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A Comparative Analysis of Predator Management Techniques of North American Wolf Species and Potential Applications in Michigan

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Abstract

Wolf populations have continued to increase after the Endangered Species Act of 1973 within the United States. Many resilient populations have reestablished themselves and have since become delisted as endangered species. Wolf reestablishment, especially near areas close to humans, has created new management problems that wildlife and land managers are responsible for solving. As wolf populations grow and human development pushes closer and closer to wild areas, conflicts pertaining to depredation of livestock, safety of pets and citizens, and potential effects on prey species populations arise. Since multiple interest groups are involved in wolf management, it is dire that wolf related mandates have multidisciplinary approaches in order to please all groups and dissolve tension. Using peer reviewed scientific literature, this research will show that the best wolf management plan for the state of Michigan will accomplish this peace, be cost effective, and ultimately beneficial to the species itself as a whole.

Introduction

History of Wolves in North America and Shifting Attitudes

It is important to review the history of wolves and human interaction in North America, specifically the United States, because they are unlike any interactions across the globe. Many countries, such as older, established countries like Italy, have learned to live at one with predators, rather than control or manipulate them (Gazzola et al 2008). When livestock are taken from a Tuscan farming region, farmers are compensated for their losses, but not a single farmer requested preventative funding (Gazzola et al 2008). Old world countries, such as Italy, accept that predation is a natural part of farming life; it is to be expected. With Old World ideals towards wolves in perspective, it is clear that understanding America's history is imperative to understanding Americans' shifting attitudes of wolves and wolf management.

Prior to the European settlement of North America, wolves existed relatively peaceably with Native Americans. Native Americans revered wolves, and thought them to be creatures of immense strength (Kellert et al 1996) There was thought to be a "symbolic connection" between Native Americans and wolves, which further aggravated European settlers to dominate and civilize anything considered 'wild' (Kellert et al 1996). Large predators in general were perceived as threat to pioneers and settlers (Kellert et al 1996). With Manifest Destiny in full swing, eliminating wolves for safety became much more; pioneers felt they had a moral obligation to eradicate wolves from the landscape (Kellert et al 1996). Wolves along with many predators were viewed as inherently evil or enemies of God (Kellert et al 1996). Set in the time

frame of the 17th century, *The Scarlett Letter* by Nathaniel Hawthorne accurately portrays the ideals of the early European settlers on nature, wildlife, and anything untamed. Even forest land, which is often revered and protected today, was viewed as "primeval", "mysterious" and a place "so black and dense" (Hawthorne 1850). Settlers associated wild lands with the ungodly and uncivilized; it was something that needed to be tamed, wolves included. With Manifest Destiny came the thought that if settled, pioneers have a right to do whatever is necessary to protect and defend what they claim as theirs. Manifest Destiny is a main ideal that has differentiated American disposition of wildlife and predators from other nations, and remnants of this ideal can be seen still today.

After centuries of exploitation and extermination, wolves were primarily eradicated from most of the continental United States. Even the beloved and arguably first conservationist president Theodore Roosevelt was quoted saying that the wolf is "the beast of waste and desolation" (Kellert et al 1996). Changes in dispositions towards wolves started during the twentieth century onward, primarily when wolves were listed on the United States Endangered Species Act of 1973 (Kellert et al 1996). This may be due to the decreased abundance of wolves which increased their value, or because as a nation the United States was becoming more mature and cultured in scientific thought, primarily in biology and ecology (Kellert et al 1996). Aldo Leopold, thought by many to be the father of wildlife management, is a great example of the shifting attitudes that occurred towards predators during the twentieth century. In one of his most famous quotes he states "a deer herd lives in mortal fear of wolves, so does a mountain live in mortal fear of deer...Perhaps this is the hidden meaning in the howl of the wolf" (Kellert et al 1996). Leopold addresses an understanding that wolves, along with many large predators, restore balance to a system that would ultimately experience catastrophic population rises and crashes without them. From the listing of wolves as an endangered species in 1973 onward, many populations have been able to recover, a significant example being their reintroduction in Yellowstone National Park (Smith et al 2003). With the reintroduction of wolves, however, comes a new host of management issues.

Issues with Wolf Management

Wolf conservation over the last several decades has been a heated and controversial issue, affecting multiple groups of people from diverse backgrounds. Conservationists, hunters, farmers and urbanites have expressed wide ranges of emotions concerning the status of wolves in the United States, spanning from persecution and hatred to reverence and adoration (Kellert et al 1996). Unfortunately this implies that wildlife managers in areas of wolf reintroduction now must find innovative ways to control wolf populations while appeasing multiple groups with strong and engrained objectives, usually opposite to one another. When comments among interest groups concerning reintroduction of wolves to Yellowstone range from "It's like inviting the AIDS virus" to ""Only a fool would not agree to the placement of this beautiful and essential animal", this task can be considered impossible (Kellert et al 1996). However, it is important that managers look beyond political boundaries in order to make a fair assessment for the public

and for wildlife. When the Michigan Department of Natural Resources (DNR) first attempted to establish wolf populations in Michigan's Upper Peninsula in the 1970's, they failed due to human induced mortality (Kellert et al 1996). Given the history of the clear negative sentiment towards wolves in the United States, it is imperative that wolf exploitation does not occur again, regardless of the management technique in place.

Within Michigan's Upper Peninsula, wolf populations have been dramatically on the rise since their reintroduction, from twenty wolves in 1992 to over 500 in 2008, to a final estimate 687 in 2012 (Figure 1., MDNR Wolves in Michigan 2014). This year in Michigan's Upper Peninsula, the Department of Natural Resources has decided to allow 1,200 permits for hunters to kill a maximum of 43 wolves in three areas of the Upper Peninsula (MDNR Wolves in Michigan 2014). Other management techniques currently used in other states with wolf-human conflicts include wolf hunting, lethal control by state and federal agencies, and nonlethal management. The objective of this research is to inspect multiple predator management techniques of North American wolf species, including the current method of allowing a wolf harvest, weigh the benefits and disadvantages of each, and come to an interdisciplinary conclusion about what is truly the best management option for the species itself as well as the stakeholders involved.

Methods

This research was conducted by gleaning information from a variety of sources, including peer reviewed scientific literature, public newspaper reports, official government documents and websites, and classic literature pertaining to culture of early North American settlers. Databases used to find such information included Grand Valley State University Library Database and Google Scholar. Information searched was related to North America, wolf management strategies, wolf history, history of European settlement of North America, and cultural perspectives regarding predatory animals. Each potential wolf management strategy was described, the strengths and weaknesses of each management technique were weighed, with variables including cost, proven effectiveness, public opinion, and benefit to the species considered. With these factors in mind, I assessed whether the best wolf management strategy for Michigan's Upper Peninsula wolf population was the one currently in place or if another strategy could be more effective.

Results

Wolf Hunting

Five states within the continental United States currently use a wolf hunting season as a wolf management strategy (Grand Rapids Press 2013). Hunting may include firearms, trapping, or bow and arrow techniques (Grand Rapids Press 2013). These five states include Idaho, Montana, Wyoming, Minnesota, and Wisconsin. Of these states, Michigan has the most conservative limits, with just 6.5% of the entire population of wolves in Michigan's Upper Peninsula (Table 1.). Other states, such as Wisconsin and Idaho, have limits as high as almost a third of their wolf populations. The number of licenses sold is also highest in Idaho and Montana, and Michigan also has the fewest licenses sold (Table 1). Clearly the Michigan Department of Natural Resources is taking a considerably conservative approach since implementing the wolf hunt.

Through researching the current literature pertaining to wolf hunting within the United States, wolf hunting potentially protects prey species (Boerje et al 1996). In a 20 year study in Alaska, it was found that hunting wolves increased caribou, moose, and wolf populations (Boerje et al 1996). The hunting season was much longer than the short two month season in Michigan, spanning from the 10th of August to the 30th of April (Boerje et al 1996). Sometimes entire packs where harvested, yet post-hunting numbers of wolves exceeded pre-hunting numbers (Boerje et al 1996). Because wolves are only recently delisted in many states, wolf hunting is a very new management technique for the species and is still being monitored.

However, there is support in the form of scientific opinion for wolf hunting. Wolf specialist David Mech wrote to the Michigan DNR that "the wolf hunting regulations seem appropriate" (MDNR email correspondence). Another large argument made by wolf hunt supporters and Michigan's DNR is that hunting is an economic force that promotes conservation (Allen, T. et al 2013). Because the Federal Aid in Wildlife Restoration Act of 1937 allows for a special excise tax to be placed on hunting and fishing equipment, including firearms for the exclusive purpose of conservation efforts, hunters have contributed over 7.2 billion dollars to conservation efforts since the program began (Allen, T. et al 2013). The wolf hunt in Northern Michigan allows for more spending opportunities for hunting, which will help conservation efforts and boost local economies. Also, while most people disagree with the extirpation of wolves, many agree with hunting or lethal control if it has the potential improve wolf and human interactions and decrease conflict (Treves and Bruskotter 2011).

Lethal Control (without Public hunting)

Lethal Control occurs typically when a farmer or rancher experiences a loss of livestock that is undeniably due to wolves and contacts a local Fish and Wildlife or DNR officer, who then exterminates the problem wolf (Bradley and Pletscher 2005). The officer would typically trap anywhere that is within a designated distance from the farm. This difference may vary between states or local governments. If a wolf is caught, the officer removes it from the property. It should be noted that in a study in Minnesota, that increased trapping or even attempted trapping of male adults lead to a decrease in reattempted kills for ranchers (Harper et al 2008). Trapping one year did not decrease the number of depredations the following year (Harper et al 2008). Currently lethal control is one of the more common wolf management strategies as it allows for a trained professional such as a DNR officer or a person with a natural resources background to execute problem wolves in very specific areas, while the rest of the population is left unharmed.

However, lethal control is often expensive, and has not been studied in length to determine if it is unarguably effective (Bradley and Pletscher 2005). Wolf attacks tend to occur in sync with calving patterns, grazing practices, and changes in energy requirements throughout the year (Musiani et al 2005). However, in some studies calf survival does not increase with lethal control (Valkenburg et al 2004). After sixty percent of the 1993 autumn wolf population was exterminated, wolves still killed 25% of radio collared caribou calves (Valkenburg et al 2004). Scale is incredibly important if lethal control is to be effective, both in terms of spatial and temporal extent (Valkenburg et al 2004). If the wrong scale is applied the lethal control effort will not only be ineffective in deterring depredations, it can also be costly.

Nonlethal Methods

There are various non-lethal methods currently used in wolf management practices. These strategies aim to lead the wolves away from valuable prey species, such as livestock, and prevent depredations rather than solve the problem after the fact (Harper et al 2008). They are often used as a preventative measure first before, and if the problem isn't resolved, lethal control may be implemented. It was found in Montana and Idaho that improved monitoring of wolf denning activity can be very useful (Bradley and Pletscher 1995). If a den is located, it can be filled in and the wolves will move to another location (Bradley and Pletscher 1995). Other nonlethal methods include strobe lights, sirens, and fladry. Fladry is the hanging of colorful plastic flagging or fencing around the perimeter of the farm, and was proven to work for 61 days before wolves dared to cross the border of the farm (Harper et al 2008).

Another nonlethal tactic is managing forest stands to promote game habitat, but not wolf habitat. For example, in extreme northern regions, caribou select for mature conifer stands with lichen present, and avoid roads, while wolves select for mixed and deciduous stands near roads (Courbin et al 2009). By managing forest stands for more mature conifer and less mixed hardwood, managers may provide a safe shelter for caribou species. However this strategy would

require managing an entire expanse of forest specifically for two species of interest, rather than the ecosystem as a whole, and is most likely costly. Another argument for nonlethal measures is that lethal measures decrease wolf populations (even if temporarily) which increase coyote populations (Ripple et al 2013). Coyotes have adverse effects on mammals, birds and reptiles as they are more of an opportunist species than wolves (Ripple et al 2013). Nonlethal control also often receives public support when wolves' perceived threat to game or livestock species is low (Decker et al 2006).

Discussion

Ultimately, the wolf hunt in Michigan is certainly the most cost effective method for wolf management. By selling licenses that aid conservation efforts, the wolf hunt is much less expensive than lethal methods that require a trained professional to exterminate problem wolves. Also if done correctly, the wolf management strategy of allowing a wolf hunting season can be successful in decreasing wolf population in problem areas without damaging entire wolf populations. However, the limits on how many individuals may be taken are incredibly important. Limits should stay conservative, as they are currently (MDNR Wolves in Michigan 2013). The Michigan DNR should take these conservative limits as an opportunity to monitor the effectiveness of the wolf hunt, both in terms of the health of the species and potential changes in stakeholder opinion. The most challenging issue with a legalized wolf hunting season is not its effectiveness on deterring wolves from human property. The most challenging issue is the fact that a wolf hunting season tends to be divisive amongst stakeholders; agriculturalists and sportsmen can be pitted against advocates for wildlife and environmentalists (Way and Bruskotter 2012).

Therefore, a set of undeniable measures should be taken into account to appease the entire spectrum of stakeholders. Wolf specialist David Mech recommends that hunting seasons be delayed until wolf pups are near full size and closing the season before the female wolves give birth (Way and Bruskotter 2012). Mech states that these measures have the potential to increase the public's acceptance of a wolf hunting (Way and Bruskotter 2012). This strategy is effective as it is already done today with other species; hunters can only hunt deer during autumn to early winter, which is not during their breeding season and only of a certain size (Michigan DNR Hunting Season Calendar 2014). Ethically, leaving younger generations unharmed during hunting seasons is one of the key aspects to gaining public acceptance of wolf hunting, and potentially secures wolf populations for future generations. Considering that the wolf breeding season within North America is January through March and females give birth after 63 days of pregnancy, the pups are most likely born from early March to early June (USFWS *Canis Lupis*

2011). Since the Michigan DNR only allows wolf harvest to occur from November 15th to December 31st, the legalized hunting season follows the suggestion that hunting should not occur during the birthing season (MDNR Wolves in Michigan 2014). However, the Wildlife Conservation Order Amendment 14 signed by Governor Rick Snyder, which created the Michigan wolf hunting season, makes no mention of the appropriate size or age for the take of wolves (MDNR WCO Amendment No. 14 2013). It merely states that hunters need to affirm whether the kill is male or female. Age is not a factor. While presumably most people hunting wolves would desire a large specimen, this amendment does not protect young wolves, which need at least a year to become adult size (USFWS *Canis Lupis* 2011).

However, these suggestions alone may not be enough to secure the minds of non-consumptive stakeholders, or those who feel negatively about wolf hunting (Way and Bruskotter 2012). Severity of wolf-human conflicts can dictate whether or not the majority of the public will agree to wolf hunting. In Alaska, the support for wolf hunting as a management technique ranged from 30 to 64 percent depending on the severity of conflict (Way and Bruskotter 2012). The Michigan DNR rationale for wolf hunting is that people living in areas with high density wolf populations are experiencing livestock and dog depredations (MDNR WCO Amendment No. 14 2013). Ethically the rationale is based on the idea that for wolf populations can only survive if wolves can coexist peacefully with humans, and for humans to coexist with wolves humans need the right to a legal harvest, especially in areas with high depredations (MDNR Amendment No. 14 Rationale 2013). The rationale attributes the negative views of people towards wolves living in 'conflict areas' to landowners' inability to use hunting as a way of solving their conflicts. Given this statement, it would then be logical that those who feel negative about wolves would be more accepting of their populations if they were able to harvest them. When thinking about relationships between a hunter and his or her game species, there is typically a respect or even adoration for the subject they hunt. Hunters want to conserve populations of game species for it warrants that they can continue to hunt them for generations to come.

While this may be true, stakeholders that already possess positive associations with wolves may still feel negatively and reject acceptance of wolf harvesting as a management tool. Researched found that "if one of the goals of wolf harvest is to increase public tolerance of wolves, then it is critical that agencies not only quantify the effectiveness of harvest for reducing the major sources of conflict, but also evaluate its effectiveness for increasing tolerance of wolves among various types of stakeholders" (Way and Bruskotter 2012). While people will tolerate lethal control of carnivores where there are many conflicts, the general public is usually more accepting of non-lethal methods as a means of management if they prove effective and humane (Way and Bruskotter 2012). This implies that if wolf harvest is the main strategy for managing wolves, stakeholder participation and human dimensions are more important than ever.

Sadly, the Michigan DNR 'Wolves in Michigan' website offered little information on

how to become involved as stakeholder, and the Wildlife Conservation Order Amendment 14 showed the ways that Michigan DNR reached out and held public meetings for stakeholders previous to the 2013 Wolf Hunt, but nowhere is it mentioned in the amendment how the Michigan DNR will measure or record changing human opinions about the wolf hunt or the species as a whole over time (MDNR WCO Amendment NO. 14 2013). While wildlife biologists and land managers know the importance of regulating wolf populations using lethal control, it is clear there has been a breach in communicating this importance to all stakeholders. There are plenty of interest groups that protest the harvest of wolves, attending public events, creating websites and petitions to stop the wolf hunt, and there are already 225,000 signatures to petition future wolf hunts in Michigan (Barnes 2014). However, it is rare to see anyone spreading information on why wolf harvest can be beneficial. What wildlife biologists and the Michigan Department of Natural Resources staff need to take into consideration is there has been little published research devoted to understanding just how much the public is informed on basic ecological principles, on predator management, and how what the DNR is incredibly important to maintaining healthy and functioning ecosystems.

A common fear among anti- wolf hunt stakeholders the act of history repeating itself; they feel this hunt will inevitably lead to another wolf extirpation in the United States (Keep Michigan Wolves Protected 2013). One of the leading petitioners for the wolf hunt is an organization called Keep Michigan Wolves Protected argues that a major reason for prohibiting wolf hunting is that "People don't eat wolves" (Keep Michigan Wolves Protected 2013). While this is true, people don't typically eat wolves, people also don't typically eat porcupine, opossum, skunk, woodchuck, and feral pigeons, which the Michigan DNR states is legal to hunt year round with a hunting license (MDNR Hunting Season Calendar 2014). There does not seem to be much debate about these species being harvested.

After being delisted from the Endangered Species Act for such little time, it can be concerning to such interest groups that Michigan is already starting to harvest wolves. The Michigan DNR should focus more attention on educating the public on the basics of predator management to ensure that wolves in Michigan will never be listed on the Endangered Species Act again based on human actions. For example, pointing out the strengths of how the wolf hunt is organized could help increase stakeholder approval; such as the fact that Michigan DNR uses adaptive management techniques for wolf populations. Each wolf management area was specifically studied to determine how many wolves could be harvested with the least impact, with varying bag limits in each of the three sites (Figure 2, MDNR Wolves in Michigan 2014). Being situation-specific and impact-dependent, the Michigan wolf hunt management strategy is vastly progressive to one that could have allowed hunters to hunt in a larger range and allowed for more harvest or equal harvest amongst the management areas. These adaptive management techniques used in the Wildlife Conservation Order Amendment 14 in Michigan's Upper Peninsula show that thought, effort and time were invested into the biological success of wolves during the planning process and the amendment was not created solely for economic or political

gain.

Another example of potential stakeholder ignorance is the Federal Aid in Wildlife Restoration Act of 1937. This act allows for a special tax to be placed on hunting and fishing equipment that goes toward wildlife conservation and restoration efforts. This tax along with the money gained from 1,200 wolf hunting licenses sold at 100 dollars per resident and 500 dollars per nonresident will help immensely with other endangered species and wildlife restoration efforts throughout Michigan. In my own personal experience, I did not know of the Federal Aid in Wildlife Restoration Act of 1937 until halfway through my degree in Natural Resource Management. That being said, it is fair to say that stakeholders and members of the public potentially also have little knowledge that wolf harvest or any legal harvest of species can contribute to conservation efforts. Addressing economic support for conservation efforts through wolf harvest should be a main argument for the Michigan DNR when addressing negative views towards wolf harvest.

Conclusion

Ultimately, the current wolf hunt in Michigan's Upper Peninsula is a scientifically sound management technique for addressing wolf-human conflicts. The limits are very conservative and take into consideration the wolf birthing season. Landowners who feel threatened by the presence of wolves within the three wolf hunt management zones are able to exert their right to protect their land, a right that is ingrained in American culture through the ideals of Manifest Destiny. The right to hunt is thought to quell some landowners' hatred for wolves, as they will no longer feel powerless to them. Hunters often foster respect for the species they seek, which can further help human-wolf relations. The economic gain from selling wolf hunting licenses can not only boost Michigan's economy but can also go towards conservation efforts for species that are still listed on the endangered species list. However, if wolf harvest is to be the dominant management strategy in Michigan's Upper Peninsula large efforts towards education must be implemented. Otherwise, year after year, stakeholders that disagree with the wolf hunt will continue to sign petitions against it, and it is possible in the future it will no longer be a legal management strategy. The continuation of ignorance towards effective predator management could eventually lead to hateful and negative views towards the Michigan Department of Natural Resources itself. While it must be advocated that *Canis lupus* is never listed on the Endangered Species list due to human folly again, the Michigan DNR should focus on large scale education efforts to help the public understand the importance of predator management.

Table 1. Wolf populations and hunting regulations across United States (Grand Rapids Press 2013).

State	Wolf Population	License Sold	Limit	Percent of Population
Idaho	683	42,286	185	27%
Montana	625	6300	None	NA
Wyoming	192	2085	26	13.5%
Minnesota	2211	3300	220	9.9%
Wisconsin	809	2510	251	31%
Michigan	658	1200	43	6.5%

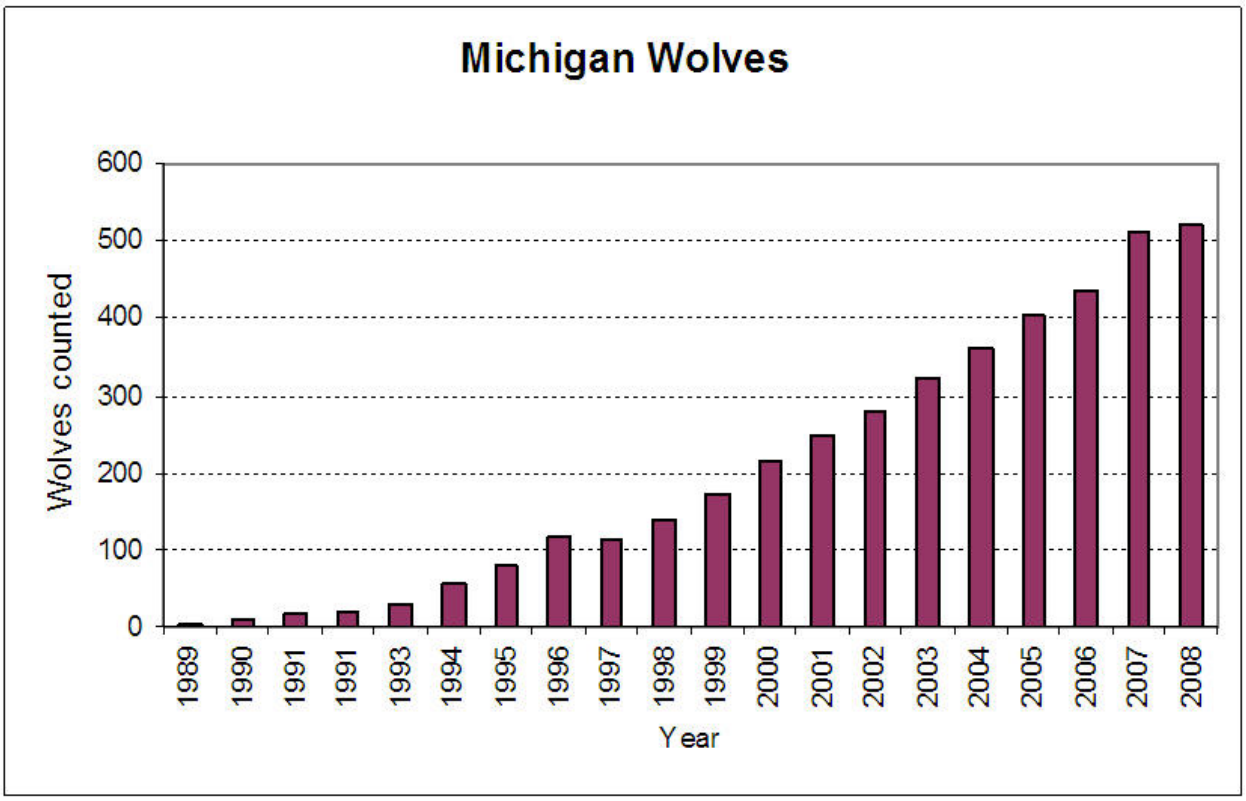

Figure 1. Population fluctuations of gray wolf (*Canis lupis*) in Michigan's Upper Peninsula. (MDNR Wolves in Michigan 2014).

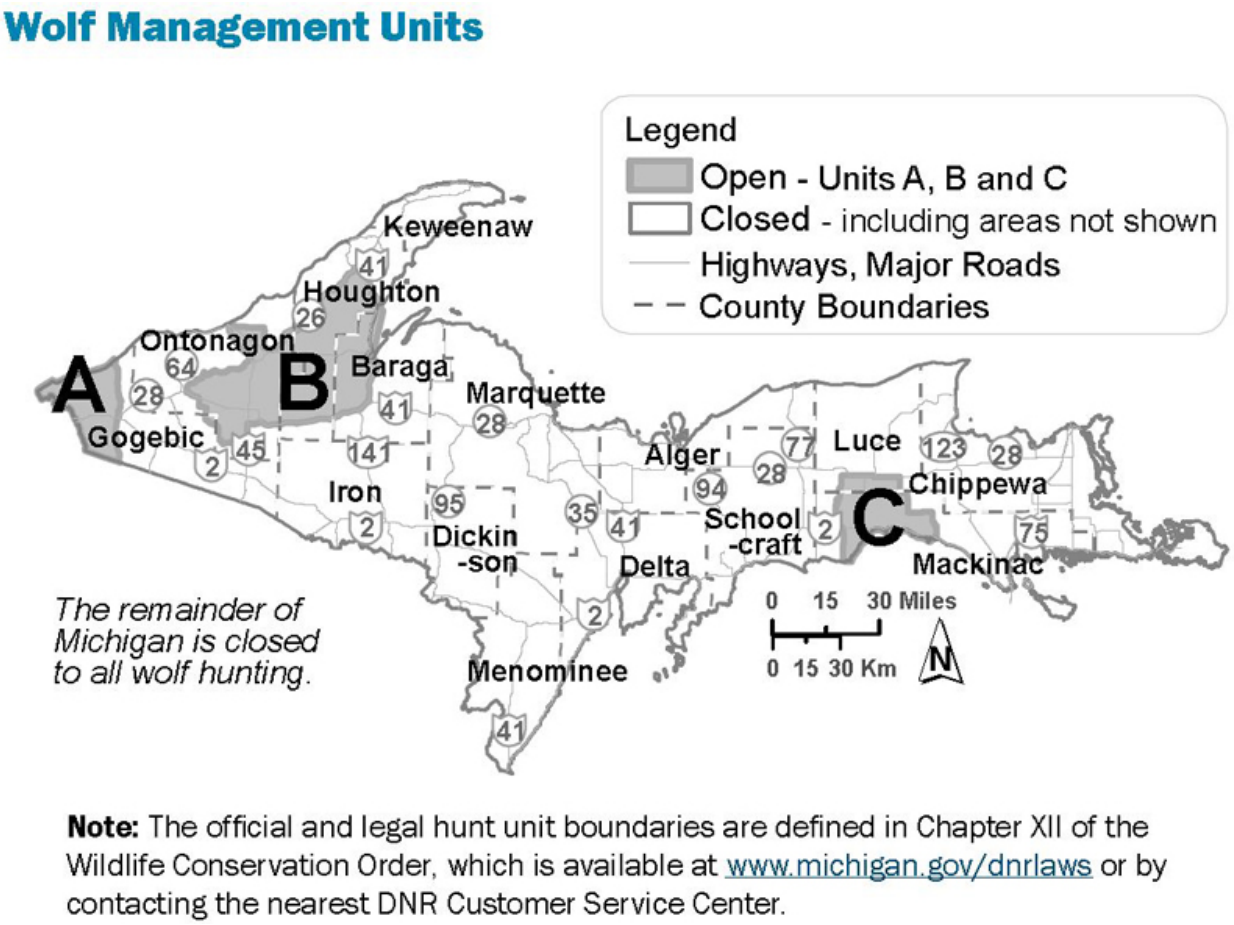

Figure 2. Wolf Management Units in Michigan's Upper Penninsula (MDNR Wolves in Michigan 2014).

Annotated Bibliography

Allen, T. et al. 2013. Hunting in America: Economic Force for Conservation. National Shooting Sports Foundation and Wildlife Agencies.

This source is an informational handout addressing the importance of hunting to conservation efforts, specifically economically.

Barnes, John. 2014. Michigan wolf hunt critics submit signatures for new ballot question; supporters aim to derail vote. Mlive. http://www.mlive.com/news/index.ssf/2014/03/michigan_wolf_hunt_critics_sub.html

This article discusses the number of signatures the current wolf hunt petition has, and how many more it needs. The article further discusses wolf populations in Michigan's Upper Peninsula.

Boertje, R.D., et al. 1996. Increases in Moose, Caribou and Wolves following Wolf Control in Alaska. The Journal of Wildlife Management 60: 474-489.

Short-term studies in Alaska and southeast Yukon show substantial increases in moose, caribou after wolf control. Regulations allowed wolf hunting during 10 Aug- 30 April, with wolf trapping during 1 November to 31 of March. Post control numbers of wolves exceeded pre control numbers.

Bradley E.H., Pletscher D.H. 2005. Assessing Factors Related to Wolf Depredation of Cattle in Fenced Pastures in Montana and Idaho. Wildlife Society Bulletin 33: 1256-1265.

Managing wolf populations is expensive and controversial. Depredating wolves are often killed by USFWS but lethal control is expensive. Other methods include translocation, on-site wolf deterrents. Improved monitoring and management of wolf denning activity is also useful; one can fill a wolf den and they will move to a different location the following year.

Courbin N., et al. 2009. Landscape management for woodland caribou: the protection of forest blocks influences wolf-caribou co-occurrence. Landscape Ecology 24: 1375-1388.

'Wolves as predators' is the main focus of this caribou management plan, rather than the effect of humans on caribou populations in Quebec. Caribou selected for mature conifer forests with lichen, avoided roads, while wolves selected for mixed and deciduous stands and preferred roads. If protected forest blocks included more mature conifer forest and minimized mixed and deciduous stands, they may deter wolf predation.

Crying Wolf: Will the wolf hunt help us? November 3rd, 2013. The Grand Rapids Press.

Decker, et al. 2006. Situation-Specific "Impact Dependency" as a Determinant of Management Acceptability: Insights from Wolf and Grizzly Bear Management in Alaska. Wildlife Society Bulletin 34:426-432.

The authors used data from a survey of Alaskan residents on managing wolf and grizzly bear predation on moose and caribou to explore two questions. The first question was whether the individual was in opposition of lethal control no matter what the reason or whether the lethal control could be used given an appropriate circumstance. The second question is: do perceived impacts of wildlife on humans make a difference in an individual's expression of support or opposition to lethal actions? The authors found that the support for lethal action was influenced by how much people thought predation would influence their access to moose and caribou (in terms of hunting). Lethal control was less likely to be supported when the impact of predators on moose and caribou was perceived to be low. The authors point out those managers should be aware of how public perception of predatory animals' effects can skew the support or opposition of lethal control.

Gazzola, A., et al. 2008. Livestock damage and wolf presence. Journal of Zoology 274: 261–269.

Depredation of livestock by wolves was investigated in Arezzo Tuscany from 1998 to 2001. Kills were concentrated in mountainous areas. Compensation costs averaged 86863 euros. No farmer requested prevention funding from the Tuscan region. Wolf packs were distributed on 47& of the whole province.

Gray wolf (*Canis lupis*). 2011. United States Fish and Wildlife Service. http://www.fws.gov/midwest/wolf/aboutwolves/wolfbiology.htm

This source is a fact page revolving around the life history of the Gray wolf. Information is related to their previous endangered status, habitat, reproduction, pack formation, and prey preferences.

Harper et al. 2008. Effectiveness of Lethal, Directed Wolf-Depredation Control in Minnesota. Journal of Wildlife Management 72: 778-784.

Addresses wolf depredations on livestock as an economic problem and sought to determine effectiveness of lethal control. Non-lethal methods have not consistently prevented depredations. Farmers who believed their livestock killed by wolves contacted either MNDNR or WS (wildlife services). If it was determined that the livestock was killed by a wolf, WS initiated trapping to catch wolves with foot-hold traps or neck snares. Trapping had to be within .8km of property boundary and usually to 15 days. Fladry is the hanging of plastic flagging on fencing surrounding farms as a barrier to wolf depredations and kept wolves out for 61 days before they crossed the barrier and killed.

Hawthorne, Nathaniel. 1850. *The Scarlett Letter*. Boston: Tickner, Reeds and Fields.

Keep Michigan Wolves Protected. Author Unknown. 2013. http://www.keepwolvesprotected.com/about

This source is a website dedicated to protecting wolves in Michigan from hunting. The website lists various reasons why the wolf hunt should not be permitted in Michigan and how to become involved.

Kellert, et al. 1996. Human Culture and Large Carnivore Conservation in North America. Conservation Biology 10: 977-990.

This paper compares human attitudes toward wolves, grizzly bears, and mountain lions in North America with an emphasis in the Rocky Mountains of both the US and Canada. Wildlife provides many physical, emotional, intellectual, and spiritual benefits essential to human development and wellbeing. Killing wolves attested to one's belief in community and God as they had little value and were threats to livestock and humans.

Michigan Department of Natural Resources 2014-2015 Hunting Calendar. 2014. https://www.michigan.gov/dnr/0,4570,7-153-10363-312005--,00.html

This source is from the MDNR website and is composed of a list of hunting dates for various species.

Michigan Department of Natural Resources. Email Correspondence with David Mech on Proposed Regulations. Date Unknown. Wolf Related Literature. http://www.michigan.gov/dnr/0,4570,7-153- 10370_12145_12205_63607_63608-301023--,00.html

This source is an email sent from David Mech, a wolf biologist, to a staff member of the Michigan DNR concerning the proposed wolf hunt.

Michigan Department of Natural Resources. 2013. Rationale and Basis for Natural Resources Commission for its Approval and Adoption of Wildlife Conservation Order Amendments 13 and 14 of 2013.

This is a source that describes the rationale for the adoption and approval of the wolf hunt.

Michigan Department of Natural Resources. 2013. Wildlife Conservation Order Amendment Number 14.

This source is the amendment that put the wolf hunt into legislation.

Michigan Department of Natural Resources. 2014. Wolves in Michigan. http://www.michigan.gov/dnr/0,1607,7-153-10370_12145_12205-32569--,00.html

This source is a website containing many links and information concerning the Michigan wolf hunt and biology of wolves.

Musiani, M., et al. 2005. Seasonality and Reoccurrence of Depredation and Wolf Control in Western North America. Wildlife Society Bulletin 33: 876-887.

This article covers wolves in relation to livestock depredation, and the importance of predicting it in order to prevent it. The range covered in the article spans from Alberta, Idaho, Montana and Wyoming. Wolf attacks occur with a seasonal pattern that reflects calving patterns, grazing practices, and seasonal variation of energy requirements of wolves.

Ripple, W.J. et al. 2013. Widespread mesopredator effects after wolf extirpation. Biological Conservation 160:70-79.

The article shows that there is a link between the ecological extinction of wolves in the American west and the expansion in distribution, increased abundance, and inflated ecological influences of coyotes. Coyotes affect faunal elements including mammals, birds, reptiles and invasive species in a negative way. More studies should be conducted to compare exploited and unexploited populations and evaluate the influence of anthropogenic food subsidies on coyote densities.

Smith, D. et al. 2003. Yellowstone after Wolves. BioScience 53: 330-340.

This article covers the ecosystem of Yellowstone National Park with wolf restoration, and looks at possible ecological implications in comparison with the natural science experiment that is Isle Royale. The article looks at the effects wolves will have on forest growth and compositions as well as mesocarnivore assemblages. Long term comprehensive ecological research is essential to the management team of Yellowstone.

Treves, A. and J.T. Bruskotter. 2011. Gray Wolf Conservation at a Crossroads. Bioscience 61: 584-585.

This article discusses the importance of stakeholder views on the hunting and other management practices of wolves.

Valkenburg P. et al. 2004. Calf Mortality and Population Growth in the Delta Herd after Wolf Control. Wildlife Society Bulletin 32: 746-756.

This study tries to figure out why calf survival did not increase after a removal of 60% of the autumn 1993 wolf population in the Delta caribou herd in Alaska. After the removal, wolves still killed 25% of 166 radio collared calves from 1995-1997. Low calf: cow ratios in the Delta Caribou herd were attributes to other predators (grizzlies), temporal natality rates and nutritional conditions declined during the five years before wolf control.

Way, J. G. and J.T. Bruskotter. (2012), Additional considerations for gray wolf management after their removal from Endangered Species Act protections. The Journal of Wildlife Management, 76: 457–461.

This article is a review of options regarding regulated public hunting of gray wolves when state regain control of wolf management. The conclusion is that the use of lethal management should focus on areas of conflict and less in wilderness areas, especially in national parks. The authors feel that more work with human dimensions research is

needed, preventative measures to protect livestock and pets, and selective use of sport hunting in areas of wolf impacts.