Stream-side Forests Impacts on the Riparian Zone

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Abstract

The type of vegetation present in a system has a large influence on the surrounding area. Likewise, the history of the area greatly influences what type of habitat is present today and what will be there in the future. This study looks at the forest types present along a man-made canal that resembles a swamp-like habitat that is became a specialized environment compared to several control sites sampled on different areas of the same lake.

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Intro

Burt Lake is one of the many inland lakes in Northern Michigan that is used as a recreational lake. In the early 60's, a canal was built on the East side of Burt Lake to increase the amount of lake front property and to therefore increase the property value. To build the canal, the entire forest in the area was cut down and then most likely burned to dispose of the slash. The areas that were not developed had the opportunity to become established with a variety of pioneer species and grow into a new forest. This forest is an area called the riparian zone, or the terrestrial area that influences the surrounding aquatic system. The size and the productivity of the riparian zone influence how much allochthonous carbon is brought into the aquatic system, and therefore impacts the water nutrients. A greater amount of allochthonous carbon input to a stagnant system will have elevated levels of decomposition, which releases more usable nitrogen into the system through the process.

In order to have a comparative control area, two sites were selected to represent the ecosystem around the lake. The first control was at the mouth of Carp Creek, which presents a similar history to the vegetation around the canal. It is assumed that by the large presence of stumps there is a history of logging in the area. Logging in Northern Michigan took place in the late 1800's so the time frame of the disturbance was much earlier than that of the canal. The second control site was located at Maple Bay, which also shows a similar history as well. The growth patterns of several trees are indicators that logging or fire was a disturbance at some point in time. Both of these sites provide a good comparison because they have a similar a similar history so the type of habitat can be compared based on the water presence and flow.

To properly assess the type of forest present, an analysis of the relative biomass can be completed. Biomass is calculated by taking the DBH, or the diameter at breast height of the tree (in cm) and then inserting that number into the formula diameter^2 X 0.00007854. This gives you the basal area, or biomass for that particular tree and all the trees for each species are added together to come up with a total biomass for the species. The different species are compared to each other for the plot in order to come up with the relative dominance for the area. So then, by definition, the relative dominance is a comparative analysis of the total basal areas of the trees present in the plot.

To further assess the forest characteristics, soil sampling can be done to observe the development of the soil layer and what type of nutrients may be available. The different layers and how well they are developed can tell you how much organic material is being deposited and broken down, how much of the nutrients are staying in the system, and how old the soil is. Other dynamics that can be concluded from soils is the fire history; whether or not the area has been burned and relatively how recent.

Several tree species will be discussed and a few of them will be the focus to make the conclusions about the habitat types and influences on those habitats. The first of focus group of species is Thuja occidentalis, commonly known as Northern white cedar. It is a typically reaches 10-15m in height and 30-60cm in diameter when mature. Characteristics of its typical habitat are cold, fairly drained swamps with moving water with a soil pH that is neutral to basic. It keeps it roots shallow and spreads them over large areas. It can occur in very dense stands in swamps and is often common along stream borders. In these habitats is associated with black ash, balsam poplar, speckled alder, trembling aspen, spruces and red maple.

The second species that is quite prevalent in this study is Populus balsamifera, commonly known as the Balsam poplar. It typically grows to 18-30m in height and 30-60cm in diameter when mature. It has a wide spreading, shallow root system and disturbances cause it to send up root sucker sprouts. Characteristics of its typical habitat are wet, cool, lowland sites such as swamps, stream banks, flood plains, borders of lakes and other wet depressions. It is commonly associated with swamp conifers, black ash, red maple, trembling aspen, paper birch, speckled alder, and black and white spruce. It can also be found on dry sands such as dunes where the water table is near the surface. Populus tremuloides, commonly known as trembling aspen, typically grows to 16-32m in height and 30-60cm in diameter when mature. It has a shallow, very wide spreading, extensive root system and disturbances cause it to send up root sucker sprouts. Typical habitats are lowland sites such as stream and swamp regions and will thrive on wet-mesic, fertile sites. It can survive but will grow slowly on dry, sandy soils. It is very nutrient, moisture and light demanding species and colonizes on diverse sites following wildfires and human disturbances. It is commonly associated with balsam poplar, red maple, big tooth aspen, paper birch, pines, oaks and many other species.

Another set of species relevant to the study begins Acer rubrum, commonly known as red maple. It typically grows to 18-30m in height and 50-80cm in diameter when mature. It tolerates saturated soils of wet, poorly drained sites and has a shallow, spreading root system. It is found in a broad range of site conditions and is an aggressive colonizer of upland sites compared to its traditional swamp and poorly drained sites. It is tolerant of saturated or waterlogged soils but intolerant of flooding or partial inundation during the growing season, and is common in conifer and conifer-hardwood swamps. It is commonly associated with white and black spruce, balsam fir, northern white cedar, yellow birch, American elm, basswood, black ash and speckled alder. It will root-collar sprout vigorously after fire, cut or browse damage and spontaneously with stress from drought or shade. The second in the series is Tilia Americana, commonly known as basswood. It typically grows from 18-30m in height and 40-100cm in diameter when mature. Its roots are deep and wide spreading, allowing it to be a very wind firm species. It will root collar sprout spontaneously and also after fire, cut and browse disturbance. It is characteristic of mesic deciduous forests with moist, nutrient-rich, well drained to somewhat poorly drained soils. It is commonly found on lake and stream borders and in bottomlands. It is commonly associated with sugar maple, white ash, hop-hornbeam, American beech, American elm, yellow birch, red maple, black walnut, butternut, Northern red oak and white oak. The last species that is focused on in this study is Tsuga canadensis, commonly known as Eastern hemlock. It typically grows from 22-30m in height and 50-100cm in diameter when mature. Its root system is wide spreading, but shallow, making it not very wind firm. It is characteristic of a variety of sites, including cool and moist to wet swamps and wetland edges, to fire-prone dry slopes and outwash plains. It is commonly associated with yellow birch and conifers while in moist sites and will occur in northern hardwood stands; sugar maple, American beech, basswood, yellow birch, and red maple. It regenerates quite vigorously after wildfires on a variety of sites where it is associated with Eastern white pine, red pine and Northern red oak.

The variety of species described and discussed are the main indicators of the different sites included in this study and provide a great deal about the ecosystem and the conditions that area present, particularly for them to survive.

Methods

In order to sample the vegetative species present, four 10m by 10m plots were laid out on the south end of the canal where there was still natural vegetation present. The plot was laid out from the water's edge and back 10m inland, and then the species observed were recorded, quantified, and the DBH for the overstory trees were also taken and recorded. The soil was also sampled to look at the development of the layers. A mini soil pit was dug to minimize the disturbance of the habitat. The mini soil pit was simply a small square of a shovel's width and then brought up by the shovel.

Plots were chosen based on the amount of vegetation present. Since the area was still partially still residential, there were trails in the small forest that was being sampled. Plots did not have any trails going through them and there was complete ground cover by herbaceous and grassy species. The species that were recorded were researched to determine what type of habitat that they were likely to grow in and if they were an indicator of any particular habitat or disturbance type. A field guide of Michigan trees was used to research the trees, their characteristics and the habitats typical of each species. The DBHs of the trees were analyzed and the relative densities and dominance for each plot was determined by calculation.

Results

The vegetation that was sampled and analyzed reflects the history of the area. Many of the species found are either cut and/or fire indicators and some of them can only establish after an area has been burned. Also, a majority of the species found are typical of very moist habitats, mainly swampy or stream-side.

Site 1	Overstory				Understory		**Total**	
Species	No. of Stems	Rel. Density	Biomass	Rel. Dom.	No. of Stems	Rel. Density	No. of Stems	Rel. Density
Thuja occidentalis	7	33.3	0.0736	16.4	10	58.8	17	44.7
Abies balsamea	6	28.6	0.0566	12.6	5	29.4	11	28.9
Populus balsamifera	5	23.8	0.1885	41.9	0	-----------	5	13.2
Betula papyrifera	1	4.8	0.0405	9.0	1	5.9	2	5.3
Fraxinus nigra	1	4.8	0.0232	5.2	0	-----------	1	2.6
Salix sp.	1	4.8	0.0670	14.9	0	-----------	1	2.6
Pinus strobus	0	-----------	-----------	-----------	1	5.9	1	2.6
TOTAL	21	100%	0.4494	100%	17	100%	38	100%

Site 2	Overstory				Understory		**Total**	
Species	No. of Stems	Rel. Density	Biomass	Rel. Dom.	No. of Stems	Rel. Density	No. of Stems	Rel. Density
Thuja occidentalis	2	25.0	0.0298	17.4	4	23.5	6	24.0
Abies balsamea	1	12.5	0.0100	5.8	2	11.7	3	12.0
Populus balsamifera	4	50.0	0.1230	71.9	1	5.9	5	20.0
Picea glauca	1	12.5	0.0083	4.9	7	41.2	8	32.0
Abies concolor	0	-----------	-----------	-----------	3	17.7	3	12.0
TOTAL	8	100%	0.1711	100%	17	100%	25	100%

Site 3	Overstory				Understory		**Total**	
Species	No. of Stems	Rel. Density	Biomass	Rel. Dom.	No. of Stems	Rel. Density	No. of Stems	Rel. Density
Populus tremuloides	2	66.7	0.1694	64.0	0	-----------	2	18.2
Populus balsamifera	1	33.3	0.0951	36.0	4	50.0	5	45.5
Thuja occidentalis	0	-----------	-----------	-----------	1	12.5	1	9.1
Abies balsamea	0	-----------	-----------	-----------	3	37.5	3	27.3
TOTAL	3	100%	0.2645	100%	8	100%	11	100%

Site 4	Overstory				Understory		**Total**	
Species	No. of Stems	Rel. Density	Biomass	Rel. Dom.	No. of Stems	Rel. Density	No. of Stems	Rel. Density
Betula papyrifera	6	40.0	0.0811	26.5	1	3.9	7	17.1
Populus balsamifera	1	6.7	0.0343	11.2	0	-----------	1	1.0
Acer saccharum	3	20.0	0.0515	16.8	22	84.6	25	61.0
Tilia americana	5	33.3	0.1394	45.5	0	-----------	5	12.2
Fraxinus nigra	0	-----------	-----------	-----------	3	11.5	3	7.3
TOTAL	15	100%	0.3063	100%	26	100%	41	100%

Total Canal	Overstory				Understory		**Total**	
Species	No. of Stems	Rel. Density	Biomass	Rel. Dom.	No. of Stems	Rel. Density	No. of Stems	Rel. Density
Thuja occidentalis	9	19.1	0.1034	8.7	15	22.1	24	20.9
Abies balsamea	7	14.9	0.0666	5.6	10	14.7	17	14.8
Populus balsamifera	11	23.4	0.4409	37.0	5	7.4	16	13.9
Populus tremuloides	2	4.3	0.1694	14.2	0	0.0	2	1.7
Tilia americana	5	10.6	0.1394	11.7	0	0.0	5	4.3
Acer succharum	3	6.4	0.0515	4.3	22	32.4	25	21.7
Picea glauca	1	2.1	0.0083	0.7	7	10.3	8	7.0
Betula papyrifera	7	14.9	0.1216	10.2	2	2.9	9	7.8
Fraxinus nigra	1	2.1	0.0232	1.9	3	4.4	4	3.5
Salix sp.	1	2.1	0.0670	5.6	0	0.0	1	0.9
Abies concolor	0	0.0	0.0000	0.0	3	4.4	3	2.6
Pinus strobus	0	0.0	0.0000	0.0	1	1.5	1	0.9
TOTAL	47	100%	1.1913	100%	68	100%	115	100%

Maple Bay (2 plots)	Overstory				Understory		**Total**	
Species	No. of Stems	Rel. Density	Biomass	Rel. Dom.	No. of Stems	Rel. Density	No. of Stems	Rel. Density
Acer rubrum	11	68.8	0.8765	89.3	0	-----------	11	50.0
Abies balsamea	2	12.5	0.0437	4.5	1	16.7	3	13.6
Tilia americana	1	6.3	0.0179	1.8	0	-----------	1	4.5
Betula papyrifera	1	6.3	0.0227	2.3	5	83.3	6	27.3
Fraxinus nigra	1	6.3	0.0204	2.1	0	-----------	1	4.5
TOTAL	16	100%	0.9812	100%	6	100%	22	100%

Carp Creek (2 plots)	Overstory				Understory		Total	
Species	No. of Stems	Rel. Density	Biomass	Rel. Dom.	No. of Stems	Rel. Density	No. of Stems	Rel. Density
Tilia americana	6	23.1	0.3302	22.1	0	-----------	6	18.8
Thuja occidentalis	10	38.5	0.4030	26.9	2	33.3	12	37.5
Tsuga canadensis	3	11.5	0.4141	27.7	0	-----------	3	9.4
Betula allenaghensis	1	3.8	0.0423	2.8	2	33.3	3	9.4
Ostrya virginiana	1	3.8	0.0083	0.6	1	16.7	2	6.3
Fraxinus nigra	2	7.7	0.1054	7.0	0	-----------	2	6.3
Acer rubrum	3	11.5	0.1938	12.9	1	16.7	4	12.5
TOTAL	26	100%	1.4971	100%	6	100%	32	100%

The soil samples that were done showed very little development of definite layers. The most relevant type that was observed was a 'salt & pepper' top layer, which is common for burned sites.

SITE	Soil type	Texture	Layer Development
Plot 1	Salt & pepper A	sandy loam	med-well
Plot 2	heavy O layer, grasses, Salt & pepper A	sandy clay loam	very poor
Plot 3	some O, Salt & pepper A	sandy	poor
Plot 4	very defined layers, deep A	loamy sand	well
Carp Creek 1	Salt & pepper A, little organic	sandy	med-poor
Carp Creek 2	well developed A layer	sandy	well
Maple Bay 1	Salt & pepper A, little organic	sandy	very poor
Maple Bay 2	thick A layer	loam	very well

Discussion

The plots along the canal showed a steady gradient as we moved further toward the dead end of the canal. There was a high density of Thuja along the waters' edge and further inland, Populus and Abies were the densest. This is due to the typical characteristics of the individual species and the type of habitat that they prefer to live in based on the amount of saturation of the soil. Plot 4 was very different from the rest of the samples taken along the canal. It was more of an upland site and appears to not have been disturbed, and if so, it was slight due to the large diameter Tilia that were recorded on site. The arrangement of the Tilia presents itself as a remnant of root collar sprouting which suggests either a fire disturbance from well before the canal construction or a result of logging from earlier settlers.

Compared to the canal sites, both of the control areas have a much greater biomass. This is most likely due to the control sites being much older both in growth and the current succession stage. The productivity of the canal sites appeared to be much higher than the control sites in terms of species diversity and the amount of ground species present. This type of difference suggests that a lot of that carbon that is being cycled through the canal sites is not all staying in the system. Many of the leaves of the trees may fall into the water and then stay in the canal, increasing the amount of allochthonous carbon in the aquatic system. Likewise, then, much of the carbon being cycled in the control plots is staying in the system and being stored in the trees which are acting as a carbon sink. Though there are much fewer trees in the control sites, the diameter of the trees was much greater, leading to a much higher biomass, in which each site was over two times greater than any of the canal sites.

The species present in an area can tell an observer a lot about the history and the current conditions of the habitat. The south end of the Burt lake canal was still naturally vegetated even though it had been previously cut and burned. The forest type today is typical of a northern Michigan swamp or stream-side habitat and the high species diversity is a reflection of a high productivity site. Because the site is still very young, in the age of forests, it is still dominated by early successional species, which are very generally very hardy and can tolerate a range of conditions. Though they are hardier species, several present, such as the ashes and the trembling aspen, are very demanding in the amount of nutrients that they require. These elevated nutrients could be have been typical for this site beforehand, but when a site is burned, all of the surface organic material is no longer there to be broken down and those nutrients available for future uptake. Therefore, it could be assumed that the nutrients are being pulled from the canal water itself, which has elevated levels of nitrogen and other key nutrients for a highly productive site.

The high productivity could be result of the type of habitat that is present in the area, but it could also be very heavily influenced by the canal. The fertilizers that the residents use for their lawns get washed into the canal by the rain and then it gets used by any organism that can take it up. But, considering the amount of productivity of the sites, it could also increase the amount of organic debris going into the canal, which may or may not affect the overall nutrients to a significant degree.

In order to have a better understanding of the overall workings of the canal ecosystem, a longer term study would have to be done than the month than the limnology course was sampling. There is not enough collective data to draw any solid conclusions though in all aspects of the sampling the canal appears to be a healthy ecosystem. Just after the class had finished sampling, there was another round of herbicides sprayed into the canal, in which we were unable to sample the changes in the water chemistry or species present in the canal. As of the end of our sampling set, the canal appeared to be healthy, but now that the system has been once again disrupted, the current status of the ecosystem is unknown.