Dairy Farming: A cause for biodiversity decline in Northern New York State

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EXECUTIVE SUMMARY

Dairy farming is an integral to the economy and land use of Northern New York State for over a century, with family owned and operated farms forming the backbone of the dairy industry within the State. However, with increased agricultural technologies and declining dairy prices the pressure for maintaining family run dairy farms is increasingly difficult. Current dairy farm trends show that dairy farms are forced to choose between “getting big, getting weird or getting out.” An increase in consolidation of dairy farms and the corresponding increase in the number of cows per farm, has the potential to result in a greater demand for cow feed as well as manure treatment practices. With feed often being locally produced by the dairy farmer, field habitat dependent organisms such as bobolink birds are feeling the impact of reduced habitat due to forest regeneration and intensified hay harvesting practices (USDA, 2012). Manure treatment and spreading is impacting local waterways as seen in the 2005 manure leakage and contamination of the Black and Beaver Rivers of Lowville, New York (Grossman, 2014). The future of dairy farming in the North Country of New York State is unknown, but current economic trends show regional consolidation and diminishing occurrence of small dairy farms, leading to land use changes that have the potential to impact the biodiversity of the North Country. Forty-five percent of New York State species are experiencing various degrees of stress and approximately a fifth of Saint Lawrence County land is used for the dairy industry (Batcher et al., 2006; St. Lawrence County Government, 2016). Therefore, it is important to understand the interface between economic growth of the dairy industry and the impact that the dairy industry has on local biodiversity. To address the changing interface between economic growth

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1 Jason Pfotenhauer, Deputy Director, St. Lawrence County Planning Office, personal communication, 14, March 2016
and biodiversity within the North County, local and statewide policies should address a changing dairy industry and the corresponding environmental risks associated with dairy production.
INTRODUCTION

New York State is home to over 1,800,000 known species, which are divided into vertebrates, arthropods, algae, protozoa, plants, fungi, viruses and bacteria (Figure 1). However, approximately 45% of all species within New York State are considered stressed, leaving 55% being considered stable (Figure 2). Despite 45% of all species within New York State being considered stressed, the majority of land within St. Lawrence County is privately owned (Figure 3). Agricultural practices such as manure spreading and intensified feed production by means of monocultural farming are considered one of the main contributors to biodiversity stress and loss within New York State, particularly within the North Country waterways (US Department of Agriculture, 2012; Grossman, 2014; Bureau of Watershed Assessment, 2009).

Industrial farming was introduced and developed in the United States at the end of the Second World War, as a means to increase agricultural yield (Gaud, 1968). However, industrial farming, otherwise referred to as the Green Revolution has social as well as environmental implications (Pingali, 2012). Due to industrial agriculture farmers have to rely on pesticides, pesticide tolerant seeds, and fertilizers in order to increase their annual yield. An effect of increased farming technologies was consolidation of small family farms, which occurred across the country. Although industrial farming occurred mainly for cash crops such as wheat, corn, alfalfa, soybeans and corn, consolidation also occurred for the husbandry of animals (Carlin and Martin, 2008). Chickens, pigs and cows were consolidated for maximum efficiency in egg, meat and dairy production (Carlin and Martin, 2008). An increase in animal consolidation as well as monoculture systems will have the following effects, a decrease in biodiversity on the farm as well as within the local landscape and a corresponding increase in animal and fertilizer waste production.
Governmental bodies at all levels implement legislation and policy to protect land use and endangered species, however, New York State is a home rule state, resulting in the local government having more say in regards to land use than the federal or state government (Cuomo and Rosado, 2015). Agricultural policy and how effectively the policy is enforced, is dependent upon the local government, resulting agricultural policy variance between counties within New York State. Despite New York State being a home rule state, New York has the reputation of having strict environmental laws that are heavily enforced.

New York State is viewed as having stringent environmental regulations towards farming, particularly manure disposal. In addition to environmental regulations for agricultural practices, New York State has policies and protocols that aim to protect the health and well-being of farm workers, including migrant workers (Congiu, 2008). Furthermore, the New York State Government provides incentives to promote environmentally conscious farming practices, through a series of grants reaching up to five thousand dollars, provided by the New York Farm Bureau (Sommerstein, 2013).

The penalty for farmers who violate set environmental protocols can be severe, and often result in licence revocation, preventing the farm from selling their products for an entire year until the subsequent inspection. An alternative penalty is the repossession of the farm at fault by the State or town, as seen in the Black and Beaver River manure leakage (Grossman, 2014). Many farmers go above and beyond the environmental regulation enacted by the State and local government, because of their dependency on a healthy local environment and the severe consequences derived from violating the environmental regulations instituted by the State and local government. The State focuses the majority of its energy enforcing their protocol on

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2 Kitty O’Neil (Field Crops & Soil Specialist) and Kimberley Morrill (Dairy Specialist), Cornell University Cooperative Extension, personal communication, 28, March 2016
large dairy farms and often small dairy farms slip through the cracks. This provides an interesting environmental benefit for consolidation of dairy farms, as large dairy farms are under regulations that are strictly enforced making it very difficult for farmers to cut corners².

New York State is no exception to the industrialization and consolidation of small family farms. The State is nationally ranked third in milk production, and has had a long history in the North Country, the northern part of the New York that borders the St. Lawrence River (USDA, 2016). Cattle was first introduced in America in the 17th century with the first immigrants, however, specialized species of cattle for dairy production did not occur until the 19th century (USDA, 2016). The future of dairy farming in the North Country is unknown, but current economic trends show consolidation and the diminishing occurrence of small dairy farms in the industry, leading to land use changes that could impact the biodiversity, land use and water quality of the North Country. Therefore, local and state governmental policy makers need to rethink the incentives and farming laws around dairy farming to shape future land use changes in a way that avoids environmental degradation and to preserve the maximum amount of habitat for future use and for future conservation practices.
Figure 1. Pie-chart of the species distribution within New York State (Batcher, M. et al. 2006).

Figure 2. Pie-chart depicting the percent of biodiversity that is under pressure within New York State (Batcher et al., 2006).
Figure 3. Map of St. Lawrence County, New York depicting protected land, illustrated as brown, green, orange and lime green land, within the county (New York State Department of Environmental Conservation, 2016).
METHODS

In order to determine the effects of dairy farming on biodiversity in the North Country, we gathered data from a variety of sources, namely scholarly articles and studies (Cornell Cooperative, Iowa State Cooperative, etc.), news reports (North Country Public Radio, North Country Now, etc.), governmental reports (USDA, DEC, etc.), and interviews with relevant stakeholders. We used scientific reports and studies to collect data on the overall biodiversity of the North Country, as well as how dairy farming has affected biodiversity in other areas within New York State. We used interviews to acquire information on government policies, local trends in dairy farming, and enforcement of environmental measures on farms in the North Country. We used news articles to find examples of incidents where the dairy industry or one of its byproducts directly affected biodiversity in the North Country. All of this data helped us to determine what the real cost of dairy farming is in terms of its effects on biodiversity. See Appendix 1 for a list of interviewees and the questions they answered.
PROBLEM DEFINITION

Dairy production has a corresponding impact on the biodiversity within the surrounding landscape. Byproducts of dairy farming that have impacted northern New York State, is the intensification of cattle feed production, increased dependency of pesticides and fertilizers, erosion, manure runoff, all of which resulting in contamination of the local water systems and biodiversity loss. The combination of the adverse effects of the dairy industry has resulted in biodiversity stress and loss in both the terrestrial ecosystem and the biodiversity within local bodies of water.

Cattle Feed Production

Cattle feed production is often produced locally by the dairy farmer as a means to limit the cost of feeding the cattle. Cattle feed often takes the form of haylage, hay, and corn feed, with haylage being silage derived from grass that has been partially dried (Kavanagh, 2015; Freilich, 2012). Cattle feed is often produced within a monoculture ecosystem that requires fertilizer and pesticides to maximize the crop yield (Kavanagh, 2015; Freilich, 2012).

Within St. Lawrence County approximately 106,000 acres of land has been used for haylage and corn production to feed the cows within the dairy industry, making it the dominant agricultural land use practice within the county (USDA, 2012), (Figure 4). Despite the increases in the amount of milk being produced within the North Country, the number of farms are decreasing although the size of each individual farm is increasing (USDA, 2012). Higher rates of forest regeneration, due to farm abandonment, as well as increased use of available agricultural fields are the leading cause for concern regarding the increased stress of wild meadow ecosystems. In 2007 the number of farms in St. Lawrence County was 1,330 farms, which dropped in 2012 to 1,303 farms (USDA, 2012). However the total land used for agriculture
increased from 347,424 acres in 2007 to 356,909 acres in 2012 (USDA, 2012). As more land is regenerating into forests and fields are continuously being used for agricultural purposes the result is less habitat for meadow dependant species, such as the bobolink birds (USDA, 2012; DEC, 2015).

The hay and haylage harvesting is done by the clearing and mowing of hay fields, often resulting in the removal of floral resources for insects and nesting habitat for bird species (Boone, et al., 2013). The removal of shrubs, reidy plants and floral resources is detrimental to a meadow ecosystem (Boone, et al., 2013). Modern hay production require a hay field to be mowed at least three times a year, or however often the season permits (Freilich, 2012). Modern hay production is typically characterized by repeated meadow clearing within a single season, disturbing of the biodiversity of relevant species (Boon et al., 2013; Freilich, 2012).

Figure 4. Pie chart from St. Lawrence County illustrating land use (US Department of Agriculture, 2012).
Bobolinks Impacted by Cattle Feed Production:

Bobolink or *Dolichonyx oryzivorus* are considered to be common within New York State, however, their numbers have been steadily declining by two-percent annually since 1966 (DEC, 2015). The main threat to this bird species is due to the bobolink nesting habits as they are ground nesters. The steady decline in New York bobolink populations have been attributed to farm abandonment resulting in forest regeneration converting suitable habitat into unsuitable habitat within a few years and modern hay practices (DEC, 2015).

Modern hay practices are particularly at fault for the bobolink decline, as hay cutting occurs earlier and more frequently, disturbing the bobolinks during their nesting season (Giller, 2015). The disturbances from grazing cattle have also been identified as the main causes for bobolink decline (Giller, 2013). Cutting of hay during the bobolink nesting season often results in nest failure and/or the death of the adult bobolinks (DEC, 2015).

Bobolink numbers can stabilize just by adjusting modern hay and haylage production techniques. Three possible solutions to addressing the bobolink decline is allowing meadow habitat to go wild and mow fields between once a year to once every few years in order to slow forest regeneration and preserve suitable meadow habitat (DEC, 2015). Secondly, farmers can delay field cutting until Bobolink chicks have fledged the nest, by means of cutting a field after August 1st. If cutting a field multiple times within a season is necessary, cutting from the center of the field outwards provides adult bobolinks and developed fledglings time to move into new habitats, thus increasing their chances of survival (DEC, 2015).
Water Contamination and Effects on Biodiversity

Manure Spreading:

Manure spreading has been used as a source of fertilizer in the North Country for decades, today there are regulations instituted to monitor and control when and how much manure is being spread within a farmer’s field (Kelly, 2015). Manure within the North Country, has been used as a source of fertilizer for cow feed production. Cow feed production as mentioned earlier is dependent on fertilizers, pesticides and often produced within a monoculture ecosystem, which results in increased rates of erosion and water contamination within local waterways (Bureau of Watershed Assessment, 2009). Often manure is held in manure storage areas or manure lagoons that are susceptible to flooding and spillage into other waterbodies within close proximity (Grossman, 2014). One of the most dangerous aspects of manure spreading is spring frosts. Spring frosts keep the nutrient rich manure locked at the surface of the soil horizon restricting it from permeating into the soil, and with rain or snow melt the manure will wash off into the local water system contaminating the water with their heavy nutrient and sedimentation load (Kelly, 2015; Ketterings et al., 2005; Bureau of Watershed Assessment, 2009). Frost is of particular concern as manure spreading is most beneficial in the early to mid-spring before the planting season (Kelly, 2015). Late season frost is problematic to the North Country as there has been late season frost and snowfall during the ideal time for manure spreading.

Manure spreading is regulated under State and local policy and is enforced by the New York State Department of Environmental Conservation, if the correct methods of manure spreading are met there is a minimal risk of water contamination. Such regulations limit timing and quantity of manure spread within a farmer’s field. The dates and quantities of manure is dependent upon the weather forecast for the days prior to and after the spreading of the manure,
the topography of the farmer’s land and the quantity of manure the farmer possesses (Kelly, 2015). It is recommended that farmers not spread manure within a 48 hours period of a precipitation event, in addition, it is discouraged to spread manure if a heat snap is in the forecast, as a heat snap risks rapid melting of residual snow and ice, increasing the probability of runoff into the local watershed (Kelly, 2015; Bureau of Watershed Assessment, 2009). Despite stringent regulations no landscape is absent of runoff and no agricultural system is perfect, thus there is always a risk of local and regional water contamination from agricultural runoff.

Runoff of a nutrient laden landscape, particularly one covered in cow manure, deposits vast quantities of phosphorus and nitrogen into the local watershed, resulting in water contamination and, with high enough concentrations, can lead to an anoxic environment (Johns Hopkins Bloomberg School of Public Health, 2010). The immediate result of nutrient laden runoff is the increase of the nutrient and sedimentation load that results in algal blooms that kill micro and macro invertebrates and aquatic vertebrates such as fish and frogs (Bureau of Watershed Assessment, 2009).

The New York State Department of Environmental conservation attributes poor agricultural practices, lack of silage leachate control and manure and/or milk house wastewater treatment facilities as having a profound negative impact on local water systems within northern New York State (Bureau of Watershed Assessment, 2009). Considering the intense regulations that large feedlots (commonly referred to as Concentrated Animal Feeding Operations or CAFOs) abide by, no policy is perfect. Within the North Country there are two excellent examples that occurred within the last eleven years that depict the impact that the dairy industry has on local aquatic biodiversity. Lowville, New York experienced over a thousand fish killed in 2005 due to manure leakage from a local dairy farm manure lagoon that leaked into the Black and Beaver
River (Figure 5). A second example is Broadman Brook, a tributary to the Marble River at Chateaugay in Franklin County, in which a spring frost followed by a subsequent downpour resulted in cow manure runoff off of a local farmer's field and into the local watershed in 2008 (Bureau of Watershed Assessment, 2009). Prior to contamination the water was tested for water health in 2004 in which the water body was considered clean as it contained clean water specific macro-invertebrates such as mayflies, stoneflies and non-biting midges (Bureau of Watershed Assessment, 2009). However, after contamination Broadman Brook lacked clean water specific macro invertebrates. The contamination resulted in the Village of Chateaugay repossessing the farm at fault for not abiding by DEC implemented manure spreading regulations (Bureau of Watershed Assessment, 2009). Water contamination from manure storage areas, manure spreading, feed production and waste water treatment, pesticide and soil erosion from row crops is a major contributor to water pollution in St. Lawrence County. Approximately 54% of Priority Waterbody Listed river miles or 942.84 miles of the Saint Lawrence River is considered Stressed or Threatened (Bureau of Watershed Assessment, 2009). The contamination of such a large swath of the Saint Lawrence River has a negative effect in the aquatic life found within river ecosystems (Figure 6), (Bureau of Watershed Assessment, 2009).
Figure 5. Photo of the Black River of Lowville, New York after the 2005 manure leakage into the Black and Beaver River (AP Photo, 2005).

Figure 6. Graphs depicting the 2009 causes of contamination within river and stream ecosystems of the Saint Lawrence River Basin, New York State (Bureau of Watershed Assessment, 2009).
**The Dwarf Wedge Mussel:**

Dwarf wedge mussel (*Alasmidonta heterodon*) are considered endangered both on the State and federal level (DEC, 2015). Dwarf wedge mussels are benthic freshwater mussels that inhabit streams and rivers. Adult dwarf wedge mussels spend the majority of their time buried almost completely under sediment at the bottom of a stream or river, filter feeding on algae and other small suspended organic particles (DEC, 2015). The typical habitat for dwarf wedge mussels include running fresh water, bottom substrates containing silt, sand and gravel, with the preferred water velocity of this species being slow to moderate, and water containing relatively low levels of calcium (DEC, 2015).

Dwarf wedge mussels have a historic range spanning from New York, Vermont, New Hampshire, Connecticut, Maryland, Virginia and North Carolina (DEC, 2015). Today, dwarf wedge mussels occupy 70 sites within 15 Atlantic coast drainages. However, wedge mussel historical distribution is incomplete as impoundment and channelization potentially eliminated dwarf wedge mussel from former habitat that were not documented (DEC, 2015). Today, dwarf wedge mussel populations rage within the hundreds for the majority of dwarf wedge mussel beds, with the exception of two locations one in Neversink River in Orange County, New York and the second in the Tar River in North Carolina with both locations having mussel bed populations ranging in the thousands (DEC, 2015).

The decline in dwarf wedge mussel populations has been attributed to water pollution derived from sedimentation and chemical loads from agricultural practices within the region (DEC, 2015). Furthermore, impoundments and channelization derived from dams has also played a role in the decline of dwarf wedge mussel populations.
Current efforts to aid dwarf wedge mussels is underway, however, research is still being undertaken to understand the preferred habitat requirements of the dwarf wedge mussel. The habitat requirements are unknown and the defining factors attributing to where the dwarf wedge mussel beds might be located are confined to freshwater rivers or stream systems (DEC, 2015). Furthermore, research pertaining to dwarf wedge mussel threats is focused on the impact that dams and agricultural practices have on the mussel population (DEC, 2015).

**Dairy Farming**

**Dairy in the US:**

Dairy cows arrived in the US with European settlers in the early 1600s (USDA, 2016). Dairy products were originally used to provide food for families, but began being mass produced by the year 1900 as more and more Americans began moving to the cities. Movement from the farm and into the city lead to a change in the way milk was produced in the US, changing from a small scale farm with a few cows to large scale mass production of dairy. This transformation in the industry allowed milk and other dairy products to be sold commercially throughout the United States (USDA, 2016). Currently, the dairy industry is still dominated by a system of mass production that focuses on getting as much milk as possible out of dairy cows.

Dairy farming remains an important source of income to farmers in the US. The average total net earnings was 490$ per dairy cow in the US making dairy farming a profitable business (Yale Environment 360, 2014). Despite the financial benefits of dairy farming, it is becoming increasingly more consolidated. For instance, 50% of milk produced in the US is produced by only 3% of dairies (Yale Environment 360, 2014). Larger herds, including those with 300 or more cows, in general had a greater net return than smaller ones meaning that there is a push
towards larger, more specialized dairy farms which can produce more milk with fewer workers (Laughton, 2015). In the US, the number of dairy farms fell from 648,000 dairies in 1970 to only 75,000 dairies in 2006 (MacDonald, 2007) (Figure 7). However, larger dairy farms cause more environmental problems. In Wisconsin, runoff from large scale dairy farming has been linked to increasing levels of nitrogen in aquifers (Yale Environment 360, 2014). Cases of manure contaminating waterways have also occurred in Washington, Minnesota, and Michigan. Large scale dairy farming is still relatively small in the North Country, but the trend is for the consolidation of smaller farms into large agribusinesses (Ames, n.d.).

Figure 7: Number of dairy farms as compared to the number of average number of cows on a dairy farm (MacDonald, 2007).

**History and current status of dairy farming in the North Country:**

The North Country has been an important dairy producer since the early 1800s. Throughout the 19th century and early 20th century, North Country farms were one of the largest dairy producers in the northeast and supplied a majority of the butter for the city of Boston¹. The
dairy industry has persisted for a number of reasons. The North Country has an abundance of water which dairy cows require to produce sufficient milk. Cheap land and plenty of open pastures have provided farmers with the space needed to increase their herd sizes to meet increasing demands over the years¹. Finally, the tradition of dairy farming in the region is strong and much of the infrastructure needed for dairy farming still exists today. Dairy farming remains an important source of income for many farmers in the North Country today, just as it did over two hundred years ago.

Although the dairy industry is not as lucrative as it once was, it is still a strong sector in the North Country. Jefferson County (neighboring St. Lawrence County), produces the third most amount of milk/per county in New York State (Dairy Trends in Northern New York, 2003). Dairy traditionally has been a very dominant source of income for small family farm communities¹. Dairy producers are feeling a nationwide trend that brings about significant local land use changes: “fewer farms, more milk, but still many more small farms than large ones”¹.

In St. Lawrence County, 22% of the total land mass is used for agriculture. Of this, an estimated 82.8% is used for dairy products, making dairy by far the largest agricultural practice in the County by land use (St. Lawrence County Government, 2016)(Table 1). Feed can be grown relatively cheaply and most farmers choose to grow their own feed in order to cut costs (St. Lawrence County Government, 2016). Although there is a push for large scale dairy farming, St. Lawrence County is still dominated by small scale dairy farmers (St. Lawrence County Government, 2016).
Table 1. Depiction of the milk production and ranking of each county within the North Country from 1993 to 2003 (Dairy Trends in Northern New York, 2003).

<table>
<thead>
<tr>
<th>County</th>
<th>Production 1993</th>
<th>State Ranking 1993</th>
<th>Production 2003</th>
<th>State Ranking 2003</th>
</tr>
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<tr>
<td>Clinton</td>
<td>289 M lbs</td>
<td>16&lt;sup&gt;th&lt;/sup&gt;</td>
<td>340 M lbs</td>
<td>13&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Essex</td>
<td>47 M lbs</td>
<td>46&lt;sup&gt;th&lt;/sup&gt;</td>
<td>33 M lbs</td>
<td>46&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Franklin</td>
<td>278 M lbs</td>
<td>17&lt;sup&gt;th&lt;/sup&gt;</td>
<td>295 M lbs</td>
<td>20&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Jefferson</td>
<td>495 M lbs</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>571 M lbs</td>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lewis</td>
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<td>456 M lbs</td>
<td>6&lt;sup&gt;th&lt;/sup&gt;</td>
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<tr>
<td>St. Lawrence</td>
<td>591 M lbs</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>625 M lbs</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
STAKEHOLDERS

Residents of the North Country

Locals:

The North Country is home to a number of people who do not rely on agriculture as their primary means of subsistence. Although much of the land in the North Country is used for agriculture, only 25% of the population is directly involved with farming (Demographics, 2016). While locals do not necessarily depend on dairy farming, dairy farming certainly has an impact on the lives of locals as they have a large dairy industry within proximity of their residence. Despite being so close to this industry, most residents of the North Country do not have easy access to the milk and other dairy products being produced in their own backyards. Almost all of the milk produced in the North Country is shipped downstate and sold in more densely populated areas such as Rochester or Syracuse because it is more profitable to sell milk in these areas. This brings with it the added threat to biodiversity via air pollution from the emissions of the trucks used to transport milk.

Despite not having access to the dairy products produced on their land, locals in the North Country have to deal with many of the costs of dairy farming. A great majority of these costs come in the form of environmental degradation. Some of these issues are more of a nuisance than a real problem such as the lingering smell of manure in the fields each spring. However, some of the costs of dairy farming can be dangerous such as the contamination of waterways and aquifers caused by manure pits which can affect local drinking water (Grossman, 2014). The locals of the North Country must deal with these issues on a regular basis without receiving any direct benefit from the dairy farms which cause these issues. Dairy farming will only be allowed to persist in the North Country as long as the majority of the population continues to tolerate it.
The views of locals on biodiversity depends on the individual in question and the extent of the impact. While most people would not argue against chopping down trees next to their house as building materials in the fall, the same people might be annoyed if a manure pit was opened in that spot the following spring. It is difficult to pin down how locals would feel on the whole about biodiversity in the North Country due to the diverse range of people considered to be local residents. The locals remain an unknown category when it comes to conserving biodiversity, but people with fewer ties to agriculture might feel stronger about conserving biodiversity for the sake of biodiversity than the farmers who have strong ties to the financial boon of agriculture.

**Outdoor Lovers:**

Outdoor lovers include those who live in the North County and enjoy various arrays of outdoor recreational activities. Like the locals, outdoor lovers do not benefit directly from the products of dairy farming. Outdoor lovers must also pay the costs of dairy farming in the North Country. There are a number of instances where outdoor lovers would be at odds with the dairy industry, for example birders would object to the premature cutting of haylage fields since it can lead to the destruction of bird nesting areas. Manure spills from dairy farms have the potential to make waterways unsafe for swimming and impact the number of fish caught during fishing expeditions as well as adversely affecting other activities and would prevent outdoor lovers from using waterways due to the degree of contamination that can be caused by runoff from dairy farms.

For outdoor lovers, less biodiversity means fewer places to go and experience the outdoors as more of the land is used for agriculture as opposed to recreation. After all, if all of the forests are cut down to make way for grazing lands, how will the outdoor lovers be able to see red squirrels or porcupines on a hike? How will they enjoy an afternoon canoeing or
kayaking on the river if the rivers become choked with manure, refuse and dead fish? To the outdoor lover there is beauty and fun in biodiversity, and losing it will decrease the amount of places they can hunt, fish, hike, swim, or just watch the birds fly. The main conflict lies in land usage, and using more land for dairy farming means that there will be less land to enjoy outdoor activities. Although not the most influential group, outdoor lovers as still a stakeholder who will likely take the side of improving biodiversity.

**Non-Residents of the North County**

**Wildlife Organizations and Movements:**

There are a few groups attempting to improve biodiversity and mitigate the negative effects of agriculture. One such group, the Audubon Society is concerned with how harvesting can affect the nesting times of migratory birds in the North Country. The Audubon Society has farmers sign a petition to not harvest haylage until August 1st, in order to give field nesting birds enough time to finish nesting. Although a number of farmers would like to sign on to the petition, they are unable to wait until August to cut their hay since it is later in the season and much of the crop can spoil. Farmers in need of cash before autumn must harvest their haylage earlier in the season, regardless of the effect on bird populations. This does not deter the Audubon Society however, and they continue to look for farmers who are willing to make a sacrifice for biodiversity.

Another important organization is the North Country Wild Care Center (NCWCC) which focuses on the rehabilitation of wildlife and the continuation of research on local wildlife. While the NCWCC does not actively engage in attempting to change agricultural practices, they do care for animals that are harmed by agricultural practices including birds and mice stuck in hay fields and
animals injured by machinery. Such organizations are important stakeholders for protecting biodiversity in the North Country and attempting to get local people involved in conservation.

**Dairy Consumers:**

Since most of the milk produced in the North Country is shipped to urbanized areas, dairy consumers refer to anyone who consumes a milk-based product. Dairy consumers may not be aware that their milk comes from cows in the North Country, or even that they are a stakeholder. Despite this, dairy consumers are an important and influential part of the dairy industry.

Although consumers do not actively influence the outcomes of production, consumers do influence the industry through what they purchase. For example, in recent years the increase in yogurt production is fueled solely by consumer demand¹. Dairy consumers drive the market and can make or break those involved in production.

Consumers also have the ability to influence the state and federal governments on matters concerning food production. Last year, the New York State Government increased dairy subsidies in an attempt to strengthen the industry and meet growing consumer demand¹. Demands for healthier or environmentally stable production practices have also led to changes in government policy (New York State Governor, 2014). Consumer demand has pushed New York State toward one of the strictest agricultural policies in the country¹. Although consumers of milk can be in favor of biodiversity by demanding products produced in a sustainable way, they do not make such demands and are currently driving the dairy industry to expand without considering the effects it will have on biodiversity. The influence of consumers makes them an important stakeholder in the dairy industry although their lack of knowledge on the subject can often make them sway in one way or another making them a stakeholder which can change its viewpoint rather quickly.
The New York State Government:

When it comes to preserving and upholding biodiversity, the New York State Government is actually its chief supporter. The State has a number of strict regulations which favor environmental sustainability over increasing the production of agricultural lands. Dairy, being one of the main agricultural products in the state, is strictly regulated to prevent the contamination of waterways and ensure that the byproducts of dairy farming practices are disposed of in a safe and clean manner. The DEC must inspect farms with over 300 head of cattle annually to ensure that they are complying with state environmental codes including proper handling and storage of cow manure, as well as ensuring that small tributaries are not placed within cattle grazing lands. The state government reserves the right to remove the licenses of farmers who violate regulations.

Despite the strict approach of environmental inspections, the state does provide farmers with options to help them meet expectations. For example, over the past two years the State has offered to pay for the installation of roofs on open manure pits in preparation for additional regulations which will be added in the coming years. It is also worth noting that state regulations can change depending on who is currently in office. In 2012 new regulations were passed that resulted in an increase in the classification of a CAFO from farms with 200 animal units to farms with 300 animal units. This was an important change in policy as it reduced the number of farms that qualified as CAFOs, decreasing environmental regulations on these farms and eliminating yearly inspections. Although the State is currently a stakeholder which tends to side with biodiversity, this can change with each election year and the State should not be the only voice devoted to preserving biodiversity.
Farmers

Small Farmers:

In dairy farming, small farms are defined as any farm with less than 300 animal units. Small dairy farms are often owned by a single family and can be passed down through generations. Traditionally, small dairy farms make up a majority of the farms in the North Country, but the number of these farms has gradually declined over the years as more and more people have left the dairy industry and moved on to greener pastures. Farmers who leave are either moving to agricultural areas outside of the North Country, leaving the dairy business and changing to a different type of crop, or leaving agriculture altogether for other work. New York has lost 27% of its dairy farmers between 1989 and 2007 (DiNapoli, 2010).

Figure 8. Decline in dairy farming between 1989 and 2008 (DiNapoli, 2010).

Small-scale farmers have a stake in dairy production because it is their family's livelihood and in many cases has been for generations. While the biodiversity of the North Country might
not be on the mind of every farmer, it directly impacts them since their success is directly tied to the land. Farmers rely on good soil and water quality in order to grow the best crops year after year and therefore should be concerned with maintaining biodiversity in order to ensure their continued success for years to come. Most dairy farmers in the North Country also produce haylage to feed their own cattle, which is a much cheaper alternative to buying feed. Drastic shifts in biodiversity could cause a decline in hay production and thus milk production in the near future. As a result, small farmers have their financial interests directly tied to the land and in maintaining biodiversity.

When it comes to the stance of small scale farmers on biodiversity, the position depends of the choice of the individual. While farmers look to make the most from their land, they are also aware that overexploiting it for too long will lead to problems down the road. Unfortunately, due to economic pressures, most farmers do not have a choice and must utilize all of their fields each year in order to make a profit, even if fallowing fields would be better in the long run². After all, a farmer who cannot pay his bills might not have all of his fields in the coming years. Because of this, we can classify small farmers as stakeholders that would not side with increasing biodiversity. Although small farmers might want to support increasing local biodiversity, they are unable to for economic reasons.

**Larger industrial scale farmers:**

While there are no “industrial” farms present in the North Country, there are a few farms that are significantly larger than the small farms discussed above. These farms have more than 300 head of cattle and are considered CAFOs under New York State Law², while farms with over 700 animal units are considered large CAFOs (Kelly, 2015). While there are not as many CAFOs and small farms in the North County, the economic impact of these CAFOs is immense. For example,
the largest 8 CAFOs produce half the milk in St. Lawrence County. Currently, there are over 25 CAFOs in the North County with 5 of them being large CAFOs (Kelly, 2015).

Many of the CAFOs in the North Country are family owned and operated, although they often hire a number of farm hands to assist in the milking of their cows. As these large-scale farms expand, they require more and more land in order to grow enough feed to supply their ever growing herds. Smaller farms are often bought or leased to provide more space for feed production. However, an increase in herd size brings an increased burden in the form of government inspections. CAFOs are classified differently than small scale farms under New York State laws and must adhere to strict regulations and pass a number of yearly environmental inspections to remain operational. All farms which qualify as CAFOs must follow the yearly guidelines set by the Cornell Guide for Integrated Field Crop Management in order to remain in business. The actual rules behind these guidelines are not free, meaning that a physical copy of the book must be bought annually in order to keep up with changing regulations (The Cornell Store, 2016). Any farmer who fails to adhere to the regulations risks losing his license and having his herd size reduced to meet environmental standards. Because of the strictness of New York environmental policies, becoming a large-scale farm can be a risky business, though the rewards can be lucrative. Since economic pressures push large scale farmers to purchase land for grazing and haylage, it is safe to say that they are uninterested in increasing biodiversity in the North Country.
Dairy Processing

**Dairy processing plants:**

Raw milk is rarely used for human consumption in the US. Before milk is bottled and sold to the public, it must first be processed to remove any potentially harmful substances. Antibiotics and preservatives are added to the milk to prevent bacterial growth and increase its overall shelf life (USDA, 2016). Specialized plants take the raw milk from different farms and convert it into the pasteurized milk found in supermarkets.

There are no milk processing plants in the North Country, and all milk is shipped down state for processing. Shipping creates an increased cost for farmers as they must pay to have their milk shipped to processing plants located outside of Syracuse and Rochester. Shipping costs depend on gas prices, a factor which dairy farmers have no control over. Shipping milk can lead to a financial loss if gas prices rise too high, but not shipping will lead to an even greater loss of not selling dairy products. Many farmers have found a cheaper alternative to bottling milk.

Milk can be converted into a variety of products, with yogurt being the second most profitable industry for milk (NY Governor’s Press Office, 2014). Yogurt processing is not equally accessible for small dairy farms, meaning much of the price of milk is determined by gas prices to-and-from the factory. However, the energy inputs and environmental stress these industries put on local communities can be significant (Chobani, for example, processes Greek yogurt using milk from the North Country). Unlike milk processing plants which are only found in Syracuse or Rochester, there are a few dairy processing plants located in Massena. These provide a cheaper alternative to most North Country small farmers who cannot afford to have their milk shipped to Syracuse for packaging and processing.
The biggest concern however from both dairy producers and Greek yogurt processors is how to handle acid whey, a major byproduct of Greek Yogurt. To produce one ounce of Greek yogurt, Chobani uses 4 ounces of milk and creates 3 ounces of acid whey, a thin liquid composed of water, lactose, minerals, and some protein. Dumping acid whey directly into the ground or into waterways is illegal because of its toxicity to natural fresh-water communities. Acid whey, when dumped, can trigger massive drops in dissolved oxygen levels, killing off aquatic wildlife (Elliot, 2013).

In the years between 2007 and 2013, Greek yogurt production has tripled into a $2 billion industry, with many more plants opening in dairy producing states across the country. This trend was caused by an increase in consumer demand for yogurt products. New York yogurt factories reportedly produced 150 million gallons of acid whey in 2012 (Elliot, 2013). This whey is harmful to the environment and has a negative effect on biodiversity. Processing plants are a stakeholder because they are an important part of the dairy industry which connect the dairy farmers to the dairy consumers. While not necessarily interested in maintaining biodiversity as it would be more expensive for them to deal with the byproducts in a more sustainable way, the plants still have a say in how the dairy industry is run in the North Country and are therefore a stakeholder.

**Industrial dairy sellers:**

Industrial dairy sellers refers to the large companies which are found on packaged supermarket dairy products. Companies included are Kraft, Philadelphia Cream Cheese, and Chobani. Although industrial dairy sellers put names on many milk based products, they do not own the processing plants or the farms that produce the milk (Elliot, 2013). Large companies buy dairy from all over the country, and in some cases other countries as well. North Country dairy is
just one supply source for these companies. Industrial dairy sellers are not as much of a direct presence in the North Country as they used to be, but their influence still persists.

Industrial dairy sellers have a stake in dairy farming since it supplies them with the base materials for all of their products. While they have multiple suppliers of dairy, changes in production in the North Country might change some of their supply routes and may lead to a financial loss for the company. Because they are making money off of the current dairy industry, industrial dairy sellers have no reason to change the dairy industry. For dairy sellers, the stakes might not be as high as they are for the North Country dairy farmer, but companies still have a large say in how dairy is produced. Dairy corporations are large enough to influence government policies and often attempt to alter regulations for their benefit. The disproportionate influence of industrial dairy sellers as compared to their actual presence in the North Country makes them an important stakeholder. Dairy sellers see little of the direct impacts of their actions and do not have a tie to maintaining biodiversity in the area.
GOVERNMENTAL ISSUES

Land Rights

Home rule:

New York State is considered a home rule state. This means that the local cities governments and municipalities are allowed to pass their own laws and are mostly operating independently from the State government². The local city government has the right to determine how to use land and settle disputes between private land owners. As long as city laws do not violate the state constitution, they are allowed to proceed without permission from a higher body (Cuomo and Rosado, 2015).

Home rule is both helpful and detrimental to preserving biodiversity. Fortunately, laws and regulations can be enacted much quicker without the need to pass through the hoops and hurdles of the state bureaucracy. Unfortunately, neither the county nor the state has the authority to enforce any laws pertaining to land use that would preserve local biodiversity. The state and county can only make suggestions on how the city should use its land; larger governmental bodies have no control over the city’s land use. Home rule makes it much harder to implement land use policies that would help biodiversity on the state or regional scale since the city can choose to act in its own self-interests rather than the interests of the greater region.

Land Use:

Land use in New York is determined in part by the town and in part by the landowner. While the owner is allowed to use his or her land for whatever activities they wish, the town has some control over land use through zoning¹. Zoning allows the town to set aside certain sections of land for particular uses and seize private lands to create new zones. Zoning is usually done for road construction and the landowner is often paid compensation for loss of land and land value
Land zoning has also been used to claim spaces for public buildings such as hospitals, schools, and agriculture.

All of the land in the North Country has been surveyed throughout the years and placed on a scale which rates the soil quality with the best defined as agricultural land. The land is ranked on a scale ranging from 7 to 1 with 7 being low grade land unfit for intensive agriculture and 1 being the richest soils in the state. The best agricultural land in the North Country is rated as level 2, meaning the land has good soil². This information is readily available to policy makers and the general public, but is seldom used in deciding the actual usage of lands¹. For example, the Canton-Potsdam hospital in Canton was constructed on rank 2 land¹. Despite disagreements on how land is used within the township, the state government does not have the right to interfere with city plans. Such decisions often result in high quality land utilized for projects which do not require high caliber land¹. Similar instances have occurred with solar farming, as panels are laid on nutrient rich land which would be perfect for agriculture. Current land use policies in the state have created an interesting situation where higher level government officials have become land advisors as opposed to land managers.

**Growing the Dairy Industry**

As the secondary dairy products coming out of the North Country begin to pick up pace, policy makers reexamine dairy input regulations. State officials are already incentivizing large yogurt buyers to bring more packaging and processing operations into New York State to decrease the price of inputs such as buffing yogurt research and subsidizing yogurt processing plants (NY Governor’s Press Office, 2014). New York will continue to increase the sales of dairy products produced in-state to state operated institutions (NY Governor’s Press Office,
Several food-supplying governmental departments, including Correctional Facilities, have placed 4-ounce vanilla yogurt on their menus across the state. These alliances, in addition to public contracts with other businesses, resulted in $1.2 million in sales of cups of yogurt each year to support North Country farms with $300,000. Over a third of the Corrections Facilities’ budgets for food go towards food products grown, produced, or packaged in-state (NY Governor’s Press Office, 2014).

A recent partnership with SUNY Cobleskill seeks to construct a dairy processing teaching lab. The state government has committed $1 million to build processing equipment and recruiting technicians for dairy studies programs (NY Governor’s Press Office, 2014). This project seeks to address the low numbers of qualified personnel graduating from New York institutions. The program plans to issue certificates for each level of processing, everything from lab technicians to food safety and sanitation managers (NY Governor’s Press Office, 2014).

The new facilities for processing demand energy, of which a significant percent will soon be renewables. At a 2014 Summit, Governor Cuomo pledged millions of dollars to research, development, and construction of energy-efficient and renewable resources (NY Governor’s Press Office, 2014). The governor has assembled a Renewable Energy for Agriculture Task Force to guide state officials on renewable options and industry-specific demands. The New York State Energy Research and Development Authority has already pledged $75,000 for task force research, $7 million for Agricultural Energy Efficiency Program, $1.2 million for construction of anaerobic digester technology at Cornell University’s Dairy Research Facility to help in processing biogas (NY Governor’s Press Office, 2014).

In 2013, Governor Cuomo reported that New York is the largest yogurt producer in the United States (695 million pounds in 2012, 741 million in 2013), ahead of California (589 million pounds...

**Dairy Research**

The study of dairy and dairy products in the US began in 1895 with the creation of the Division of Agrostology and the Dairy Division, both parts of the US Department of Agriculture (USDA, 2016). These divisions were responsible for all research involving dairy and milk production as well as running food safety inspections related to dairy. The divisions were reclassified to the Bureau of the Dairy Industry in 1945 and then again into the Dairy Husbandry Research Branch and Meat Inspection Branch of the USDA in 1954 (USDA, 2016). Throughout the years, federal dairy research has focused on a number of different projects in an attempt to improve dairy products including studying the effects of different types of forage grass on milk quality, revising standards of sanitation to be used on dairy farms, and leading a nationwide push for the pasteurization of all milk products, now required by the USDA (USDA, 2016).

Dairy processing facilities have doubled between 2001 and 2011, with yogurt facilities having tripled between 2005 and 2011 (Hamilton, 2013). Chobani and Fage Greek Yogurt collectively employ over 1600 people. Dairy processing facilities have a high economic multiplier effect meaning nearly 5 jobs are created for every 1 dairy processing job (Hamilton,
For every dollar of yogurt sold, $1.25 is generated for surrounding communities (Hamilton, 2013). Since having dairy facilities is so rewarding for local economies, governments are trying to find alternative ways to encourage processors to move to New York. Muller, Quaker and Alpina Foods are creating plants in the Finger Lakes region, as a joint venture with Pepsi Co. (Hamilton, 2013). These facilities are planning on buying milk only from New York farmers and the Upstate Niagara Coop. and ship the yogurt to Chicago, New England, Philadelphia, Pittsburgh, and Washington D.C. (Hamilton, 2013).

However, there are some challenges in growing the industry for both the buyer and producer side of dairy. The biggest of these concerns is federal price regulation and dairy cooperative’s advantage over small farmers. This is known as the “Chobani Paradox”, by Cornell Economists Andrew Novakavic (Novakavic, 2012). Cooperatives buy milk from member farms and sell to milk processors. Thus, the farm price of milk is far below the processor buying price. Federal laws maintain a minimum buying price for processors purchasing milk from both farms and coops. This minimum price guarantees that farms can sell milk directly to yogurt processors and still make profit. Farms and coops have therefore established a rationing mentality, making actual supply figures inaccurate by blurring the lines of who actually creates supply: the coops or the farms.
DEVELOPMENT OF SOLUTIONS TO THE PROBLEM

Potential solutions that help ease or eliminate the negative effects of dairy farming on biodiversity in the North Country must meet three different parameters. First, the solution must actually improve biodiversity. Although there are a number of social and economic issues that are tied up in dairy farming, it is important to remember that the conserving biodiversity must come before any other objective. While some solutions may tackle other problems as well, fixing biodiversity must be the primary objective of any solution. Second, after improving biodiversity, a solution must protect the interests of both local people and wildlife in the North Country. Not accounting for the local people could lead to resistance against any measures made to improve biodiversity in the North Country. Finally, after serving the needs of biodiversity and the local people, a solution must allow dairy farming to be a stable form of income. While abolishing agriculture in the North Country would definitely help biodiversity, it would also cause a quarter of the North Country population to lose their jobs and again lead to resistance against any future measures taken to improve biodiversity.

Spacing out active fields/letting fields go fallow

One of the biggest threats to biodiversity that has come out of dairy farming is the creation of a monoculture in the North Country that focuses on either creating grazing lands for cattle or growing haylage to feed cattle. Monoculture has led to a depletion of available habitats for animals in the North Country. The increase the Western Bean Cutworm (*Striacosta albicosta*), a major pest of corn, has forced farmers to utilize more land in order to make up for losses due to pests (Purdue, 2009). The worm’s larvae feed on corn and have been estimated to cause a yield
loss of 4 bushels/acre in heavily infested fields (Purdue, 2009). Climate change has allowed the Cutworm to move its range north and run rampant in the North Country. The pest is able to thrive due in part to the vast fields used to grow food for the North Country’s cattle.

Spacing out fields or allowing overworked fields to go fallow for a season would provide a number of places for other activities. The result would be different ecosystems supporting various types of wildlife in the area. Using fewer hayfields or allowing overworked fields to go fallow for a season would allow migratory birds to nest safely during the summer. Spreading fields apart and adding forested land would help to slow the spread of the Western Bean Cutworm and other pests arriving due to climate change (Purdue, 2009).

**Use best agricultural land for agriculture**

With dairy and agriculture being an important source of income for the North Country, it makes sense that a significant proportion of the landmass is used to support the industry. However, not all lands are of equal value when it comes to agricultural production. Some lands are naturally richer and better support crops. Currently, there is sufficient data available to the public on what lands are best used for agriculture, however this data is often disregarded when enforcing local agricultural policies. Using the most suitable land for agriculture would help to increase production and make better use of the resources available in the North Country.

Using the most suitable land for agriculture would also improve biodiversity in the North Country. Although good agricultural land is also beneficial for natural ecosystems, not all land would be converted due to ease of access and remoteness of certain patches. However, richer soil found throughout the North Country would yield more productive fields and help to alleviate current pressures on less productive fields. Using land appropriately would allow farmers to let
some fields go fallow and create meadows and other habitats, increasing the overall biodiversity of the North Country. Better distribution and utilization of agricultural lands would be beneficial in preserving North Country biodiversity.

**Incentivize small dairy farmers**

Currently, the New York State government is pushing to increase dairy production within the state. The State provides incentives for all dairy farmers to help pay for suppliers, compensate for losses, and offset some of the transportation costs. The States relies on energy efficiency incentives such as providing solar panels or utilizing methane fuel. The State also provides small incentives for improving infrastructure such as roofs for manure pits. One problem with incentives is that the number of incentives currently available are rather limited and not every farmer has access to tax breaks.

Providing incentives for farms with a small herd size would help to increase the number of small farms in the North Country as small farms would be able to produce milk with fewer state regulations (Kelly, 2015). This could help biodiversity as it would spread out the impact of cattle across the region as opposed to concentrating cattle into a single location. Incentives would greatly reduce the chances of large disastrous manure leakages such as the one that occurred in Broadman Brook (Bureau of Watershed Assessment, 2009). Incentivizing smaller herd sizes would make the waste much more manageable, reducing the likelihood of such events occurring in the future.
Promoting a Locavore mentality

Although there are dairy farms throughout the North Country, the residents do not have access to local milk. There are some dairy processing plants for milk products such as cheese in Massena, but most of the milk processing plants are located in and around Syracuse and Rochester. The lack of local dairy processing plants results in the majority of milk flowing out of the North Country, with none being locally consumed. As a result, the residents of the North Country are forced to deal with some of the adverse costs of dairy farming such as manure pits and spills without receiving a proportionate share of the benefits (GardenShare, 2016).

Providing a locavore mentality, or having people eat food which comes from an area within a few miles of their home, would help spread the benefits and costs of dairy farming for all North Country residents. This would require milk processors to move to the North Country, in the long run has the potential to aid in conserving biodiversity (GardenShare, 2016). Having milk processors in the North Country would cut down on transportation costs and carbon footprint. Moving milk processing plants to the North Country would also provide jobs for local residents. The reduction of fossil fuels required for milk processing and packaging has the potential of conserving biodiversity, making local dairy processing a worthwhile venture.

Implement a supply management procedure

Not all solutions to dairy farming need to involve the local people alone. One possible solution to protecting biodiversity in the North Country (and anywhere in the US which relies on dairy farming) is to implement a supply management procedure. Supply management is a national procedure which has worked for milk price regulation in the past. Currently supply management is used in Canada and focuses on stabilizing the price of milk across the country.
and providing a fair wage to dairy farmers for their product (Dairy Farmers of Canada, 2016). The system works by creating a maximum price at which milk can be sold within the country and sets a maximum yield for each farmer (Dairy Farmers of Canada, 2016). Although a farmer could theoretically produce as much milk as they wanted, farmers cannot sell excess milk on the open market and therefore have no incentive to produce more milk than is allowed by the quota (Dairy Farmers of Canada, 2016). Competition from outside sources is minimized through the use of tariffs, which make foreign dairy products more expensive, encouraging people to buy local products (Dairy Farmers of Canada, 2016). Unlike the system of dairy subsidies currently used in the US, supply management does not require payment from the federal government. The basic idea of the system is to set a maximum yield for each dairy farmer per year and then sell milk in stores at a price that allows farmers to live comfortably (Dairy Farmers of Canada, 2016).

While supply management is usually implemented to deal with the social implications of farming, it would be a useful way to deal with biodiversity issues as well. If each farmer had a milk production quota, there would be no incentive to produce excess milk and therefore the incentive to increase the number of cows on each farm. Decreasing the number of cows on each farm would greatly improve local biodiversity in areas which are heavily impacted by dairy farming since there would be fewer cows packing into a small area (Kelly, 2015). This would cut down on the amount of manure produced locally and the amount to feed needed to feed the cattle within the dairy industry. Less manure would help the North Country as a whole. This solution would also help to reduce herd sizes on a national level as opposed to a local level and would be a good way to begin considering farming's effects on biodiversity throughout the country.
Crop Diversification and Organic Farming

Any plan worthy of implementation must allow farmers to either maintain or improve their economic success in farming and also improve soil and water conditions. If small farmers can’t afford to ease the intensity of dairy farming on their land, should they exclusively farm dairy in the first place? New York grows many different agricultural products, some of which could be viable crops to replace feed corn and haylage. New York ranks second in apple production, and third in grape production (New York Farm Bureau, 2016). New York also ranks 5th in the nation for cabbage, onions, and sweet corn. There is also evidence that the switch from conventional to organic farming mostly does not result in a decrease in profits/demand, as demand for organically grown produce continues to rise (Heins, 2011). Not only will these crops and many others support local demand for food (taking advantage of increasing demand for local food), it will force soil communities to adapt from a predominantly monoculture system to a diverse agroecosystem, increasing microbial and fungal diversity and resilience in soil ecosystems (North Country Now, 2015). Farmers can still use their land for profit and continue to grow dairy feed products, while simultaneously farming other crops that have proven to do well in New York State.
EASE OF IMPLEMENTATION

While the solutions provided in the section above might help to improve biodiversity, not every solution is viable within the North Country of New York State. The failure of a particular solution could be due to a number of reasons, including a lack of funding, the size of the operation, or unforeseen complications preventing implementation. In addition, a few of the solutions mentioned above have other problems that would make them less suitable for biodiversity conservation. Understanding the potential complications within each solution is important for identifying the best solutions for improving biodiversity in the North Country.

Spacing out active fields/letting fields go fallow

Spacing out fields and allowing overused fields to go fallow is a promising solution to preserving biodiversity in the North Country. Currently, most fields are used annually and are not given a chance to lay fallow\(^2\). Farmers can replenish nutrient poor fields by means of crop rotation. Crop rotation is a sound agricultural strategy which should be used more frequently than it is today\(^2\). Fallow fields would provide habitat for migratory birds to nest without being disturbed by farmers and farming practices (DEC, 2015). Increasing space between agricultural plots would also help prevent the spread of pests between fields (Purdue, 2009).

Implementing fallow fields and spacing policy is not without potential complications. Under state law, the government does not have jurisdiction over private property meaning that it would be difficult to force landowners to create large areas of fields or forests on their land (Cuomo and Rosado, 2015). In addition, fallowing laws do not address the underlying economic restraints. The current market for milk and haylage is so low that a farmer cannot economically afford to leave fields fallow for an entire season. The same problem arises with spacing fields out, as it would be more difficult for farmers adequately manage their fields. Although the implications
for biodiversity look promising, there would be a number of difficulties implementing this strategy on a regional scale.

**Use best agricultural land for agriculture**

While rich soils should be utilized for agricultural purposes, it is unlikely that this practice could be easily implement or successfully carried out. As previously mentioned, private landowners are allowed to use their land as they see fit and while the government can offer suggestions on how they might better utilize what they have, in the end it is the landowner's choice (Cuomo and Rosado, 2015). In addition, high quality land areas are not concentrated, but are dispersed throughout the North Country¹. Accessing rich soils might be more trouble than it is worth and could even be worse for biodiversity in the long run as a path would need to be cleared to access them. Natural areas need a combination of high and low quality soil, and certain ecosystems can only be found in locations with favorable conditions. If all high quality areas are devoted solely to agriculture, then important ecosystems would be lost as would local biodiversity. Devoting the best agricultural land for agriculture alone is not a viable strategy for improving biodiversity in the North Country.

**Incentivize small dairy farmers**

Incentivizing small dairy farms would certainly be an easy solution to implement. There are already a number of incentives provided by the State Government as well as grants and loans available through research institutions such as Cornell University (NY Governor’s Press Office, 2014). The idea behind the incentives would be to allow small scale farms to stay in business and prevent them from being bought out by larger CAFOs (Kelly, 2015). This would in turn promote
the growth of small scale farming and hopefully lead to smaller and more manageable herd sizes in the future. Since the government already uses incentives as a way to promote dairy in New York, it would not be difficult to change the requirements for certain incentives to give preference to farms with fewer head of cattle.

One potential block to this solution is the industrial food industry. As mentioned earlier, there are a number of powerful companies who have an interest in maintaining large CAFOs (Elliot, 2013). It is easier for these companies to buy in bulk from large farms instead of spreading out their dairy sources. In addition, it is unclear whether or not this solution would actually benefit biodiversity at all. While it makes sense that spreading out herds would reduce the potential of large scale spills, there have been no studies showing that this would be the case. Small scale farming does not necessarily mean organic farming, and incentivizing smaller farms might not improve biodiversity at all. Incentivizing small farms would not be an optimal strategy for improving biodiversity.

**Promoting a Locavore mentality**

Attempting to promote a locavore mentality is certainly not the easiest task as it requires changing the mindset of how people in the North Country view the food they eat. Despite the almost momentous task, there are a few groups that are attempting to accomplish local food utilization. For example, GardenShare is a group devoted to providing residents of the North Country with locally grown fruits and vegetables (GardenShare, 2016). Although the group has made a tremendous effort, they do not distribute meat or dairy products. Having a distribution group similar to GardenShare that specialized in dairy would be one way to promote Locavorism.
Providing dairy products in local farmers markets, food coops, and schools would also help to build ties between the dairy industry and the residents of North Country.

Creating a milk processing plant would also help to promote eating local as it would allow farmers to distribute their product. However, the pollution given off by such a plant might lead to detrimental effects on local biodiversity as the refuse from processing plants has been shown to be detrimental to waterways (Elliot, 2013). Although a processing plant would be one way to help residents of North Country eat local, other methods might be better for local biodiversity.

**Implement a supply management procedure**

Implementing a supply management procedure would mean changing how the dairy business is run, not just in the North Country, but in the entire United States. It would mean fixing milk prices and implementing a maximum amount of milk that can be sold by each farmer annually (Dairy Farmers of Canada, 2016). With a maximum quota for milk, farmers would need fewer head of cattle than they currently have and herd size would fall. This would benefit local biodiversity as fewer cows would mean less stress on the local environment (Kelly, 2015).

There are three main problems with implementing a supply management procedure. First, a supply management procedure would have to be implemented on the national scale, as implementing one locally would allow dairy from other states to flood the market with cheaper milk and put North Country farms out of business. Second, it goes against our ingrained sense of capitalism and the idea of the free market. An important belief in the US is that the economy should be allowed to grow unrestricted by government agencies, contradictory to the supply management procedure. Finally, it is uncertain that such a procedure would actually benefit local biodiversity. As with incentivizing small farms, we cannot be certain that reduced herd size
means increased biodiversity. Therefore, implementing a supply management procedure would not be a viable solution.
IMPLEMENTATION PLAN

Of the solutions outlined above, the best solution is increasing crop diversity and wild species diversity around dairy farms. Farming a wide variety of crop species using a rotating field system greatly increases the soil microbial and fungal diversity (Tiemann, 2015). Most agricultural systems operate on a two-crop rotation monoculture, thereby simplifying the soil community (Altieri, 1999). High biodiversity of below-ground soil communities increases soil fertility factors, mainly carbon, nitrogen, and microbial biomass (West & Post, 2002). Increasing the number of different crops planted onto feed crop land, rotating these crops regularly, and allowing fields to go fallow could potentially allow farmers to increase the fertility of their crop land while simultaneously improving the surrounding biodiversity. Such adjustments to land use and management has roots in organic, low-input agriculture, which has been used in the North Country for decades. However, organic feed production and livestock raising does not produce as much milk or as much profit/cow as conventional farming (Heins, 2011). Can a low-input, highly diverse farming system remain profitable enough for North Country residents?

In some places in the Northeast, organic farming is still profitable and the trend for more organic farms is on the rise. In Vermont 21% of dairies are organic (Heins, 2011). Despite the cost/cow being higher in organic farms than conventional, the net income/cow was practically the same ($914 vs. $925), as well as the veterinary costs ($102 vs. $91) (Heins, 2011). In Minnesota, organic herds had less veterinary costs ($75 less than conventional) and had more income per cow ($544 more than conventional) (Heins, 2011). Of these organic farms, many of the owners and operators report satisfaction with the past performance of organic practices and continue farming organically for up to ten years or more (Heins, 2011). Some farmers remarked
that organic farming is more profitable in the long run and that their farms would not be in business if they weren’t organic (Heins, 2011).

Many small farmers in the North Country are making barely enough to sustain their families and livestock, and simply cannot afford to spend the time and money for changing over to organic markets, as it requires a different set of resources than conventional farming (Delbridge, 2015). Transitioning from conventional to organic typically does reduce the number of acres available for farming and reduces the total product return per acre (Delbridge, 2015). Small farms must therefore apply for a short-term loan and redo budgets at the beginning of every season leading up to the organic certification.

In order to assist North Country farmers in transitioning to organic and preventing farmers from going bankrupt, the state government needs to assist farmers who want to go organic through a financial planning system for farmers seeking loans (DiGiacomo, 2015). The Tools for Transition Project is a four-year funded grant from the USDA National Institute of Food and Agriculture (Delbridge, 2015). This project has two goals: first, to collect data on farm input and profit measures during the organic transition process; second, create web-based materials and resource lists to satisfy the dearth of information to aid in the transitioning to organic farming and advise local agriculture government officials in facilitating the transition (Delbridge, 2015). Advisors from state and agro-economic research institutions (like Iowa State Extension, the University of Minnesota Department of Applied Economics, and Sustainable Agriculture Research & Education[SARE]) can assist farmers in developing a transitioning plan (DiGiacomo, 2015). SARE specifically offers several varieties of grants designed for stakeholders in the dairy industry (DiGiacomo, 2015). Farmer/Rancher and research/education grants allow farmers to test innovative ideas in the field with the added benefit of gaining insight
concerning critical sustainable agriculture issues (DiGiacomo, 2015). SARE even offer grants for funding training programs on sustainable agriculture and combining these programs with producers to provide valuable feedback (DiGiacomo, 2015).

Diversifying crops can assist farmers that are struggling to compete with internationally controlled prices with only local resources (Myers, 2004). Low commodity pricing for corn, haylage, and inevitably milk has driven many farmers to try other options; adopting alternative crops can provide an “immediate and significant” enhancement of income (Myers, 2004). Struggling small farms that are open to trying new crops (vegetables, sweet corn, mixed agroforestry) or livestock (goats & sheep) can gradually switch to mixed farming techniques. The local government business advisors as well as grants and tax incentives from state and educational institutions can assist farmers during the transition.
CONCLUSION

North Country species depend on healthy water, soil, and forest/field ecosystems for survival, and ensuring these natural resources remain healthy is critical if Northern New York is to maintain the ecosystem services necessary for productive agriculture. Now, over a third of New York State’s biodiversity is under threat, and much of this threat stems from agriculture. Nearly 80% of the agricultural land in the North Country is devoted to farming dairy cows and their feed crops (corn and haylage). Fifty percent of all land in the North Country is dedicated to agriculture, so a third of the land is used exclusively for dairy. Many of the farms are small farms although eight major CAFOs in the North Country contribute to most of the milk that gets shipped downstate from Northern New York.

Farmers that are struggling to make a profit are using every piece of land they have to support increasing herd sizes and farm consolidation. Because there are so many waterways and forests that border and intersect corn fields, hay fields, and pastures, common land use practices (such as frequent hay cutting, proliferation of corn monocultures, inconsistent manure dumping, and erosion of soils) all contribute to biodiversity loss. These losses are linked to the practice of dairy farming in the North Country and need to be alleviated if local biodiversity is to stabilize or increase.

Considering the financial limitations of lessening the intensity of agriculture in the North Country, dairy farmers should consider diversifying what they plant on their land. New York is known for producing many different kinds of crops, and North Country ecosystems would benefit from increasing crop diversity to other crops besides dairy feed. Since there is an upward demand in local organic produce in the North Country, the profits from alternative crops can still
help farms supplement dairy income. The Department of Agriculture and Department of Conservation can also ease farms into organic and alternative crops during the transition period through grants. St. Lawrence County government can issue conservation-based tax breaks to landowners that allow fields to go fallow for a season or create buffer forested zones around their property to lessen soil erosion. Biodiversity is important for continued success in agriculture. New York’s leaders in agriculture and policy have all agreed that they want to push dairy and make New York State renowned for its dairy products. However, if the State wants Northern New York to continue to produce milk, maintaining biodiversity is paramount for the ecosystem services that keep agriculture productive and sustainable.

**ACKNOWLEDGEMENTS**

We would like to thank Jason Pfotenhauer, Dr. Kimberley Morrill, and Dr. Kitty O'Neil for their time and the information they provided to help in our research. We would also like to thank Justin Dalaba, Darcy Best, and Kristen Jovanelly for their help in reviewing the paper. We would like to give a big thanks to Dr. Erika Barthelmess for her insights and reviews of the paper. Finally, we would like to thank the St. Lawrence University Conservation Biology Department for their help in making this project possible.
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APPENDICES

Interview Materials

Interview questions asked to Stakeholders during interviews

Appendix 1

Interview Questions (Policy Makers):
Q: How did you get involved in agricultural policy?
Q: Overall, how would you describe the state of agriculture in the North Country?
Q: What sort of changes have you seen in the agricultural industry over the years? Advances in technology, yield changes, climate changes, etc.
Q: What limitations in policy have you encountered through your time on the board/in office/experiences?
Q: Where do you feel that SLC agriculture has succeeded? Failed?
Q: How is agriculture monitored in the North Country?
Q: Is there anything you feel that could be done to improve agriculture in SLC?
Q: Within the last half a century there has been a shift from small family owned farms to larger industrial farming techniques, is agriculture policy adapting with higher concentrations of cattle per farm?

List of subjects interviewed for this study

Jason Pfotenhauer, Deputy Director, St. Lawrence County Planning Office
Dr. Kimberley Morrill, Dairy Specialist, Northern New York Regional Ag. Team, Cornell University
Dr. Kitty O'Neil, PhD, Field Crops & Soils Specialist, Cornell University Cooperative Extension, Northern NY Regional Ag Team