deer presence would determine that even if they can access the island, they still do not consume the Canada yew. It would be beneficial to do a nutritional analysis of the leaf and compare it to samples collected by others who are studying deer and yew interaction.

Anecdotal evidence states that at one time yew was abundant around the Douglas Lake Region. Its disappearance from the area may be attributed to the increasing pressures of deer browsing. It is possible that the populations of deer and yew cycle inversely in this region, and that the deer population boomed, resulting in a bust of yew. Perhaps if populations continue to grow, deer will be forced to venture to the island in search of food, resulting in the Canada yew being wiped out completely.

Tables and Figures

Table 1. Mean values for light intensity and moisture content, carbon:nitrogen ratio, phosphorous content, and pH for soil sampled at Pells Island and at the two control sites.

Variables	Pells Island	Maple Point	Sedge Point
Moisture Content (%)	11.2	11.7	8.9
Light Intensity at Ground Level (Lux)	439	1032	1399*
Light Intensity at 1m (Lux)	894	1922	2791*
Light Intensity at 2m (Lux)	1777	2082	3184
Carbon:Nitrogen Ratio	19.0	16.2	21.5
Phosphorous Content (%)	4.5×10^{-3}	4.6×10^{-3}	5.4×10^{-3}
pH	6.2	6.3	5.3*

*denotes a significant difference ($p<0.05$, $df=1$) between Pells Island and control site.

Figure 1. *Taxus canadensis*, commonly known as Canada yew, is an evergreen ground covering shrub (http://www.borealisforestry.com/yew_stand.jpg)

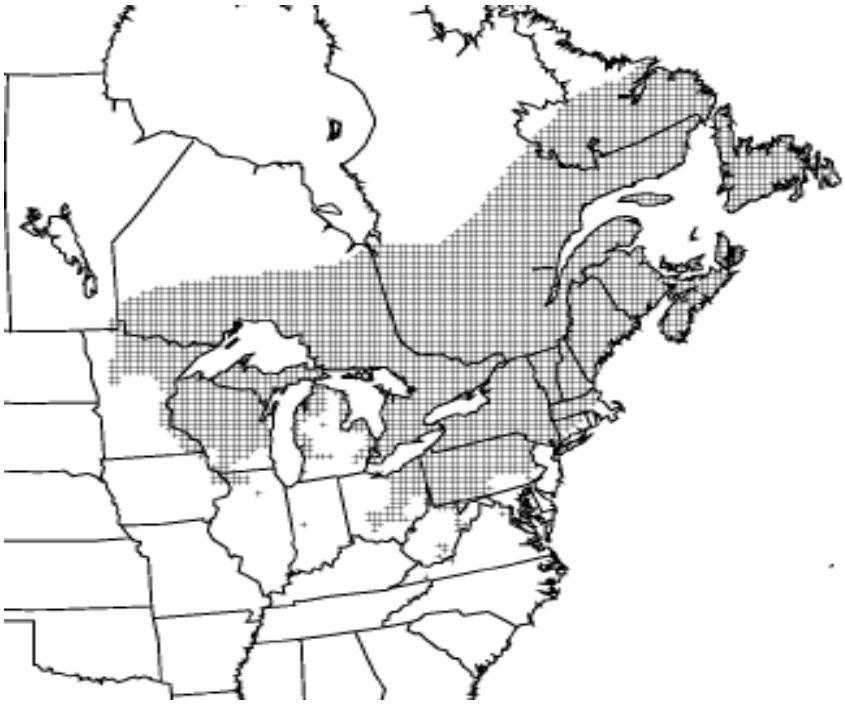

Figure 2. Canada yew distribution. Figure from Shafer el al. (2001)

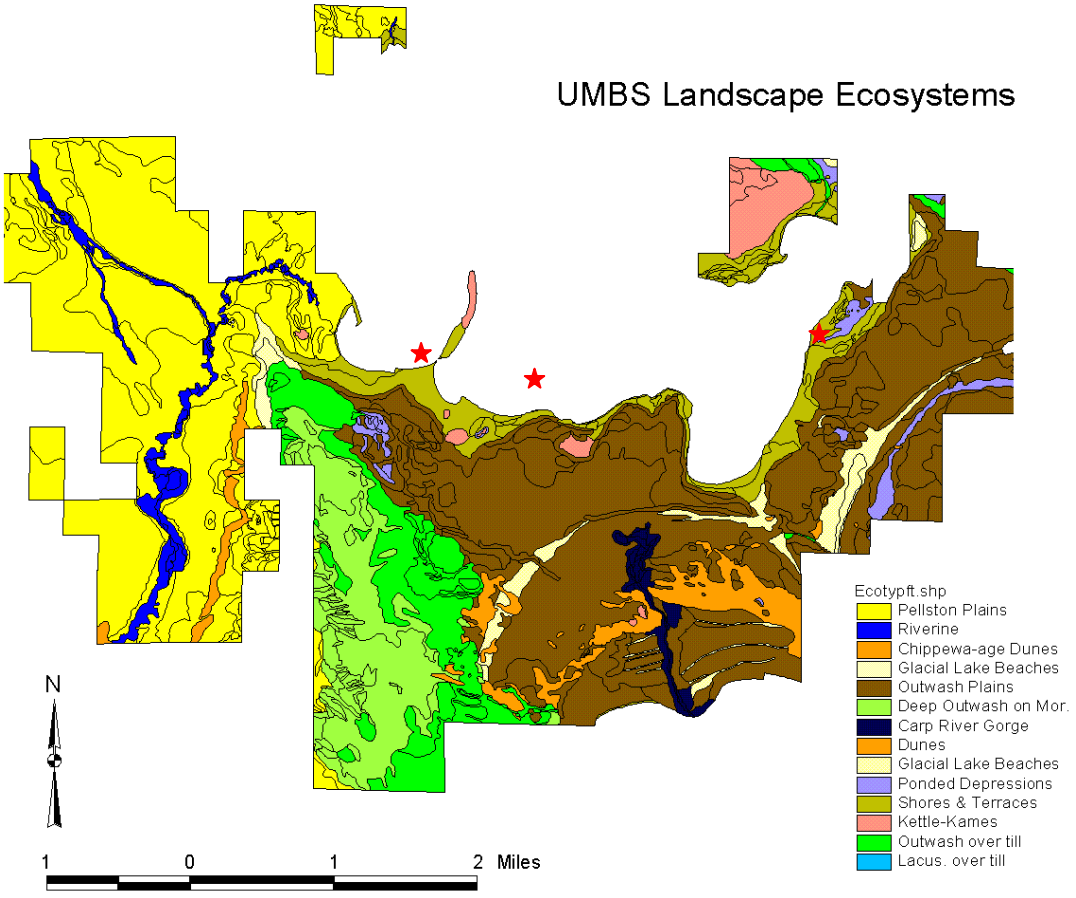

Figure 3**.** This map depicts the different ecosystem types found across Michigan's Cheboygan and Emmett Counties. Pells Island, Maple Point, and Sedge Point are all areas with similar ecosystems, as seen by their coloring on the map. Barnes and Burton (1995) Image available from: http://sitemaker.umich.edu/umbs/files/ecotypes.gif.

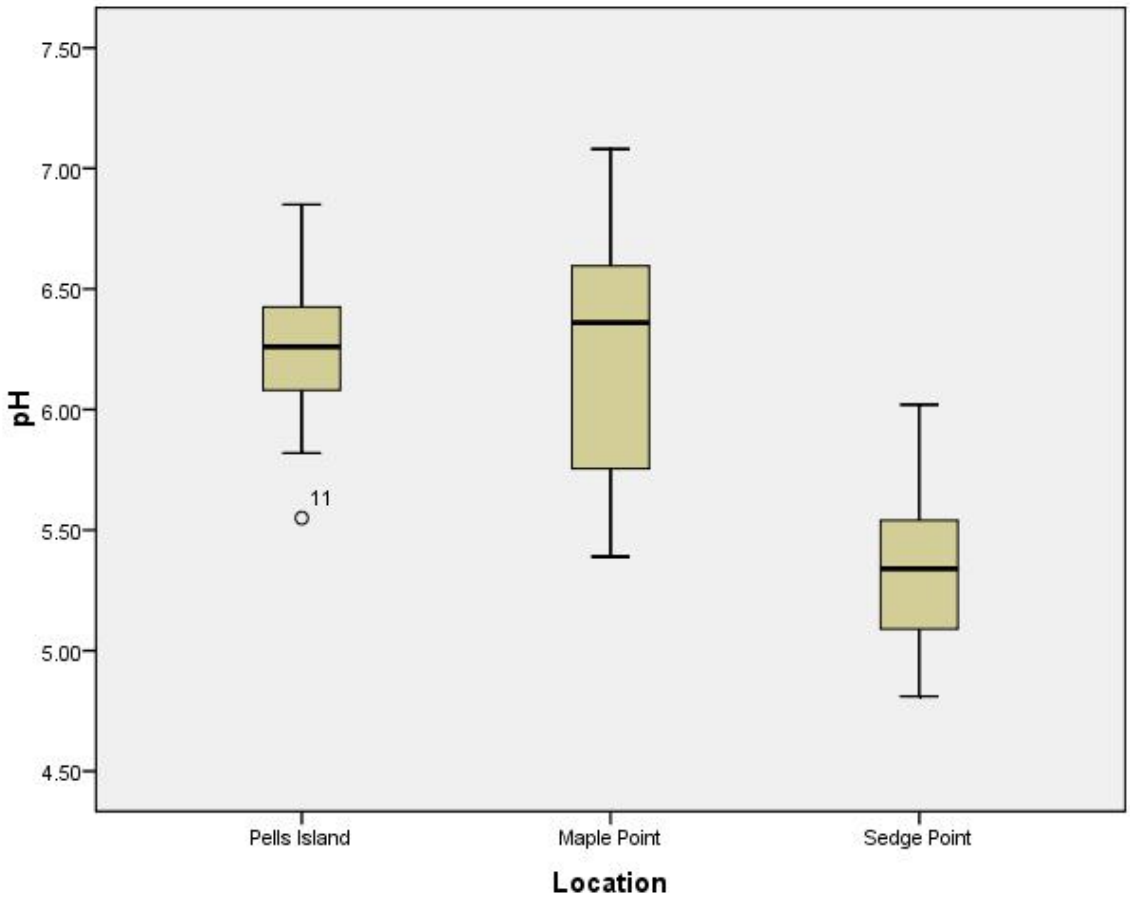

Figure 4. Boxplots of soil pH

BIBLIOGRAPHY

Allison TD. 1990. The influence of deer browsing on the reproductive biology of Canada yew (*Taxus canadensis* Marsh) pollen limitation: An indirect effect. Oecologia 83(2):530-4.

Brower JE, Zar JH, Von Ende CN. 1977. Field and Laboratory Methods for General Ecology. Dubuque, IA: Brown Publishers. 237 p.

Cowan, P., Dillman, R., Fabbri, L., Lea, R., Peters, A., Roth, J., Wilson, K., Winder, C., Witmer G. 1973. A survey of the vegetation of Fairy Island. University of Michigan Biological Station Student Research Project. Pellston, MI.

Darwin C. 1859. The Origin of Species. Great Britain: John Murray. 502 p.

DeNicola AJ, VerCauteren KC, Curtis PD, Hygnstrom SE. 2000. Managing white-tailed deer in suburban environments. The Wildlife Society 1:2-6

Gill, John D.; Healy, William M. 1974. Shrubs and vines for northeastern wildlife. General Technology Representative. NE-9. Forest Exp. Station, Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 180 p.

Leschishin M Z. 2010 [cited 2010 Jun 16]. Borealis: Forestry and GIS services. [Internet]. Ontario: Borealis Forestry and GIS services. Available from: http://www.borealisforestry.com/yew_stand.jpg. (Figure 1)

Pearsall, D.R., B.V Barnes, G.R Zogg, M. Lapin, and R.R Ring. 1995. Landscape Ecosystems of University of Michigan Biological Station. School of Natural Resources and Environment. University of Michigan, Ann Arbor, MI.
132 and 133 pg.

Scheffer VB. 1940. A newly located herd of pacific white-tailed deer. Journal of Mammology 21(3):272-3.

Shafer SL, Bartlein PJ, Thompson RS. 2001. Potential changes in the distributions of western North America tree and shrub taxa under future climate scenarios. Ecosystem 4(1):200-15.

Synder JD, Janke RA. 1976. Impact of moose browsing on boreal-type forests of Isle Royal National Park. American Midland Naturalist 95(1):79-92.

Wallace A R. 1890. The Malay Archipelago. England: Macmillan and Company. 544 p.