Illusory Timelessness:

A Geologic and Anthropomorphic History of the Belgrade Lakes Watershed

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Introduction

Generation after generation people have been captivated by the allure of a secluded lakeshore tucked among the pine trees somewhere in a northern forest. To escape the hustle and bustle of urban life, to listen to a pair of loons call each other, to paddle a canoe leisurely around a bay, or to hike up a pine-covered hill are all part of an experience that has been sought by many for decades. In his critically acclaimed play *On Golden Pond*, Ernest Thompson depicted this northern lakeshore lifestyle beautifully through his loveable protagonists, Ethel and Norman Thayer. The Thayers summer in a cottage on the shore of Great Pond in Belgrade, Maine. They epitomize the sentiment that while the people occupying the lakeshore may come and go, the lake, the loons and the pine trees will always remain to welcome them back. In the opening scene of the well-known movie adaptation, Ethel exclaims, "The loons! They're welcoming us back!"

While the Thayers are a fictional couple, Great Pond is a real place - one of a chain of seven lakes in the Belgrade Lakes Watershed in central Maine. All the Belgrade Lakes are surrounded by summer cottages and camps that have been popular destinations since the turn of the century when Maine itself experienced a "second discovery" among the New England elite as a vacation destination.[1] Each year, when summer visitors travel north to central Maine and the Belgrade Lakes Region, they arrive to find the comforting retreat

[1] Richard W. Judd. "Reshaping Maine's Landscape: Rural Culture, Tourism and Conservation, 1890-1929." *Journal of Forest History* 32 (Oct. 1988): 183.

they seek seemingly frozen in time. While they may need to sweep pine needles off the porch, change a rusty lock, or replace a broken window, they listen to the same call of the loon, paddle the same canoes, and hike the same trails they remember from the prior summer. The culture of the Belgrade Region seems to be characterized by timelessness.

But this timelessness is, in truth, a convincing illusion. Those who know the area well will argue that, as with any landscape, the Belgrade region is far from unchanging. Through a geologic history spanning millions of years and a human history spanning a fraction of that, the Belgrade Lakes Watershed has undergone dramatic change that is still taking place today. From the radically destructive and constructive effects of the last ice age, to the rapid environmental transformation that human existence has brought, the scenic Belgrade backdrop has been far from static. This paper moves from a broad description of the geologic history of the Belgrade region, to the waxing and waning of the area's diverse flora and fauna, to an overview of the major human impacts on the Belgrade Lakes in the past 400 years. The broad strokes of information given in this paper are meant to illustrate that the Belgrade Lakes landscape, while it remains idyllic and beautiful, is not a given. The lakes have been subject to dramatic change in the past and will continue to evolve at an even faster pace. They will likely be subject to increased environmental stress with increased human presence. However, the strong attachment visitors and residents feel to this unique landscape has led to a sense of pride and an interest in stewardship that may help the region endure the pressures of an ever increasing population.

The Belgrade Lakes Watershed is located in south-central Maine, at the tip of the Northern Appalachian Mountain range. The watershed spans 180 miles and 13 different

towns. It has two primary headwaters.[2] East Pond serves as the first starting point. Water flows from East Pond into the adjacent North Pond, where it then flows south into Great Pond. The second headwater location is McGrath Pond, from which water flows south into Salmon Lake and west into Great Pond. All the water collected in Great Pond is transferred west into the adjacent Long Pond. Long Pond is connected to Messalonskee Lake via the Belgrade Stream that makes a southeastern-bending loop around the rim of the watershed. Finally, the water exits the watershed via the Messalonskee Stream as it joins with the Kennebec River. The Belgrade Lakes Region is also home to the Kennebec Highlands, a mountainous portion of undeveloped forestland. The Kennebec Highlands contain the highest summit in the surrounding Kennebec County- McGaffey Mountain.[3]

Geologic History

Often when we attempt to understand a region's history, we reach only as far back as human history can take us, typically to the arrival of early European settlers, or perhaps to the culture of pre-historic peoples. We picture the land prior to human occupation as immobile, unchanging and waiting for humans to arrive. Knowledge of the dynamic and often cataclysmic events that took place on a geologic timescale prior to human arrival can dramatically change our perception of a region. A look at the geological history of the Belgrade Lakes region helps us see that the lakes, streams, mountains, hills, and soils unique to the area are not the timeless features of a unchanging landscape, but are, in fact,

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[2] "What is a watershed?" BRCA Watershed Protection Program. Belgrade Regional Conservation Alliance. Web. Accessed 26 April 2010. http://www.belgradelakes.org/watershed-definition.html

[3] "Kennebec Highlands Interim Management Plan." Maine Department of Conservation: Bureau of Parks and Lands. August 2007. P. 2.

battle-weary remnants of millions of years of intense construction, destruction and alteration by the Earth's geologic forces.

Bedrock History

Before we zoom in on the Belgrade Lakes Watershed itself, which, covering 180 square miles, is a relatively miniscule portion of the planet, let us take a crash course in how the Earth's landmasses were created. By most estimates, the Earth itself is around 4.54 billion years old.[4] Much like a snowball increasing its size as it rolls down a hill, in the early solar system the Earth gradually gained mass as space rocks and meteorites became incorporated into a growing ball of molten rock. Gradually, the massive sphere that is now called Earth started to cool. This cooling hardened the surface rock known as the crust while maintaining a molten rock core with a layer in between known as the mantle. The liquid core is the reason that our landmasses are not static, but are constantly growing and shrinking. The Earth's crust consists of a series of plates that fit together like a jigsaw puzzle, and along the borders of the puzzle pieces are ridges through which magma from the molten mantle continuously emerges. While these ridges are producing fresh portions of crust, older portions of crust are being pushed back down towards the Earth's center in oceanic trenches, through a process known as subduction.[5]

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[4] "Geologic Time, The Age of the Earth." U.S. Geologic Survey. 9 July 2009. Web. 30 March 2010. http://pubs.usgs.gov/gip/geotime/age.html

[5] "Plate Tectonics." U.S. Geologic Survey. 13 January 2009. Web. 30 March 2010. http://geomaps.wr.usgs.gov/parks/pltec/index.html

This constant movement of the Earth's crust, known as plate tectonics, is the process that assembled the underlying bedrock of the Belgrade Region.[6] About 500 million years ago, a precursor to the North American continent had formed. This continent, known as Laurentia, was adjacent to an ancestor of the Atlantic Ocean, Iapetus, which contained a number of smaller micro continents.[7] In the Silurian Era, about 420 million years ago, one of these micro continents, Avalon, began to approach, closing the ocean and pushing sediments and volcanic deposits onto the Laurentian plate. About 400 million years ago, Avalon and Laurentia collided. The immense forces generated by the collision catalyzed a major mountain building event, resulting in the Northern Appalachian Mountains.[8] Simultaneously, the bed of the Iapetus Ocean, consisting of sediments layered on top of rock salt deposits, was pushed nine miles underneath the North American plate.[9] At this depth, the accumulation of heat from frictional sliding and the underlying mantle caused the lower crust of the Iapetus plate to start to melt and form pools of magma. The more buoyant magma then migrated upward before cooling into granite. Much of the bedrock in Belgrade is this kind of metamorphosed sedimentary rock—formed originally as sedimentary rocks in the ancient Iapetus ocean, but over time subjected to intense heat and immense pressure that altered its original composition. At the highest degree of metamorphism, the minerals in the metamorphic rock are completely different from the

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[6]Carol T. Hildreth. Surficial Geology of the Belgrade 7.5-Minute Quadrangle, Kennebec County, Maine. Department of Maine: Maine Geological Survey. 2004. P.2

[7] Robert G. Marvinney. A Summary of the Geologic History of Maine. Department of Conservation. Maine Geological Survey: Augusta, Maine. 2002.

[8] Dwight C. Bradley, Robert D. Tucker, Daniel R. Lux, Anita G. Harris, and D. Colin McGregor, "Migration of the Acadian Orogen and Foreland Basin Across the Northern Appalachians of Maine and Adjacent Areas," U.S. Geological Survey Professional Paper 1624 (2000) at http://pubs.usgs.gov/pp/pp1624/

[9]Robert G. Marvinney., P.H. Osberg., A.M. Hussey., G.M. Boone. 2002.

minerals in the original non-metamorphic rock.[10] In addition to undergoing metamorphosis itself, the granite intrusion of the Northern Appalachian mountain building event forced it way into the higher layers of crust. The accompanying heat metamorphosed the surrounding rocks of the region as well.

Like underground tea kettles reaching boiling point, the volatile magma chambers formed from the subducted crust of Avalon were also subject to extreme pressure, leading to volcanic activity all throughout Maine and North America. [11] Formed by a continental collision and massive amounts of volcanic activity, the Appalachians were an impressive range of mountains in this era. While we can only speculate at their exact height, it is thought that the modern Rocky Mountains, their geologically younger sibling, provide a good picture of the original Appalachian Mountains.

For the next 100 million years, these mountains experienced both erosion and additional uplift through subsequent plate collisions. By about 300 million years ago, all the Earth's crustal plates had combined into one super continent, Pangea. Continual uplift brought more deep, metamorphosed rocks toward the surface of what would become the Belgrade Lakes Region.

Between 240 and 66 million years ago—in the age of the great reptiles—Pangea broke up. A continent, which is now Europe and Africa, drifted away, opening the modern Atlantic Ocean and leading to further faulting and fracturing of the North American bedrock. The combined effect of all these ancient forces created the bedrock in the

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[10] Thomas K. Weedle. "Primary Sediment Structures in Some Metamorphic Rocks." Maine Geological Survey. Department of Conservation. 13 November 2006. Web. 24 March 2010. http://www.maine.gov/doc/nrimc/mgs/explore/bedrock/facts/nov06.htm

[11] Robert G. Marvinney. "Bedrock Geologic History of Maine," Maine Geological Survey http://www.maine.gov/doc/nrimc/mgs/explore/bedrock/facts/geol-hist.htm

Belgrade Lakes region, which consists largely of metamorphosed sedimentary rock, igneous rock such as granite (Figure 1) and, in formal geological terminology, "vertical, tightly isoclinal-folded, north-northeast-trending, high-grade metasedimentary rocks."[12] These metasedimentary rocks were produced when sedimentary rocks such as limestone or sandstone were folded together from continuous tectonic plate pressure to produce cross sections of rock that appear as if highly flexible ribbons of rock have been squeezed together. Figure 2 shows a portion of isoclinal-folded metasedimentary rocks found near the Blue Rock Quarry on I-95 at the Sidney Exit in Augusta, Maine.

Glacial History

Over millions of years, the once impressive Northern Appalachian Mountains slowly eroded and shrank. It was the work of multiple ice ages and a series of massive glaciers that finally shaped the Belgrade Lakes landscape into the broad contours we see today. The cycle of massive ice sheets advancing forward and receding backward began in earnest three million years ago during the Pleistocene Epoch. During this series of 4 or 5 Glacial and Interglacial periods, up to 30% of the Earth's surface was ice.[13] Over eons, continuous erosion and friction caused by the ice sheets wore down the sharp, jagged peaks of the Appalachians to the more rounded mountains they are today. By the time the last glaciation began, the Appalachian Mountains in the Maine region looked similar to the modern southern Appalachians today.[14] During this cycle, Maine alternated between glacial and

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[12] Carol T. Hildreth. P.2

[13] Jerry Binninger., and Jeanne Allen. "The Ice Age (Pleistocene Epoch)." Gulf of Mexico Program. U.S. Environmental Protection Agency., 2 November 2009. Web. 24 March 2010. http://www.epa.gov/gmpo/edresources/pleistocene.html

[14] David L. Kendall. Glaciers and Granite: A Guide to Maine's Landscape and Geology. North Country Press: Unity, Maine. 1987 p.22

interglacial epochs, between a landscape similar to modern Antarctica and a more temperate environment.

To the average observer in the Belgrade Lakes Region, the most visible legacy of the glacial age is the changes wrought by the most recent glacier, the Wisconsin Stage of the Laurentide Ice Sheet. This glacier formed in Canada around 95,000 years ago. This ice sheet covered all of Maine and most of New England, extending as far south as Long Island 25,000 years ago.[15] As the glacier expanded southwards it also grew in mass, becoming 3,300 feet thick, or about two thirds of a mile deep, over the Maine region.[16] The harsh environment that this enormous glacier brought with it eliminated most species of plants and animals and forced the mobile organisms to migrate southward. This left the glacial environment deprived of most biological diversity, leaving only the most hardy plant organisms and resilient mammals, such as the wholly mammoth, caribou and muskox, to eat what plant material was left as well as each other.[17]

As the glacier advanced, it scraped the bedrock, leaving a pattern of south trending lines in the bedrock, known as striations. The direction of the glacial scouring reflects the motion of the glacier. (Figure 3)[18] As the ice moved over northern slopes of bedrock, the grinding mass of ice scraped and rounded the profile of hills and mountains, while on southern slopes, the glacier plucked fractured rock from the cliff sides, exposing the bedrock and leaving the ridges jagged and precipitous. As the glacier crossed bedrock,

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[15] Tom Wessels. Reading the Forested Landscape: A Natural History. Woodstock, Vermont: The Countryman Press, 1997. P.143.

[16] Kelley, Joseph T., Dickson, Stephen M., and Belknap, Daniel. "Maine's History of Sea-Level Changes." Maine Geological Survey. Department of Conservation. 6 October 2005. Web. 24 March 2010. http://www.maine.gov/doc/nrimc/mgs/explore/marine/facts/sealevel.htm

[17] Pielou, E.C. After the Ice Age: The Return of Life to Glaciated North America. Chicago: University of Chicago Press, 1991. PG #.

[18] Carol T. Hildreth. p. 2.

boulders were broken loose and were sometimes carried great distances. These often massive boulders, called glacial erratics, are still scattered through the Maine landscape, some as big as a truck or even a small house. Figure 4, showing a large glacial erratic next to an Smithfield's resident's garage near East Pond, demonstrates how easily the footprints of the Laurentide ice sheet can be seen throughout the Belgrades.

While the power of the advancing glacier was impressive, many of the Belgrade Lake Region's most lasting surficial geologic features were actually formed as a consequence of the glacier's retreat. As with all ice ages, the Laurentide Ice Sheet was not a permanent fixture of North America's landscape and began to recede around 16,000 to 15,000 years ago. The glacier retreated at a rate of 0.3 km/year,[19] reaching Freeport 14,045 years ago and Belgrade shortly thereafter.[20] When the final retreat of the Laurentide Ice Sheet was completed around 10,000 years ago a wholly remodeled landscape was unveiled.

The enormity of a glacier as large as the Laurentide created a powerful gravitational force against the landmass beneath it, causing entire areas of the continent to compress and sink. As the glacier retreated, the sunken landmass was exposed and massive amounts of melting water from the ice sheet as well as sea water inundated a large percentage of Maine, including the Belgrade area. (Figure 5)[21] Despite the fact that world-wide sea levels during this period were as much as 360 feet below current levels (due to the huge amount of water tied up in the glaciers), the weight of the glacier had actually pushed much of the

[19] Minze Stuiver and Harold W. Borns, Jr., "Late Quaternary Marine Invasion in Maine: Its Chronology and Associated Crustal Movement," *GSA Bulletin*; January 1975; v. 86; no. 1; p. 99-104 at http://bulletin.geoscienceworld.org/cgi/content/abstract/86/1/99

[20] Carol T. Hildreth. p.2.

[21] Ibid.

region to a level below sea level.[22] As the ice retreated inland, the sea invaded, creating a vast inland sea known as the DeGeer Sea. This sea deposited a distinctive bluish-gray marine mud, the Presumpscot Formation, which is now found in many parts of Maine, including Belgrade. [23]

Thus, Belgrade's landscape during this period around 14,000 years ago can be pictured as a huge sea lapping at the edge of a massive, slowly receding ice sheet. In addition, "the harshest climatic conditions occurred in a zone adjacent to the ice edge. Cold temperatures and strong winds, due to the proximity of the ice, created an Arctic desert, devoid of virtually all plants and littered with rock debris and fine-grained sediment deposited by the glacial melt water" [24] running off the ice sheet via huge tunnels within the ice sheet itself. As water flowed through these tunnels, sand and gravel contained in the melting glacial ice settled directly underneath the tunnels, eventually leaving ridges of stratified sand and gravel where the tunnels had once run. These ridges are known as eskers and are one of the most significant features of the Belgrade landscape today. [25] "Geologists have long considered the Belgrade esker system to be one of the very best esker systems in Maine."[26] However, a majority of the physical evidence of the Belgrade esker system has now been removed due to the profitable business of sand and gravel extraction, especially in

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[22] Joseph T. Kelley, Stephen M. Dickson, and Daniel Belknap. "Maine's History of Sea-Level Changes." Maine Geological Survey. Department of Conservation. 6 October 2005. Web. 24 March 2010.

[23] Joseph T. Kelly, Stephen M. Dickson, and Daniel Belknap, "Maine's History of Sea Level Changes," Maine Geological Survey and Dept. of Geological Sciences, University of Maine, Maine Geological Survey Website. http://www.maine.gov/doc/nrimc/mgs/explore/marine/facts/sealevel.htm

[24] Jerry Binninger, and Jeanne Allen. http://www.epa.gov/gmpo/edresources/pleistocene.html

[25] Carol T. Hildreth. p.2.

[26] "Belgrade Esker and Kettle Complex (Belgrade, Augusta)." Maine Natural Areas Program. Focus Area Maps. 2005. Web. 29 April 2010. http://www.maine.gov/doc/nrimc/mnap/focusarea/belgrade_esker.pdf

Smithfield.[27] Furthermore, continuous gravel mining has begun to impact several sensitive wetland areas near bog lands that were also created by post-glacial forces. The Colby-Marston bog located at the north end of the Belgrade Watershed and the chain of small kettle lakes at the opposite end of the watershed are both under threat due to the gravel mining industry.[28]

This glacial retreat, however, did not occur uniformly. There were periods of time as short as a year when the weather was cold enough to slow or halt the ice retreat. During these periods a vast amount of glacial till accumulated and was deposited into what is known as a recessional moraine.[29] When the glacier began to retreat once more, this pile of glacial till was simply left in its place. These recessional moraines in turn were major contributors to the creation of basin ponds, serving as the dams which formed the Belgrade Lakes.[30] In contrast, when the Earth was experiencing gradual warming, the glacier retreated at a consistent rate. The melt water exiting the ice sheet deposited an even layer of foreign rock and soil known as glacial till and lighter sandy deposits known as fan deltas.

Thus, whereas the advance of the glacier resulted in various destructive processes, constructive processes that left deposits and landforms through a variety of eskers, deltas, and moraines marked the glacier's retreat.[31] A pattern of eskers, deltas and end moraines is still visible in the Belgrade area between Augusta and Smithfield, as shown in Figure 3.[32]

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[27] "Belgrade Esker and Kettle Complex (Belgrade, Augusta)." http://www.maine.gov/doc/nrimc/mnap/focusarea/belgrade_esker.pdf

[28] "Belgrade Esker and Kettle Complex (Belgrade, Augusta)." http://www.maine.gov/doc/nrimc/mnap/focusarea/belgrade_esker.pdf

[30] David L. Kendall. P.27

[31] David L. Kendall. P.22

[32] Carol T. Hildreth. p.2.

About 11,450 years ago, the marine submergence of the Belgrade region ended as a result of isostatic rebound, or post-glacial uplift, which allowed the land surface to rise back up as it was released from the enormous weight of the glacier.[33] During this time period, the rate of crustal rise in Maine is estimated to be about 19m/100yrs. This rate allowed the gently sloping Maine coastline to move seaward to its modern position at a breakneck speed of about 50m/yr.[34] To illustrate how rapidly the DeGeer Sea disappeared, it is thought to have caused marine Atlantic salmon to become trapped in saltwater lakes whose outlet streams and rivers could not carve a route to the Atlantic fast enough.[35] Routes to the Atlantic were eventually established, but by this time the salmon had adapted to their new landlocked environment.

However, in the Belgrade area, many of the smaller ponds and bogs were not formed by glacial rebound, as was the case with the landlocked salmon. They were more likely formed by segments of the Laurentide glacier known as "dead ice" that were separated from the glacier and settled into valleys and low areas, as the rest of the glacier, its "active ice," continued to retreat. These giant blocks of "dead ice" created isolated landmass depressions that filled with water, known as kettle lakes. Smaller segments of dead ice left behind are called kettleholes, but are more commonly called bogs. The previously mentioned Colby-Marston Bog is considered an ideal example of a glacial kettlehole.[36] (Figure 6) At the south end of the watershed, a classic "Kettlehole Bog-Pond

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[33] Ibid.

[34] Robert N. Oldale. Rapid Postglacial Shoreline Changes in the Western Gulf of Maine and the Paleo-Indian Environment. *American Antiquity*. 50 (Jan., 1985) p. 146.

[35] D.W. Caldwell, "The Isolation of Landlocked Salmon in Maine and Quebec Near the End of the Last Ice Age," Presentation at 2003 Seattle Annual Meeting, Geological Society of America, (Nov. 2003) http://gsa.confex.com/gsa/2003AM/finalprogram/abstract_57274.htm

[36] "Belgrade Esker and Kettle Complex (Belgrade, Augusta)." http://www.maine.gov/doc/nrimc/mnap/focusarea/belgrade_esker.pdf

Ecosystem" is made up of Hamilton Pond whose depths allow its groundwater to drain into Stuart Pond. Stuart Pond drains into a chain of smaller kettleholes located alongside the Belgrade esker system.[37] This micro-ecosystem within the broader Belgrade Watershed is home to valuable wetland flora and fauna.

The continental glaciers, primarily the Larentide Ice Sheet, had profound effects on the surface features of the area over which it moved, including the Belgrade Lakes Watershed. The chief result of glaciation has been the modification of preglacial topography by both the exposure of the underlain bedrock in some areas and the deposition of glacial till in others as well as the construction of both the basin ponds and kettleholes of the Belgrade Lakes system.

Post Ice Age History

Once the drawn-out drama of the last ice age subsided, the Belgrade landscape bore the barren and desolate characteristics of an arctic environment.[38] Slowly, however, biological life prevailed, and the first pioneering species of an arctic tundra environment, such as dwarf shrubs and sedges, started to appear around 12,000 years ago. These pioneering species served as the starting point in a long successional development of the plant communities of central Maine. In ecological terms, succession may be defined as "the orderly replacement over time of plant species/communities by another as a result of competitive interactions for limited resources."[39] Once pioneer species such as dwarf shrubs are established, plants themselves enable succession in a feedback loop, modifying

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[37] Nelson, Robert E. et. al.. "Palynology of Three Bog Cores Shows Complex European Impact on the Forests of Central Maine." *Northeastern Naturalist* 17 (2010) p.2.

[38] Tom Wessels. P.146.

[39] Marchand, Peter J. North Woods. An Inside Look at the Nature of Forests in the Northeast. Boston, Massachusetts: Appalachian Mountain Club, 1987. P.19

their environment and making way for competitors who are better adapted to the altered environment. Succession is a critical component of the evolution of an ecosystem because it encourages plant species diversity, the recycling of nutrients and improved animal habitat.[40]

Climatic warming allowed evergreen forests, at first present in the southern region of New England, to start to dominate the forests of Belgrade from 9,000 to around 6,500 years ago.[41] Spruce, beginning in valleys of the Belgrade streams and rivers and progressing into the Kennebec highlands, were the first conifers to venture into the Belgrade landscape. Firs and other similar conifers followed closely behind. Conifers thrive in cold and relatively harsh environments such as the Belgrades because they avoid producing annual foliage and are able to start photosynthesis earlier in the spring since they don't need to wait for their foliage to develop.[42]

Finally, as Belgrade's climate became progressively more temperate, a broadleaf forest containing species such as aspen, paper birch and alders started to develop. Starting around 9,000 years ago, the more southern members of a broadleaf forests' composition such as oaks, ashes, maples, white pine, and hemlock started to encroach upon central Maine.[43] As Maine's climate started to stabilize at modern temperatures, plant succession in the Belgrade Region slowed until the forest reached its present composition of species diversity around 1,000 years ago or during the early middle ages.[44]

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[40] Peter J. Marchand. p.19.

[41] Dawson, John P. "Post-glacial vegetational history of the Great Bog, Belgrade, Maine." Colby College Senior Scholar Papers. 1995. P.iv

[42] Peter J. Marchand. p.39.

[43] John P. Dawson. P.iv

[44] Tom Wessels. P.168.

As one can surmise from the previous description, continuous climatic warming during the current geologic time period known as the Holocene Interglacial supported a progression of temperate species moving northward. Thus, the modern Belgrade forest is a transitional mixed hardwood forest sandwiched between the southern broadleaf forest and the northern boreal forest.[45] Therefore, climate is perhaps largest natural factor which influenced the Belgrade Region's plant succession and current species composition. Climatic factors such as variation in temperature, precipitation and wind can control growth and abundance of a plant species via physiological reaction rates and encouragement of interspecies competition.[46]

The modern climate of the Belgrade region and the broader northern New England area is characteristically cold, wet and relatively harsh. In fact, it is one of the coldest places in the Northern Hemisphere at its latitude. It is surprising to realize that Belgrade, Maine and the French Rivera are located at the same latitude.[47] Northern New England's relatively cool climate is due to the accumulation of low-pressure systems circulating across the United States from west to east. Almost all low-pressure systems in the United States converge in Northern New England before entering the atmospheric wind currents of the Atlantic Ocean. The distinctive counterclockwise airflow of these low pressure systems exacerbates cold conditions by continuously introducing Canadian arctic air to the Maine coast and beyond.

Atmospheric circulation can explain much of why New England and Maine is so cold, but the presence of the Northern Appalachians is the major reason why it is so wet. The

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[45] "White Pine-Mixed Hardwoods Forest Ecosystem." Maine Natural Areas Program. Maine Department of Conservation. 2005. Web. Accessed 28 April 2010.

[46] Peter J. Marchand. P.8

[47] Ibid.

Northern Appalachians form a mountain barrier against incoming winds that requires the air to rise in order to reach an elevation at which it can move past the mountains. This upward movement to higher altitudes causes the air to reach its condensation point, bringing much snow and rain into the Northeast.[48]

The climatic conditions of the Belgrade region eliminated all but the most hardy plant species. The species that were established prior to human arrival were not only able to tolerate cold and wet climates, but also short growing seasons and severe winters where temperatures dip below -40 F degrees.[49] With this in mind, the pre-settlement composition of the Belgrade forests included a mixture of hemlock, maple, white pine, birch, and red oak in the highlands. [50] The abundant bog environments of the Belgrades, many of which originate from kettleholes, include sphagnum mat, cinnamon ferns, black spruce, mountain holly and leatherleaf.[51]

While the region's climate largely dictated the species composition of the Belgrade Lakes, many smaller forces within its natural disturbance cycle also affected the forest's make-up such as storms, blowdowns, animal activity, such as beaver dam building, and forest blights.[52] For example, a forest blight consisting of a pre-anthropogenic disease that damaged or killed much of the region's hemlock, resulting in a higher percentage of maple trees. [53] As will be discussed later, humans had enormously large impacts on the forests as well, through forest fire land management, logging, and agriculture.

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[48] Peter J. Marchand. P.8
[49] Peter J. Marchand. P.12
[50] John P. Dawson. P.4
[51] Ibid.
[52]Craig G. Lorimer. The Presettlement Forest and Natural Disturbancy Cycle of Northeastern Maine. Ecology. 58 (1977) 139.
[53] Robert E. Nelson, et. al. p.1.

Anthropogenic History

Early Human Presence

The introduction of humans to the North American ecosystem has proven to be the single most dramatic and swift impact on the ecosystem during the Holocene Interglacial. Scientists agree that humans probably came to occupy the east coast of North America in significant numbers around 11,500 years ago.[54] The early Paleo-Indians wasted no time in proving their overwhelming ability to impact their surroundings. Early humans are hypothesized to be the primary reason that North America experienced a wave of mass extinction of large mammals from 12,000 to 9,000 years ago.[55] This wave, known as the "Pleistocene Overkill," mostly impacted large mammals such as the American lion (*Panthera leo atrox*), the woolly mammoth (*Mammuthus primigenius*) and the giant short-faced bear (*Arctodus simus*). In order to survive in the polar climate that the Ice Age had brought, evolution allowed these creatures to optimize their total surface area-to-volume ratio, increasing their body's volume and thereby conserving heat. Furthermore, these large mammals also tended to experience long gestation rates and low reproductive rates.[56] Therefore, when a new super-predator, Homo-sapiens, who preferred hunting large game as a food source, was introduced into the ecosystem, these large mammals were not able to undergo a quick enough evolutionary adaptation to defend themselves. Consequently, as the "Pleistocene Overkill Hypothesis" states, human hunting practices are

[54] E.C. Pielou. P.112
[55] E.C Pielou. P.251
[56] Tom Wessels. P.147.

a likely cause of the disappearance of these majestic mammals. Other factors might include the loss of habitat due to climate warming and the outbreak of disease. [57]

At this time, the activities of the humans present in central Maine were no exception to the Pleistocene Overkill Hypothesis. There is evidence of Paleo-Indians living in Maine from 9,000 to 13,000 years ago.[58] While physical evidence of these early humans is extremely rare, three prehistoric or Paleo-Indian sites have been found in the Belgrade Region: west of North Pond in New Sharon, further northwest in Farmington, and south of the Belgrade Lakes in Wayne.[59] While central Maine did indeed serve as the coastline of the Atlantic Ocean during this period because the effects of isostatic rebound had yet to take place, it cannot be assumed that these ancient occupants of Central Maine initially relied on marine resources for sustenance. The tremendous degree of bottom sediment disturbance in these newly-formed coastal environments resulted in a very low biological productivity rate.[60] Lacking fish and marine plant life as dependable food resources, these early Paleo-Indian tribes were likely dependent on terrestrial plant and animal life, including such victims of the Pleistocene Overkill as the woolly mammoth.

These Paleo-Indian tribes continued to occupy central Maine as the coastline receded and the climate continued to warm from 10,000 to 3,000 years ago. Climatic warming increased food availability and permitted Paleo-Indian populations to grow while productive hunting continued to decline as the Pleistocene Overkill continued. This situation, in addition to climatic warming, inspired the Paleo-Indian tribes to develop new

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[57] Tom Wessels. P.174
[58] Robert N. Oldale. p. 145.
[59] "Kennebec Highlands Interim Management Plan." P. 31.
[60] Robert N. Oldale. p. 145.

technologies such as agriculture, woodworking tools and canoes for fishing and travel.[61] Thus, the Native American tribes shifted from primarily hunter-gather nomad lifestyles to agriculture-based permanent settlements. The group that eventually developed permanent settlements in the Belgrade Region was the Abenaki Indians (also known as Norridgeworks).[62] The Abenaki's livelihood depended on agricultural products such as corn, squash and beans, and hunting game such as deer and moose. Further archeological data reveal that fishing was also a critical part of the early Abenaki diet.[63]

One of the largest impacts the Abenakis had on the Belgrade Region's environment and ecosystem was their utilization of forest fires as a landscape management tool.[64] Forest fires were an extremely common method of mass forest clearance because burning the undergrowth yielded multiple benefits. It made the forests more passable for hunting and travelling, rendered them easier to develop agriculturally, discouraged insect populations, and encouraged the proliferation of berry-producing plants on which both humans and animals were dependent.[65] The continual suppression of new forest growth by the early North Americans caused the forest to look strikingly different to the first European colonists than the commonly perceived stereotype of a dense, untouched and impenetrable forest. Instead, European fur traders that first came into contact with the Abenakis in the middle of the 16th century around Farmington Falls[66] described much of the New England forests that were heavily occupied by Native Americans as having a "park-like" appearance,

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[61] "Kennebec Highlands Interim Management Plan." P. 31.

[62] Deane W. Ferm and Debra Campbell. The History of Smithfield: The Center of the Universe. Smithfield, Maine: Town of Smithfield, 1990. P.8

[63] "Kennebec Highlands Interim Management Plan." P. 31.

[64] Timothy J. Fahey, William A. Reiners. Fire in the Forests of Maine and New Hampshire. Bulletin of the Torrey Botanical Club. 108 (1981) p. 373.

[65] Tom Wessels. P.35.

[66] "Kennebec Highlands Interim Management Plan." P. 31.

with large, old growth hardwood and evergreen forests underlain by a suppressed undergrowth.[67]

Early European settlers

While early European settlers explored the Belgrade Region and established contact with the Abenakis in the 16th and 17th centuries, the tribe continued to be the primary residents of the area until the mid 18th century.[68] In 1607, a few months after the Jamestown colony landed, a group of English settlers also funded by the Virginia Company established a settlement at the mouth of the Kennebec River known as the Popham Colony. Their primary goal was to establish trading, especially for furs. The settlement lasted only a year; its failure was likely due to a late arrival, harsh weather and internal power struggles between the colonists. There is no evidence that the Popham settlement explored the Belgrade area. However, the Popham colonists did make contact with the Abenakis, but their relationship was considered strained.[69] In general, the Abenakis and other Native Americans in Maine held a hostile, unwelcoming reputation among European colonists. Their frequent raids of coastal settlements gave Maine the nickname, "Land of the Bad People," and aided the prolonged dominance of the Abenakis in the Belgrade Lakes.[70]

Despite its intimidating reputation, European settlement eventually gained a foothold in central Maine in the mid-18th century. In 1749, a group of wealthy Boston merchants purchased rights to land in the Kennebec Highlands and the Belgrade

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[67] Peter J. Marchand.P.13.

[68] Deane W Ferm and Debra Campbell. P.8

[69] William H. Tabor. Maine's Popham Colony. Athena Review: Peopling of the Americas. Vol. 3, no. 2. 2002. Web. Accessed 23 April 2010.

[70] Maine Memory Network. Maine Historical Society. 2010. Web. Accessed 14 April 2010. http://www.mainememory.net/timeline/pre1600.shtml

Watershed.[71] Pioneers from the southern New England colonies began to trickle slowly into the area and claim parcels of land, clear them, and construct homes for themselves. [72] Thus, widespread and intensive forest clearing for residential and agricultural purposes began as the European population of the region started to accumulate. However, the accumulation was somewhat slowed by the challenging obstacles that the natural environment dealt the pioneers. By 1790, only 159 people had settled in the Belgrade Region. [73] One Smithfield pioneer described the typical timeline that settlers followed when establishing a home in the Belgrade frontier:

> Cut down the trees on 5 or 6 acres the first year, burn the ground over and plant with corn the next year, and build a log house; cut more trees, move the family in before harvest time; live on corn meal one year, raise wheat the third year and build a small barn; raise English hay, wheat, rye and corn the fourth year and then they were in a way to live comfortably. After living seven years in a log house everyone had a right to build a frame house, if he could; they were then called old settlers."[74]

These old settlers, who received the first pick of land property to develop, were most likely to settle in the Kennebec Highlands portion the Belgrade Watershed because the higher elevation allowed for easier deforestation and less susceptibility to environmental nuisances such as flooding and unseasonal frosts.[75] Therefore, the earliest systematic European agricultural practices were established in the Kennebec Highlands and progressively moved downhill to the lake shorelines.

In the early 19th century, before intensive anthropogenic influences began to take full effect, the appearance of the Belgrade Lakes would have looked somewhat different

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[71] "Kennebec Highlands Interim Management Plan." P. 31.

[72] David C. Smith. A History of Lumbering in Maine: 1861-1960. Orono, Maine: University of Maine, 1972. P.5

[73] Robert E. Nelson, et. al. p.1.

[74] Deane W Ferm and Debra Campbell. P.14

[75] Deane W Ferm and Debra Campbell. P.22

than the watershed of today. In general, the lakes, streams and bog land of the area were much more extensive. In fact, the stream connecting North Pond and East Pond was much wider than it is today and the initial residents of Smithfield needed to construct a bridge across it in 1821.[76] In addition, post-glacial pollen records indicate that Great Pond's surface area during this era was much larger due to its inclusion of Great Bog wetland area.[77] However, continuous warm-arid conditions resulted in lake level drops throughout Maine, including in the Belgrades. One study attributes these lowering lake levels to the development of the Great Bog and its underlying sphagnum moss mat, thereby separating it from Great Pond. [78] As the lowland areas dried up, settlements expanded down from the hills even further.[79]

Early Agriculture and Logging

When considering the agricultural tradition of the Belgrade Region, it is important to keep in mind that, while farming was a critical component of rural life in the Belgrade Area, commercial agriculture never gained a strong foothold. The early pioneers established subsistence farms growing corn, barley, turnips, wheat, and potatoes while raising sheep, beef cattle and oxen. [80] As the population density increased in the mid-1800s, potatoes became the primary cash crop. In the 1850s, gristmills were built in the area to ground corn and wheat into cornmeal and flour, turning these grains into cash crops as well. However, these cash crops were primarily sold to local residents and the farm products of the central Maine area were never seriously exported to other regions. In

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[76] Deane W Ferm and Debra Campbell. P.18

77 Robert E. Nelson, et. al. p.2.

[78] John P. Dawson. P.iv

[79] Deane W Ferm and Debra Campbell. P.22.

[80] Ibid.

addition to the short and cold growing seasons, the area's extensive glacial till deposits resulted in rocky soil, preventing farms from being able to compete with farms located in warmer climates with longer growing seasons and more fertile soil.[81]

One industry that thrived in Belgrade Lakes Region was logging. Pine was the most valuable lumber product in the early 1800s because its tall, straight characteristics lent itself well to ship masts and other high-quality construction material. While not as abundant in the Belgrades due to the pre-settlement forest blight mentioned earlier, Hemlock nevertheless was another valuable cash crop of the Maine forests due to its density and durability.[82] While initial logging practices in central Maine were somewhat of a rogue free-for-all, the logging industry became increasingly legitimized and organized in the mid-19th century. The Kennebec Lumbering Company, founded in 1835 and headquartered in Waterville, was the first such company to arrive in the Belgrade Region.[83] Due to the close proximity of the headquarters of the Kennebec Lumber Company, little forest land in the Belgrade Lakes Watershed remained unlogged, save for the steep Hemlock slopes in the Kennebec Highlands and portions of the Penney and Joe Pond area located at the southernmost tip of the watershed.[84] The Belgrade Lakes Watershed was both a help and a hindrance to the Kennebec Lumber Company. The additional water stored in the lakes provided an insurance policy against abnormal weather patterns and ensured a steady water flow to transport logs and run the mills. Ironically, the steady water

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[81] Peter J. Marchand. P.16

[82] Robert E. Nelson, et. al. p.10.

[83] Richard G Wood. A History of Lumbering in Maine: 1820-1861. Orono, Maine: University Press, 1935. P.43.

[84] "Kennebec Highlands (Rome, Vienna, Mount Vernon)." Maine Natural Areas Program. Focus Area Maps. 2005. Web. 29 April 2010. http://www.maine.gov/doc/nrimc/mnap/focusarea/kennebec_highlands.pdf

flow was so slow that lumber companies had to expend extra manpower and resources to prevent logjams and maintain their product's flow[85] [Figure 7].

Dam building to assist log drives across lakes systems such as the Belgrade Lakes began in earnest in the 19th century as the logging industry continued to expand. Logging companies like the Kennebec Lumbering Company built haphazard dams to direct logs correctly downstream. One can picture the classic stereotype of a rugged lumberjack sent off into the forest with instructions to construct splash dams or protrusions to guide logs around the bends of streams and to prevent the logs from becoming stuck in lake water. Due to the freedom and improvisation that these early lumberjacks practiced, the recordkeeping of dams constructed were dismal and it is difficult to determine the number of dams built in this manner. In addition, many of these dams had to be rebuilt on a seasonal basis, also making it difficult to keep track of them.[86] The dams themselves were constructed in a "crib-work pattern and filled in with stone with a gate into the center where water could be released when needed." [87] In particular, the portion of the Messalonskee Stream that runs through Oakland was a hot bed of dam development starting in 1790 because it carried the water from the Belgrade Lakes Watershed into the Kennebec River, a major waterway for the lumber industry. [88] In addition, the Messalonskee Stream rapidly declines 210 feet from the Belgrade Lakes to the Kennebec, rendering the powerful stream an ideal location for sawmills to process the timber as well.[89]

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[85] Richard G. Wood. P.16
[86] David C. Smith. P.14
[87] David C. Smith. P.64
[88] Irwin, Clark T. The Light from the River: Central Maine Power's First Century of Service. Augusta, Maine: Central Maine Power Company, 1999. P.4
[89] Ibid.

When the logging industry in Maine reached its peak during the 1880s, about 50 percent of the forests in southern and central Maine had been cleared.[90] By the 1890s, however, a portion of the environmentally damaging effects of logging was relieved when aquatic log drives began to fade in popularity. With increasingly extensive railroad networks, loggers began to rely on railways instead of rivers because of their predictability and reliability.[91] In turn, more saw and paper mills were constructed on logging sites themselves in order to process the logs before they were delivered to their destination by rail. Subsequently, the last log drive that took place on the Kennebec River was in 1912.[92] Shortly thereafter, the frenzied growth of the logging industry in central Maine slowed down to stagnancy. Large paper companies began to buy enormous parcels of land, eventually owning virtually all commercially viable forestry land. Sustainable logging year after year was a much more attractive strategy to paper corporations than it had been to traditionally smaller logging companies, who could easily relocate their headquarters once their clear-cutting practices had depleted the local resources. In contrast, paper companies began to utilize strategic selective logging strategies in their vast land holdings — practices that are much more sustainable to a forest than clear-cutting.

The extensive deforestation that took place in the 1800s caused a host of problems for the Belgrade ecosystem. With the loss of a vegetational buffer, runoff from the surrounding lands increased sediment deposition in the lakes and increased the rate of water flow within the lakes, ultimately lowering lake water levels.[93] In turn, these lower

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[90] Eves, Jamie H. "Shrunk to a Comparative Rivulet: Deforestation, Stream Flow and Rural Milling in 19th Century Maine." Technology and Culture 33 (Jan., 1992) p.58.

[91] David C. Smith. P.63.

[92] David C. Smith. P.63.

[93] Jamie H. Eves. p.58.

lake levels caused owners of saw and paper mills to construct "outlet dams" to raise the water levels and storing capacity of the lakes in order to maintain the status quo water levels they needed to run their mills properly. Additional dams meant additional disruption to wetland habitats and increased erosion of the lake's shorelines. [94] In addition, the loss of forest cover also contributed to the decline of wildlife populations in the region. Habitat loss, in contrast to hunting, was the biggest factor in the decline of species such as the white-tailed deer and the wild turkey.[95]

Fortunately, once the surrounding forests were thoroughly logged and hopes of commercialized agriculture in the region had faded, the Belgrade Region's forests were able to begin to recover. Remarkably, the modern Belgrade landscape has undergone an almost complete reforestation. However, reforestation has not guaranteed a return to the original biodiversity of the natural communities. Studies of peat cores from sphagnum bogs within the watershed show that forest composition changed significantly after the abandonment of agriculture and logging.[96] Reforestation allowed different species to flourish than had previously such as Red and White Spruce, Balsam Fir and White Pine, which reclaimed the colder, higher elevations.[97] White Pine underwent one of the most dramatic changes, becoming much more abundant in post-settlement times, due to both intentional planting and natural reforestation processes on abandoned agricultural lands.[98] Overall, the forest species composition was altered to support less hemlock, birch and beech and more pine, fir and spruce.[99] Furthermore, the increased erosion of lake

[94] Jamie H. Eves. p.64
[95] Peter J. Marchand. P.15.
[96] Robert E. Nelson, et. al. p.1.
[97] Peter J. Marchand. P.16
[98] Robert E. Nelson, et. al. p.12.
[99] John P. Dawson. P.12

shorelines allowed more nutrient flow into the bordering wetlands, raising the acidity of these environments and encouraging small shrubs and heath-type plants.[100]

The 20th Century

Hydropower

While the logging and agriculture industries moved on, other industries with clear environmental impacts such as hydropower and gravel mining were continuously introduced and incorporated into to the Belgrade Lakes Region. As the Industrial Revolution made electricity an essential resource, the Belgrade Lakes Region became home to one of Maine's first hydropower dams and the site of the establishment of Maine's largest electricity provider, Central Maine Power (CMP) in 1899. [101] The dams along the Messalonskee Stream in Oakland, as previously mentioned, were extremely effective in providing power due to their steep elevation drop. Consequently, these dams became the starting point for electricity generation in the region, with a predecessor of CMP, Oakland Electric Light Company, starting to power small portions of the region in 1887 with a 22.5-kilovolt electric generator, which was able to light the streets of Oakland and several other relatively small uses.[102] [Figure 8] The establishment of a large, electrical corporation brought more jobs to the region and allowed it to modernize rapidly.

Seasonal Tourism

Another critical industry that developed in the Belgrade Lakes Region was the seasonal tourism industry. Maine became a popular summer vacation destination for well-to-do New England residents starting around the turn of the century, when transportation

[100] Robert E. Nelson, et. al. p.1.
[101] Clark T. Irwin. P.4
[102] Clark T. Irwin. P.5.

in the form of railroads was more readily available and Americans were being encouraged to escape urban pollution during their vacations. [103] For example, Pine Island Camp was established on Great Pond in 1902 "to give boys a healthful and beneficial summer outing, to clarify their minds and reinvigorate their bodies."[104] As upscale hotels and summer camps such as Pine Island Camp began to proliferate, more value began to be placed on environmental conservation for the sake of preserving Maine's reputation as a rustic and wild vacation destination. Therefore, investors in the tourism industry became increasingly involved in establishing restrictions and regulations of natural resources. For instance, tourism lobbyists encouraged restrictions on fishing and hunting in order to maintain a stable population for summer visitors to enjoy on an annual basis. While local residents initially reacted with resistance to increased regulation, an eventual understanding was reached between permanent and seasonal residents to protect their resources in a profitable yet sustainable manner. [105]

Impacts on Natural Resources

As the 20th century progressed and the population of the Belgrade Region continued to grow and modernize, the multitude of anthropogenic effects impacting the environment continued to accumulate. The existence and maintenance of the dozen or so permanent dams in the watershed used for water control and hydroelectric power generation has significantly expanded the lake's surface area, increasing shoreline erosion and decreasing water quality. A study conducted by Dr. Bruce Reuger and Mallory Young of Colby College found that dam installation had caused the surface area of Great Pond to increase by 43%,

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[103] Richard W. Judd. p.187.

[104] "History." Pine Island Camp. Web. Accessed 28 April 2010.

[105] Richard W. Judd. p.185.

Long Pond by 22.5%, Salmon Pond by 28.2%, and Messalonskee Lake by 12%.[106] However, these dams have produced some positive results as well. The Messalonskee Lake marsh, located at the southern tip of Messalonskee Lake was developed as a result of elevated water levels that the dams on the Messalonskee Stream have produced. This marsh now provides a wetland habitat for many rare wildlife species, including the stinkpot turtle, which is on Maine's list of special concern species. [107] Therefore, there is considerable debate surrounding whether these established dams should be removed and the surrounding shoreline rehabilitated to its "natural" state. There are costs and benefits to both sides of the argument environmentally, socially and economically.[108] While previously important ecosystems may be restored by dam removal, newly established ones such as the Messalonskee marsh will be destroyed. Socially, the dams would impact the shoreline properties of many local and seasonal residents effecting both their property values and quality of life. Studies show that dams decrease property values because of their common relationship with industry as well as their safety issues.[109] Therefore, dam removal would most likely increase property values but also lower lake shorelines critical to the quality of life of local and seasonal residents.

The increasing residential population and increasing popularity of summer camps and vacation homes has resulted in a continuous incoming and outgoing flux of visitors and residents. This continuous flux has allowed several invasive species on both ends of the

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[106] Bruce F. Reuger, Mallory C Young. "Geological and Historical Investigation of the Belgrade Lakes Watershed." Geological Society of America *Abstracts with Programs*, 37:1 (2005) p. 62.

[107] "Messalonskee Lake Marsh (Belgrade)." Maine Natural Areas Program. Focus Area Maps. 2005. Web. 29 April 2010. http://www.maine.gov/doc/nrimc/mnap/focusarea/messalonskeemarsh.pdf

[108] Curtis Bohlen and Lynne Y. Lewis. "Examining the economic impacts of hydropower dams on property values using GIS." *Journal of Environmental Management* 90 (2009): p. 258.

[109] Curtis Bohlen and Lynne Y. Lewis. p. 266.

food chain to disrupt the ecosystem of the Belgrade Lakes. The Northern Pike has taken over the role of top predator in the lakes, drastically reducing the populations of mid-sized fish that are critical to the recreational fishing industry. On the other end of the spectrum, invasive milfoil has begun to encroach upon the southernmost wetland areas of the Belgrade Lakes Watershed, crowding out other native aquatic plants. [110]

Anthropogenic activity has a huge impact on the natural lake maturation process called eutrophication. As lakes age, they evolve from glacially scoured rock basins filled with clean water to enclosed, vegetation-filled wetlands. This is a natural process that usually occurs on timescales of centuries but human influence can accelerate the process to decadal timescales. Nutrient-loading of the lakes from human activity can over-encourage vegetational encroachment and cause a lake to suffer from algal blooms, oxygen depletion, fish kills and overall decreasing lake health. [111] Nutrient loading of lakes is caused by land-use changes such as road construction and lawn development and usage of fertilizers, septic systems and detergent products. The combination of these anthropogenic activities allows increased run-off to deposit excess nutrients such as carbon, nitrogen and phosphate into the lake stimulating unnecessary growth of the lake's plant and plankton species. [112]

The Belgrade Lakes are especially susceptible to anthropogenic eutrophication because their shallow nature allows easier displacement of lake water with soil and marsh

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[110] "Messalonskee Lake Marsh (Belgrade)." http://www.maine.gov/doc/nrimc/mnap/focusarea/messalonskeemarsh.pdf

[111] Dorte Koster et. al. "Historical Eutrophication of in a River-Estuary Complex in Mid-Coast Maine." *Ecological Applications* 17 (2007) 765.

[112] Robin H. Nesbeda. "Sedimentological and Geochemical Characterization of East Pond, Belgrade Lakes Watershed, Central Maine. Colby College Geology Department. 18 May 2004. P.3

vegetation.[113] For example, the northwest arm of Long Pond has already been filled in with sandy sediment deposition. [114] Evidence of anthropogenic eutrophication can also be seen in the algal blooms experienced by East Pond. [115]

Future Perspectives

From glacial ice sheets to forest fires by early natives to forest clearing by European settlers and land-use changes incited by incoming tourists, the Belgrade Lakes Region has experienced a wide variety of forces altering its landscape. All these forces have left behind a different footprint on the lakes, both constructive and destructive. Over time, these footprints tend to become accepted as a natural part of the landscape or simply blend in with their surroundings. However, just because these footprints are difficult to detect, doesn't mean they should be ignored. The paradox our society has reached in modern times is that the human race has come to accept our surrounding landscape as a static entity instead of a dynamic one. However, at the same time, humans are playing the largest role in accelerating the rate of change in this dynamic landscape. Humans must become aware of the susceptibility of the environment to change and take responsibility for their role in facilitating this change.

Recently, various local conservation groups such as the Belgrade Lakes Association, the Belgrade Regional Conservation Alliance, and the Maine Congress of Lake Associations among others have formed to help maintain a portion of what is perceived as the timeless landscape of the Belgrade Lakes. While the landscape of the Belgrade Lakes may not be timeless, these efforts can serve to slow the accelerated rate of change caused by humans and bring back a rate of change only visible on large time scales.

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[113] David L. Kendall. P.99
[114] Ibid.
[115] Robin H. Nesbeda. P.3

Figures

Figure 1: Exposed Granite Bedrock in the Kennebec Highlands. (Personal Photograph)

Figure 2: Metamorphic bedrock in the Blue Rock Quarry on I95 at the Sidney Exit. (Personal Photograph)

Figure 3: Map of the DeGeer esker and ice-flow patterns from the receding Laurentide Ice Sheet. (http://www.maine.gov/doc/nrimc/mgs/pubs/online/surficial/04-38-belgrade-surficial.pdf)

Figure 4: A glacial erratic located near East Pond in Smithfield, Maine. (Personal Photograph)

Figure 5: Extent of DeGeer Sea in the late-glacial era.
(http://www.maine.gov/doc/nrimc/mgs/explore/surficial/virtual/slides.htm)

Figure 6: The Colby-Marston Bog is an exemplary kettlehole.
(http://www.colby.edu/biology/ColbyM.jpg)

Figure 11: The 1865 spring log drive down the Kennebec .
(http://www.mainememory.net/bin/Detail?ln=9023)

Figure 8: Site of Central Maine Power's first hydroelectric generator on Messalonskee Stream. (Personal Photograph)

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