Factors Limiting Deer Abundance in the Upper Peninsula

Executive Summary:

In the Upper Peninsula of Michigan, there are numerous factors that may act singularly or in combination to influence deer abundance. For instance, if food availability was greatly reduced, especially during critical times, or habitat that is essential for survival (such as deer yards) was reduced to below critical levels, it could have a drastic impact on deer populations. Likewise, if predators of deer increased to extreme numbers, deer populations could be kept low. These factors, and environmental factors can interact and can vary over space (across the Upper Peninsula) and time and can be complex to understand. Some of these factors have a greater impact on deer populations and thus are more important than others. In addition, some of these limiting factors can be managed by state wildlife agencies, while others cannot. We take an in-depth look at the important limiting factors which affect deer abundance in the Upper Peninsula and discuss the complex interactions among predators and prey in various life stages, their environment, abundance, and distribution (Appendix B, page 24). We use buck harvest as an indicator of trends in the deer population. Despite the limitations, buck harvest is the best data source relating to deer numbers that we have in Michigan (Appendix A, page 22). Much of the data in this report came from the Michigan Predatory Prey Research Project which investigated the role that winter weather, predators and habitat have on white-tailed deer survival from 2009-2020. For each graph or figure in the document, there are bullet points explaining the information. When appropriate, data sources are listed in italics at the end of each bullet point.

winters, including multiple back-to-back severe winters with compounding effects have resulted in a reduced buck harvest compared to the high levels in the late 1980’s.

- In the last 11 years there have been six severe winters that have impacted buck harvest. 14
  During this time the wolf population has remained stable, emphasizing that winter weather, has a much greater impact on the deer numbers than wolves.

<u>The role of predation in deer mortality</u>

- In most years, it is the recruitment of fawns that drives deer population growth. The 15-16
  major source of mortality for white-tailed deer fawns less than four months of age across North America is predation. In the Upper Peninsula, coyotes kill more fawns than any other predator, followed by black bears, bobcats, and wolves. Other non-predatory types of mortality, including malnutrition, disease, abandonment, vehicle-collisions, etc. have a greater impact than predation from any specific predator in the Upper Peninsula.

- The abundance of each predator is important in determining how many fawns are kill 16-17
  across the landscape. In the Upper Peninsula, each coyote kills about 1.5 fawns per year, on average. However, coyotes are so numerous that the overall impact from coyotes is the greatest for all predators. Black bears are also effective predators on fawns, killing 1.4 fawns per bear each year. Bears are also abundant and therefore, have a large impact on fawn mortality. Bobcat and wolf populations are much lower, so even though they kill more fawns per year (6.6 per year for each bobcat and 5.6 per year for each wolf), their overall impact on fawn mortality is reduced.

- Typically, adult does have very high survival from year to year and few are killed by 18-19
  predators. In the Upper Peninsula, occasionally very severe winters are substantial enough to cause high adult doe mortality due to malnutrition. In those years, adult doe survival is the most important factor driving deer population growth until the population rebounds. Unlike with young fawns, wolves are the predator with the highest predation on adult does and are responsible for 8.6% of adult doe mortality. However, most of those kills occur when adult does are the most nutritionally stressed with little fat reserves and nearly half of all adult does killed by wolves were malnourished and at a high risk of starvation and winter mortality.

<u>Summary</u>

- Wolf abundance has remained relatively stable in the Upper Peninsula for the last 20-21
  12 years with an estimated 557–695 animals while buck harvest has varied substantially. Predation, winter conditions, and habitat quality all interact to play a role in deer abundance in the Upper Peninsula. Wolves are the least abundant predator with the lowest impact on fawn mortality. Wolves prey upon deer, yet annual adult deer survival is high. Wolves are simply one part of the complex predator-prey relationship and are not a primary limiting factor on deer in the Upper Peninsula. Winter conditions, particularly consecutive severe winters, appear to have the greatest impact on buck harvest. In addition to human sources of deer mortality, the combination of severe winter conditions, loss of winter habitat, and predation impacts (including wolves) may contribute to local changes in deer abundance.

Data limitations of using buck harvest to represent deer abundance

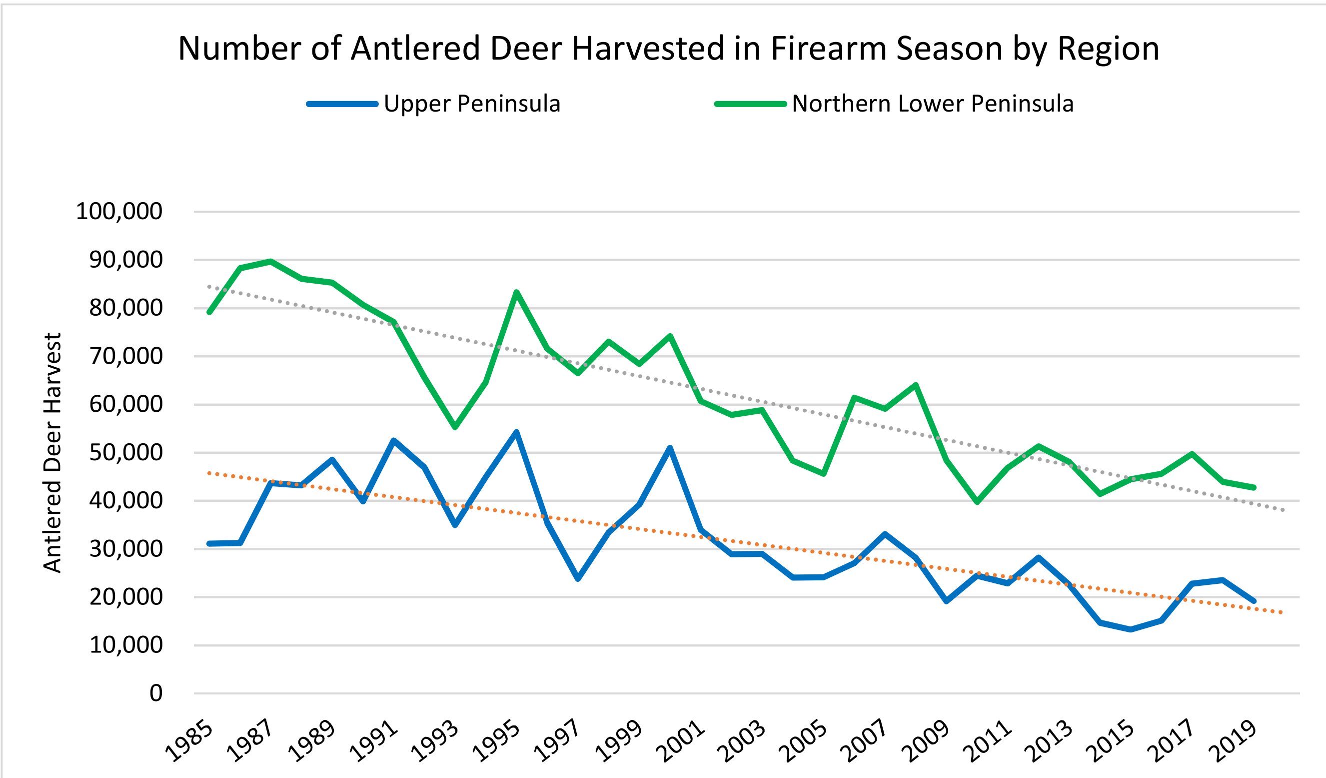
Buck harvest for all seasons (from the Michigan Deer Harvest Survey Reports) will be used to represent trends in the deer population. We recognize that the number of bucks harvested can be influenced by changes in hunter numbers, changes in deer hunting regulations, poor weather conditions during firearm season, and even which day of the week the firearm opener occurs. Hunter effort (the number of hunter days to harvest a buck) has fewer limitations than buck harvest. However, hunter effort data is not available historically which limits the analyses of potential long-term trends.

Ideally, we would have reliable deer abundance estimates for the Upper Peninsula for the analysis outlined in this report. Unfortunately, that data doesn't exist, so we must rely on another source of data as an indicator to represent changing deer numbers. The DNR is currently researching more accurate methods of estimating deer abundance in the Upper Peninsula.

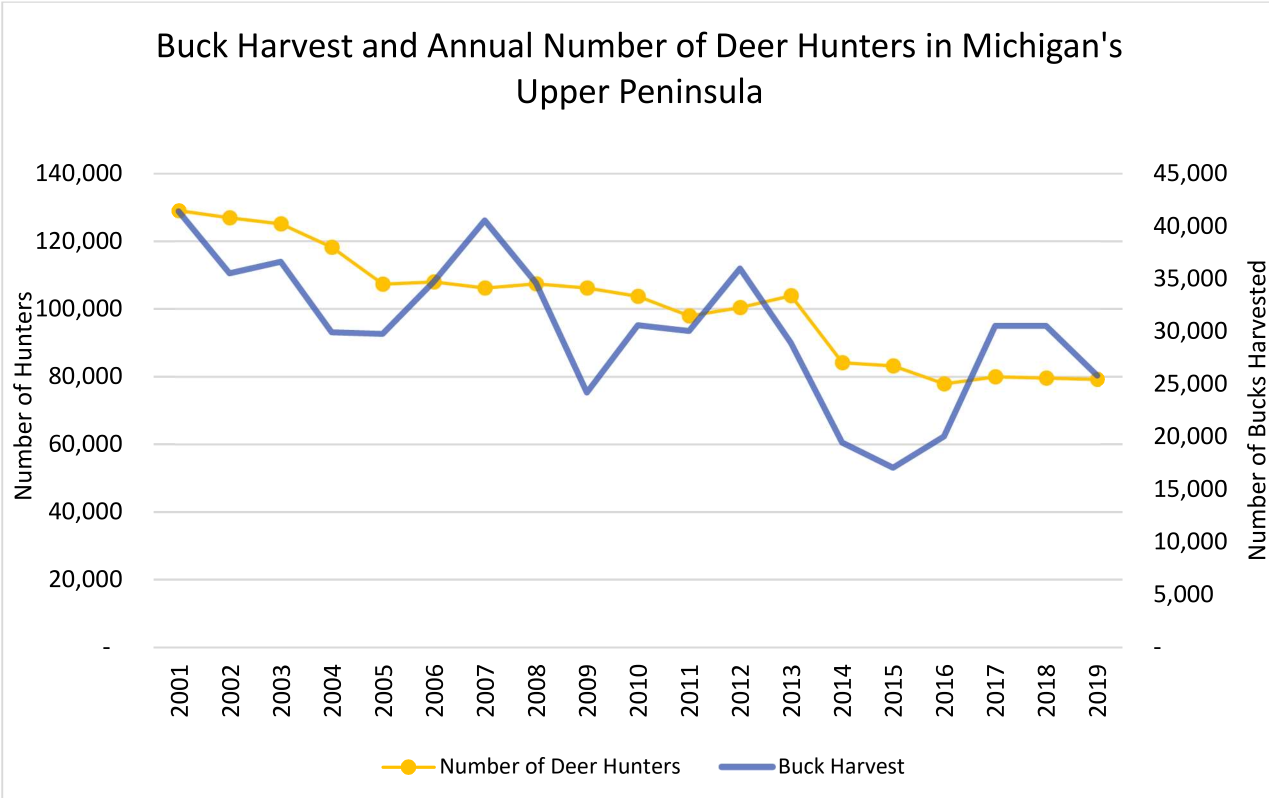
To clarify the decision to use buck harvest to represent deer population changes, we graphed buck harvest and the number of days to harvest a buck with estimates of deer abundance from research which occurred during in the mid-snowfall zone in the western Upper Peninsula. This analysis clearly showed that buck harvest tracks well with deer abundance which suggests it is a good indicator of trends in the deer population, despite some limitations. This data and graphs can be viewed in Appendix A.

Trends in buck harvest across northern parts of the state

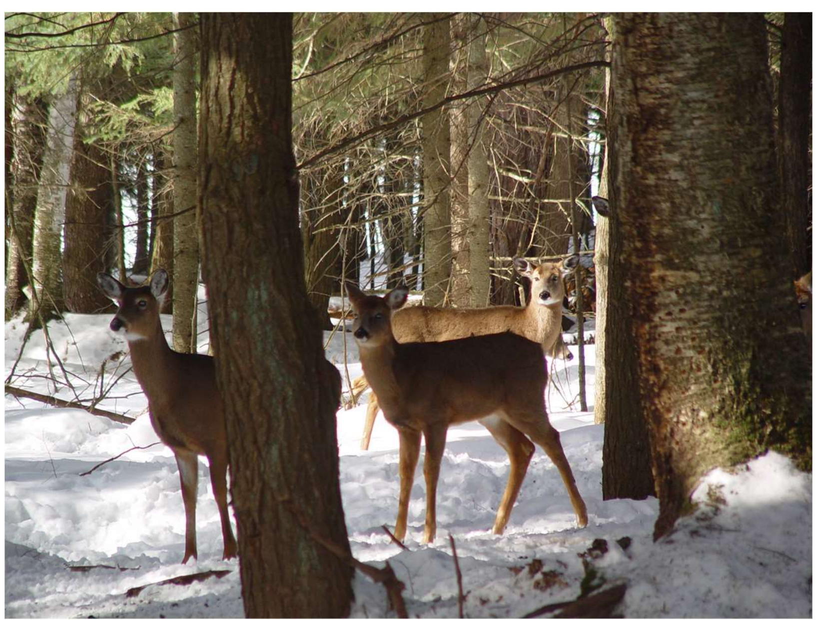
Deer numbers can be influenced by many factors such as predators (wolves, coyotes, black bears, bobcats), environmental conditions (weather), number of deer hunters, deer hunting regulations, levels of timber harvest, and winter habitat. Some of these factors are more important and have a greater impact in limiting deer numbers than others and some are beyond human control (such as weather or geographical location). These factors often interact with one another and the relationships can be complex to understand.

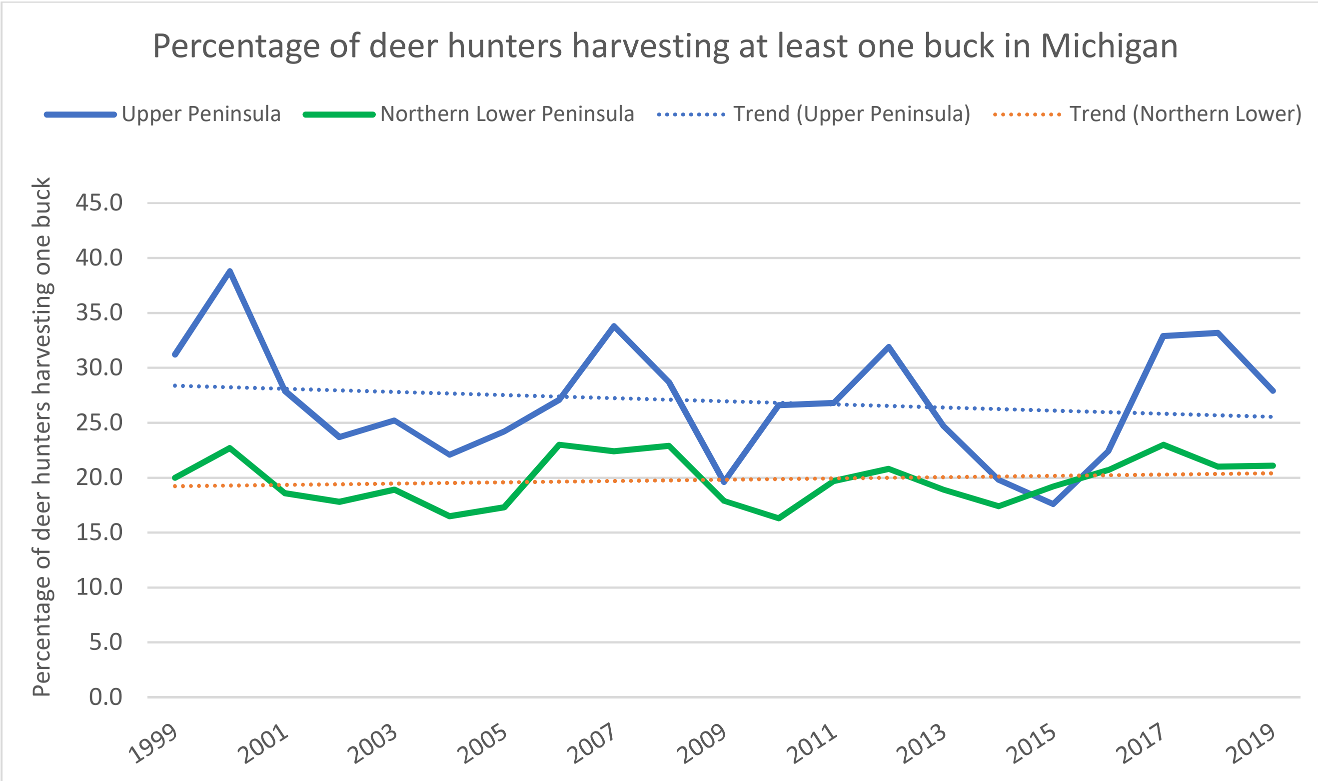


- The graph above shows that buck harvest across the northern portion of state has been in a relatively steep decline during the last 35 years in both the Upper Peninsula (blue line) and Northern Lower Peninsula (green line). The dotted lines represent the trend in the deer population 1985–2019. Wolves began recolonizing the U.P. in 1989 and remained below 100 animals until 1996. By this time, the number of harvested bucks in the Upper Peninsula was already in decline and had been since the late 1980's. Wolves have not colonized the Lower Peninsula, so they do not impact buck harvest in this region. This decline in buck harvest across both peninsulas of Michigan suggests that factors other than wolves alone are playing a more significant role in the changing deer population. *(Michigan Deer Harvest Survey Reports, 1985-2019, T. Reis, B. Frawley)*

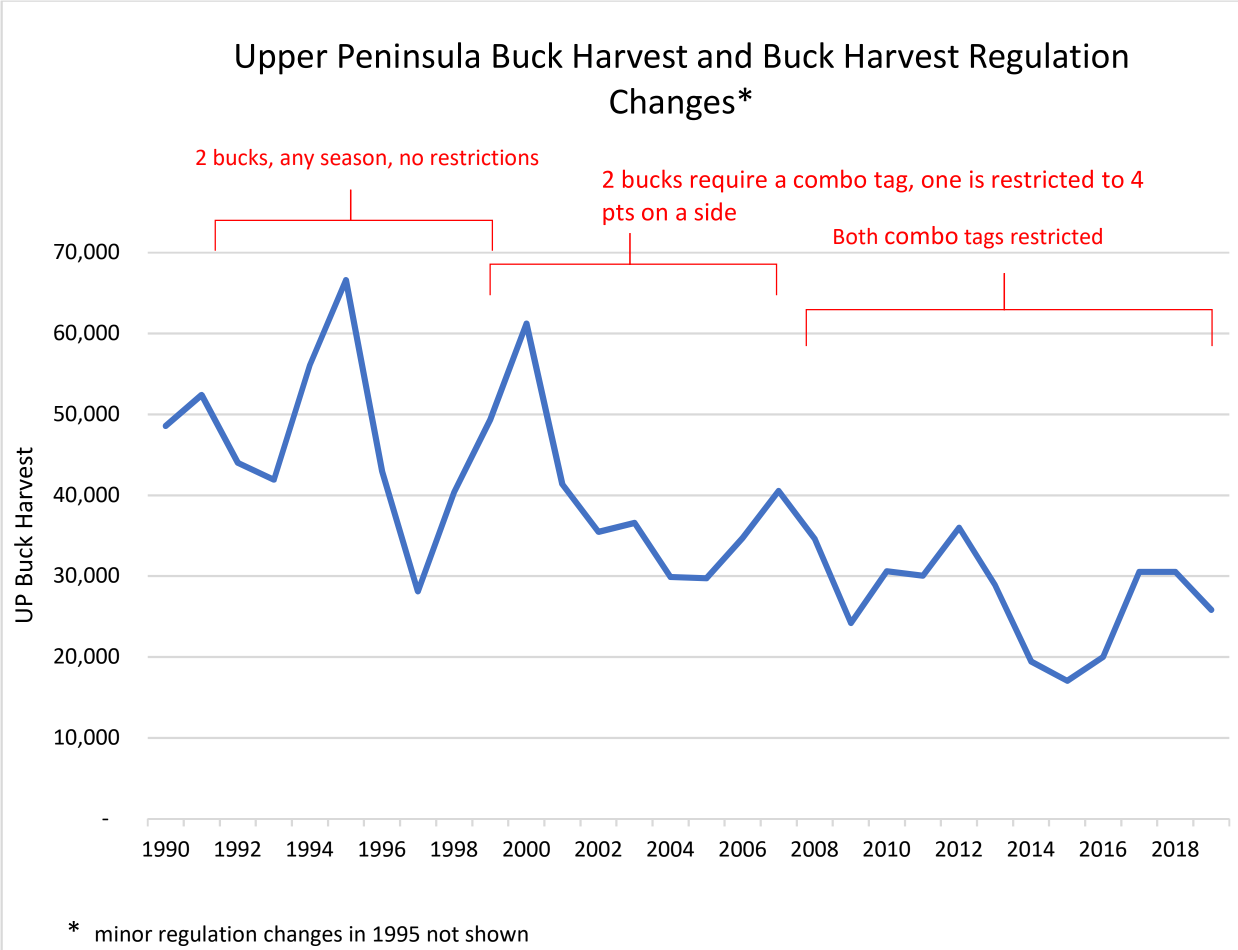


- The yellow line on the above graph shows the number of deer hunters in the Upper Peninsula of Michigan and the blue line represents buck harvest. There has been a 38% reduction in deer hunter numbers over the past approximately 20 years. As hunter numbers have decreased, fewer bucks have been harvested on average. This decline in hunter numbers is one contributing factor to the decline in buck harvest in the Upper Peninsula. *(Michigan Deer Harvest Survey Reports, 2001-2019, B. Frawley)*





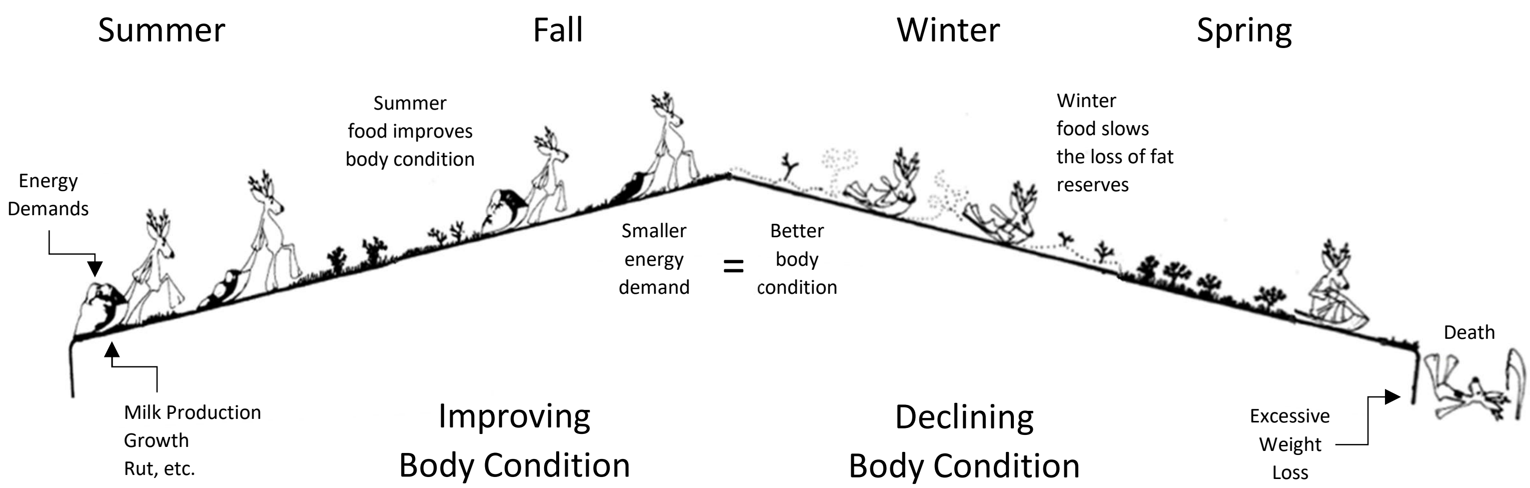
- The percentage of hunters harvesting a buck in the Upper Peninsula (blue line) has varied little in the last 21 years. If predators (or wolves specifically) were impacting the deer population (ultimately the number of bucks available for harvest) one would expect to see at least a moderate downward trend in hunter success. However, the percentage of hunters harvesting at least one antlered deer has remained relatively flat (blue dotted trendline). In almost all years, Upper Peninsula hunters have had a higher percentage of successful hunters than hunters in the Northern Lower Peninsula (green line) even without the presence of wolves. *(Michigan Deer Harvest Survey Reports, 1999-2019, B. Frawley)*



- The blue line on the graph above represents the change in buck harvest in the Upper Peninsula of Michigan. The light blue arrows and text indicate where significant changes to buck harvest regulations have occurred since 1990. More restrictive changes to buck harvest regulations have likely contributed in part to the decline in buck harvest over the past several decades. Beginning in 1991, two bucks could be harvested in any season with no antler point constraints, allowing hunters to choose which bucks to harvest without restrictions. From 1998 through 2007, the harvest of two bucks required a combination tag where one tag was restricted to a buck with at least four points on one side. In 2008, further restrictions were added in the Upper Peninsula, which added antler point restrictions to both buck tags on the combination license. This regulation further restricted hunters who chose to purchase the combination license. As buck harvest restrictions increased, the number of harvested bucks in the Upper Peninsula has declined. *(Michigan Deer Harvest Survey Reports, 1990-2019, T. Reis, B. Frawley)*

Environmental factors such as winter weather and habitat can influence deer populations and the number of bucks available for harvest

The availability of food and shelter aid deer in surviving winter conditions by offsetting energy demands. In most of Upper Michigan, due to deep snow conditions, deer are obligated to migrate each winter to areas containing dense conifer cover (hemlock and cedar are especially important with mixed conifers also having high value) for shelter and food in order to survive. The dense conifer areas, called Deer Wintering Complexes (or deer yards), result in reduced snow depths. These congregated deer pack down trails which make moving around to access food and evade predators easier, saving valuable energy resources. Food availability for deer is always going to be limiting during winter, but the benefits of even small amounts of hemlock and cedar for shelter and leaf litter (as a food source) are critical for deer survival.



Adapted from: Mautz, W.W. 1978. Sledding on a Bushy Hillside: The Fat Cycle in Deer. Wildlife Society Bulletin. 6: 88-90

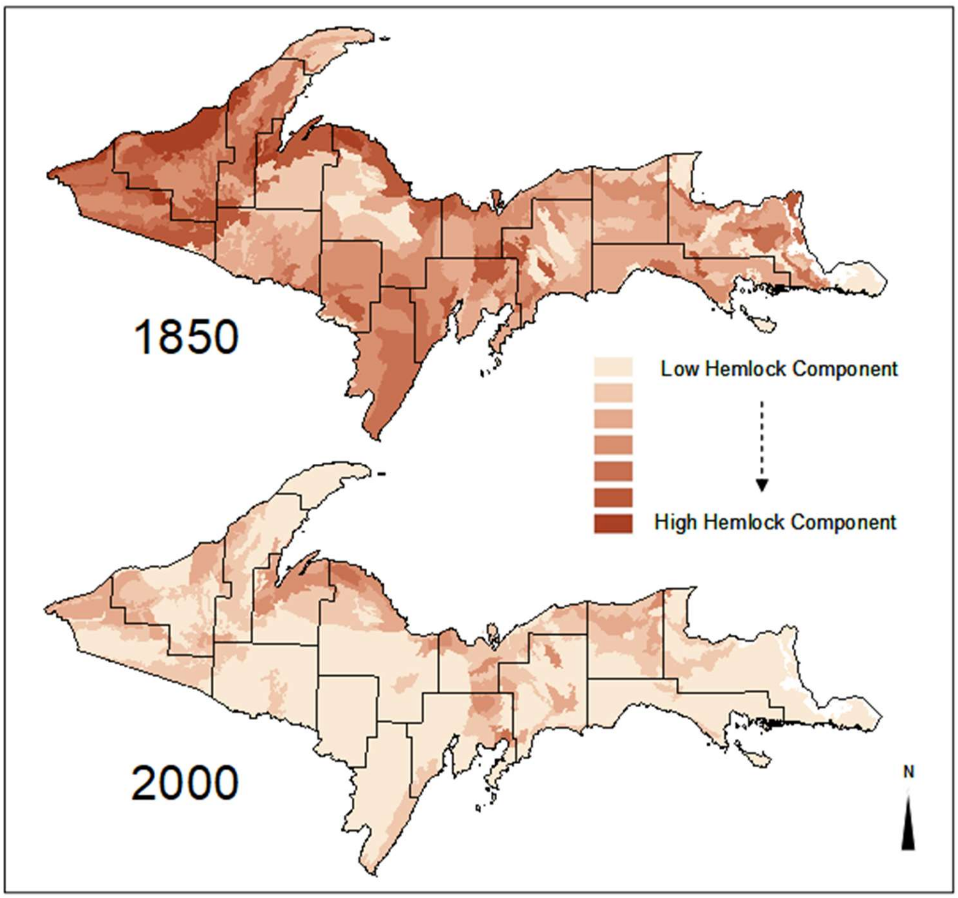
- Deer have evolved to survive the varying energy demands across a calendar year and like hibernating mammals, deer build up fat during the late summer and fall with nutritious forage. They rely on this energy reserve to survive the winter months when food availability is dramatically reduced. The image above relays the story of those changes in energy demands throughout a year.

- Each summer through fall deer trek up the hill building their body fat reserves by eating abundant nutritious forage. Along the way deer experience energy demands such as milk production, body and antler growth, and energy expenditures such as the rut and migration. These demands slow the development of fat reserves which make it harder to survive the upcoming winter. As winter approaches deer reach their peak body weight, arriving at the top of the hill.

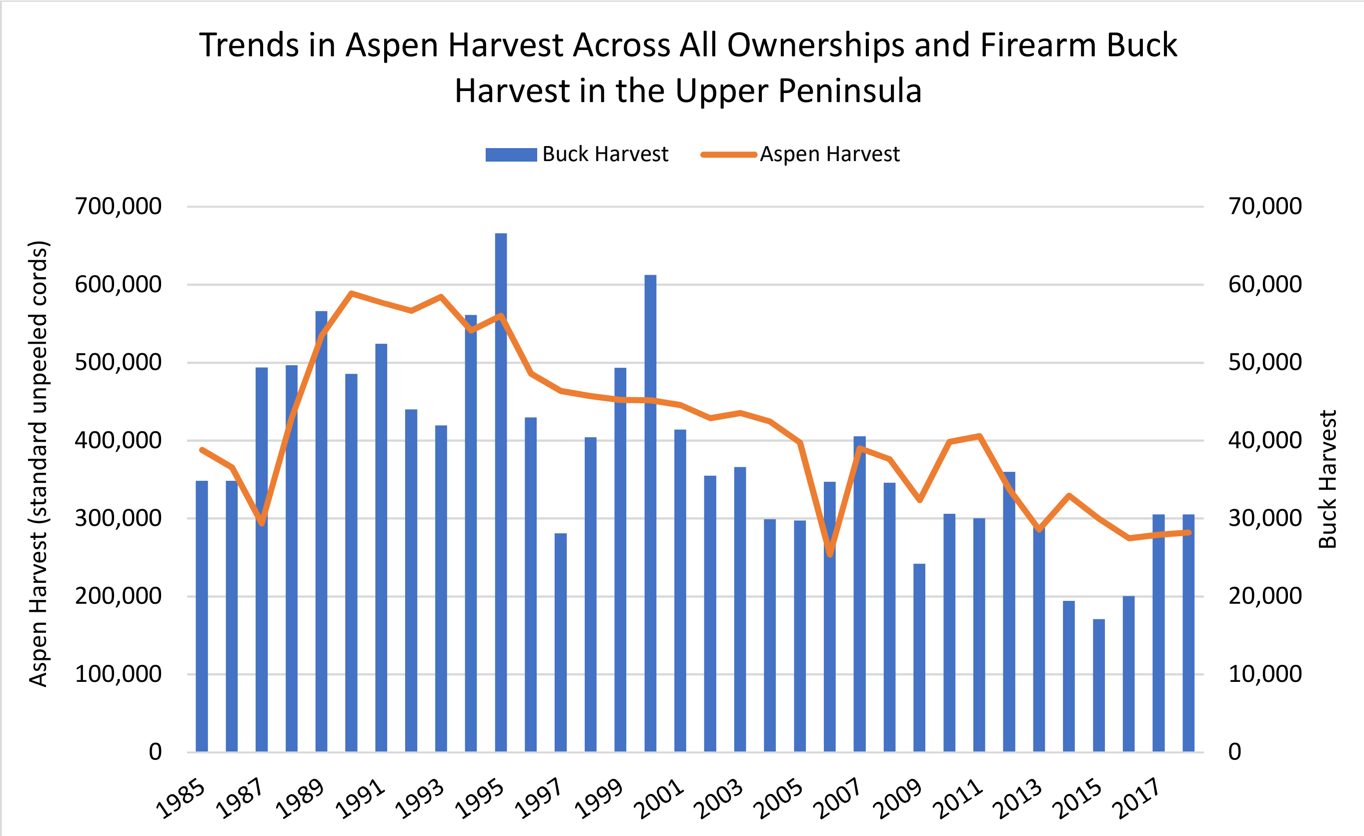
- Throughout the winter, deer utilize body fat reserves and begin the downward slide which continues until spring green up. Increased energy demands such as deep snow, prolonged subzero temperatures, and poor winter habitat can speed up this slide. Eventually, some deer reach the bottom of the hill, having used all their energy reserves, and die of starvation.

- Research in the Upper Peninsula found that the timing of spring snowmelt was twice as important for survival than extremely low temperatures or deep snows throughout the early and mid-winter months. *(J. L. Belant[1], D. E. Beyer, Jr.[2], [1]Global Wildlife Conservation Center, State University of New York College of Environmental Science and Forestry; [2]Michigan Department of Natural Resources)*

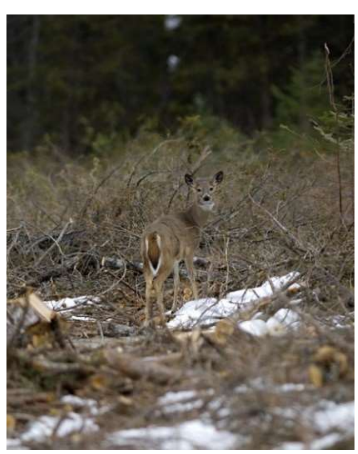
Habitat

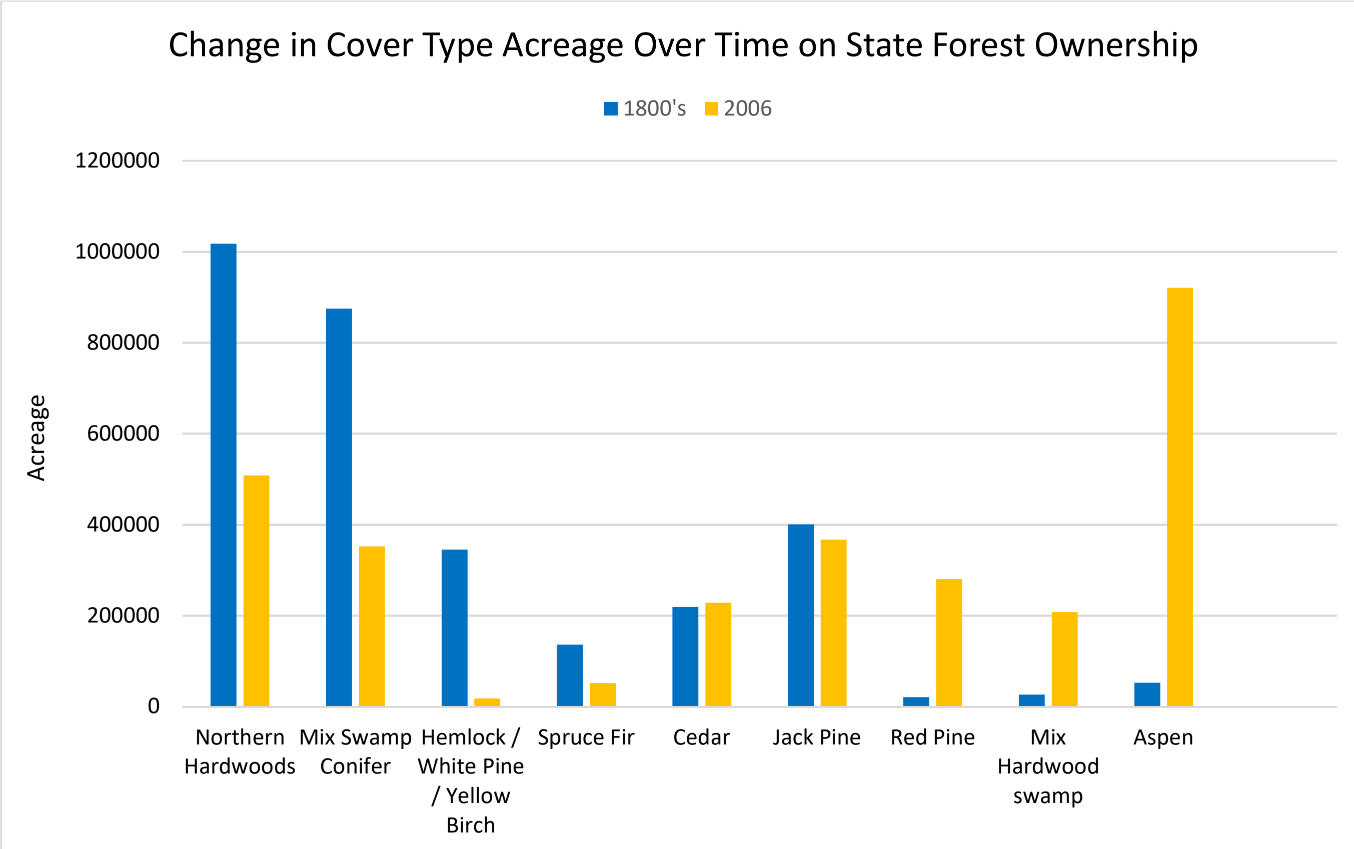


- In the 1850's, hemlock was widespread and the third most common tree species in the Upper Peninsula. Hemlock now comprises less than 1% of forestland, declining over 97% from an area of 4.7 million acres to little more than 100,000 acres, most of which occurs in the Upper Peninsula. *(Albert L. Digital Representations of Tree Species Range Maps from Atlas of United States Trees. USGS November 2006; Mark MacKay. Unpublished Analysis of GLO and FIA data by LTA 2006. Michigan DNR; Mark MacKay. Forest History of the WUP Ecoregional Plan 2006)*



- Aspen, especially young aspen, is a forest type which increases food availability for deer. The more food made available, particularly in fall or during winter harvests near shelter, the more likely deer will survive winter. Aspen forests produce an abundance of forage for deer and can produce more than 10 times the amount of food of coniferous forests. After a timber harvest, the quick-sprouting root system of aspen clones rapidly regenerates providing dense, young growth which provides cover and high-quality browse for deer. The above graph shows the trend in aspen harvest (orange line) and the trend in buck harvest (blue bars). Deer harvest increased at the same time as aspen harvest in the late 1980's and early 1990's. This high level of aspen harvest isn't sustainable because it takes 40 to 50 years to reach harvestable size. As the aspen harvest declined following the mid-1990's, so did the number of bucks harvested. (*United States Department of Agriculture - Pulpwood Production in the North-Central Region, 1976-2008; Michigan Deer Harvest Survey Reports, 1976-2008, T. Reis, B. Frawley).*

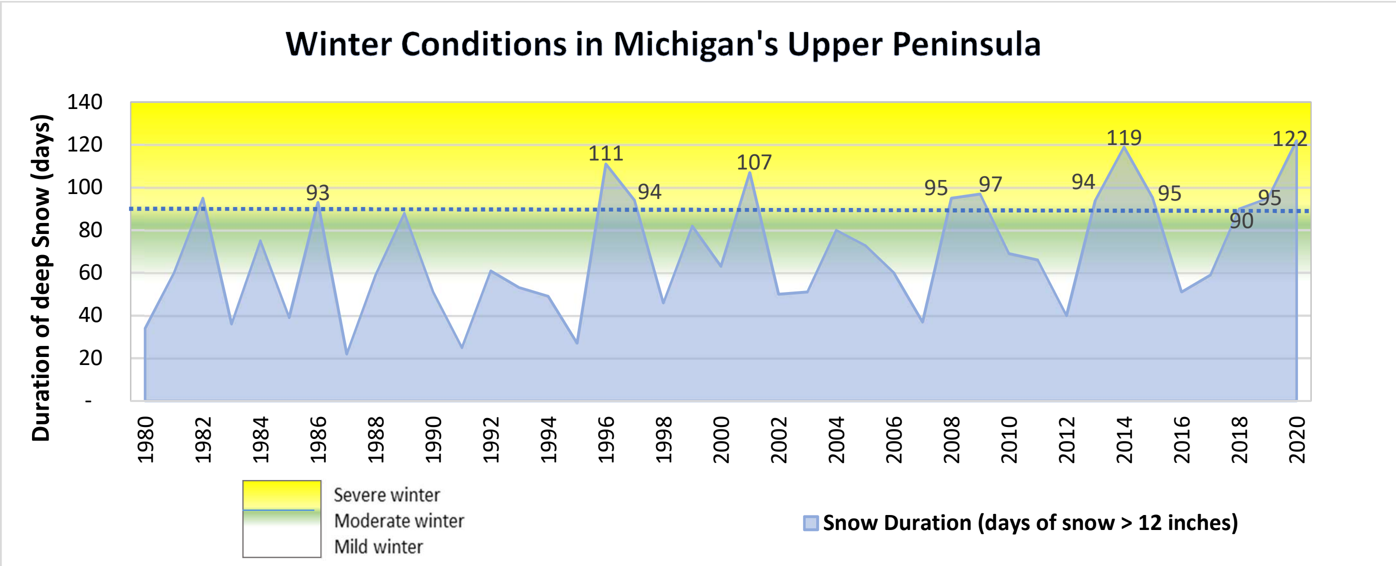




- As mentioned above, hemlock is a critical species that aids in winter survival of deer. Today hemlock comprises just over 17,000 acres (0.4%) of state forest lands and is the least represented of any native tree species in the Upper Peninsula. Impacts to cedar composition in the state forest are more complex because cedar is a component in various conifer types that have undergone substantial changes over time as well. Hemlock and cedar are slow growing species, and preferred winter foods of deer, therefore increasing or improving winter habitat takes a long time. *(Michigan State Forest Management Plan April 10, 2008).*

- The changes in relative forest cover type on state forest ownership on the graph above shows that aspen has increased 16.5 times since the 1800's (nearly 870,000 acres). While this increase provides a tremendous amount of summertime food for deer in the Upper Peninsula, it is the balance of winter shelter and food availability which is critical for deer overwinter survival. *(Michigan State Forest Management Plan April 10, 2008).*

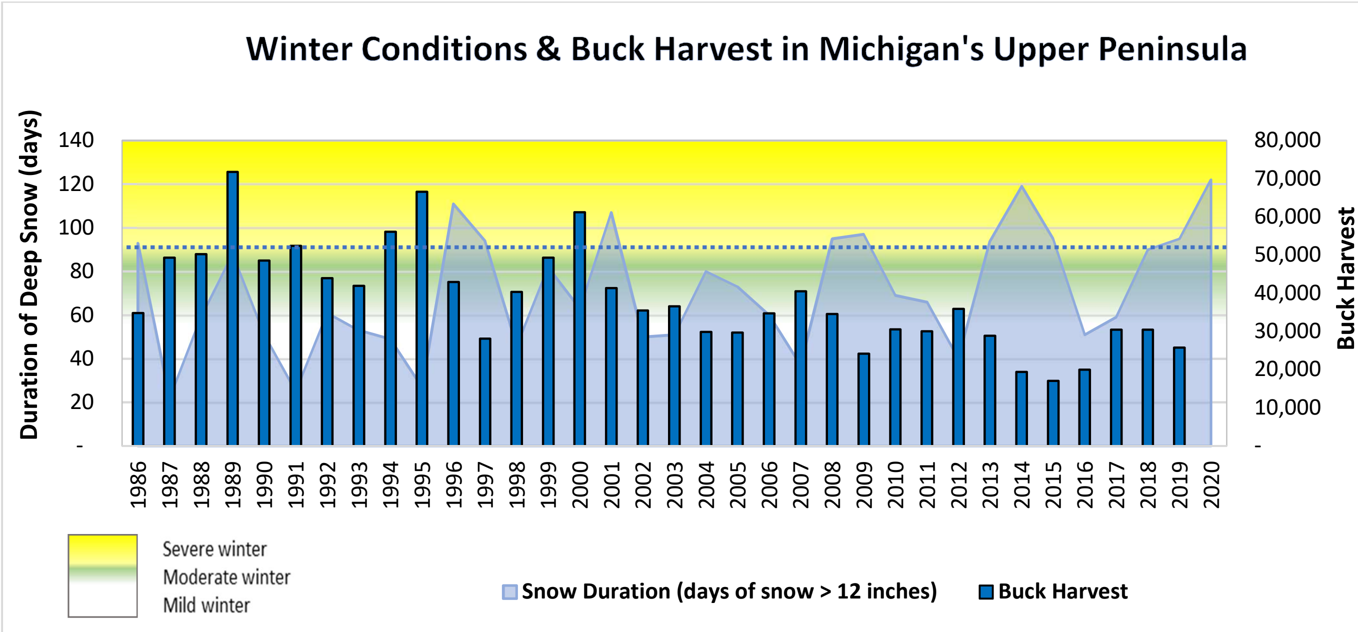
Winter Weather



- Recognizing the annual energy requirements of white-tailed deer, the next set of graphs depicts annual winter weather conditions across the Upper Peninsula. The graph above uses a historical data set showing the number of days in the Upper Peninsula with snow depth greater than 12 inches (in the blue shaded area) from 1980–2020. Snow depths greater than 12 inches start to hinder the movement of deer causing them to use more energy. Winters with peaks in the green shaded areas had fewer days with deep snow and were considered moderate, winters with peaks in the white background were considered mild. Winter severity fluctuates annually; when the duration of deep snow is greater than 90 days it is considered a severe winter for deer. Shaded areas above the horizontal blue dotted line (with the yellow background) indicate the occurrence of severe winters, with greater numerical values (more days) being more severe. The more severe the winter (larger numerical value), the more deer die due to starvation. *(Combined Winter Severity Index Data and NOAA National Weather Service's Snow Data Assimilation System (SNODAS))*

- Between 1980–1995, there were very few severe winters in the Upper Peninsula. The majority (67%) of winters during this time were characterized as mild and only 13% were severe. There were also no consecutive severe winters during this time.

- Since 1996, the Upper Peninsula experienced more than three times as many severe winters (44%), and mild winters occurred less than half as often (32%) than during the 1980's to mid-1990's. This time period also included two instances of back-to-back severe winters (1996 & 1997 and 2008 & 2009) and two instances of three consecutive severe winters (2013-2015 and 2018-2020). As you might expect, consecutive severe winters can have a devastating effect on deer populations, particularly on fawn survival and body condition of surviving deer. The impact of severe winters also influences birth weight of fawns born the following spring. Research has shown there is a strong relationship between low birth weight and poor fawn survival. (*J. L. Belant[1], D. E. Beyer, Jr.[2], [1]Global Wildlife Conservation Center, State University of New York College of Environmental Science and Forestry; [2]Michigan Department of Natural Resources)*



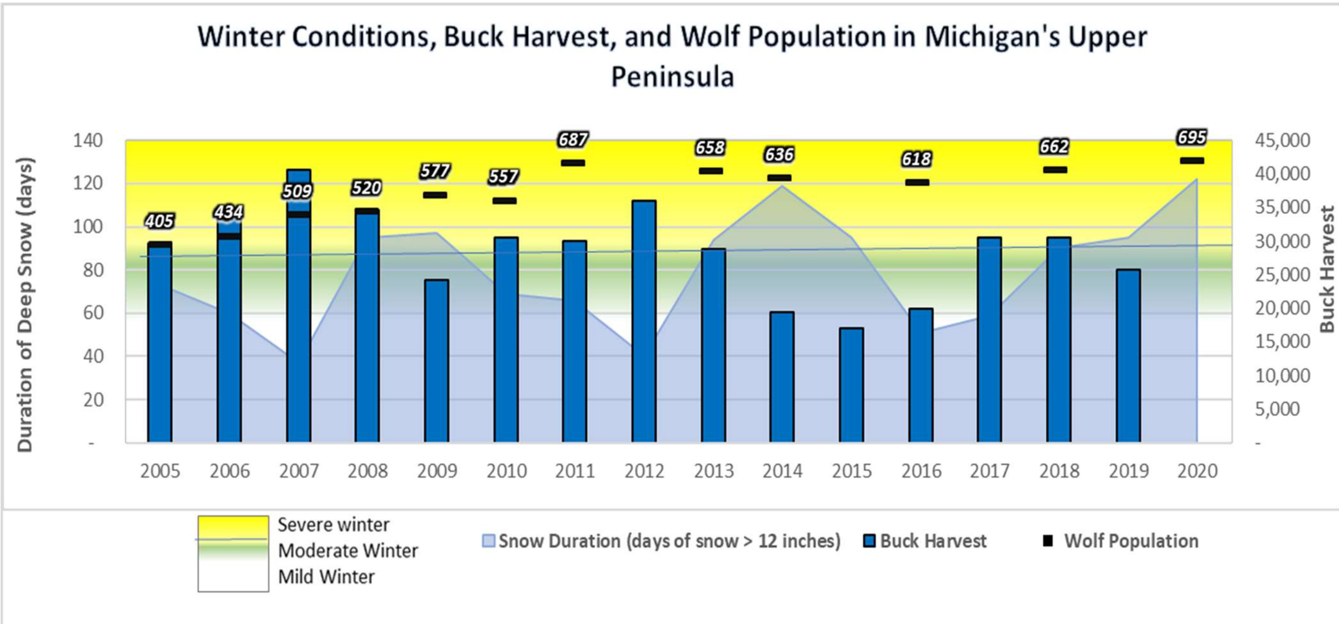
- The graph above depicts the relationship between buck harvest and winter conditions in the Upper Peninsula. As a reminder, winter condition is shown by the blue shaded area and winters above the horizontal blue line are considered severe (greater than 90 days of 12 inches or more of snow on the ground). When duration of snow cover exceeds the horizontal dotted blue line, winter is likely to impact deer populations to some degree. The further the snow duration exceeds the blue line, the larger the negative impact on deer populations. *(Combined Winter Severity Index Data and NOAA National Weather Service's Snow Data Assimilation System (SNODAS); Michigan Deer Harvest Survey Reports, 1990-2019, T. Reis, B. Frawley)*

- Buck harvest was at an all-time high from the late 1980's to mid-1990's and winters were noticeably milder during this time period. Without frequent severe winters and with high levels of aspen harvest (see earlier aspen harvest graph), deer populations and consequently buck harvest, remained high during this time.

- The consecutive severe winters of 1996 and 1997 (the first in a decade) resulted in drastic declines in buck harvest (35% decrease in each year). Moderate and mild winters helped the deer population and buck harvest rebound until the next severe winter of 2001 where again, buck harvest declined (32% in one year). Buck harvest remained stable for a few years and began increasing again with fewer severe winters through 2007.

- Another set of back-to-back severe winters (2008 and 2009) resulted in declines in buck harvest (15% and 30% respectively) and just as harvest levels were recovering, three severe winters in a row (2013-2015) occurred and buck harvest decreased 41% overall. Only two mild winters followed, before another three consecutive winters (2018-2020) occurred.

- The repeated occurrences of consecutive severe winters during the last 24 years have had a pronounced impact on deer populations and their ability to recover to the levels seen in the late 1980's and mid 1990's.



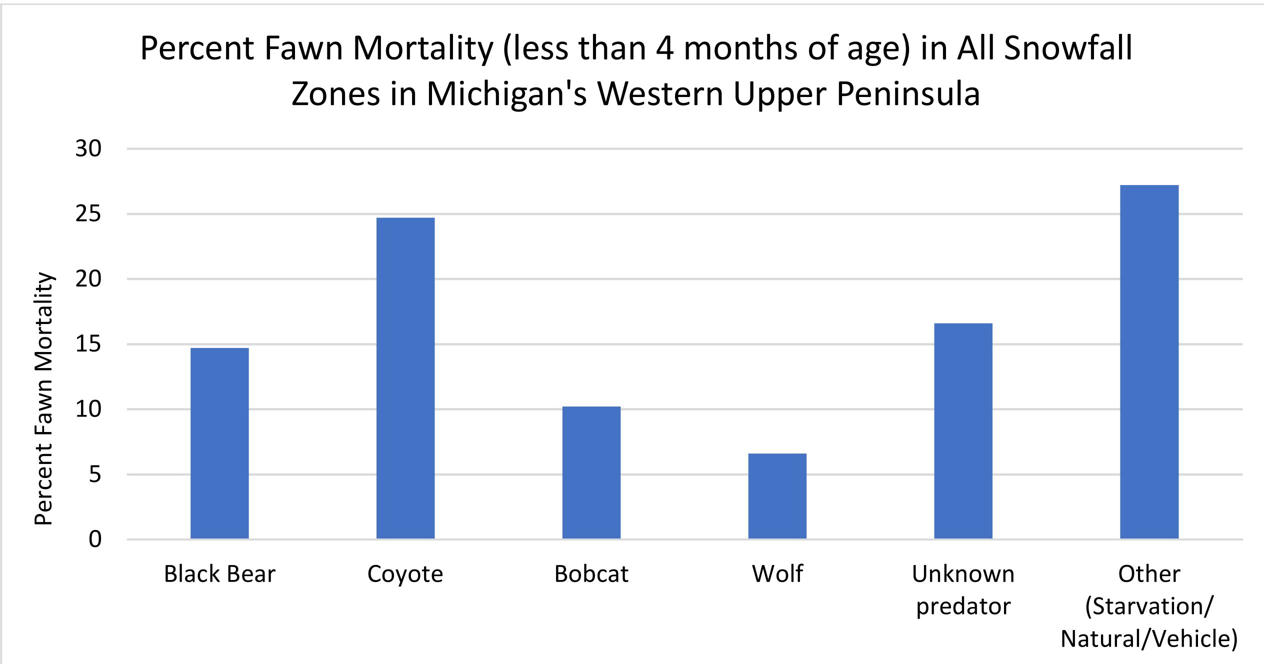
- The graph above shows the relationship between buck harvest, winter weather and the minimum wolf population estimates. Wolves recolonized the Upper Peninsula beginning with very low numbers in 1989 but this graph shows the last 15 years in which wolf numbers have been the highest. The wolf population is shown in black bars with numerical values indicating population estimates. From 2011 to 2020 the wolf population has remained essentially stable between 600-700 animals. The declines in buck harvest (blue bars) during the severe winters of 2013-2015 (blue shaded area with yellow background) and again from 2018-2019 are apparent as are the increases in buck harvest when winter conditions were mild and moderate in 2010-2012 (blue shaded areas with green or white background) and again in 2016-2017. This fluctuation in buck harvest with varying winter severity and stable, yet high wolf numbers suggests that wolf predation is not responsible for the major variations in buck harvest from year to year. *(Combined Winter Severity Index Data and NOAA National Weather Service's Snow Data Assimilation System (SNODAS); Michigan Deer Harvest Survey Reports, 2005-2019, T. Reis, B. Frawley; DNR Minimum Wolf Population Estimates in the Upper Peninsula of Michigan)*

- While buck harvest was lower during the last 15 years compared to the 1980's to mid-1990's, it is important to remember that there were very few severe winters impacting buck harvest from 1980 through 1994. During the last 11 years, however, there have been many more severe winters, (6 out of 11) including multiple consecutive severe winters, that have compounded the impact on deer population recovery.

The role of predation in deer mortality

The above information describing the impact of winter weather, habitat, hunter numbers, and hunting regulations clearly shows that predation is not solely responsible for variation occurring in the Upper Peninsula deer population. Other sources of mortality influence deer populations including, vehicle strikes, legal and illegal harvest, natural mortality (starvation, drowning, disease etc.) and wounding losses from legal harvest. However, predation can be an important source of mortality in the Upper Peninsula, with four main predators which prey upon deer (black bears, coyotes, bobcats and wolves). We recognize that wolves prey directly upon deer, but to understand their role we need to look at predation by all predators and their relative impact on the deer population. In the next set of graphs, figures and text we provide data detailing the impact of predators on deer populations.

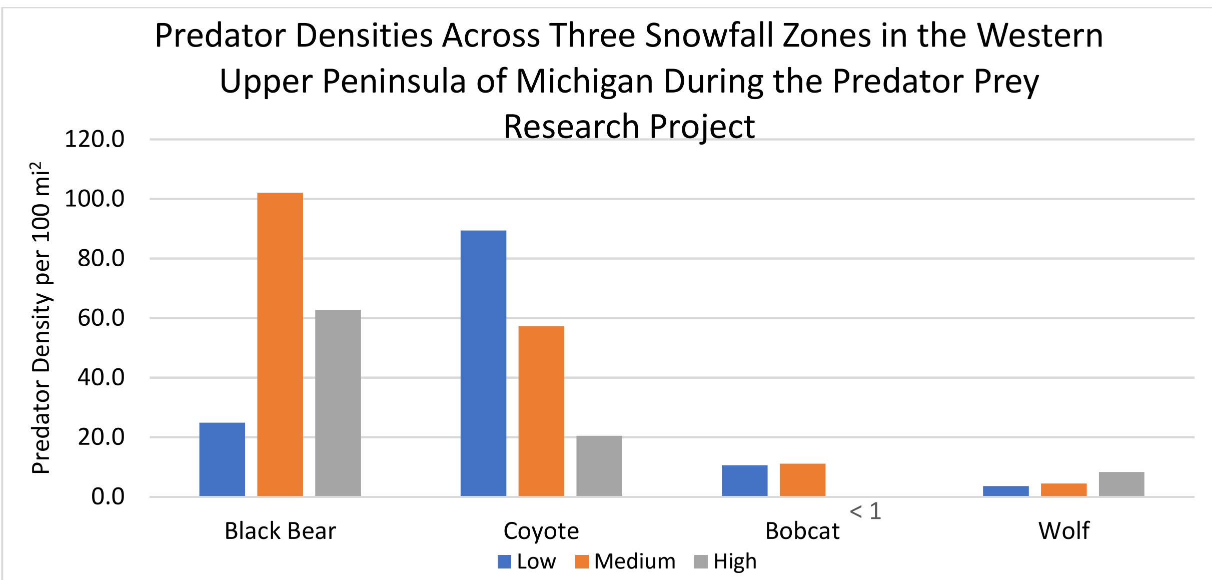
Fawn Mortality



- Generally, for white-tailed deer in North America, the major source of mortality for fawns less than 4 months of age is predation. In the western Upper Peninsula during a long-term study across all three snowfall zones (low, medium, high) it was found that fawns have high mortality rates (53%) in the first 4 months of life. However, deer have evolved to withstand predation and these high rates of fawn mortality. In the graph above the blue bars indicate sources of mortality for fawns up to 4 months old. The results show that wolves are a relatively small source of overall mortality on young white-tailed deer fawns and the lowest source for all predators. Coyotes have the highest overall predation impact on fawns in the Upper Peninsula followed by black bears and bobcats, and wolves. This makes sense when you consider the abundance of coyotes and bears compared to bobcats and wolves (see next graph on predator density). In addition, research in the low- snowfall zone suggests that does with young fawns seem to avoid the core areas of wolf pack territories to obtain abundant food, which puts them in more frequent proximity to coyotes that are also avoiding wolf territories. This can result in higher fawn predation by coyotes but higher adult doe survival, improving their overall lifetime reproductive success. *(Wolf predation rates on radio-collared white-tailed deer within the western Upper Peninsula of Michigan, USA, 2009–2019. Todd M. Kautz[1], N. L. Fowler[1], T. R. Petroelje[1], D. E. Beyer, Jr.[2], J. F. Duquette[2], and J. L. Belant[1]; [1]Global Wildlife Conservation Center, State University of New York College of Environmental Science and Forestry; [2]Michigan Department of Natural Resources; Jared F. Duquette, J.L. Belant, N.J. Svoboda, D.E. Beyer Jr, P.E. Lederle. 2014. Effects of Maternal Nutrition, Resource Use and Multi-Predator Risk on Neonatal White-Tailed Deer Survival. PLoS ONE 9(6))*

- Fawn mortalities assigned to an unknown predator are unlikely to be attributed to bobcats and black bears since they leave uniquely identifiable evidence behind during a predation event (i.e. bobcats cache their kills, and bears leave matted vegetation). Therefore, the unknown category is expected to be predations caused by coyotes or wolves and it is anticipated that the same ratio of identified coyote and wolf kills applies to this category as well. Meaning that approximately 21% of those unidentified predation losses would be attributable to wolves and approximately 79% would be due to coyotes.

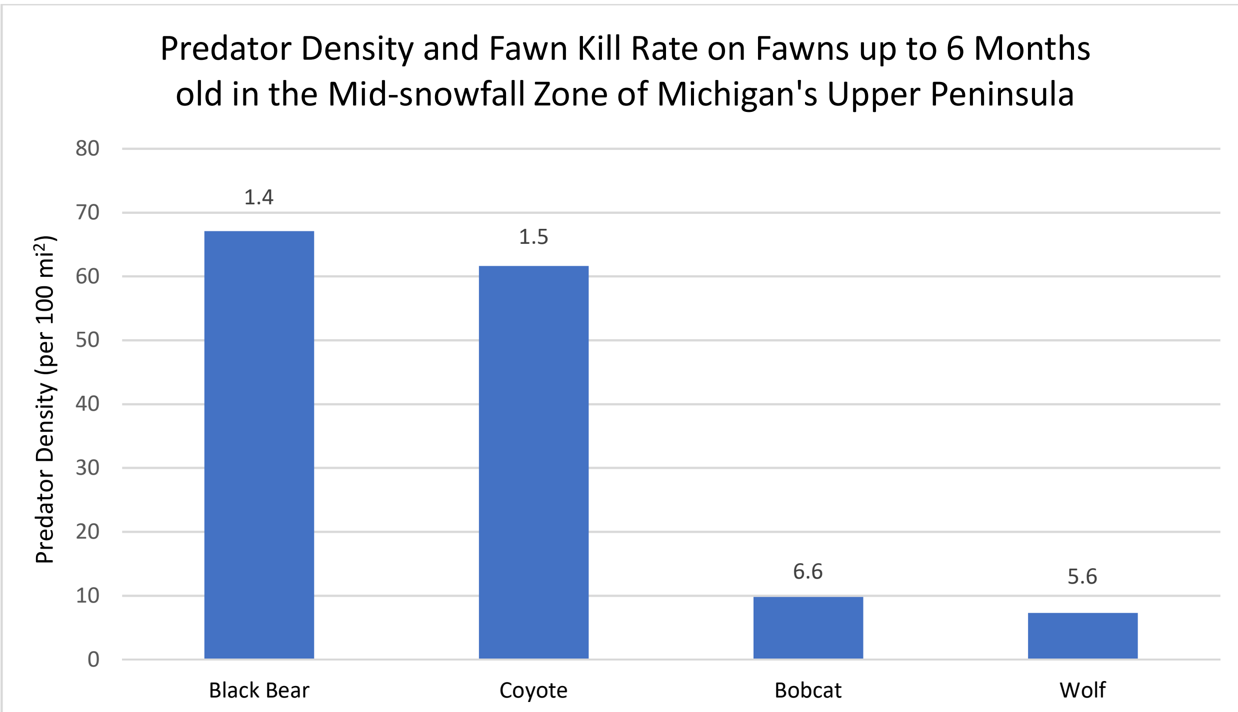
- Other significant sources of fawn mortality include starvation, disease, abandonment, vehicle collision, etc. Despite mortality due to predation and natural causes, nearly half (47%) of the collared 363 fawns survived longer than four months.



- The graph above displays the predator densities (abundance) across three snowfall zones (blue = low, orange = medium, gray = high) in the Western Upper Peninsula. It should be noted that predator densities presented here are the number of predators per 100 square miles (mi^2), in other words an area 10 miles wide by 10 miles long. Black bears and coyotes are substantially more numerous than bobcats and wolves in all three snowfall zones. *(J. L. Belant[1], D. E. Beyer, Jr.[2], [1]Global Wildlife Conservation Center, State University of New York College of Environmental Science and Forestry; [2]Michigan Department of Natural Resources)*

- To put these predator densities in perspective, the number of deer greatly outnumber predators by many orders of magnitude in the low, medium and high snowfall zones respectively (1,891 deer per

100 mi^2, 1,062 deer per 100 mi^2 and 984 deer per 100 mi^2). By comparison, the number of wolves found in the three snowfall zones range from 3.6 wolves per 100 mi^2 to 8.3 wolves per 100 mi^2. Because predator density is significant, considering the home range size of predators is also important for understanding their distribution (Appendix B). *(J. L. Belant[1], D. E. Beyer, Jr.[2], [1]Global Wildlife Conservation Center, State University of New York College of Environmental Science and Forestry; [2]Michigan Department of Natural Resources)*



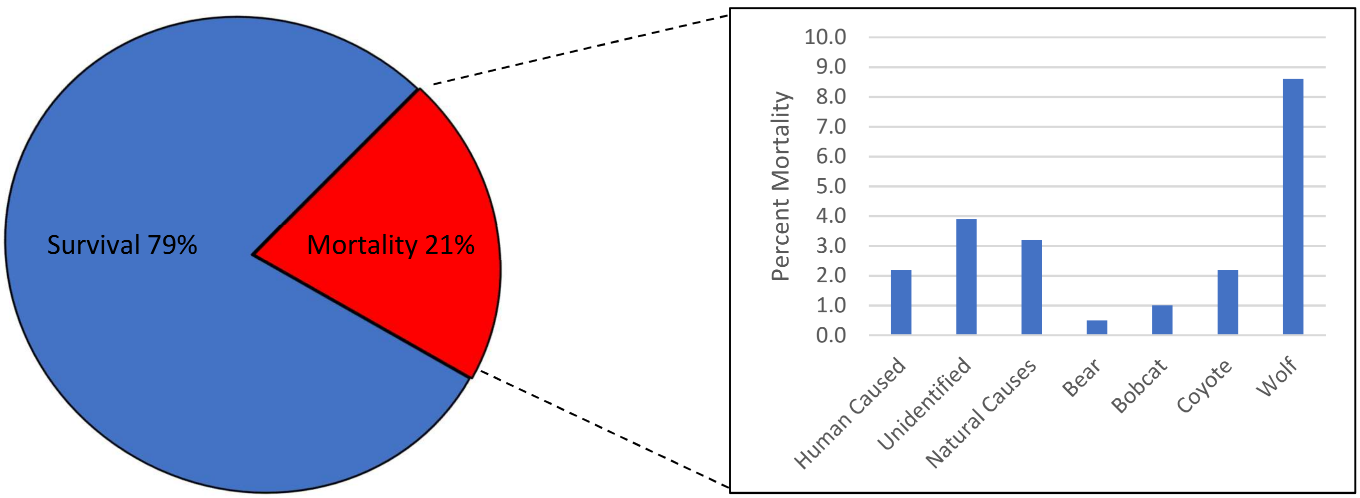
- The graph above shows the relationship between predator abundance (blue bars) and overall mortality rate on fawns up to six months of age in the mid-snowfall zone. As shown in the previous graph, black bears and coyotes are the most abundant predators. Bobcats and wolves are the least abundant. *(J. L. Belant[1], D. E. Beyer, Jr.[2], [1]Global Wildlife Conservation Center, State University of New York College of Environmental Science and Forestry; [2]Michigan Department of Natural Resources)*

- The numbers above the blue bars illustrate the fawn kill rate for a given predator. A common misconception is that wolves are primarily to blame for killing the most fawns, resulting in the greatest impact on future deer populations. Black bears and coyotes both have lower kill rates on young fawns. However, because they are so much more abundant, the overall predation impact is greater. Bobcats and wolves have a higher kill rates on young fawns but because their populations are so much smaller, their overall impact is significantly less than coyotes or bears. Bobcats had the highest kill rate, but because their populations are low, their predation effect on fawns is low. *(J. L. Belant[1], D. E. Beyer, Jr.[2], [1]Global Wildlife Conservation Center, State University of New York College of Environmental Science and Forestry; [2]Michigan Department of Natural Resources)*

Adult Doe Mortality

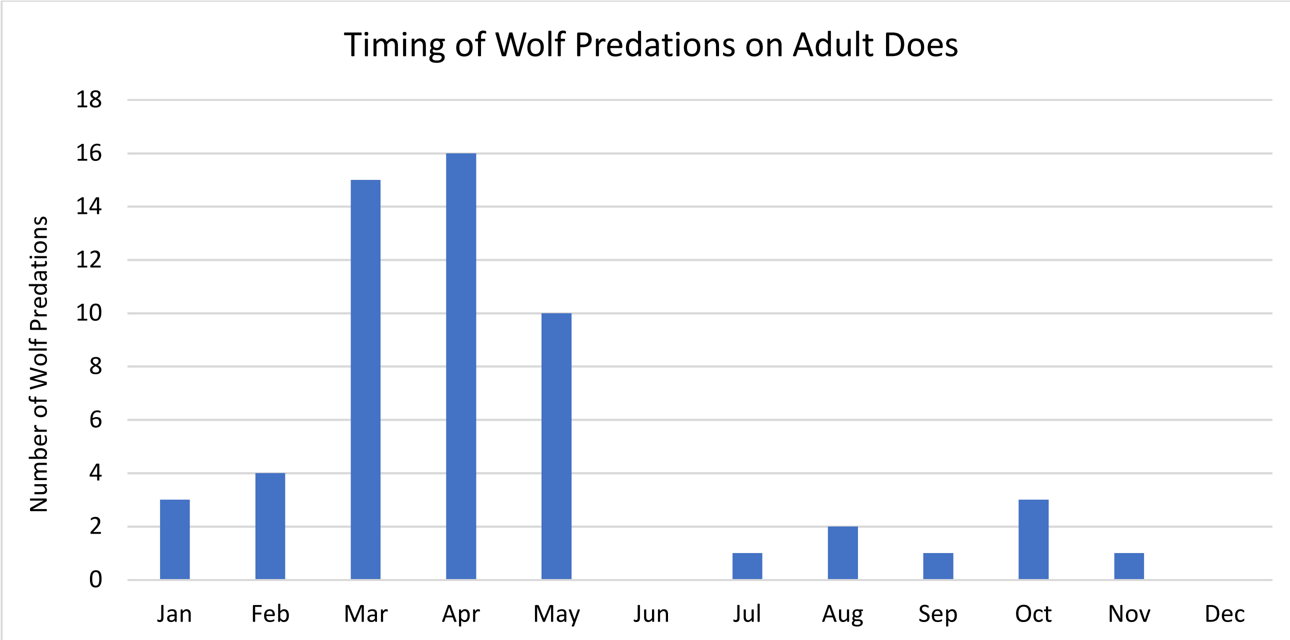
White-tailed deer mortality rates are highest in fawns, yet deer populations have evolved to withstand these high mortality rates. In most years, the proportion of fawns recruited into the population is what drives deer population growth. Meaning that in years with good fawn survival, the deer population would increase more than in years with poor fawn survival. In the Upper Peninsula, occasionally very severe winters are substantial enough to significantly reduce adult doe fat reserves and body condition, which increases rates of starvation and predation. In those instances, adult doe survival is the most important factor driving population growth until the population rebounds. Thus, understanding adult doe mortality is very important. In the next set of graphs, figures and text we provide data on sources of adult doe mortality.

Annual Mortality of Collared Adult Does in the Western Upper Peninsula



Adapted from: Kautz et. al. 2020, Wolf predation rates on radio-collared white-tailed deer within the western Upper Peninsula of Michigan, USA, 2009–2019; Midwest Wolf Stewards Meeting

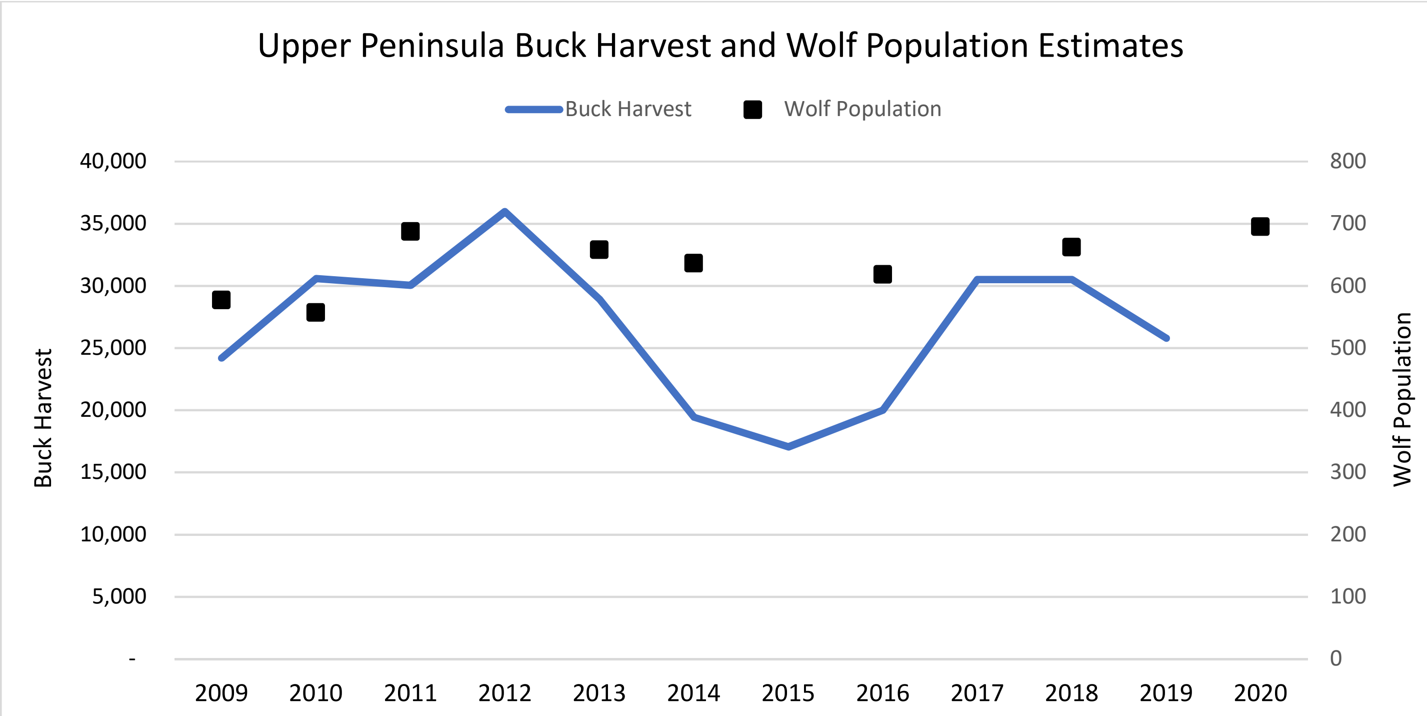
- Adult does typically have consistently high annual survival rates. Research in the western Upper Peninsula (in all snowfall zones) found that annual (yearly) survival of 423 radio-collared adult does averaged 79% from 2009-2019 (as shown in the pie chart on the left). Of the 21% of radio-collared does that died, wolves were the highest cause of mortality, killing 8.6% of adult does as shown in the pie chart on the right. All other predators combined (black bear, bobcat and coyote) were responsible for killing 3.3% of adult does, followed by natural sources (starvation, disease, harvest and vehicle collision etc.) which caused approximately 3.2% of adult does to die. This figure shows that predation is an important source of mortality for adult does, however, annual survival was very high, (nearly 80%) for adult does annually. *(Wolf predation rates on radio-collared white-tailed deer within the western Upper Peninsula of Michigan, USA, 2009–2019. Todd M. Kautz[1], N. L. Fowler[1], T. R. Petroelje[1], D. E. Beyer, Jr.[2], J. F. Duquette[2], and J. L. Belant[1]; [1]Global Wildlife Conservation Center, State University of New York College of Environmental Science and Forestry; [2]Michigan Department of Natural Resources)*



- The graph above takes a closer look at the timing of mortality for adult does killed by wolves (blue bars). Most wolf predations of adult does (68%) occurred in the late winter and spring months when body condition of deer was at its poorest. *(J. L. Belant[1], D. E. Beyer, Jr.[2], [1]Global Wildlife Conservation Center, State University of New York College of Environmental Science and Forestry; [2]Michigan Department of Natural Resources)*

- Further investigation into the body condition of adult does killed by wolves in the high snowfall zone found that nearly half (43%) were in extremely poor nutritional condition and likely would not have survived the winter even if they were not preyed upon. In these instances, predation is considered compensatory (cumulative), meaning the deer would have died due to starvation regardless.

Summary



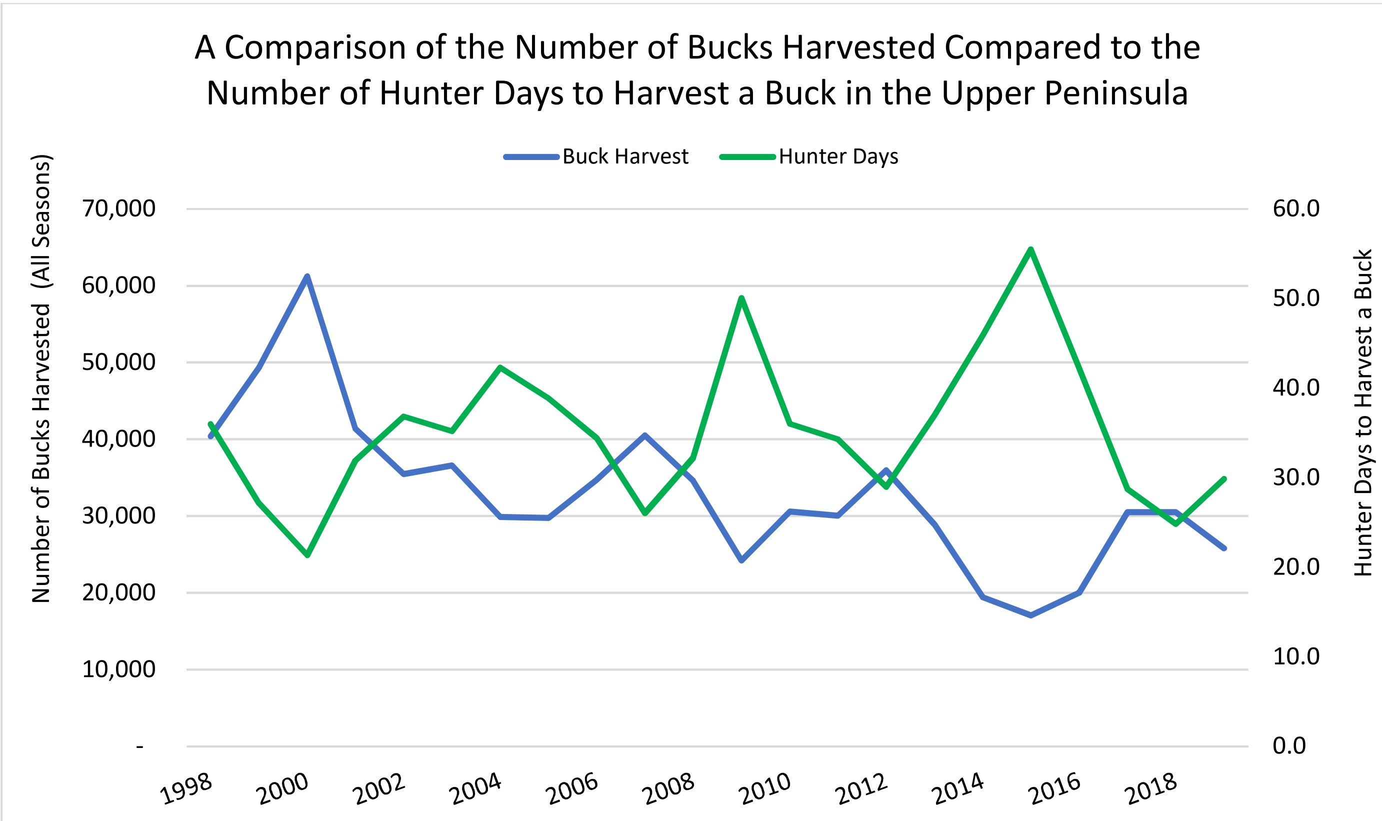
- Wolves, more so than other predators, are often blamed for a lack of deer. The graph above shows relatively stable minimum wolf population estimates for the last 12 years, roughly falling between 600–700 animals. During this same time period, buck harvest in the Upper Peninsula has increased and decreased numerous times, even nearly doubling from 2015 to 2017 (despite a stable wolf population). This data shows that changes in the Upper Peninsula deer population are not primarily driven by wolf population levels or wolf predation. Which is to say when deer numbers decline, it is not because wolf numbers have increased and when deer numbers increase, it is not because wolf numbers have declined. Deer have co-evolved with predators (including wolves) and as such have developed predator avoidance behaviors (selecting habitat outside of wolf core areas) and physical characteristics which increases survival. (*Michigan Deer Harvest Survey Reports, 2009-2019, B. Frawley; DNR Minimum Wolf Population Estimates in the Upper Peninsula of Michigan)*

- The data and graphs on the previous pages have shown that predation from wolves (the least abundant predator) has a relatively small impact on the deer population *compared to severe winters.* This is because they are not the main predator on fawns, and fawn survival is what drives the deer population changes in most years. Wolves do prey on adult deer, especially during late winter, when deer are in relatively poor condition. Instead, buck harvest (and the deer population) fluctuates with winter conditions. More substantial impacts are expressed following consecutive severe winters which have been more frequent in recent decades. Data indicates that winter weather has the greatest influence on changes to deer abundance and quality winter deer habitat increases survival.

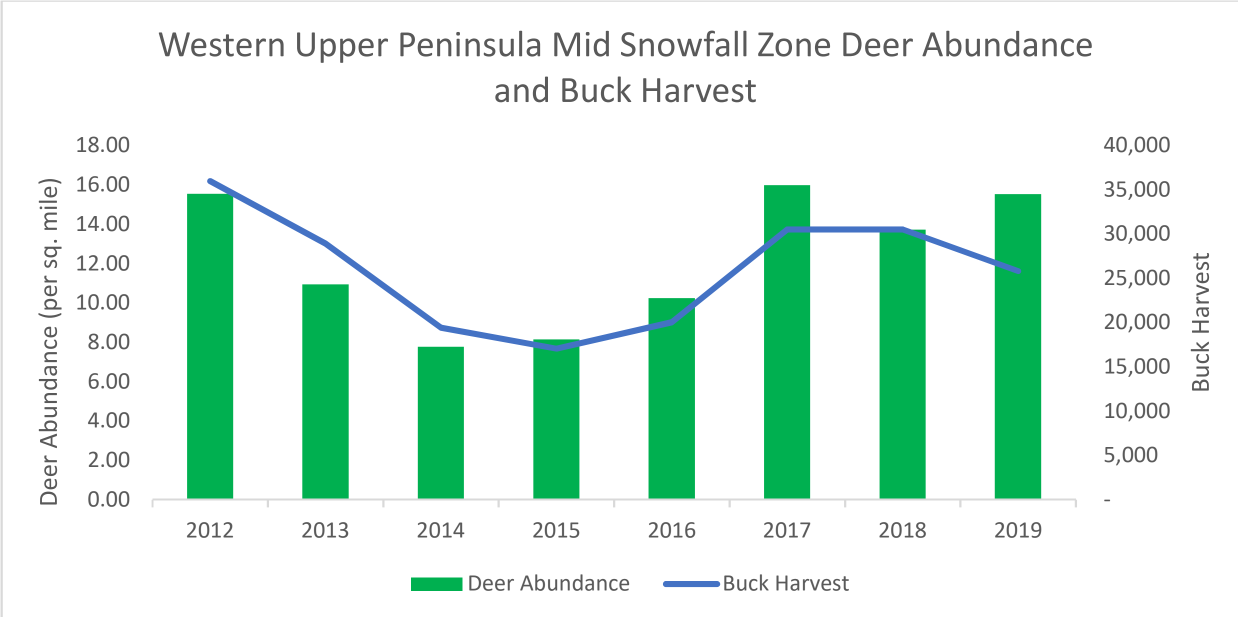
- Wolf predation, winter weather, predation by other species, habitat quality, changes to deer harvest regulations, declining hunter numbers, and changes in timber harvest all play a combined role in changes to the deer population in the Upper Peninsula. Predation from wolves is simply one portion of what impacts our deer herd in the Upper Peninsula, they are not solely responsible for the variation.
- Recently completed predator-prey research in the Upper Peninsula has greatly increased our understanding and knowledge of predator and prey populations and their interactions which has allowed us to work toward improving the way we assess deer abundance and fitness, including relative impacts of predators, weather measures and habitat. *(J. L. Belant[1], D. E. Beyer, Jr.[2], [1]Global Wildlife Conservation Center, State University of New York College of Environmental Science and Forestry; [2]Michigan Department of Natural Resources)*

Appendix A

Data limitations of using buck harvest to represent deer abundance



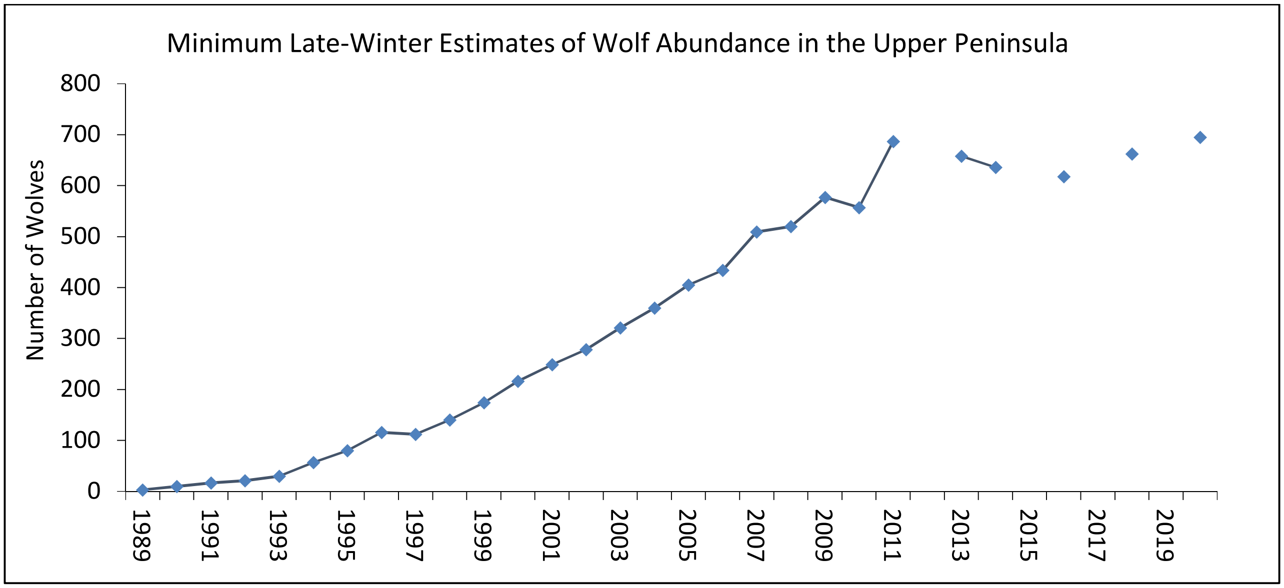
- The blue line represents the buck harvest over the last 22 years while the green line represents the number of hunter days (effort) to harvest a buck in the Upper Peninsula. It should be noted that hunter days does not represent the actual number of days a hunter would need to take a buck. The number of hunter days is calculated by dividing the hunter effort (number of days afield for all hunters) by the total number of bucks harvested each year. Interestingly, as you can see above, hunter days shows the opposite trend of buck harvest. In other words, as buck harvest decreases the number of hunter days to harvest a buck increases. The close relationship between these data sets, supports the use of bucks harvested for our analysis in this report. *(Michigan Deer Harvest Survey Reports, 1998-2019, T. Reis, B. Frawley)*



- Deer abundance estimates were derived during the second phase of the predator prey research project for the mid snowfall zone for a period of eight years. In the graph above, buck harvest (blue line) is very closely associated with deer abundance estimates, suggesting that it can be used as an indicator of deer population trends. This is another indication that, while recognizing the limitations of using buck harvest in the absence of population estimates for our analysis, it is the best representation we have available.

Appendix B

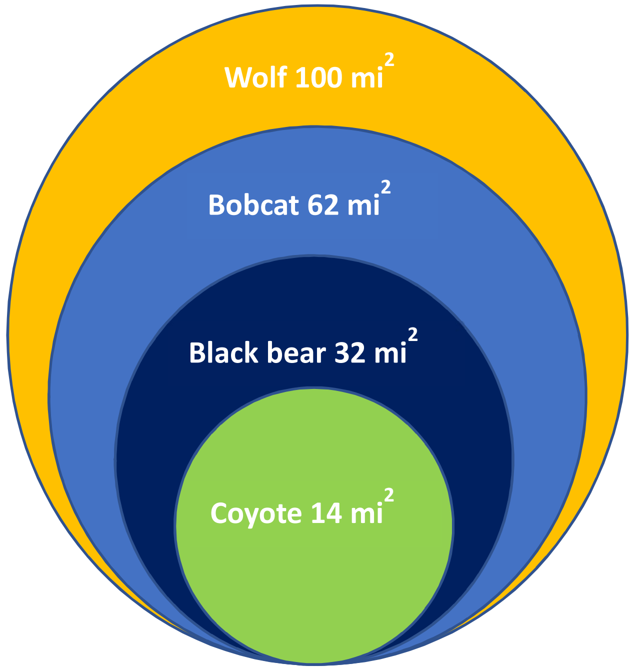
Minimum wolf population estimates and predator territory/home range size



*After 2011, wolves were counted every other year.

- Estimating the abundance of most species of wildlife is challenging and wolves are no exception. Minimum wolf population estimates are conducted during winter months when tracking snow is available. An assessment of the accuracy of wolf population estimates was conducted during a 4-year period from 2001–2005, by Michigan Technological University (MTU). During this study, MTU and the DNR conducted two independent wolf surveys in a 750 mi^2 study area in the western Upper Peninsula. The MTU and DNR estimates were similar, with an average difference of only 4%. These results indicate with confidence that DNR wolf population estimates are an accurate measure of abundance. (*Huntzinger, B. A., J. A. Vucetich, T. D. Drummer, and R. O. Peterson. 2005. Wolf recovery in Michigan, 2002-05 Summary. Michigan Technological University, Houghton, Michigan; Michigan Department of Natural Resources Report, Estimating Wolf Abundance in Michigan, Version 1.0; June 2, 2008)*

- Wolf territories are large, and even at the highest densities reported, wolves are relatively rare compared to other species. The Upper Peninsula is approximately 16,600 mi^2 in size. However, not all of it is suitable wolf habitat (e.g., urban areas, extensive agricultural areas, northern areas with low deer density, and lakes, etc.). Wolves live in packs and have very large territories, averaging approximately 100 mi^2 in the Upper Peninsula. In 2020, we estimated 695 wolves in 143 packs with an average of just under five wolves per pack. An approximation of suitable wolf habitat in the Upper Peninsula was recently estimated at just under 10,000 mi^2. This estimate divided by the average territory size (100 mi^2) would indicate an estimate of 100 packs. This suggests that our recent estimate from 2020 is reasonable (143 packs with an average of 5 wolves per pack is 715 total wolves which is very close to our estimate of 695 wolves). *(Shawn T. O'Neil. 2017. The Spatial Ecology of Gray Wolves in the Upper Peninsula of Michigan, 1994-2013. Doctor Dissertation, Michigan Technological University).*



Average territory/home range size of predator species in Michigan's Upper Peninsula.

- Wolves are built for long distance movement and tend to travel for 10 to 12 hours a day nearly every day and this amount of movement is greater than other predators. Wolves live in packs and have very large territories, averaging 100 mi^2 in the Upper Peninsula. They travel their entire territory frequently, using the easiest routes such as road edges, two-track roads, and trails. Their large territories and high levels of daily movement cause them to leave behind a lot of tracks across a large area which is often confused with representing a high population of wolves. The combination of large territories and their tendency for substantial travel along commonly used roads and trails makes their tracks very noticeable. It is therefore important to note that a single pack of wolves can be detected on roads many miles apart. *(J. L. Belant[1], D. E. Beyer, Jr.[2], [1]Global Wildlife Conservation Center, State University of New York College of Environmental Science and Forestry; [2]Michigan Department of Natural Resources; Mech, L. D. and L. Boitani. 2003a. Wolf social ecology. Wolves: behavior, ecology, and conservation. University of Chicago Press, Chicago, Illinois, USA.)*